World Customs Organization

WORLD TRADE ORGANIZATION

WCO/WTO Study Report on Disruptive Technologies

JUNE 2022

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Acknowledgements

The updated Study Report on Disruptive Technologies (2022) is the result of the collective effort of the World Customs Organization (WCO) and the World Trade Organization (WTO) Secretariats working closely with the Member Customs administrations, private sector representatives and other stakeholders. The Report was prepared by Milena Budimirovic, Özlem Soysanlı, Vyara Filipova and Lesego Mmolai from the WCO and Emmanuelle Ganne and Sheri Rosenow from the WTO. Research assistance was provided by Zakaria Imessaoudene from the WTO.

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The updated Study Report on Disruptive Technologies (2022) is the result of the collective effort of the World Customs Organization (WCO) and the World Trade Organization (WTO) Secretariats working closely with the Member Customs administrations, private sector representatives and other stakeholders.

Foreword by the WCO Secretary General

"Insights on the technologies used to digitalize global supply chains is an indispensable part of the discussions around digitalization of Customs and border management and must be viewed within a broader framework of paperless cross-border trade."

Dr. Kunio Mikuriya
WCO Secretary General

Understanding the need to keep abreast of developments in the field of disruptive technologies and to seek to understand the challenges and opportunities they bring to Customs and border management, we are presenting an updated version of the Study Report on Disruptive Technologies. In the three years since it was first published, it has served as an important source of information. However, considering the numerous pilot projects and progress that has been achieved in the meantime, we believe the time is right to provide an update to ensure that Members, the trading community and other stakeholders are well informed about the latest developments on the ground, that can further support implementation of WCO standards, such as the Revised Kyoto Convention.

I am pleased that the Study Report comes as a result of a fruitful partnership with the World Trade Organization (WTO), with which we have longstanding cooperation in many different fields, and most recently in the field of disruptive technologies. Customs, even though an important international trade stakeholder, is nevertheless only one stakeholder in the global supply chain. Insights on the technologies used to digitalize global supply chains is an indispensable part of the discussions around digitalization of Customs and border management and must be viewed within a broader framework of paperless cross-border trade.

The 2022 Study Report builds on the one published in 2019 with lessons learnt and new experiences gained. In the spirit of Customs-Business partnership, and public-private partnership more broadly, we have provided case studies submitted not only by Customs, but also by the private sector. The time is ripe to consider all options and the overall context before opting for the most suitable solutions.

The WCO has dedicated 2022 to scaling up Customs Digital Transformation by embracing a data culture and building a data ecosystem. I am confident that this Study Report will complement the WCO's extensive efforts in building a data-driven culture in Customs.

Foreword by the WTO Director General

We live in a time of rapid technological change that has the possibility of profoundly altering the conduct of international trade. For many people keeping up to date with the latest technology and fully understanding its implications can be daunting. This report will help illuminate the so-called "disruptive technologies" that are most relevant to border management, as well as assist governments to better understand the challenges and benefits of their use by Customs.

Technologies of the kind referred to in this publication hold enormous potential to aid governments in efficient and effective administration of WTO trade rules. As this publication shows, our Members have found that the use of blockchain and the internet of things can play an instrumental role in implementing the WTO Trade Facilitation Agreement, for example, through improved transparency and inter-agency cooperation, and the use of data mining for more effective risk management. These technologies can also enhance administration of health and safety requirements through better monitoring the movement of perishable goods to detect and avoid spoilage, and they can enable implementation of electronic certification such as e-Phyto certificates in a more efficient, secure and trusted manner. In addition, these technologies can allow Customs and other agencies to capture massive amounts of data that can be used to support the administration of trade rules.

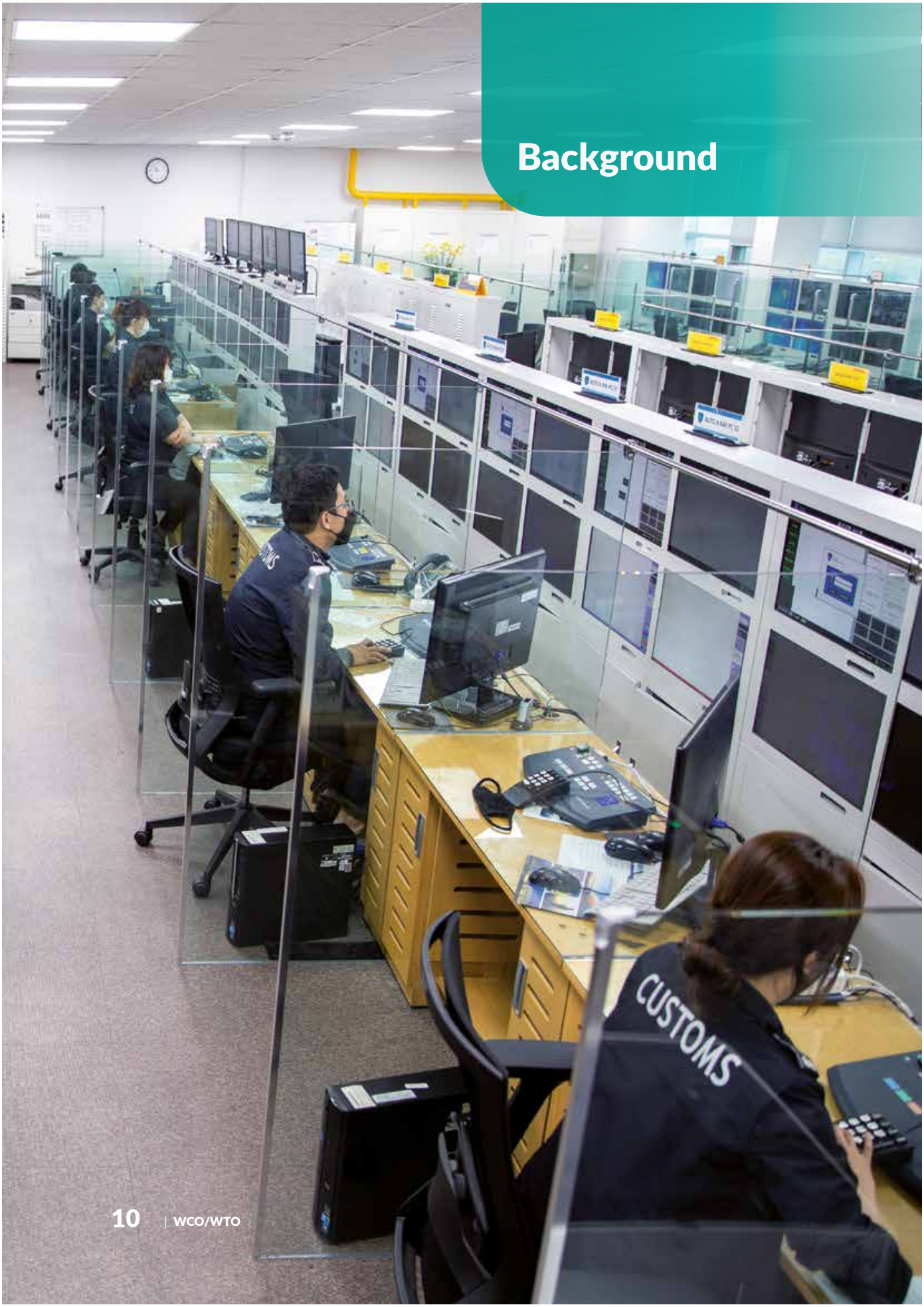
The WTO is very pleased to have this opportunity to collaborate with the WCO on this publication. Both of our organizations are interested in providing information to our Members about the impact of digital technologies on trade and its administration, the opportunities they open and the challenges that stand on the way to their broader adoption. Together we are in a unique position to gather the experience of our Members to provide a global picture of the use of these technologies to enhance border management.

I hope that this publication will provide a useful resource to inform policy debate and guide Members on how they might harness the benefits of these technologies.

"Technologies of the kind referred to in this publication hold enormous potential to aid governments in efficient and effective administration of WTO trade rules."

Dr. Ngozi Okonjo-Iweala
WTO Director General

Background



Based on the proposal submitted by the WCO Permanent Technical Committee (PTC) delegates, the Future of Customs topic was launched at the 207th/208th Sessions of the PTC in March 2015. This came as a result of discussions on the role of the PTC, where it was agreed that the Committee would take a more active role in discussing strategic matters and future-oriented topics.

The March 2015 PTC discussed new and emerging threats, and how these would affect the roles and responsibilities of Customs in the future. The discussions resulted in the establishment of a Virtual Working Group on the Future of Customs (VWG FC) under the PTC, consisting of Customs administrations, the private sector, international organizations and academia.

The Group, which consisted of over thirty Members, worked on papers that steered discussions in the PTC meetings on a number of topics, such as the Customs in the 21st Century strategic document, 3D printing, drones, biometrics, the Internet of Things (IoT), etc.

At its 215th/216th Sessions in April 2017, the PTC discussed the way forward for the Group, two years after its establishment, to ensure more focused and results-oriented discussions. Consequently, and bearing in mind the importance of exploring new and emerging trends for successful policy making, the PTC decided that the Group would, amongst other things, focus on exploring disruptive technologies, which were gradually becoming part of people's lives. However, the benefits of these technologies for Customs and border management had not yet been fully explored.

It was therefore deemed relevant to carry out further exploratory work and research on these topics, and to provide more information on their use, benefits, risks and role in the supply chain, in Customs etc. The aim was also to take into consideration the interlinkages between the different technologies and to gain a more holistic picture of how they impact or support Customs work.

The PTC moved on to the development of the Study Report on Disruptive Technologies, collating all the work already carried out, including papers developed by a number of its Members, and, more broadly, bringing together relevant open-source information, as well as the outcomes of discussions in the PTC and other WCO working bodies and meetings, including the WCO IT Conferences.

The first version of the Study Report was published in 2019, and had the objective of raising awareness within the Customs community of the latest technologies and their potentials, providing practical examples and case studies.

The first version of the Study Report was published in 2019, and had the objective of raising awareness within the Customs community of the latest technologies and their potentials, providing practical examples and case studies, but also sharing some more aspirational and innovative propositions on their use in the future.

Bearing in mind the fluidity of the topic, the Study Report is meant to be a living document, to be updated on a regular basis to include lessons learnt and recommendations stemming from ongoing discussions. Hence, this 2022 version of the Study Report incorporates some of the developments and findings collected in the course of the past three years.

In early 2021, the WCO partnered with the World Trade Organization (WTO) in the work on disruptive technologies, which resulted in the collection of survey results on the use of particular disruptive technologies by Customs and the development of a joint paper, "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective", that is summarized in more detail below in the section on joint WCO-WTO initiatives.

During the course of 2021 and 2022, two TECH-CONs and a number of WCO regional workshops on disruptive technologies were held with the aim of further raising awareness of the possibilities these technologies offer in facilitating and better controlling the cross-border movement of goods through the sharing of recommendations and lessons learnt.

The results of the survey, the paper, and the regional workshops have been incorporated into this update of the Study Report, which has been carried out jointly by the WCO and the WTO.

Lastly, the case studies from the 2019 version were updated, where relevant, or removed if considered redundant. New case studies that describe some of the latest projects using disruptive technologies were provided by Members and other stakeholders and annexed to the Study Report.

Executive Summary

I. Introduction: disruptive... or (just) emerging technologies?

There has been a significant uptake of disruptive technologies, in particular blockchain, the Internet of Things, artificial intelligence and machine learning, since the Study Report was first published in 2019, including in the Customs domain. However, there are still opportunities for broader implementation, which is why the WCO, the WTO and other stakeholders are looking into these and other technologies, with an eye towards identifying the key benefits for supporting international trade and economies more broadly, as well as identifying ways in which they can assist Customs administrations in fulfilling their objectives, such as ensuring trade facilitation, safety, security, and fair revenue collection. Numerous initiatives, including webinars, online conferences, policy documents and capacity building work, have been carried out by both organizations in the past three years with the aim of supporting their Memberships in these endeavours.

II. Holistic use of technologies for Smart Customs of the future

2021 has highlighted the critical role that Customs play in enabling global trade. To make global supply chains of the future more efficient, Smart Customs have to minimize Customs clearance time and costs, while intelligently managing inbound and outbound goods and vehicles. Disruptive technologies need to be used in combination. Furthermore, numerous elements such as cyber security, data collaboration, identifiers and others need to be considered when implementing innovative solutions.

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III. The technologies

1. Blockchain technology

Blockchain's potential to facilitate Customs processes is multifaceted, from Customs clearance to inter-agency cooperation, certification, identity management, compliance management, revenue collection and post-clearance audit. Through this technology, the same copy of a ledger is instantly available to all parties at different nodes in the most updated, trusted, secure and immutable manner, obviating the need to maintain separate ledgers by each party as per the current practice.

Considering the potential of blockchain, the WCO and the WTO have been exploring the use of this technology in the Customs domain for the last few years. According to the results received through the WCO's 2021 Annual Consolidated Survey (ACS), blockchain and distributed ledger technology (DLT) is still in an experimental phase for Customs, with around a third of Customs authorities who responded to the survey testing it through proofs of concept (22 Members) and pilot projects (15 Members) using mainly private (permissioned) blockchains, while only two Customs administrations have reported a full deployment of this technology. 26 Customs authorities have plans for this technology in the next three years, while another 45 have indicated that they have no plans in place for it as yet.

2. Internet of Things

Statista estimates that, by 2025, the Internet of Things (IoT) will be made up of over 30 billion devices worldwide (more than four devices per person). Customs can work towards strengthening cooperation with certain stakeholders (shippers, carriers, forwarders etc.) that have employed IoT applications, with a view to promptly obtaining any information that corresponds to certain risk factors. Thus, Customs administrations would be able to focus on using analytical tools to identify high-risk and low-risk shipments and supply chains based on information collected through IoT technology.

The fact that everything that is connected to the Internet or interacting with it can be geo-located is now an important new parameter which may also provide new opportunities to Customs. Half of the respondents to the above survey indicated that they used IoT in Customs business processes, and 9 per cent planned to deploy them. However, as many as 40 per cent had no plans to use

the technology, for now. Of the 72 respondents deploying IoT, the majority indicated that this was in relation to X-ray or computed tomography (CT) scanning, and significant numbers used QR code and barcode readers, automated licence plate readers and cameras, as well as electronic seals (e-seals).

3. Big data, data analytics, artificial intelligence and machine learning

Use of big data, data analytics, artificial intelligence (AI) and machine learning (ML) in Customs and border management presents a tremendous opportunity in the cross-border movement of people and on the commercial side. As huge volumes of data are generated by people and goods moving across borders, this group of technologies provides the ability to make sense of this huge and ever-increasing amount of data. These technologies can be used to ingest this data, and to detect and predict patterns more accurately than humans can. Visual search and facial recognition technology, and behavioural and predictive analytics that are already being used in other sectors, can also be further tailored for use in Customs and border management.

Use of big data, data analytics, artificial intelligence (AI) and machine learning (ML) in Customs and border management presents a tremendous opportunity in the cross-border movement of people and on the commercial side.

According to the WCO's ACS, almost 45% of Customs authorities use either data analytics, or AI/ML, or both. There are numerous case studies that are focused on risk management and targeting, improving tariff classification and revenue collection, fighting fraud including undervaluation, advance analytics for Authorized Economic Operators (AEO), and many more.

4. Biometrics

Governments and organizations all around the world are choosing biometric technology to combat identity fraud and security breaches, secure confidential data, reduce costs and improve overall user experience. Biometrics is a rapidly growing field in the information technology sector, with fingerprint recognition expected to remain the most dominant form of biometric technology.

Customs administrations are uniquely situated to demonstrate useful methods of interagency coordination, which biometrics requires. Customs administrations also have a long history of coordination and interagency work, as they enforce laws and regulations for partner government agencies. They are often co-located with immigration agencies, and can work to promote the adoption and facilitation of such efforts.

Customs agencies, other government partners and private actors should monitor this field closely to identify additional uses, potentially for the following purposes: verifying identities and controlling the access of Customs operators; identifying the different actors in the supply chain such as Customs brokers, freight-forwarders, logistics operators and others; etc.

5. Drones

Drones are already an integral part of the international trade supply chain, pushing regulators to become more comfortable with the technology, and thereby developing a legal framework that determines the conditions in which they will operate. Studies indicate that the integration of drones in the trade environment can support economic growth. However, integrating them successfully and safely requires all players in the market to be prepared and engaged in the process to ensure that the supply chain can fully realize the benefits. In the trade environment, modes of physical delivery of goods are being continually re-defined.

Drones are already being used by some Customs administrations for surveillance and monitoring purposes. Some are increasingly using drones to monitor port areas and coastal regions. This involves surveillance not only to combat drug smuggling but also to provide aerial assistance. A remote-controlled drone with a high-definition camera for underwater surveillance has already been used to go as deep as 50 metres to perform a detailed scan of a boat.

Customs need to monitor, analyse and comprehend emerging developments in the use of drones, and related regulatory developments, and come up with an appropriate policy response, together with potential adjustments of Customs procedures and requirements where needed.

6. Virtual, augmented and mixed reality

As regards Customs, augmented and mixed reality can be used to project visual assistance in the physical world, e.g. when carrying out a physical inspection.

Another potential use is the visualization of big data sets. When using mixed reality, data can be projected in the physical world as digital artefacts that can be manipulated as real objects.

The use of virtual reality solutions for Customs training purposes has been successfully employed by governments and the WCO to improve inspectors' efficiency in identifying prohibited items. Virtual training programmes offer inspectors the chance to hone their skills and knowledge of their duties and responsibilities in a low-risk virtual environment, while following a progression system.

7. 3D printing

According to some reports around 1.4 million 3D printers were shipped globally in 2018, with an estimated 8 million units to be shipped in 2027. There are predictions that 3D printing could potentially have a major impact on the work of Customs in the future.

Some feel that Customs should be involved in monitoring the virtual supply chain, and the question has been raised as to how this could this be achieved, including whether existing legal instruments are sufficient to cover such responsibilities. In general, the cooperation of Customs with tax authorities and other relevant agencies (possibly as a new dimension of coordinated border management) is regarded as important in this field.

The implications of 3D printing for origin, valuation, IPR, and security, and for VAT in particular, have been stressed in the WCO. It has even been posited that there may be a need to redefine the term "goods" in the future.

Challenges remain in assessing the overall impact of 3D printers, as stressed by the 2021 OECD trade policy report. In response, the new heading 84.85 for additive manufacturing (3D printers) was created as part of the 2022 edition of the WCO Harmonized System (HS 2022) and entered into force internationally on 1 January 2022, which will enable better national monitoring of 3D printers and their impact on trade.

IV. Strategy behind technology

There is a need to harness the latest technologies as traveller and trade growth, including e-commerce, has significantly outpaced the typical public service evolution, challenging our conventional operations, programme policies and legislation.

Technologies such as blockchain, biometrics and artificial intelligence are more than business enablers, they set expectations for our clients and change how we work. It is essential, however, to focus technological changes on those key to an organization's mandate, as otherwise there is a risk of overcommitting.

Options for the implementation of emerging technologies must be evaluated based on the services required and the needs of the Organization.

Options for the implementation of emerging technologies must be evaluated based on the services required and the needs of the Organization. The high rate of failure in large, multi-year IT-enabled projects has resulted in organizations moving away from large IT system development and instead selecting technologies that can easily migrate to new hardware in the future. Key to the new methodologies used is the principle of failing fast, and recovering quickly.

V. Recommendations

The WCO and the WTO have extensively explored the topic of disruptive technologies, sharing experiences and discussing the different projects and lessons learnt. A number of possible recommendations have been considered for policymakers. They include recommendations on how Customs and the private sector can cooperate in making best use of disruptive technologies for the purpose of facilitating and securing trade.

VI. Conclusion

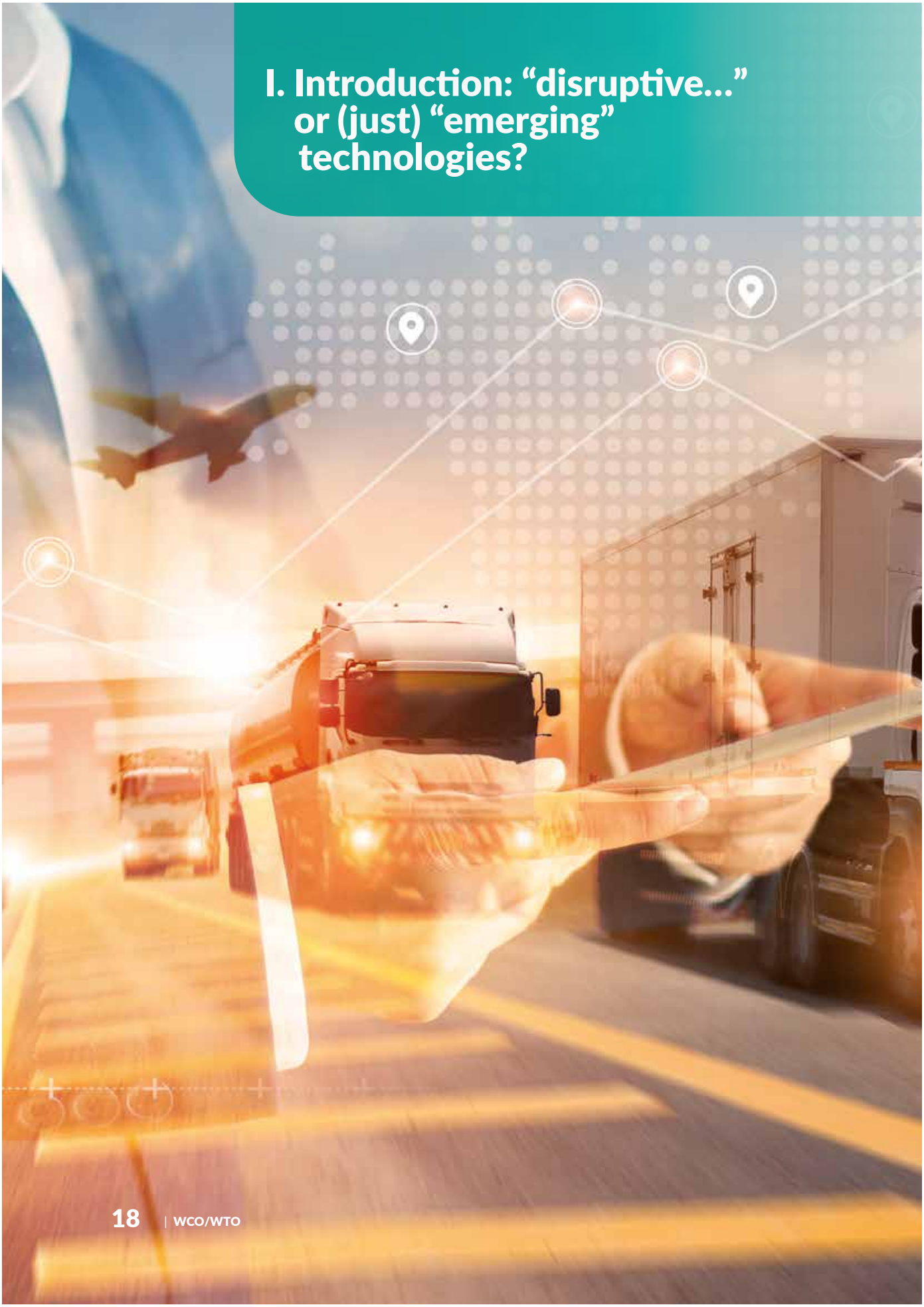
There is a general understanding of the need to keep abreast of the developments in this field and continuously seek to understand the challenges and opportunities that the latest technologies can bring to Customs and border management.

Information on numerous pilot projects and proofs of concept (PoCs) shared by the Customs administrations and other stakeholders show the interest in expanding the use of these technologies, as well as the confidence in the benefits they will bring to Customs in achieving its objectives and supporting cross-border trade.

The Study Report will continue to be updated with the latest insights and information on pilots.

Drones are already being used by some Customs administrations for surveillance and monitoring purposes. Some are increasingly using drones to monitor port areas and coastal regions. This involves surveillance not only to combat drug smuggling but also to provide aerial assistance.

I. Introduction: “disruptive…” or (just) “emerging” technologies?



When we talk about “disruptive technologies”, what exactly do we mean? According to the Cambridge Dictionary, a disruptive technology is a new technology that completely changes the way things are done. Even though we cannot be certain which technologies will accomplish this in the future, the public has over the past years broadly accepted “disruptive technologies” as a term which refers to blockchain, the Internet of Things, artificial intelligence, virtual reality, drones, 3D printing and other cutting-edge technologies, which are the subject of this Study Report.

The term emerged from an examination of the failure of once dominant corporations, when the technology their dominance was based upon changed. The authors Clayton M. Christensen and Joseph L. Bower introduced this idea in their 1995 Harvard Business Review article “Disruptive Technologies: Catching the Wave.” They examined the hard-disk-drive industry to illustrate their point. They focused on the challenges faced by a corporation as they attempted to introduce a new technology which often struggled against the existing dominant force in the market place. In subsequent work, it was argued that disruptive technology did not disrupt at a single point in time, but that what was disruptive was the path the technology followed from a fringe product to the mainstream.

When we speak of disruptive technologies or disruptive innovation we are not talking about a negative reaction within a certain market, but rather the natural evolution of technology. Our lives are enriched in many respects by disruptive technologies. History is full of technologies that transformed the way we do business or live our lives.

According to the WTO World Trade Report 2018, we are entering a new era in which a series of innovations that leverage the Internet could have a major impact on trade costs and international trade. The Internet of Things (IoT), artificial intelligence (AI), 3D printing and blockchain have the potential to profoundly transform the way we trade, who trades and what is traded. This comes as a consequence of a number of forces. The past half-century has seen a massive increase in processing and computing power, an equally enormous decline in its cost, and widespread adoption of personal computers. This has been accompanied by an equally rapid increase in bandwidth – the carrying capacity of a communication system – that has proved to be an important catalyst for the swift growth of the Internet and mobile networks. Finally, the ability to turn many forms of information that once existed solely in analogue form into digital information, and to collect, store and analyse it, has expanded enormously.

Today, we are also seeing the rise of quantum computing, which harnesses the phenomenon of quantum mechanics to deliver a huge leap forward in computation to solve certain types of problems. Namely, quantum computers and algorithms are being designed to solve complex problems that today’s most powerful supercomputers cannot solve, and never will. These complex problems have lots of variables interacting in complicated

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ways, for example, sorting out the ideal routes for a few hundred tankers in a global shipping network or finding the prime factors of a large number. Since quantum computing is good for solving certain types of problems but not others, it is not expected to replace classical computing, but to extend and complement it.[1]

Customs authorities are key actors in international supply chains. The extent to which they leverage disruptive technologies to improve Customs processes can, as a result, have an important impact on cross-border trade processes and supply chain operations. The key understanding must be how Customs reacts not only to the use of technology by its stakeholders, but also how it utilizes the emergence of new technologies which itself changes the manner of conducting business. The challenge for Customs administrations, like any consumer, is that the fervour which surrounds an emerging technology can dominate any discussions on reform and renewal.

However, paramount to Customs administrations is the ability to ensure that efficiency and effectiveness are constantly improved, and the latest technologies are in most cases aimed at achieving these goals.

It should also be noted that disruptive technologies can be a catalyst for strategic decision-making, with an administration having to review the emergence of a technology and to make a strategic decision on its use in the short to medium term. Having direct frontline interaction with trade, Customs must be aware of, and adapt to, the way trade innovates and develops. This can be observed through the development of supply chains and the manner in which information is created and stored, which is evident in the emergence of blockchain technology and the manner in which it has caught the imagination of many.

Blockchain technology is a prime example of where a Customs administration must be aware of how trade is adapting to a new environment. For a Customs administration to be able to interact with their primary stakeholders, they must be able to share information in the most efficient way possible, both for the administration itself as well as for trade. While this particular technology is being heralded as the future of information security, as well as of the accessibility of information, it is crucial that Customs administrations observe it, and inform themselves as to how this technology works.

Reviewing the detailed examinations contained within this Study Report, it is apparent that technologies such as blockchain and distributed ledger technology (DLT), the Internet of Things (IoT), artificial intelligence (AI) and machine learning (ML) have either already had a significant impact on international trade and Customs, or promise to do so in the future, offering both trade and Customs administrations multiple opportunities to embrace added efficiencies and effectiveness. There has been a significant uptake of these technologies, in particular since the Study Report was first published in 2019, including in the Customs domain. However, there are still opportunities for broader implementation, which is why the WCO, the WTO and other stakeholders are looking into these and other technologies, with an eye to identifying the key benefits for supporting international trade and economies more broadly, as well as identifying ways in which they can assist Customs administrations in fulfilling their objectives, such as ensuring trade facilitation, safety, security, and fair revenue collection.

Customs authorities are key actors in international supply chains. The extent to which they leverage disruptive technologies to improve Customs processes can, as a result, have an important impact on cross-border trade processes and supply chain operations.

One of the major challenges facing the digital economy is the digital divide between developed and developing countries. This divide remains wide in terms of access to broadband services and e-commerce platforms, quality of infrastructure and legal framework. Therefore, what needs to be taken into consideration are the capacity building programmes which can support a more balanced spread of adoption across the globe.

1 *The Quantum Decade, IBM Institute for Business Value, 2021, https://www.ibm.com/thought-leadership/institute-business-value/report/quantum-decade*

a. WCO initiatives

Promoting the findings from the Study Report on Disruptive Technologies

Since the adoption of the Study Report in June 2019, the WCO has shared its findings and the case studies in many different international forums, including with Customs, international organizations, the private sector and academia. The aim has been to continuously and consistently raise awareness of the possibilities and benefits of these technologies for Customs today and in the future, as well as to potentially trigger new initiatives. It has become evident that three groups of technologies in particular, more so than any others, were either already transforming the work of Customs or else promising to play a significant role in its future work, thus supporting the facilitation and security of cross-border trade. These technologies are blockchain/DLT, the Internet of Things, and big data, data analytics, artificial intelligence and machine learning.

Data analytics project (BACUDA)

The BACUDA data analytics project was launched in 2019 and falls within the remit of the Capacity Building Directorate, with the main purpose of guiding Members in embedding data analytics in their organizations. It is funded by Customs Cooperation Fund (CCF) Korea and is comprised of data analytics experts who use their expertise to collaborate on applied projects. They produce new algorithms and methods specifically tailored to the needs of the Members, in regard to applying data analytics in the Customs domain. By organizing capacity building activities that enable Members to deploy these algorithms and embed them into their current processes, the project aims to provide intrinsic support to the Members. Currently, there are multiple online courses on the topic of data analytics in the field of Customs, in addition to a practical introduction to the methods provided by the expert team, including the DATE algorithm, which is used to detect fraudulent trade, and the HSearch algorithm, which aims to recommend HS Codes after receiving the commodity description as an input. The team aims to add to the plethora of training programmes. By adding more languages to courses, the courses will be made more accessible to a wider audience. To enrich the skills of already knowledgeable participants in the field of data analytics, more advanced courses with the focus shifted towards the application of new algorithms in the field of Customs will be introduced in the future.

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Additionally, a scholarship programme is being conducted for 12 Customs and data experts from each region of the world in collaboration with the Sung Kyun Kwan University in Korea. The curriculum encompasses some of the most relevant topics in the data analytics field and aims to develop the participants into driving forces in transforming their respective organizations into data driven ones.

Five regional workshops have already been held at the management level to raise awareness of data analytics. Specific capacity building activities took place at the national level, such as an assessment of current data analytics capacities in the Member administrations, and pilot tests of algorithms. These were very fruitful for both the expert group and the Members. Further technical assistance to Members via diagnostic missions and accreditation of experts will be executed according to Member requests.

WCO TECH-CONs

In 2020 and 2021, due to the disruptions caused by the COVID-19 pandemic, the WCO held its technology conferences in a virtual mode. The so-called TECH-CONs (2020 WCO TECH-CON and 2021 WCO TECH-CON) were an attempt to continue the sharing of experiences on the use of latest technologies, amongst others. There was general agreement that the use of technology had accelerated since the beginning of the crisis. The

speakers echoed the conclusion of consulting firm McKinsey & Company, along with many others, who noted that "responses to COVID-19 have speeded up the adoption of digital technology by several years and many of these changes could be here for the long haul".[2]

The same has been seen in Customs. With social distancing measures in place, there has been a need for contactless procedures and we have seen a real momentum in the uptake of many technological solutions, including through the use of disruptive technologies.

Regional workshops on disruptive technologies (2021 and 2022)

In March 2021, the WCO launched a round of regional workshops on disruptive technologies aimed at further sharing experiences and discussing the different projects and lessons learnt, and drawing possible recommendations for the future, which have also been reflected further in this Report. The first workshop was held in the Asia/Pacific region, followed by the European region in May, the Americas and Caribbean region in November 2021, and the workshop for East African and West and Central African regions in January 2022. The events revealed that existing projects had progressed further and new ones had emerged, but also that the uptake of the technologies varied depending on the region and the level of development.

b. WTO initiatives

Publications and events

Over the last few years, a series of WTO events and publications have examined the interplay between digital technologies and international trade with a view to spreading awareness about the impact of digital technologies on trade, fostering dialogue among Members of the international community, and catalysing action.

The 2018 World Trade Report (WTR) examined the growing importance of digital technologies – and in particular of the Internet of Things, artificial intelligence, 3D printing and Blockchain – and how they affect trade costs, the nature of what is traded and the composition of trade. The Report discussed how international trade cooperation can help governments both seize these opportunities arising from the development of these technologies and address the challenges.

That same year, the WTO hosted a research workshop on blockchain and international trade in which the WTO publication Can Blockchain Revolutionize International Trade was presented, followed up by a series of panels on trade finance, Customs and border procedures, and logistics. The workshop drew on insights from a variety of actors across relevant sectors to address the opportunities and implications associated with the widespread adoption of these technologies in the modern trading system.

With social distancing measures in place, there has been a need for contactless procedures and we have seen a real momentum in the uptake of many technological solutions, including through the use of disruptive technologies.

2 *https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever*

Indeed, although digital technologies can transform the trading system and bring about new levels of economic prosperity and growth, they also pose new challenges to the multilateral framework – raising questions about regulation, privacy, distortions to productivity, and inequality associated with the digital divide.

As several WTO publications and events have noted, digital trade and information technologies have given countries access to markets that were previously considered unreachable, and consumer choices have largely expanded as e-commerce has expanded the variety of goods available to a local demographic. Following the conclusion of the second phase of the WTO Chairs Programme (WCP)[3], a publication, titled Adapting to The Digital Trade Era: Challenges and Opportunities, was released in 2021. The research examined how rapid adoption of digital technologies, alongside domestic policy and greater international cooperation, could offer new opportunities for economic growth and prosperity to developing countries. In 2019 and 2021, the WTO hosted the two Global Trade and Blockchain Forums which brought together Members of the public and private sectors, and highlighted the potential transformative effects and challenges new digital technologies, notably blockchain, could bring about in the global trade system – touching issues from trade finance to transportation and logistics, border procedures, and agriculture. The forums fostered discussions around the role of international organizations in promoting a regulatory and policy framework conducive to the deployment of these technologies while mitigating the risks that may arise.

Digital trade and information technologies have given countries access to markets that were previously considered unreachable, and consumer choices have largely expanded as e-commerce has expanded the variety of goods available to a local demographic.

Two publications mapping existing DLT projects in trade were released in 2019 and 2020 on the margins of the Forums. Surveys of key actors in the field conducted as part of these studies highlighted the important benefits that DLT can bring in terms of transparency, gains in speed and efficiency, and real-time overview of transactions, as well as the challenges that this technology raises in terms of standardization, governance and regulation. The publications discussed ongoing work aimed at creating digital standards relevant for trade to drive digital interoperability, as well as the impact of the COVID-19 pandemic on digitalization efforts.

A more recent publication, Accelerating Trade Digitization to Support MSME Financing, investigated the potential of advanced technologies, including the Internet of Things, big data analytics, artificial intelligence, quantum computing, and DLT, to facilitate small businesses' access to trade finance. A new (February 2022) WTO Secretariat publication Trade in Knowledge - Intellectual Property, Trade and Development in a Transformed Global Economy, drawing together contributions from diverse set of scholars, analysts and institutions, provides in-depth discussions of the measurement, impact and regulation of knowledge flows in the global digital landscape, ranging from global value chain analysis in the digital context to the adaptation of trade rules for the age of 'big data'. The work in this volume is providing the basis a platform for further engagement in this dynamic area.

3 *The WCP was a capacity-building project launched in 2010 which sought to enhance knowledge and understanding of the trading system among academics and policymakers in developing countries through research, curriculum development, and outreach activities. The first phase of the programme ran from 2010 to 2013, the second phase ran from 2014 to 2018, and a third phase has been implemented since 2021.*

E-Learning course

The WTO and International Trade Centre jointly developed an online course on Introduction to Blockchain for Trade that is freely available and aimed at both technical and non-technical participants. It consists of four modules: (1) Why blockchain?; (2) What is blockchain technology?; (3) How can blockchain be used in international trade?; (4) Implementing blockchain for trade.

Work in WTO bodies and facilities

WTO Members have also been discussing trade digitalization and the impact of digital technologies on trade in various WTO bodies and facilities that support developing and LDC Members.

Members are discussing initiatives on electronic commerce in both the Council for Trade in Services (under the 1998 Work Programme) and the Joint Statement initiative.[4] Discussions address issues such as how to leverage technology to bridge the digital divide; as well as the means to facilitate digital and paperless trade, electronic signatures and authentication, electronic invoicing, and electronic contracts.

WTO Members have also been discussing trade digitalization and the impact of digital technologies on trade in various WTO bodies and facilities that support developing and LDC Members.

In 2022 and 2023 the Technical Barriers to Trade (TBT) Committee will explore the impacts that technical barriers to trade may have on trade in intangible digital products (e.g., artificial intelligence (AI), enterprise applications, cyber security, financial technology, health IT, telecommunications, digital media software, and software as medical devices), and how to minimize those impacts. The Committee members will also share views on cyber security regulation; digital solutions for conformity certificates; and challenges and best practices for conformity assessment of goods obtained through e-commerce.

Funding from the Enhanced Integrated Framework (EIF) has been supporting least developed countries (LDCs) to leverage technologies, particularly frontier technologies, to improve productivity, promote e-commerce and facilitate cross-border paperless trade. The EIF partnered with the UN Technology Bank to conduct a Technology Needs Assessment in selected LDCs, and with UNESCAP to conduct feasibility studies on the application of emerging technologies for digital trade.

c. Joint WCO-WTO initiatives

The WCO and the WTO have a long-standing partnership in which the two organizations have complementary roles, whereby the WTO sets rules in international trade and the WCO develops the relevant standards and tools relating to border formalities. The typical areas of cooperation are in Customs valuation, rules of origin, and trade facilitation, while more recently the two organizations have also embarked on numerous joint initiatives, such as those relating to ways to mitigate the effects of the COVID-19 pandemic, and in the area of paperless trade and technologies. Both organizations provide capacity building and technical assistance aimed at facilitating trade and Customs formalities.

The WCO and the WTO jointly developed a paper "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective". The paper was developed based on the results of the WCO's 2021 Annual Consolidated Survey and more specifically its chapter on disruptive technologies that provided a snapshot of the level of implementation by Customs administrations of the three groups of technologies that already proved to be extremely useful in the Customs environment or were promising to be game-changers in the future: blockchain/distrib-

4 *86 Members are part of the Joint Statement initiative on e-commerce.*

uted ledger technology (DLT); big data, data analytics, artificial intelligence and machine learning; and the Internet of Things. This paper intends to shed light on the level of implementation, as well as opportunities and challenges faced by Customs in deploying the above-mentioned technologies. The paper may be of particular interest to those WCO and WTO Members in the process of implementing the WTO Trade Facilitation Agreement, which aims to reduce processing time through the use of techniques such as risk management, Single Window, exchange of Customs information, and authorized economic operators, to name but a few. In addition, the paper may further assist other stakeholders to take well informed decisions under initiatives aimed at facilitating and securing global supply chains.

The WTO also participated in the 2021 WCO TECH-CON and the regional workshops held during the course of 2021 and early 2022. Lastly, the two organizations partnered in updating this Study Report in order to ensure the broader trade perspective and all relevant stakeholders are considered, duplication is avoided and the biggest possible benefits are reaped in developing relevant projects.

II. Holistic use of technologies for Smart Customs of the future

2021 has highlighted the critical role that Customs play in enabling global trade. To make the global supply chains of the future more efficient, Smart Customs have to minimize Customs clearance time and costs, while intelligently managing inbound and outbound goods and vehicles. Disruptive technologies such as IoT devices are enabling autonomous equipment to drive effective monitoring of cargo and tracking of journeys.

IoT sensors like smart seals can be embedded at critical checkpoints in vehicles and containers to detect fraud and other crimes, including tampering in containers and cargo that is not moving along approved routes, thus making cross-border movements safer and faster. Customs administrations are then able to focus on using artificial intelligence to automate supply chains and processes, carry out risk profiling, and identify priority cargo, and high-risk and low-risk shipments, thus ensuring better facilitation and controls.

Another example of Smart Customs is image recognition used in X-ray screening machines and detectors, cargo and vehicle inspection systems, explosives and drug detectors, wildlife trafficking detection or dangerous liquid detectors – all can use IoT to track and communicate data.

Disruptive technologies such as IoT devices are enabling autonomous equipment to drive effective monitoring of cargo and tracking of journeys.

Robotic process automation (RPA) and low code automation allow for rapid deployment, and this was urgently needed during the pandemic. RPA can help to speed up Customs processes such as data verification, mimic a human worker by adapting to changing circumstances, or detect and resolve common errors that would otherwise take up considerable time and human resources. RPA allows for automation of simple, repeatable tasks at high volumes, with much greater accuracy than humans can provide.

Cyber security issues

Cyber security technologies are crucial when designing, procuring, implementing and operating secure systems for the Smart Customs of the future. This is particularly important given the trend of convergence of physical security and IT infrastructure as increasing volumes of data need to be processed and moved to digital platforms. Technology, workforce, and budget planning should bear cyber security in mind. Field communications, video surveillance, ground sensors and actuators, remote and mobile video surveillance systems or GPS have to be protected from potential attacks that could put the integrity of any field operation at risk, and possibly endanger lives.

This means verifying all endpoints. That includes not only contractors, partners, and guest devices, but also apps and devices used by employees to access work data, regardless of device ownership.

Identity

Identifiers, such as usernames, can be replaced with IDs that are self-owned, independent, and enable data exchange using blockchain and distributed ledger technology to protect privacy and secure transactions. The benefits of decentralized identity are the elimination of redundancy and increased trust in an ecosystem, since there is a single source of truth.

Identity technologies such as biometric scans and touchless identity verification can play a role in a post-pandemic scenario as they can decrease the risk of disease transmission and provide a quicker throughput of passengers through given checkpoints due to less time being taken.

Data collaboration

Data exists in Customs environments in various formats on various types of repositories on different clouds as well as on various Customs on-premises infrastructures. With the growing data landscape, two of the most common capabilities required to manage as well as extract value out of Customs and trade data are data cataloguing and data warehousing. Integrating these two capabilities gives Customs authorities the freedom to query data on their terms.

By design, Customs have multiple stakeholders, each with its own infrastructure and formats, but it needs to exchange significant amounts of data in real-time. This involves gaining transparency along the supply chain.

The evolution of trade in a digital world could be represented by intelligent connected trade windows where, with real-time data collaboration achieved, new services would be unlocked enabling better capacity utilization, new value creation, cost optimization, and trusted transactions through Distributed Ledger Technology (DLT) and application programming interface (API) data integration, which provide supply chain visibility.

Secure data sharing, analytics and governance

Secure data sharing enables big data sets to be shared and updated while ensuring that data governance rules are adhered to. Sharing technologies allows data access to be given to new partners without requiring them to set up new infrastructure. Data duplication is reduced or eliminated.

Once stakeholders, assets and processes have been digitalized it becomes critical to enable data collaboration between all these entities to generate insights into trends, challenges and gaps, as well as capacity usage and profitability. Insights can then enable the automation and optimization of processes. An important building block is the ability to perform risk profiling. With a risk scoring for each economic agent, the processes related to Customs clearance and trade facilitation could be automated.

Artificial Intelligence: machine learning and cognitive services

Cognitive services for Customs agencies help improve compliance and facilitation by enabling Customs officers to make better decisions. Data analytics – for example, automated selectivity rules – has become an increasingly important tool for Customs agencies. ML capabilities help solve general problems such as analysing text for emotional sentiment, analysing images to recognize objects or faces, converting speech (audio) to text, translating the text into many languages, then using the translated languages to get answers from a knowledge base. Applying various AI components can significantly enhance Customs operations. Visual search and facial recognition technology, behavioural and predictive analytics, revenue collection models, classification of products, Customs audits, risk-based targeting, analysing container images from X-ray scanners, logistics monitoring, identifying high-risk passengers and vehicles etc. can all be tailored for use in Customs and border management.

Sharing technologies allows data access to be given to new partners without requiring them to set up new infrastructure.

HPC as the next maturity level in terms of big data processing in real time

High-performance computing (HPC)[5] is a complete set of computing, networking, and storage resources integrated with workload orchestration services for HPC applications. It includes next-generation machine-learning tools to drive smarter simulations and empower intelligent decision making. HPC allows for automated machine learning, auto scaling cloud computing, and built-in DevOps which translates into big data processing in real time through the incorporation of intelligence and building and training new AI models faster. It allows the running of very complex algorithms for risk profiling, prediction of cargo positioning, as well as image recognition and detection of different anomalies in cargo scans.

High-performance computing (HPC) allows the running of very complex algorithms for risk profiling, prediction of cargo positioning, as well as image recognition and detection of different anomalies in cargo scans.

Modern DevOps: microservices

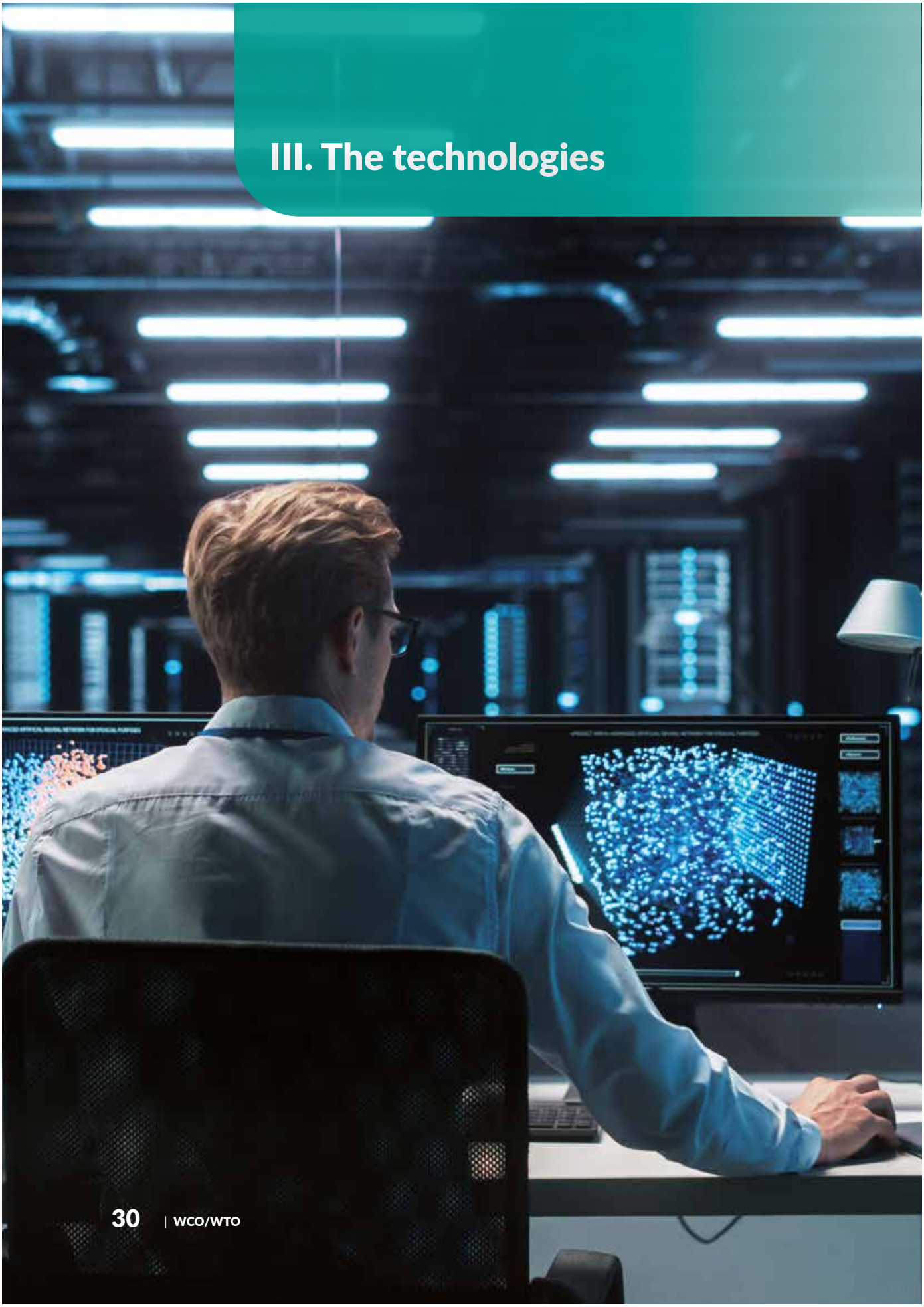
Microservices are an architectural approach to building applications where each core function, or service, is built and deployed independently. Microservice architecture is distributed and loosely coupled, so one component's failure will not break the whole app. Independent components work together and communicate with well-defined API contracts. Customs can build microservice applications to meet rapidly changing business needs and bring new functionalities to market faster.

Microservices provide many benefits over monolithic architectures. They can remove single points of failure (SPOFs) by ensuring issues in one service do not crash or impact other parts of an application. Individual microservices can be scaled out independently to provide additional availability and capacity. DevOps teams can extend functionality by adding new microservices without unnecessarily affecting other parts of the application.

Using microservices can increase team velocity. DevOps practices, such as Continuous Integration and Continuous Delivery, are used to drive microservice deployments. Microservices complement cloud-based application architectures by allowing software development teams to take advantage of several patterns such as event-driven programming and auto-scale scenarios.

5 *HPC is a discipline in computer science in which supercomputers are used to solve complex scientific problems. HPC dramatically reduces the time, hardware, and cost required to solve mathematical problems critical to core functionality. On the other hand, quantum computing is a fundamentally different approach to computing than the type of computing we do today on laptops, workstations, and mainframes. It will not replace these devices but, by leveraging the principles of quantum physics, it will solve specific and often very complex problems of a statistical nature that current computers struggle to solve.*

III. The technologies



1. Blockchain and distributed ledger technology (DLT)

A. What is blockchain technology?

(DLT) The term blockchain is often used in a generic way to refer to distributed ledger technology. However, technically speaking, blockchain is only one type of DLT, one that combines transactions in blocks and links them in a linear manner. Other DLTs validate transactions, not blocks, and link them in a non-linear way. However, what all these technologies have in common is their decentralized and distributed architecture and the use of advanced cryptographic techniques. This Report, like many others, uses the terms blockchain and DLT interchangeably.

Blockchain is a type of sophisticated cryptographic decentralized and distributed ledger architecture, a continuously growing list of records. It has the capability to move any kind of data securely among participants in the network (called nodes) on a peer-to-peer basis and, at the same time, make a record of that change, movement, or transaction available instantly, in a trusted and immutable manner to all participants. No entity controls it (it is decentralized) and data is distributed among the participants in the network (each participant has a copy of the records). The decentralized and distributed nature of blockchain, combined with the use of advanced cryptographic techniques, makes it a highly secure technology.

Blockchain is now being explored or used in areas as diverse as health, education, identity management, voting, food traceability, transportation, document provenance, trade finance, and of course Customs processes.

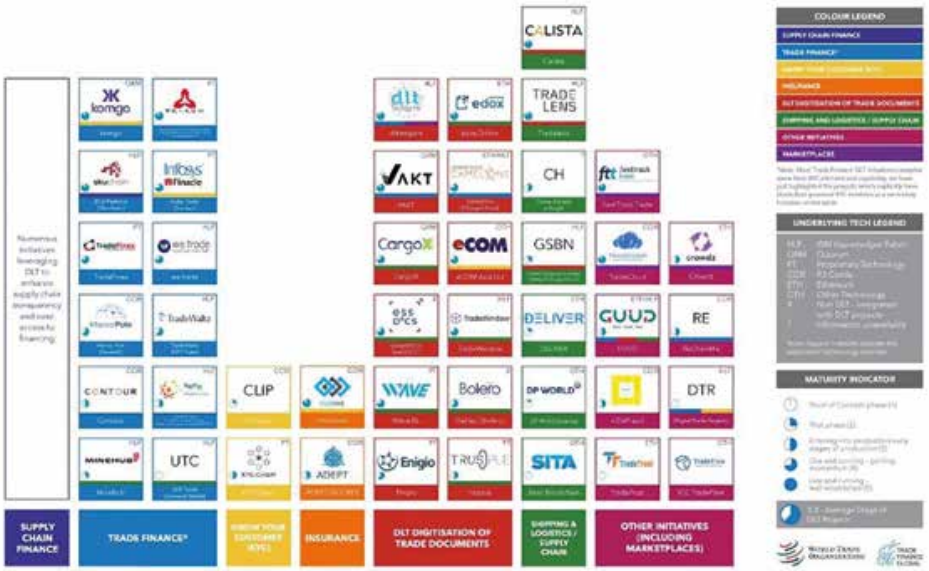
Transactions or blocks added to the ledger are linked to one another and time-stamped, making the technology inherently resistant to modification of the data. Data recorded on a blockchain cannot be altered retroactively without altering all previous records, which requires collusion of the network majority. The immutability that blockchain provides, combined with the fact that records are linked to one another, makes blockchain an extremely useful technology to track the full chronology of events, e.g. along the supply chain.

Blockchain was invented by Satoshi Nakamoto in 2008 for use in the cryptocurrency bitcoin, as its public transaction ledger. The invention of the blockchain for bitcoin made it the first digital currency to solve the double-spending problem without a need for a trusted authority or central server. The bitcoin design has been the inspiration for other applications.

In recent years, the number of projects leveraging the technology for applications other than cryptocurrencies has been skyrocketing. Blockchain is now being explored or used in areas as diverse as health, education, identity management, voting, food traceability, transportation, document provenance, trade finance, and of course Customs processes (see Box 1 below).

Box 1: DLT case studies in international trade

Beyond the use of blockchain by Customs (see section 'c. Implementation by Customs in 2021' below), many projects leverage blockchain technology to digitize trade documents and, through this, solve the double-spending issue, to facilitate the sharing of information among supply chain stakeholders and streamline processes, and to enhance supply chain management (see figure below).



Source: DLT projects in Trade: Where do We Stand? (2020)

Many projects have also emerged that use blockchain to trace products along the supply chain with a view to asserting ethical, social or environmental claims; providing customers with greater transparency; tracking tainted products, or combatting fraud. Examples in this field include projects by:

- **Everledger**, which has placed millions of diamonds on a blockchain to verify the provenance (origin and authenticity) of precious stones to curb the problem of counterfeits and 'conflict diamonds'. Entries include dozens of attributes for each diamond, including the colour, carat, and certificate number, which can be inscribed by laser on the crown or girdle of the stone;

- **Provenance**, a company which enables enterprise food, drink, beauty and fashion brands to prove their social and environmental impact;

Continuation box 1: DLT case studies in international trade

- **LVMH**, Cartier and Prada, which in April 2021 launched the Aura Blockchain Consortium, the world's first global luxury blockchain. Each product is given a unique digital identifier during the manufacturing process that is recorded on the Aura ledger, allowing customers to access the history of the product, including its origin, components, environmental and ethical information, proof of ownership, a warranty, and care instructions;
- **IBM Foodtrust**, which is a permissioned network that connects participants across the food supply to increase food safety, reduce supply chain efficiencies, minimize waste, and enhance consumers' trust;
- **Aircraft manufacturers** which are exploring how a blockchain might track disparate parts of their jets as they make their way from machining shops to the tarmac. SITA, an IT solution provider for 90 per cent of airlines, partnered with ShoCard to develop a passenger identity management app for airlines. The app combines facial recognition technology and blockchain-based data to streamline passenger processing at airports.

Various important features make blockchain a useful technology to leverage in international supply chain management:

1. Increased security

- The decentralized and distributed architecture makes blockchain-based systems more resilient as it eliminates the single point of failure.
- The use of advanced cryptographic techniques makes blockchain highly secure and quasi-immutable. Once added to the blockchain, records are tamper-proof, i.e. they cannot be modified.

2. Greater transparency

The full chronology of events (e.g. transactions) that take place are tracked, thus allowing anyone with access, including regulatory authorities, to trace or review prior transactions, providing a full audit trail.

3. Greater efficiency

- Blockchain's decentralized and distributed nature and the use of advanced cryptographic techniques allow participants to interact on a peer-to-peer basis. It provides "trust" between and among unknown parties to transact business and exchange information without an intermediary.
- The use of smart contracts, i.e. computer programs that self-execute when certain conditions are met, makes it possible to automate transactions, thereby further reducing processing costs.

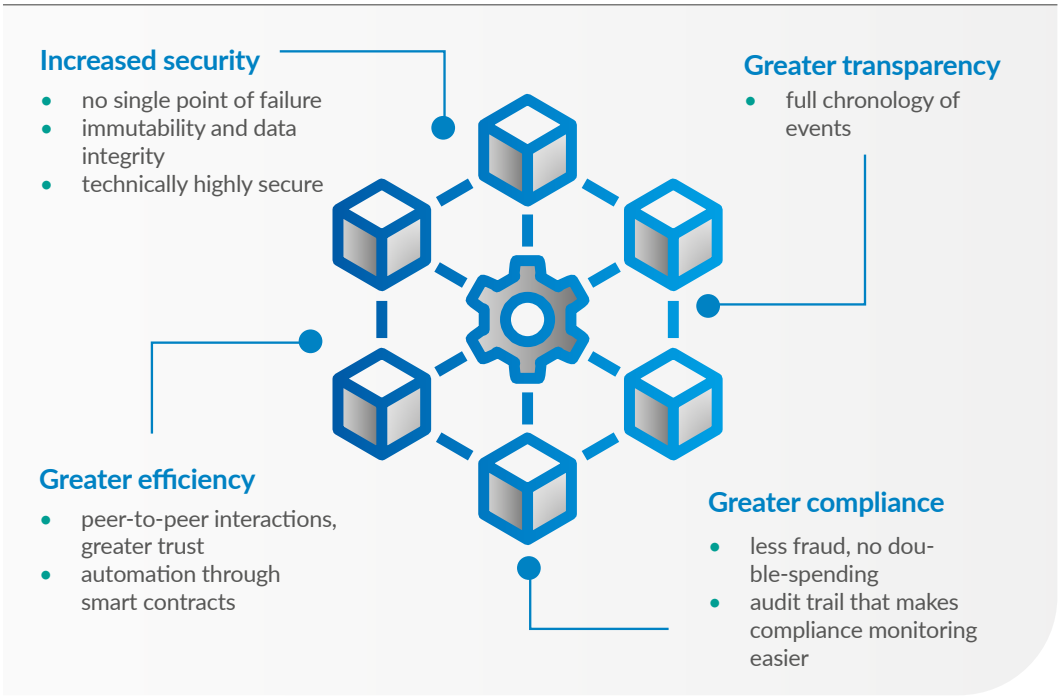
4. Greater compliance

- Transactions are verified and approved by consensus among participants in the network, making fraud more difficult.
- Blockchain solves the double-spending problem, making documentary fraud more difficult. Under traditional approaches to trade digitalization, copying and replicating electronic documents is easy. Keeping track of who possesses the original can become particularly complex and lead to double-spending problems. The immutability and traceability

features of blockchain offer the guarantee that the electronic documents are authentic and have not already been "spent."

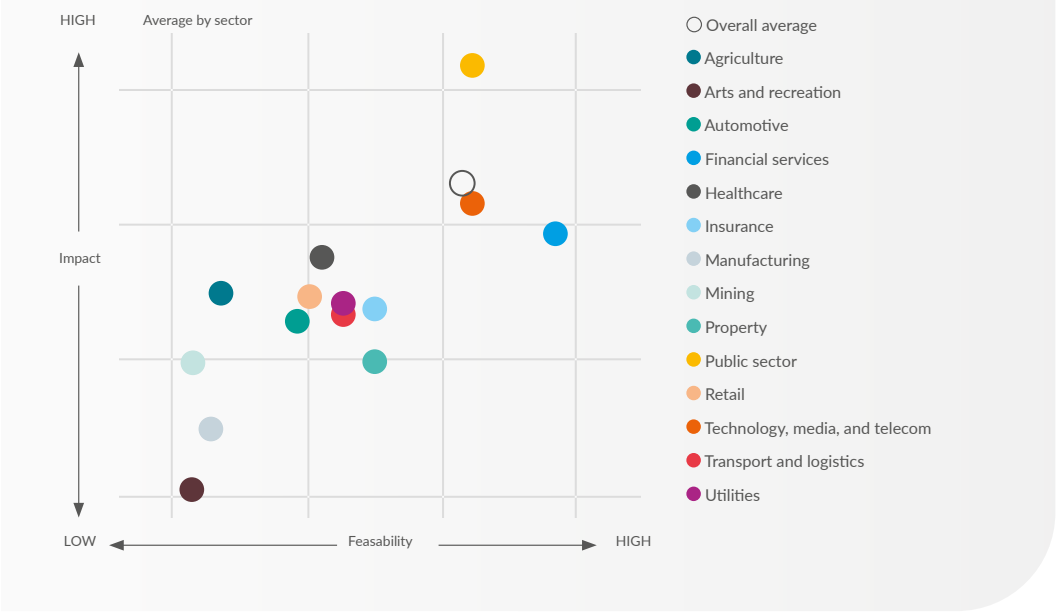
- By providing a full audit trail of transactions, blockchain makes compliance monitoring easier.

Figure 1: What are the blockchain benefits for trade?



Blockchain is a useful technology to leverage in international supply chain management.

Figure 2: Blockchain opportunities by industrial sector



Source: Digital McKinsey[6]

Blockchains can be public (there is no central entity controlling the network and everyone can read and write on the ledger) or private (a single entity or a group of entities – consortium - manages the network). In addition, participation in the network can be subject to certain conditions – permissioned blockchains – or open to anyone – permissionless blockchains. An increasing number of projects are using hybrid approaches that combine components of both public and private blockchains, to benefit from the higher level of security that public blockchains offer and higher scalability of private blockchains.

Most projects launched in relation to trade and Customs are permissioned or hybrid blockchains.[7]

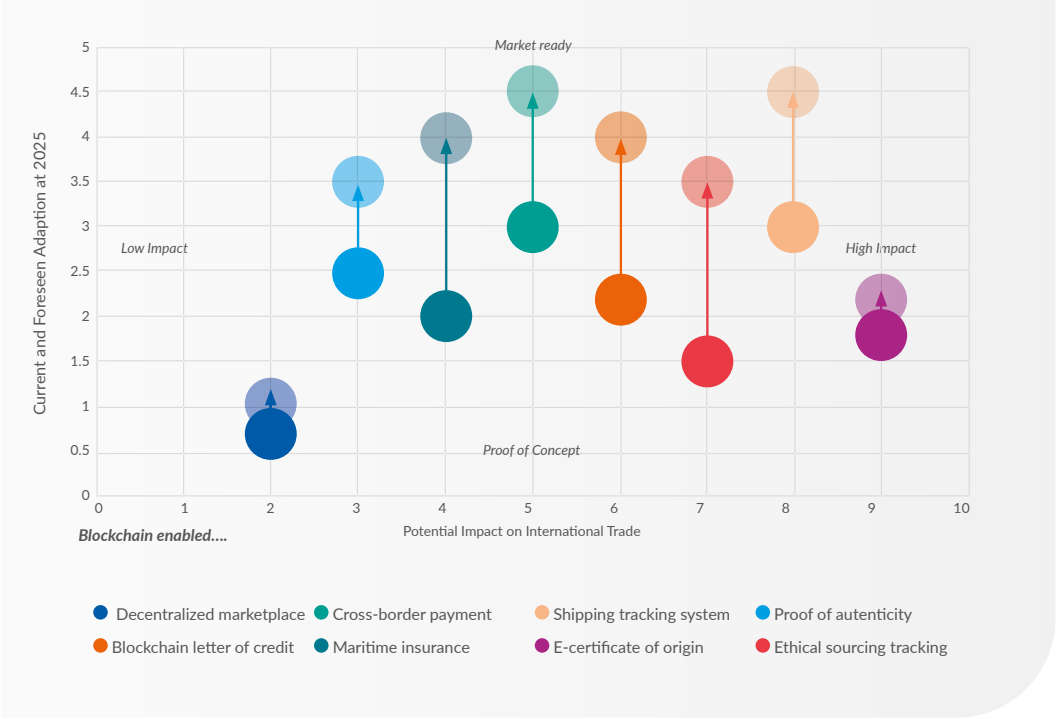
Although blockchain technology presents interesting features in terms of security, immutability, transparency, traceability and automation, its wide-scale deployment currently hinges on various challenges.

With the blockchain technology, efficiencies in the supply chain can be improved not only in the reduction of intermediaries and paper/manual tasks but also in improving certainty and predictability based on the reliable real-time data available to all the stakeholders in a supply chain participating in a blockchain. This allows for traceability and end-to-end visibility, thus enhancing supply chain security and facilitation. To begin with, however, it would be necessary to map the data elements at different points in time to demonstrate what the inputs are and at what level, as well as what the outputs are, perhaps at different levels.

6 B. Carson, G. Romanelli, P. Walsh, and A. Zhumaev (2018), "Blockchain beyond the hype: What is the strategic business value?", McKinsey & Company, Digital McKinsey, https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/blockchain-beyond- the-hype-what-is-the-strategic-business-value, accessed on 13 January 2019

7 WCO-WTO paper "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective", 2021

Figure 3: Current and future adoption of the case studies



Source: IDATE Digiworld 2019[8]

Although blockchain technology presents interesting features in terms of security, immutability, transparency, traceability and automation, its wide-scale deployment currently hinges on various challenges (see also Box 3). Scalability remains limited, existing blockchain networks and platforms do not "talk" to one another, and there are a number of unresolved legal issues, ranging from the legal status of blockchain transactions to the question of liability.[9]

It might also be asked whether blockchains are truly impenetrable to cyber security issues. Last but not least, implementing blockchain systems can be relatively more costly.

8 *Scientific Foresight Unit (STOA), EPRS | European Parliamentary Research Service, "Blockchain for Supply Chains and International Trade" (2020), https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641544/EPRS_STU(2020)641544_EN.pdf*

9 *WTO World Trade Report 2018: https://www.wto.org/english/res_e/publications_e/world_trade_report18_e.pdf*

Figure 4: Five blockchain myths

Five common blockchain myths create misconceptions about the advantages and limitation of the technology.

	Myth	Reality	
1	**Blockchain is Bitcoin**	● Bitcoin is just one-crypto-currency application of blockchain	● Blockchain technology can be used and configured for many other applications
2	**Blockchain is better than traditional databases**	● Blockchain's advantages come with significant technical trade-offs that mean traditional databases often still perform better	● Blockchain is particularly valuable in low-trust environments where participants can't trade directly or lack an intermediary
3	**Blockchain is immutable or tamper-proof**	● Blockchain data structure is append only, so data can't be removed	● Blockchain could be tampered with if >50% of the network-computing power is controlled and all previous transactions are rewritten – which is largely impractical
4	**Blockchain is 100% secure**	● Blockchain uses immutable data structures, such as protected cryptography	● Overall blockchain system security depends on the adjacent applications – which have been attacked and breached
5	**Blockchain is a "truth machine"**	● Blockchain can verify all transactions and data entirely contained on and native to blockchain (eg. Bitcoin)	● Blockchain cannot assess whether an external input is accurate or "truthful" – this applies to all off-chain assets and data digitally represented on blockchain

Source: Digital McKinsey

B. Potential use in Customs and border management

Blockchain's potential to facilitate Customs processes is multifaceted, from Customs clearance to inter-agency cooperation, certification, identity management, compliance management, revenue collection and post-clearance audit. Through this technology, the same copy of a ledger is instantly available to all parties at different nodes in the most updated, trusted, secure and immutable manner, obviating the need to maintain separate ledgers by each party as per the current practice.

Considering the potential of blockchain technology, the WCO and the WTO have been exploring the use of this technology in the Customs domain for the last few years (see Box 2 below).

Box 2: Discussions on blockchain at the WCO and the WTO

WCO

An exploratory discussion was held at the April 2017 Permanent Technical Committee (PTC) meeting, where IBM shared its perspective and the preliminary outcomes of the pilot, Global Trade Digitization (GTD), which later grew into TradeLens, a joint venture between IBM and Maersk.

Following that, this topic was discussed from a more technical perspective at the May 2017 Information Management Sub-Committee (IMSC) meeting, and in most of the WCO technology conferences and WCO working body meetings that followed. The May 2017 IMSC explored potential opportunities for the use of blockchain technology, and suggested collecting case studies and outcomes of pilots and other emerging initiatives concerning its use in regulatory and supply chain management processes. It also identified several case studies of blockchain technology in Customs business processes and overall supply chain management for carrying out future work through engagement with relevant stakeholders and technology experts/solution providers.

Furthermore, in June 2018, the WCO issued Research Paper No. 45 "Unveiling the Potential of Blockchain for Customs" to identify possible case studies and uses of blockchain for Customs and other border agencies, with a view to improving compliance, trade facilitation, and fraud detection, while touching on associated adjustments in legal and regulatory frameworks. The research paper elaborated the above concepts in more detail.

More recently, at its December 2021 meeting, the Policy Commission endorsed the launch of a Feasibility Study on a Global Customs Data Exchange Platform which is intended to be based on blockchain technology. This clearly indicates the interest of the WCO Membership in making use of this technology and its benefits.

WTO

A research workshop held at the end of 2018 explored the potential of blockchain/DLT to facilitate trade finance processes, transportation and logistics, and border procedures. A number of case studies were presented to highlight the potential of the technology. The workshop also discussed challenges raised by the use of blockchain for trade. Discussions highlighted the need for greater coordination between all stakeholders to address interoperability and regulatory challenges.

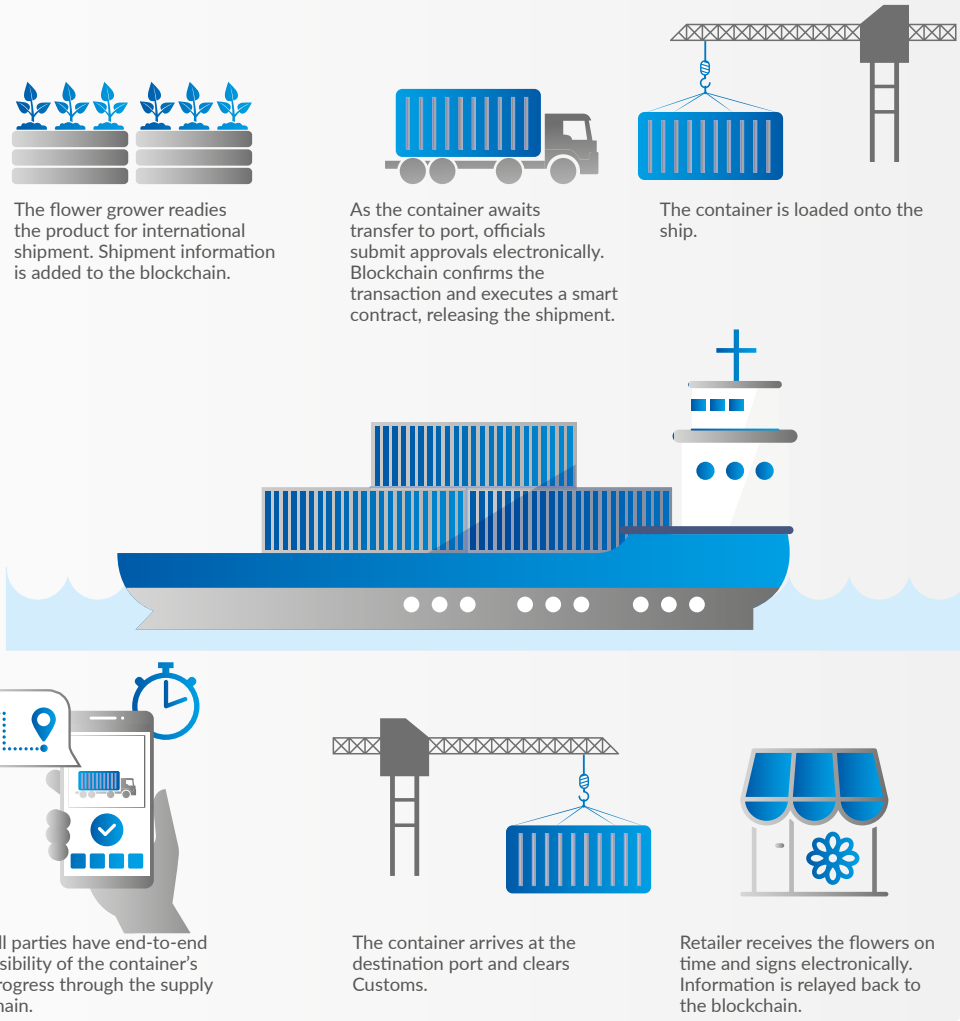
Following that, two Global Trade & Blockchain Forums were organized in 2019 and 2021. The 2019 Global Trade & Blockchain Forum provided an update on case studies aimed at facilitating international trade using blockchain, in trade finance, transportation and logistics, and border procedures. It also explored the potential of the technology for trade in agriculture and intellectual property, and introduced the current patent landscape of blockchain-related innovations, its trends, and new challenges arising. A session on standards addressed whether disruptive technologies, including blockchain, might lower the cost of certification for MSMEs and developing countries or whether they might create new barriers, the challenges that might arise as many standards were being developed in different organizations, how regulators would deal with risks, and the need for cooperation. The session discussed examples such as self-driving vehicles, pharmaceuticals, and agriculture, and highlighted the importance of coherent standards development across the Internet of Things, autonomous systems, and blockchain. Discussions highlighted the need for multilateral work on interoperability/standardization, the regulatory framework, awareness raising and capacity building. The importance of fostering a multi-stakeholder dialogue was stressed.

Continuation box 2: Discussions on blockchain at the WCO and the WTO

The 2021 Global Trade & Blockchain Forum explored the opportunities that blockchain opens to enhance transparency and efficiency of supply chains, and discussed issues related to digital identity and trade and how trade agreements could be leveraged to develop a common framework for digital identities. Speakers also noted the need to accelerate work on standardization, and called on governments to quickly put in place regulation on e-signatures and electronic transferable records.

Figure 5: Blockchain – a shared, distributed ledger

Blockchain – a shared, distributed ledger – can trade the container's path through the supply chain with exceptional transparency and security.



Source: IBM[10]

10 *W. Lehmacher, "Why blockchain should be global trade's next port of call" (2017), World Economic Forum, https://www.weforum.org/agenda/2017/05/blockchain-ports-global-trades/, accessed on 13 January 2019*

As for the Customs administrations and other border agencies, solutions based on blockchain can significantly improve their capacity for risk analysis and targeting, thus contributing to greater trade facilitation.

Blockchain technology can potentially be used in Customs business processes to validate the transactions/actions of different parties in the international supply chain through permissioned blockchains - clearly defining roles, responsibilities, levels of access, and validation rights for each party. It could equip Customs with the necessary tools to tackle problems of compliance, as it provides an unbiased tool essentially designed for uploading and sharing information between unrelated parties. This can help in the end-to-end integrated supply chain management in a transparent and trusted manner.

As for the Customs administrations and other border agencies, solutions based on blockchain can significantly improve their capacity for risk analysis and targeting, thus contributing to greater trade facilitation.

Going forward, the following specific case studies in Customs and border processes have been identified for future work:

Customs declaration

Creation of Customs declaration documents is a very complex task, involving multifarious activities. There are challenges in collating (often manually) the correct information from various documents and various stakeholders, such as sales data, product information, manufacturing details and logistics information. Owing to outsourced services and distributed data sources, this process is cumbersome and involves a potential risk of non-compliance. In many cases, traders involve third-party providers to handle the Customs declaration process.

Blockchains can help collect all the information required from ordering, preparing and shipping the products in a common ledger. Ideally, this would require trade documents to be used in electronic format and different stakeholders in the supply chain to be part of a blockchain, allowing for provision of information from the most reliable sources. Customs could automatically pull the information required for a Customs declaration from the primary sources, which would have the benefit of improved data quality and immutability.

This would provide benefits on the trader side due to a significant reduction in the work needed to accurately assemble the pieces of information required for Customs processing, and on the Customs side by reducing the manual verification processes and hence the resources required to validate declarations. This would lead to faster Customs declaration processing and reduced end-to-end lead time, provided data is submitted in a standard format to minimize the need for reconciliation and facilitate processing.

The pilots carried out to date have not involved a sufficient number of stakeholders to allow for processing of Customs declarations via a blockchain platform, but some are working towards that end (see the Usyncro case study in the Annex to this Study Report).

Inter-agency cooperation: exchange of information

There are several challenges in receiving advance electronic information and sharing it with other government agencies. There could be issues with data quality, data not being submitted in time, and potential inadvertent or deliberate mistakes in data due to it changing through multiple hands.

Blockchains can help overcome some of these challenges. Data sharing through "permissioned" blockchains (a distributed architecture) in a trusted and secure manner can help realize the vision of an end-to-end "data pipeline". This kind of blockchain can be operated by supply-chain consortia, accessed and updated by all participants. Customs and other government agencies can secure accurate data, right from the source.

Given the global security environment, and the renewed focus on trade facilitation with the implementation of the WTO Agreement on Trade Facilitation (TFA), there is a greater need for different government agencies to cooperate more effectively. Blockchains may open up new pos-

sibilities for these different agencies, including Customs, to share information and resources by using a common distributed technical platform, especially in a Single Window environment[11] as well as new options for cross-border data exchange, such as between and among different Single Window or within a Globally Networked Customs (GNC) Utility Block (UB).[12] This could be a good case study for blockchain technology if all participants had a specific identifier code throughout the transactions, bearing in mind that one of the common challenges associated with this is that the entities are often given different names by different agencies.

In a growing digital economy, this technology can also help enhance cooperation between Customs and Tax authorities and the exchange of information between them, producing a more harmonized approach to revenue collection, audit and risk management, as well as to the issue of Customs valuation and transfer pricing.

Electronic certification/verification of regulatory requirements

Traders must comply with a number of requirements, such as non-tariff requirements. There are increasing obligations for product certification in view of growing concerns about product quality and safety. Various licences, permits, certificates, and other authorizations (LPCO) may be required for Customs clearance, depending on the nature of goods and the related national regulatory requirements.

Several pieces of data are needed, including, for example, data concerning the certification of inputs to products (e.g. intellectual property rights (IPR) of products, IPR of inputs/constituents). Furthermore, a number of associated activities are carried out by various stakeholders such as certifiers, laboratories, producers, regulators and consumers. But often this information is not shared between all of the stakeholders concerned, leading to an iterative process of information gathering and carrying out the necessary certification and verification.

Blockchain technology can be very useful in terms of managing the identity of multiple stakeholders and customers in a supply chain (particularly in the e-commerce environment).

Blockchains can help overcome some of these challenges through holistic product lifecycle data management. The community of producers, laboratories, logistics players, regulators, and consumers can all join hands on a blockchain, providing a shared provenance, testing, certification, licensing, etc. with all relevant actors having full access to all related information.

Furthermore, the blockchain can enable the implementation of electronic certification of LPCO, such as e-Phyto certificates and e-Certificates of Origin (e-CoO) in a more efficient, secure and trusted manner. It could ensure that a certificate is issued appropriately, and signed properly and digitally by a valid regulatory/issuing agency, and at the same time could also prevent any alteration/manipulation of the content or misuse of an e-certificate by a third party.

We have already seen a significant number of projects that are aimed at implementing electronic certification and their validation, such as in the case of e-Certificates of Origin.

Identity management

Blockchain technology can be very useful in terms of managing the identity of multiple stakeholders and customers in a supply chain (particularly in

11 http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/single-window-guidelines.aspx
12 http://www.wcoomd.org/en/topics/facilitation/activities-and-programmes/gnc.aspx

the e-commerce environment). By moving away from centralized data management, it gives users control over their identity (known as self-sovereign identity) and enables them to limit the sharing of identity data to what is strictly necessary. Blockchain enables more secure management and storage of digital identities. It also presents interesting opportunities to facilitate the verification and management of identities across borders and offers concrete advantages for the implementation of mutual recognition agreements on AEO, for example, as the Cadena and bconnect projects in Latin America demonstrate.

Revenue collection

Blockchain technology could enable any intermediary in the supply chain to collect revenue on behalf of governments, potentially allowing duties and taxes to be automatically transferred to the respective authorities using smart contracts. This could be useful when implementing new models of revenue collection on low-value and small shipments (e.g. vendor collection or intermediary collection) in the e-commerce environment.

Lack of transparency along the supply chain causes a number of concerns, including that the prices paid might be an inaccurate reflection of the true value, with repercussions on revenue. The greater transparency in, and traceability along, the supply chain that blockchain enables could help address issues of undervaluation and misdeclaration.

Compliance management

Blockchain could prove the provenance of data, reduce fraud, and enhance visibility in the supply chain, for example by providing access to the commercial documents, starting with the initial purchase order between the parties.

Blockchain can help mitigate and eliminate risks around food security, conflict minerals, counterfeit goods, forced and child labour, corruption and so forth. Furthermore, it can assist in IPR management, providing transparent processes in the registration of IPR, associated authorizations, enforcement, and taxation issues.

Post-clearance audit

Another potential case study of the blockchain is in the audit of Customs declarations and associated transactions and documents, in particular system-based holistic audit with an opportunity to look into each and every transactional trail (as needed).

Prerequisites to take into consideration

To enable the future use of this technology by Customs, including the associated requirements in terms of investments, resources and capabilities, there is a need firstly to become familiarized with the technology, and then to explore whether and for what purposes it could be used, as well as identifying the minimum data needed for the various regulatory processes. A dashboard is needed to access the data; this could be connected to the blockchain platform through the API to allow Customs and other agencies to pull the required data. This could offer unparalleled confidence about the provenance of data and enhanced visibility in the supply chain, for example by accessing the commercial documents starting from the initial purchase order.

Blockchain could prove the provenance of data, reduce fraud, and enhance visibility in the supply chain, for example by providing access to the commercial documents, starting with the initial purchase order between the parties.

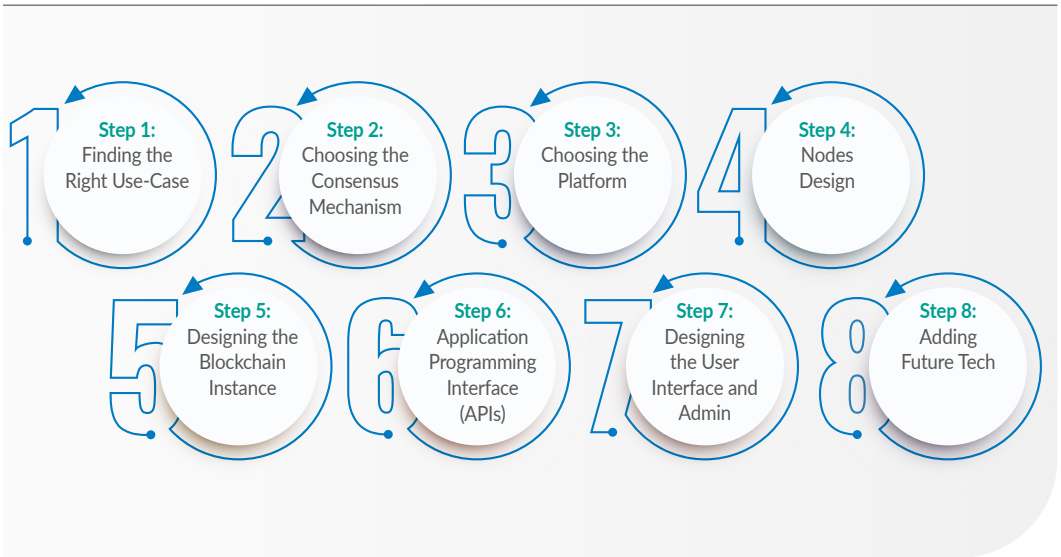
The WCO and the WTO will continue monitoring related developments on how the industry is using blockchain to provide guidance to Members and help them to prepare themselves, depending on their strategic imperatives and priorities.

As for the use of blockchain as an alternative payment solution, there are various blockchain-enabled payment solutions (the most well-known being Bitcoin). These solutions were designed to be equivalent to cash - completely decentral-

ized and anonymous monetary exchanges. These features could be easily exploited by criminals to move money around. In this context, understanding these unregulated currencies and how they work is important from a risk-management point of view. However, other electronic payment solutions are being built on blockchain that are not anonymous. Various banks and money transfer organizations are looking at using blockchain technology to create electronic payment solutions with a robust regulatory framework, in which the identity of an individual or company is meticulously authenticated. This has several benefits: for example, the blockchain could facilitate, in a couple of minutes, the negotiation of credit, a process which normally takes around two to three days. An increasing number of trade finance projects also leverage the blockchain technology. Most major banks involved in trade finance and a large number of fintechs and start-ups are developing blockchain-based solutions to facilitate trade finance processes like letters of credit, open account transactions, or supply chain finance.

Blockchain is essentially a network, rather than a stand-alone IT system. Therefore, implementing blockchain for Customs may mean that Customs participate in an existing blockchain applications, or create an initiative to introduce a new blockchain app.

Figure 6: #8 Steps to build a blockchain solution



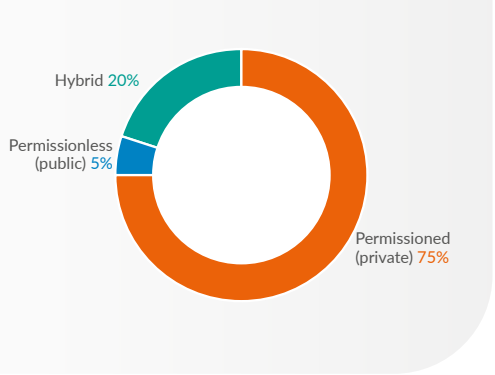
Source: Entrepreneur Europe[13]

13 *Entrepreneur Europe, 9 September 2017:* https://www.entrepreneur.com/article/300077

C. Implementation by Customs in 2021

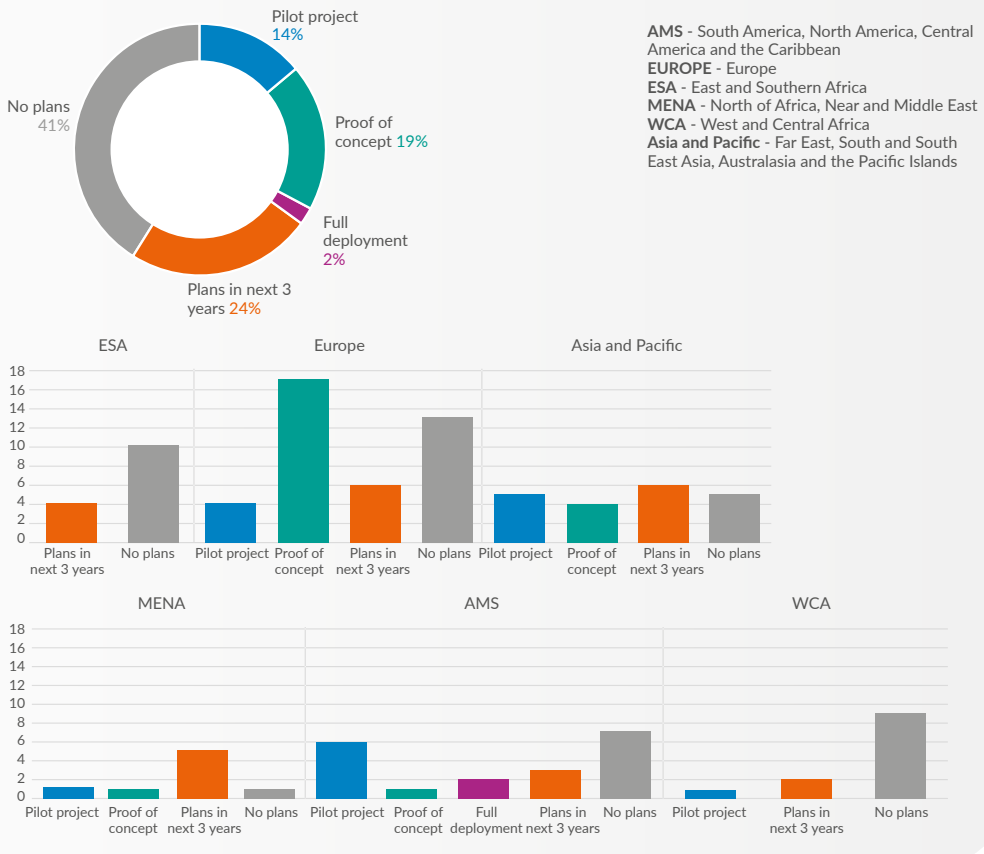
According to the results received through the WCO's 2021 Annual Consolidated Survey and the WCO-WTO paper "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective", blockchain/DLT is still in an experimental phase for Customs, with around a third of Customs authorities who responded testing it through proofs of concept (22 Members) and pilot projects (15 Members) using mainly private (permissioned) blockchains, while only two Customs administrations (Argentina and Uruguay) have reported a full deployment of this technology. Twenty-six Customs authorities have plans for this technology in the next three years, while another 45 Members have indicated that they have no plans in place yet.

Figure 7: Types of blockchain in use



Note: Total respondents numbered 44.

Figure 8: Stage of adoption of blockchain



Note: Total respondents numbered 110.

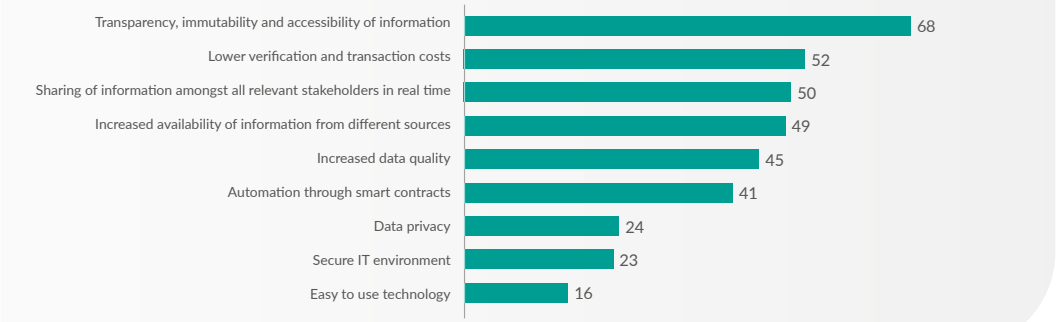
Benefits and challenges

Members have expressed the hope that the use of blockchain will allow for better transparency, immutability and accessibility of information, and data quality, as well as the sharing of relevant information on border management procedures among all stakeholders.

However, a lack of expertise and good practices, as well as associated costs, are currently posing the biggest challenge to its introduction. Other reasons that could hinder the success of its full deployment could be a lack of standardized datasets used by government agencies and economic operators, a lack of efficient governance systems, and the potential for a proliferation of different blockchain solutions that are not interconnected.

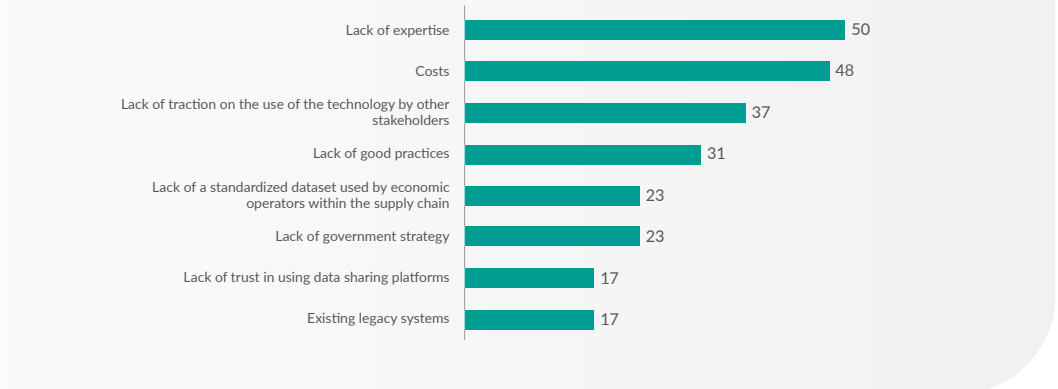
Despite a certain initial hesitancy, Customs administrations are reasonably optimistic concerning blockchain's potential; indeed, through blockchain, they hope to achieve greater efficiency and reliability in the areas of risk management, revenue collection, and trade facilitation. They are also coming to see the importance of partnering early with industry to ensure that the projects realize the benefits of the use of blockchain technologies in the trading environment, while at the same time addressing the barriers to this.

Figure 9: Main benefits of introducing blockchain



Note: Total respondents numbered 87.

Figure 10: Main obstacles to adopting blockchain



Note: Total respondents numbered 95.

Box 3: Other common general concerns raised

Many issues need to be discussed in view of the challenges in bringing blockchain technology into practice. These issues will still need to be looked into as part of the many ongoing pilot programmes. They include questions relating to security and privacy, for example. Each ledger is cryptographically secured so that people are prevented from tampering with current and past transactions. This kind of tamper-proof transaction record has become a source of trust in all the transaction history data embedded in a particular computerized network. Unlike cryptocurrencies (represented by Bitcoin), whose owners do not behave as individuals within the network, other kinds of blockchain applications are not immune to the possible outflow of personal or confidential information. In the words of a Deloitte report, many such applications "require smart transactions and contracts to be indisputably linked to known identities, and thus raise important questions about privacy and the security of the data stored and accessible on the shared ledger". In theory, blockchains have a notable security flaw: if more than half of the computers working as nodes to serve the network tell a lie, the lie will become the truth. This is called a "51% attack" – the potential defect of blockchains, inter alia, of Bitcoin – that could occur particularly in the process of "mining". More specifically, when the majority of the network's computing power has been taken over by an attacker or a group of) attackers, it is prevented from spotting and rejecting a fraudulent version of a public ledger.

Another concern relates to the decentralized nature of public blockchains; the network lacks a centralized overview function and therefore has no effective trouble-shooter that will work in the event of a contingency, thus reducing the resilience of the overall system. In other words, each participant could suffer directly from external shocks. This is less of an issue in the case of private and consortium-permissioned blockchains whose participants are known and whose governance rules have been agreed as part of the design of the platform.

Another often debated issue is the question of scalability. Public blockchains like Bitcoin are often criticized for their lack of scalability due in part to the consensus protocol used to validate the blocks. New generations of public blockchains, such as Cardano, are trying to address this issue. It is also worth noting that because they are more centralized, private blockchains do not present the same scalability challenges. Ultimately, a choice often has to be made between scalability, decentralization and security. This is what Vitalik Buterin, the co-founder of the Ethereum blockchain, called the "blockchain trilemma", the improbability of a blockchain obtaining all three of these three properties at the same time. Improving one of these three aspects would mean that the other two are likely to be compromised to some degree.

Interoperability is another issue that needs to be resolved. In the context of supply chains, blockchain is expected to bridge different supply chain parties and processes to increase the overall supply chain efficiency. The proliferation of blockchain networks that use different distributed ledger technologies and are governed by different rules has led to digital islands.

Areas of implementation

Customs authorities are involved in a number of projects and Proofs of Concept (PoCs) that are intended to bring improvements in the following areas: (i) information exchange and interoperability at national and international levels (including at the level of Customs Unions); (ii) the development of international Single Window interconnectivity, ensuring proper validation of certificates (including certificates of origin, quality, sustainability, non-toxicity); (iii) information sharing on AEOs and within e-commerce environments; and (iv) ensuring access to logistics-related information in view of tracking and tracing goods along global supply chains. Numerous advantages have been observed by administrations taking part in these pilot projects, such as expedited processing, better data quality, transaction transparency, enhanced targeting, and easier access to importers. In other cases, however, Customs sometimes lack an incentive to join blockchain projects in cases where there are insufficient numbers of participants to provide the information required.

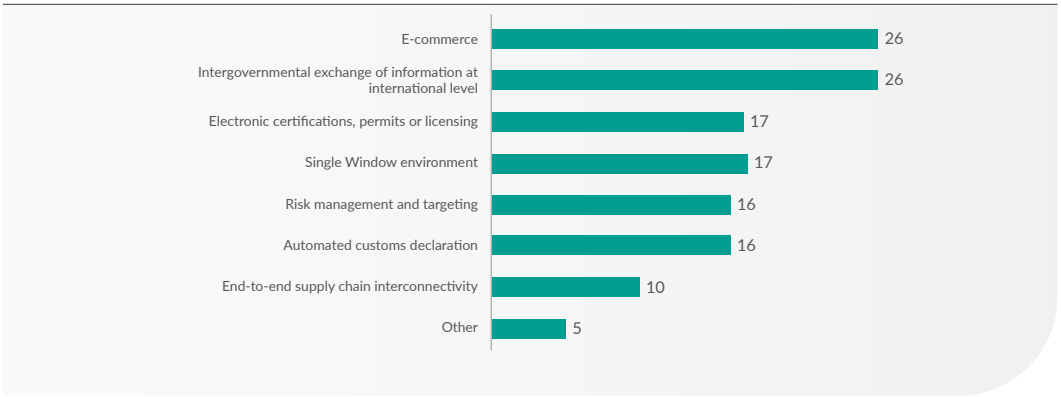
Ongoing projects

Most of the blockchain projects are being implemented in Europe, Asia/Pacific, and the Americas and Caribbean regions. Some of these projects are elaborated in more detail in the Annex to this Study Report.

In the European region, blockchain is used for the purposes of VAT collection, protection of geographical indications, and certification of product origin. Several ongoing pilot projects and PoCs are being tested.

For example, the EU Member States are exploring the use of blockchain for the sharing of VAT information between taxation and Customs authorities through the SEED-on-Blockchain project coordinated by the European Commission (DG TAXUD). Furthermore, blockchain can automate VAT payments via smart contracts, including payment of VAT to the tax authorities and from the tax authorities to a company, thus accelerating VAT collection and reducing payment delays.

Figure 11: Project areas



Note: Total respondents numbered 44.

In June 2021, Italy launched the blockchain project TRICK which provides for the certification of high-quality manufacturing products, with the objective of placing on the market products that have already been certified at various levels, from sustainability certification, with materials deriving from a sustainable economy, to chemical certification of non-toxicity, to certification of origin of the goods.

Georgia has launched a project for issuing and validating preferential Certificates of Origin using a blockchain.

In the Asia/Pacific region, blockchain technology is used to exchange Customs declarations and documents, as well as logistics-related information with a view to tracking and tracing goods/parts and transport units throughout global supply chains.

China and Singapore Customs are cooperating in developing an International Trade Single Window Interconnection Consortium Blockchain, exchanging information on clearance and logistics/cargo status, to further leverage the role of a Single Window in improving the port business environment and trade facilitation.

Hong Kong Customs is conducting a PoC study in applying blockchain to a licence management system, while Malaysia is piloting the use of blockchain to provide more efficient AEO services.

A blockchain PoC was conducted under the auspices of the Singapore-Australia Digital Economy Agreement to achieve document interoperability for cross-border paperless trade, allowing for the issuance and verification of Certificates of Origin, in accordance with an interoperability framework, the so-called TradeTrust framework.

In the Americas and Caribbean region, blockchain is to a large extent used to facilitate information exchange on AEOs, but there are other case studies as well.

The CADENA project, implemented by Customs administrations of Bolivia, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico and Peru, and with the support of the Inter-American Development Bank (IDB), allows the use of blockchain as a registration system for AEOs. CADENA is a project using the LACChain ecosystem which provides an infrastructure enabling the development of different blockchain-based applications/projects in Latin America and the Caribbean region. LACChain represents a global public-private alliance promoted by the IDB Innovation Laboratory.

Another project aimed at exchanging information on AEOs is Mercosur's bConnect Project, which deploys Blockchain Private Hyperledger Fabric 1.4. The following Member countries are part of the bConnect system: Argentina, Bolivia, Brazil, Paraguay, and Uruguay.

Guatemala is working on the development of a new maritime and air dispatch model, which is based on blockchain technology, taking as a reference the Port Community Systems (PCS). The project aims to automate exports in the Customs Terminal in Sea Port Application Performance Management (APM), and to develop web services for the exchange of information with other terminals.

Numerous advantages have been observed by administrations taking part in these pilot projects, such as expedited processing, better data quality, transaction transparency, enhanced targeting, and easier access to importers.

United States Customs and Border Protection (CBP) conducted the North American Free Trade Agreement/Central America Free Trade Agreement (NAFTA/CAFTA) PoC in September 2018, which tested the application of blockchain technology for the entry/import summary declaration submission process for NAFTA/CAFTA entries. Furthermore, in September 2019, CBP conducted the Intellectual Property Rights PoC, which tested a blockchain technology in facilitating shipments based on known licensing relationships.

In the MENA region, blockchain is used to exchange Customs declarations and documents, such as Certificates of Origin.

Moroccan Customs has launched a cooperation project with DHL and the German International Cooperation Agency with a view to developing a platform relying on blockchain technology for collecting the data of each party to an international transaction (traders, express mail service, Customs, other stakeholders) and sharing it.

Customs authorities are involved in a number of projects and Proofs of Concept (PoCs) that are intended to bring improvements in many areas.

The United Arab Emirates and Dubai Customs have developed a cross-border e-commerce platform based on blockchain technology to facilitate and track e-commerce movements, within the network of Customs, e-commerce companies, ports, couriers, third-party logistics, free zone authorities, and permit-issuing authorities.

In the ESA region, one Member (Mauritius) has reported that it is discussing with potential suppliers the implementation of a project for tracking Certificates of Origin using blockchain technology, while in the WCA region, Customs authorities are waiting for the relevant capacity and knowledge to be developed before moving forward with a blockchain agenda.

A number of Customs administrations globally have partnered with the TradeLens consortium, already mentioned above, in order to pilot the use of its platform based on blockchain technology. These are: Azerbaijan, Canada, China, Indonesia, Jordan, Malaysia, the Netherlands, Russia, Saudi Arabia, Singapore, Thailand and Ukraine.

Canada Border Services Agency (CBSA) provided feedback on the pilot projects carried out with TradeLens. They found that, while there was an increase in the visibility and traceability of a container, additional data was limited or not available. As per the CBSA's assessment, the platform currently lacks a useful volume of participants (specifically cargo owners/vendors, Customs brokers, and maritime freight carriers). Due to the limited number of participants involved in the platform at the time of the CBSA evaluation, and the fact that the information input by stakeholders was voluntary (that is, no legal or regulatory obligations), the amount of content and data quality was inconsistent and relied entirely upon the submitter's technical ability to provide such information and to do so at their own discretion. Also, while CBSA had an interest in the movement of containers and their origin provided by TradeLens, it was not truly the information that was required for it to conduct its core mission. Border management required more information than was currently available in TradeLens, such as importer declarations and manifest information, that goes beyond what is required to enable the movement of goods.

2. Internet of Things (IoT)

A. What is IoT?

The Internet of Things, or IoT, is the internetworking of physical devices (also referred to as "connected devices" and "smart devices"), vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Simply put, the IoT transforms physical objects into smart devices to communicate, as well as interpret, information from their surroundings. It is used to make our lives more comfortable, and our businesses more efficient and less costly.

Although it has not yet achieved mainstream acceptance, over recent years the IoT has been gaining more traction. Connected machines, such as ATMs and airline check-in machines, have been in use for many years now. But new and novel devices, and many ordinary objects, are now being reinvented with digital sensing, computing and communications capabilities. The IoT has incorporated many kinds of physical goods (e.g. home appliances, security cameras and garbage containers) into big data applications. The practical examples of IoT deployment range from smart fitness bracelets to driverless vehicles.

The IoT has become a powerful force for business transformation, and its disruptive impact is already being felt across all industries and all areas of society. This sudden expansion boosts the economic impact of the IoT as consumers, businesses, city authorities, hospitals and many other entities find new ways in which to exploit the technology. Statista[14] estimates that, by 2025, the IoT will be made up of over 30 billion devices worldwide (more than four devices per person).

Smart devices for household applications may be the main focus of IoT, which will offer a smart home where all electronic devices are connected, capable of communicating with each other and sending information whenever necessary.

For example, sensors in the walls will be able to detect your presence in the room and control the air conditioner's temperature. Smart sensors attached to the door will help to open and close the door once someone reaches its vicinity. They will also be able to trigger some actions such as turning the lights in the room on or off or adjusting the airflow to the room. Smart water-level sensors will be able to monitor the use of water and control the flow of water in an appropriate manner, etc.

A smart city uses technology to improve the efficiency of its services. IoT allows city officials to interact directly with the community and the city infrastructure, and to monitor what is happening in the city, how the city is evolving and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data is collected from citizens and devices and then processed and analysed.

Ultimately, the objective of smart cities is to increase efficiency and reduce costs and consumption. Smart city applications are also being developed to manage urban flows and allow for real-time responses. A smart city may therefore be more prepared to respond to challenges.

14 *Global IoT and non-IoT connections 2010-2025 | Statista*

A smart city can include energy and water management, smart lighting, predictive life maintenance for elevators, traffic monitoring etc. Examples of Smart City technologies and programmes have been implemented in Milton Keynes, Southampton, Amsterdam, Barcelona, Madrid and Stockholm, and in China. In Singapore, a Smart Nation Sensor Platform will be implemented to improve municipal services, city-level operations, planning and security, for a smarter, greener and more liveable city.

Now we are able to connect our cars with smartphones and specially designed applications can be used to perform certain tasks. Many sensors in the car collect information and send it to a service team or manufacturer's database. This data will help manufacturers to track and monitor how individual units perform. It will also help the design team to continuously improve their product. IoT can also be used in other areas such as healthcare, smart farming, and wearable technology (smart watches) etc.

However, there are risks. Each device which is connected to the IoT increases privacy and security concerns. These range from hackers stealing our data and even threatening our lives to how corporations can easily inadvertently expose or misuse private data we provide them with. Hackers could potentially take control of cars and remotely accelerate or decelerate them, or take control of baby monitors or other home appliances etc.

The fundamental security weakness of the IoT is that it increases the number of devices behind the network's firewall. Fifteen years ago, most of us only had to worry about protecting our computers. Ten years ago, we had to worry about protecting our smartphones as well. Now we have to worry about protecting our car, our home appliances, our wearable devices, and many other IoT devices.

Companies pressured to get their devices out in the market quickly end up compromising on security. Even if they offer firmware upgrades for a while, they often stop when they focus on constructing the next device, leaving customers with slightly outdated hardware that can become a security risk, or suffer compatibility issues. Furthermore, connecting large numbers of new devices to the Internet can create serious bottlenecks in telecommunication systems.

B. Links between IoT and other technologies

There is a very logical link between the different disruptive technologies which needs to be kept in mind when considering how one or more of these technologies can be used to support a certain business. The latest technologies are rarely unrelated, and generally support each other in one way or another. For example: mobile technologies are incorporating more and more artificial intelligence (AI) and machine learning to improve client service; IoT relies to a large extent on the Internet and cloud computing; AI relies on IoT data, especially for real-time responses (e.g. for autonomous vehicles), the execution of smart contracts also relies on IoT data, etc. Some interesting examples are provided below.

The IoT has become a powerful force for business transformation, and its disruptive impact is already being felt across all industries and all areas.

IoT and robotics

IoT can prove very advantageous in supporting robotics. For example, Asea Brown Boveri (ABB) has been finding ways to integrate all of the sen-

sors and devices on a manufacturing shop floor to improve all areas of their operations, including reducing the downtime of robots, improving the reliability of systems and optimizing processes.

There are great benefits when every robot is able to store and analyse its own usage data, then is able to communicate that data smartly to other connected devices. For example, it means that ABB does not have to schedule the maintenance of a robot by a simple, old- fashioned "after 10,000 hours of uptime", which might be overly conservative. Instead, the robot itself can monitor its own actual usage and report on its performance. ABB can schedule maintenance of the robot at the perfect time to avoid interfering with its operations, by looking at when the robot is actually used most. It can also mean that potential problems are addressed in a timely manner.

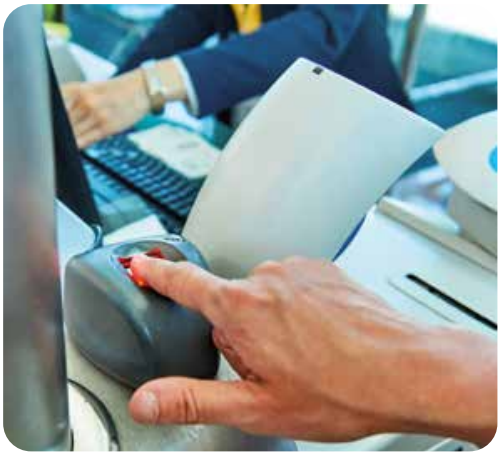
The recent upsurge of the "smart" or "connected factory" has become a modern solution to rising productivity needs, where the technology employed seeks to connect data, people, and machines into a coherent system. These new systems have, so far, shown an increase in labour productivity, factory capacity utilization, and production by offering new data-driven insights as to how factories and suppliers can optimize their processes in near real-time or real-time. Alongside IoT and robotics, artificial intelligence and machine learning (cognitive process automation) are playing a key role in what has been called the Fourth Industrial Revolution. As a 2019 Deloitte study revealed, "85% of study respondents believe smart factory initiatives will be the main driver of manufacturing competitiveness in the next five years, and 83% say they will transform the way products are made in five years."[15]

In 2014, KUKA integrated with Microsoft's Azure IoT platform to create a "connected factory" of 60,000 devices and 259 robots. Over the last few years, Amazon Web Services (AWS) has introduced several cloud-based automation and robotics services, namely RoboMaker in 2018 and IoT RoboRunner in 2021. AWS IoT RoboRunner service provides clients with the capacity to build and deploy applications that manage their robot fleets and optimize tasks carried out by different devices.[16] These applications show that IoT concepts can be well and truly integrated into industrial robotics.

IoT and biometrics

With the growth of IoT and biometric technology, authentication is being completely reimagined in smart homes, smart cars etc. Passwords and PINs are easily forgotten or guessed, but no two people have the same biometric indicators. Enterprises across sectors are looking to biometrics for their authentication needs. People always have their fingerprint, face or iris with them. The latest smartphones, as well as many new desktop and laptop computers, already contain embedded biometric sensors.

However, biometric authentication introduces a major concern for companies: that of protecting biometric data. Traditionally, biometric data is stored in one location and if someone wants to authenticate access to a system they provide their unique information, which is then compared to the database. There is a core defect with this, however; it creates a central repository of sensitive data that is a valuable target for malicious activity. But there are solutions to such issues. For example, biometric tokenization operates similarly to the form of encryption commonly used to secure payment card numbers and other sensitive information. When implemented properly, biometric authentication can be used for a connected home, connected car, and smart locks.



15 *Wellener, Paul. 2020. How Smart Factories Can Ignite Productivity. Wall Street Journal, https://deloitte.wsj.com/articles/how-smart-factories-can-ignite-productivity-01580760126*

16 *https://aws.amazon.com/blogs/aws/preview-aws-iot-roborunner-for-building-robot-fleet-management-applications/*

IoT and virtual reality

Virtual reality (VR) and IoT share a similar basic philosophy and purpose. Both involve the merging of the physical and the digital world. By combining VR and IoT, two innovators have created what could be the next step in how we communicate with each other over long distances. The two products, Empathy VR and the OdenVR Telepresence Robot pair a virtual-reality head-mounted display with a highly mobile remote-controlled robot. The ability to both look and move freely within a real-world space creates a very strong illusion of actually being present. These new capabilities have also led to virtual-reality chat rooms where users can roam around a digital landscape via an avatar they create and customize. This can be seen with new collaboration platforms like Spatial, which promises the use of augmented and virtual realities to turn physical rooms into 3D workspaces using headsets like Microsoft's HoloLens and the Magic Leap One.[17]

One of the most dramatic confluences of VR and IoT has been the technologies used in the healthcare field. Robotic-assisted surgery is already in use across the world using innovations like the da Vinci surgical system. Using a tiny camera and precision surgical tools, the da Vinci system allows a surgeon to perform minimally invasive surgery from a control console. By inserting the camera and tools through a comparatively small opening in the body, the surgeon can gain a full view of the operating area without subjecting the patient to the trauma of a large incision.

New advances in the field of robotics and communication technology have also offered a glimpse of the revolutionary changes that will affect several service industries. Technologies facilitating telepresence and telerobotics will enable users to remotely operate complex machinery, namely robots, to fulfil highly skilled and specialized tasks. While the da Vinci surgical system mentioned above requires a surgeon to directly operate the system, telesurgery capabilities will allow surgeons to perform operations in complicated or out-of-reach areas such as conflict zones, space stations, or (remote) areas lacking qualified/experienced professionals.[18]

The fusion of IoT and AI includes smart sensors (or intelligent sensors) which provide real-time data and feedback information fulfilling a number of different capabilities.

IoT and artificial intelligence & machine learning

IoT relies on sensors across assets and goods, which transmit signals to core systems. This results in a massive amount of data being recorded and analysed every millisecond, and businesses need the right systems to understand it. The smartest businesses use this data in combination with AI and ML to enable evidence-based prediction of what will be needed, when and where.

The fusion of IoT and AI includes smart sensors (or intelligent sensors) which provide real-time data and feedback information fulfilling a number of different capabilities:

- Predictive: real-time data can be analysed to determine when a large piece of machinery or equipment will break down, enabling the failure to be prevented through proactive intervention.
- Prescriptive: intelligent sensors can suggest immediate action sometimes in remote areas, thus avoiding outages and even disasters. For example, sensors on railway tracks can warn the control centre of any track failures.
- Adaptive/autonomous: continuous data feeds from sensors can enable systems to learn the right actions to take autonomously. For example, in a healthcare context, blood glucose sensors can automatically change the level of insulin delivered in response to patient needs. Similarly, monorail systems in many airports and cities run autonomously without any human drivers.

17 *https://www.vox.com/recode/2020/9/15/21434946/augmented-reality-future-remote-work-spatial-zoom-calls-feel-like-real-life*
18 *WTO 2018 World Trade Report, p. 87*

IoT and blockchain technology

One of the key links in this case is that blockchain technology can improve the security of information in the IoT and reduce costs. Namely, with blockchain technology, IoT data can be managed without setting up a complex and expensive centralized IT infrastructure where devices rely on a central cloud server to identify and authenticate individual devices. With every legitimate node being registered on the blockchain, devices will easily be able to identify and authenticate each other without the need for central brokers or certification authorities, and the network will be scalable to support billions of devices without the need for additional resources. IoT devices will be able to interconnect in a reliable way while avoiding threats such as device spoofing and impersonation. On the other hand, smart contracts often use data generated by IoT devices to trigger contract execution.

C. Current use in logistics and supply chain management

Where trade in goods is concerned, stakeholders such as manufacturers, shippers and logistics operators have focused on ensuring that the vast array of data, ranging from personal transaction history to the location of containerized goods, can be put to practical use, with a view to providing quality service and enhancing the connectivity to be reflected in the supply chain. A survey by GT Nexus and Capgemini found that 70% of retail and manufacturing companies had already started a digital transformation project in their supply chain and logistics operations.

Asset tracking has become extremely important in supply chain management. It gives companies a way to make better decisions and save time and money. IoT is used for monitoring the movement of goods in real time. This includes monitoring the position of the container, which can help voyage optimization. For instance, if there are blockages on a certain road, trucks could be rerouted to save time and money.

Fresh vegetables might last a week with no temperature variation, but not if they warm up for a few hours. According to the Food and Agriculture Organization of the United Nations (FAO), up to one third of food perishes in transit every year. Refrigerated containers (reefer containers) carrying perishable goods are equipped with sensors measuring temperature, light and humidity, for example, which will contribute to food safety and prevent/reduce spoilage. The changes in temperature can trigger alerts that will be followed by mitigation action.

Shipping companies like Maersk have partnered with telecommunications companies to develop a real-time remote container management (RCM) system capable of transmitting performance data in order to cut down on lengthy inspection processes.[19] Regarding reefers, these RCM systems relay essential information such as temperature, location, and power supply every hour, which, in turn, allows operators to determine what type of inspection will be required upon docking. This has yielded several operational efficiencies and savings, namely through better asset usage and performance, and faster turnaround times. Thus, through the implementation of smart sensors, digital management systems, and data analytics, logistics companies are now expanding their services from offering the purely physical transportation of trade to also providing value-added advisory services to their clients.[20] Additionally, as trade information becomes digitized and more accessible, special apps can help the customer receiving the goods verify whether the arriving parcel is correct, by using a bar code reader.

IoT has contributed to the growth of e-commerce. It has transformed how people buy – through Omnichannel sales and superfast shipments. Companies such as Amazon and Alibaba are able to deliver within one hour of ordering, and rely on the technology to move every item with accuracy and on time. Amazon warehouse robots show just how much technology and devices/equipment connected through the Internet can contribute to the speedy delivery of goods. Profit-driven companies are taking the most from the technologies

19 *For more information, refer to the WTO World Trade Report 2018*
20 *WTO World Trade Report 2018, p. 67*

to ensure even more profit. Some postal services use smart mailboxes in remote areas to check whether they contain anything and thus avoid a wasted journey for collection.

Asset tracking is not new by any means. Freight and shipping companies have long used barcode scanners to track and manage their inventory. But new developments are making these scanners obsolete, as they can only collect data on broad types of items, rather than the location or condition of specific items. Newer asset-tracking solutions offer much more vital and usable data, especially when paired with other IoT devices.

Several new pieces of technology are already changing how logistics companies work. RFID (radio frequency identification) tags use radio frequency technology to provide data on items to which they are attached. Internet-connected trackers use long-range networks or Low Power Wide Area Networks (LPWANs) to let companies track specific items throughout their delivery journeys. In the same vein, satellite trackers provide location data on an item almost anywhere on the planet, even in areas that do not have mobile coverage.

Bluetooth, ZigBee and Wi-Fi are adequate for consumer-level IoT implementations. The need for a technology such as LPWAN is much greater in industrial IoT, civic and commercial applications. In these environments, the huge numbers of connected devices can only be supported if communications are efficient and power costs low.

Bluetooth tags and beacons offer tracking data in smaller, more confined areas, and are most often used in retail stores to monitor customer traffic and offer marketing messages to customers.

Finally, near-field communication (NFC) tags, based on RFID standards, allow workers to use their mobile devices as readers for the tags, which provides an advantage over RFID tags and readers.

D. Potential use in Customs and border management

Suppliers and consumers are digitally connecting in real time. Big companies are using IoT to track their goods and improve customer service. The question is how can Customs and other border agencies plug into this network and benefit from this information, based on integrated supply chain management principles, to ensure that trade facilitation and security requirements in the movements across borders are met.

Customs administrations would be able to focus on using analytical tools to identify high-risk and low-risk shipments and supply chains based on information collected through IoT technology.

Disruptive technologies could make it possible to accomplish these two goals, but in order to succeed, the innovations must benefit both the private sector and governments in several different ways. Political leadership must see a match to public policy goals, and developers must see a profit opportunity in implementing such solutions. In September 2018, Singapore Customs launched the Networked Trade Platform (NTP), to give traders a one-stop interface that will enable them to interact with all business partners, stakeholders and regulators on trade-related transactions. Being an open digital platform, it allows service providers to develop new applications and foster innovation within the trade ecosystem.

Customs can work towards strengthening cooperation with certain stakeholders (shippers, carriers, forwarders etc.) that have employed IoT applications, with a view to promptly obtaining any information that corresponds to certain risk factors. Thus, Customs administrations would be able to focus on using analytical tools to identify high-risk and low-risk shipments and supply chains based on information collected through IoT technology.

As IoT is used in particular for monitoring the movement of perishable goods to avoid spoilage and loss, this information would help Customs and other relevant border agencies understand which shipments are more urgent in terms of release and clearance, and thus give them priority in release/clearance procedures. This would also help Customs ensure that health and safety concerns have been met, as information would be available on the temperature readings throughout the supply chain.

IoT is the underlying technology of so-called Smart Port Logistics which is operational in the port of Hamburg, for example. Due to a lack of space, the port operator had to increase efficiency and make sure that containers move swiftly in and out of the port. This means informing lorry drivers (or the railways) of the exact time of arrival of containers, for instance, so that they spend the shortest possible time in the port. Other major ports, like the Port of Rotterdam, have partnered with companies like IBM to develop their own IoT platforms capable of collecting and relaying vehicle, cargo, maritime and meteorological data to make their services more efficient. Through this data-driven initiative, the Port of Rotterdam is attempting to identify the optimal time and location for ships to dock and unload their cargo in order to speed up processing and minimize docking times. While these two European ports are modernizing their infrastructure and processing systems, other regions are also following suit, such as South Africa's Durban Port.

Logistics operators could prove to be very important partners in both trade facilitation and control, and inform the authorities of any suspicious occurrences in the supply chain. Using companies' track-and-trace solutions for Customs purposes could be a huge advantage.

IoT can help inform on the number of parcels arriving for clearance at a certain Customs post and on any potential delays. Artificial intelligence could

help identify, based on the number of staff, how long potential delays at the Customs post will be. It can also track down individual parcels and boxes in the shipment marked with serial numbers, which could speed up the process of singling out those which have been selected for physical inspection based on risk assessment.

A number of Customs administrations are monitoring the movement of cargo/shipments in real time, specifically shipments under duty suspension procedures, such as Customs transit. One example of such solutions is the Regional Electronic Cargo Tracking System (RECTS) deployed by Uganda, Kenya, Rwanda and the Democratic Republic of the Congo. Another IoT case study for Customs is the integration of various devices (X-ray or CT scanners, CCTV cameras, Automated Container Code Recognition (ACCR) and License Plate Recognition (LPR) devices and under-vehicle inspection systems (UVIS)) with the Customs information system for better risk management, greater efficiency of Customs clearance processes and improved analytics.

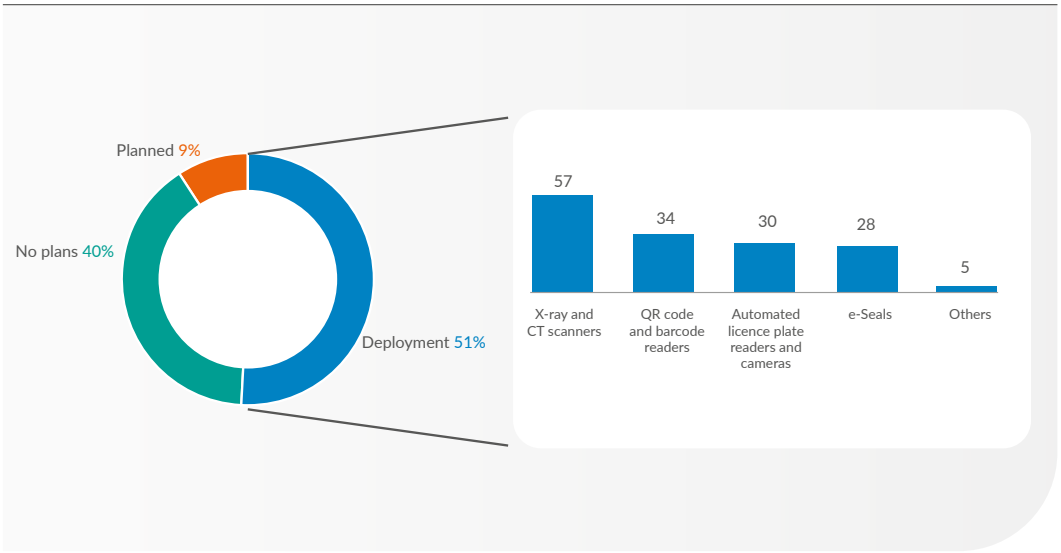
The fact that everything that is connected to the Internet or interacting with it can be geo-located is now an important new parameter which may also provide new opportunities to Customs.

E. Implementation by Customs in 2021

According to the results received through the WCO's 2021 Annual Consolidated Survey and the WCO-WTO paper "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective", half of the respondents indicated that they use IoT in Customs business processes, and 9 per cent planned to deploy them. However, as many as 40 per cent had no plans to use the technology. Of the 72 respondents deploying IoT, the majority indicated that this was in relation to X-ray or computed tomography (CT) scanning, and significant numbers used QR code and barcode readers, automated licence plate readers and cameras, and electronic seals (e-seals).

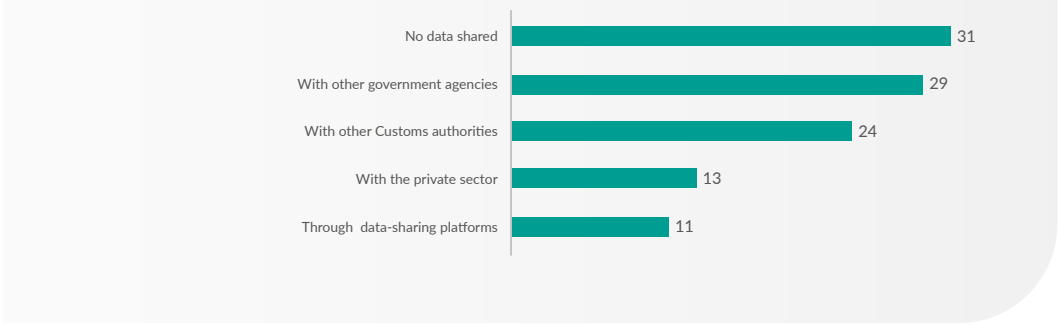
With regard to sharing information collected through IoT devices, 108 responses were provided by 78 Members, which means that some Customs authorities use multiple channels. For those who share information, the majority only share information with other government agencies and Customs authorities. A large number of respondents (31) do not share information with any stakeholders.

Figure 12: Stage of adoption of the Internet of Things



Note: Total respondents numbered 94.

Figure 13: Sharing information with other stakeholders



Note: Total respondents numbered 108.

Benefits

The main benefit of IoT for Customs authorities is to enhance the volume and variety of data, which in turn helps to achieve improved risk management, greater efficiency in Customs clearance processes, and better analytics. One respondent mentioned the benefit of monitoring the integrity of transhipment cargo movement between entry and exit control points. Another emphasized the benefit of using IoT to standardize processes for the benefit of traders, enhancing port performance by reducing times for loading and unloading goods in port areas, linking innovative solutions already implemented by the Customs authorities, and reducing manual procedures to improve security and legitimate trade.

Figure 14: Main benefits of introducing the Internet of Things

Note: Total respondents numbered 83.

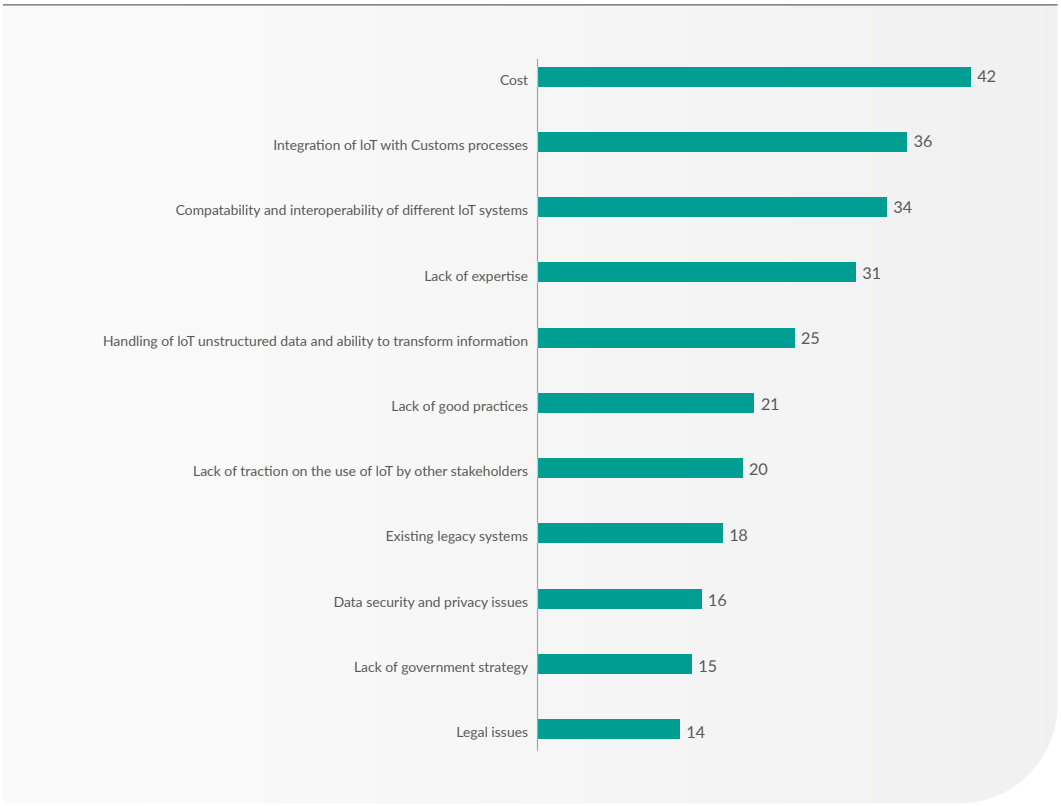
Obstacles to adoption

Many respondents viewed the cost of introducing IoT solutions as a significant obstacle, along with the work involved in integrating IoT into established processes, and issues of compatibility and interoperability of different systems.

Having the necessary knowledge to introduce IoT is a significant obstacle. Respondents indicated a lack of expertise and good practices, and the challenge of handling unstructured data. Legal issues and data security and privacy were also mentioned.

Respondents also emphasized that if two or more neighbouring countries introduced IoT solutions, then they could all reap the full benefits across borders. However, not all Customs authorities are familiar with the technology, or able to introduce it; rather, there can often be resistance to change. The lack of infrastructure was another obstacle to a more profound uptake of IoT technologies.

Figure 15: Main obstacles to adopting the Internet of Things



Note: Total respondents numbered 82.

Ongoing projects

All WCO regions have IoT deployment projects. Some of these projects are elaborated in more detail in the Annex to this Study Report.

In the East and Southern Africa (ESA) region, IoT is used to facilitate acquittal of transits through QR codes for example in Zambia. In Eswatini, the barcodes generated by the Automated System for Customs Data software (ASYCUDAWorld) are already one element in place to implement IoT. Another example of IoT deployment, also mentioned above, is the Regional Electronic Cargo Tracking System (RECTS) of Uganda, Kenya, Rwanda and the Democratic Republic of the Congo.

In the West and Central Africa (WCA) region, IoT is used to track cargo in transit through e-seals and barcode readers (e.g. in the Democratic Republic of the Congo).

The use of IoT is widespread in Europe, where CCTV cameras, licence plate readers, X-ray scanners and GPS tracking devices are quite broadly used and integrated with Customs processes at the national level, or even shared at the regional level. Other projects include the use of geo-fencing and telematics data for transferring information to Customs authorities through smart phones and apps to recognize border arrivals (e.g. in Switzerland).

The Baltic X-ray Images Exchange (BAXE) project implemented by Estonia, Latvia and Lithuania was designed to address different challenges such as the lack of interoperability of X-ray scanners produced by different vendors, and disparities in software and user interfaces. Since its adoption, 16 X-ray scanners in operation in Estonia, Latvia and Lithuania have been integrated into BAXE. The three countries exchange X-ray images, which are then analysed centrally in Latvia.

There is also an automated licence plate recognition system shared between the Baltic States and Poland, and IoT is utilized in the corridor-as-a-service (CaaS) pilot project to experiment with fully automating a border-crossing.

The use of IoT is widespread in Europe, where CCTV cameras, licence plate readers, X-ray scanners and GPS tracking devices are quite broadly used and integrated with Customs processes at the national level, or even shared at the regional level.

In Italy, the Customs and Monopolies Agency (ADM) is conducting a project to completely digitalize Customs procedures in Italian ports for goods transported by both rail and road. The project, which involves all the main port institutions, is based on IoT, with special readers providing information to authorized stakeholders. The advantages for operators include fewer requirements and submissions.

The Far East, South and South East Asia, Australasia and the Pacific Islands (AP) region has a number of IoT projects using e-seals, QR codes and X-ray scanners.

In Hong Kong, China, the Single E-lock Scheme (SELS) connects the Intermodal Transhipment Facilitation Scheme of the Hong Kong Customs and Excise Department with the Speedy Customs Clearance of the mainland Customs authority towards establishing a green lane to facilitate the flow of goods through a seamless clearance service. One single e-lock and GPS technology accredited by the two Customs authorities is applied in the SELS under the principle of one single e-lock with separate monitoring.

In Indonesia, the Customs Office of Tanjung Priok seals containers with electronic seals (e-seals) to supervise the transfer of containers and to monitor, in a control room, the shipment history in real time with GPS.

In Malaysia, SmartCargo uses new cargo scanners, integrated with a radiation portal monitor and AI and optical character recognition technology, all linked to the Customs system. The licence plate and container number are run against stored Customs declarations. The image analyst reviews the declaration together with the scanned cargo image while the container is monitored for radiation. Malaysia also has an IoT project for the authentication of a new tax stamp. When the QR code is scanned, the authenticity of the tax stamp is verified, which will lower the risk of counterfeited tax stamps.

Singapore also uses e-seals to enhance the visibility and security of container movements beyond the checkpoints, and has an integrated command centre system to analyse X-ray images from multiple scanning stations.

In Timor-Leste, barcodes are built into the ASYCUDAWorld Single Administrative Document, among others, and are commonly used for the manifest, goods declaration, payments and container pass, and the release and exit of goods from controlled Customs areas.

A number of IoT projects in the North of Africa, Near and Middle East (MENA) region use X-ray scanners and tracking solutions.

Jordan is introducing electronic gates at airports. At the Queen Alia International Airport, in Amman, the government has introduced an automated immigration clearance system to reduce the time it takes for a passenger to pass through immigration to just a matter of seconds. The system uses two-factor authentication of e-gate ID cards utilizing RFID (radio frequency identification) technology and biometric fingerprint verification of passengers.

The United Arab Emirates has a number of IoT initiatives, such as X-raying cargo on the move and a container risk-tracking platform which monitors risks inside containers with scanners integrated into the Customs risk and declaration management system.

The Dubai Customs integrated vessel tracking system uses marine traffic data to track vessels across the world and feeds the data into the internal risk and declaration management system. The marine traffic system uses IoT to collect data transmitted via an automatic identification system of receiving stations that form a marine traffic network.

The South America, North America, Central America and the Caribbean (AMS) region uses IoT for goods inspection and tracking along the supply chain through X-ray and CT scanners, e-seals and licence plate readers.

In Argentina, the Customs Transit Security Initiative (ISTA) uses e-seals for goods in transit, which allows the General Directorate of Customs (DGA) and the Customs transport agent to respond immediately when accidents occur, providing security to the global logistics chain and a reduction in operating costs.

In Chile, seaports have adopted licence plate readers integrated with Customs authorities and port systems.

In Guatemala, the Pedro de Alvarado Customs authority has installed RFID antennas to collect information on goods. More RFID antennas are to be introduced, which will ensure the traceability of the goods and means of transport.

In the United States, CBP is exploring the use of IoT to manage its extensive network of sensors. The objective is to improve domain awareness and to make the data available to a wider audience within CBP by using an IoT gateway.

3. Big data, data analytics, artificial intelligence (AI) and machine learning (ML)

A. What is big data and data analytics and how can they be used in Customs and border management?

Data analytics is the application of computer systems to analyse large data sets to support decision making. It is an interdisciplinary field that incorporates aspects from other scientific disciplines such as statistics, machine learning, pattern recognition, systems theory, operations research, and artificial intelligence. Although its interdisciplinary nature and flexibility of application offer numerous opportunities for use in Customs, at present it is used primarily for risk management. Currently, methods such as fraudulent trade detection and HS code recommendation are chiefly focused on revenue assurance through risk analysis. Adopting a more holistic approach that incorporates data analytics into all aspects should be seen as the next necessary step towards data-driven Customs and border management.

Expanding the use of data analytics to trade facilitation would ensure that Customs procedures become more user-friendly, by observing patterns, and are streamlined to remove difficulties for Customs officials. Beyond trade facilitation, data analytics can be applied to basically any process in Customs and border management, with the only challenge being finding the right way to use data analytics to extract intrinsic value from the analysis.

In order to achieve concrete results from data analysis, Customs authorities must be able to incorporate it correctly into their current procedures. Changes are usually met with resistance, as they are resource-intensive, and their impact is sometimes delayed. Therefore, it is important that agencies are aware of the challenges and how they can create solutions to ease the transition. Assessing current data analytics capabilities, developing an appropriate data strategy, and managing change efficiently are some of the challenges involved. Only when these organizational factors align with the effort to incorporate data analytics can valuable results be achieved.

In order to achieve concrete results from data analysis, Customs authorities must be able to incorporate it correctly into their current procedures.

B. What is artificial intelligence?

Artificial intelligence (AI) is an area of computer science that focuses on the creation of intelligent machines that work and react more like humans. AI refers to systems that change behaviours without being explicitly programmed, based upon data that is observed, collected and analysed. It is a broad term that includes different technologies such as machine learning, deep learning, computer vision and natural language processing that, taken individually or in combination, add intelligence to applications.

AI is the next big technological development where information systems are patterned on biological systems, giving computers human-like abilities of hearing, seeing, reasoning and learning. AI is a computerized system that exhibits behaviour that is commonly thought of as requiring intelligence; systems that think like humans (i.e., cognitive architectures), systems that act like humans (i.e., automated reasoning, learning), systems that think rationally (i.e., inferencing, optimizing) and systems that act rationally (i.e., intelligent software agents).

The accessibility of cloud computing and the large-scale availability of processing power, combined with the exponential increase in data, has brought AI into focus more than ever before.

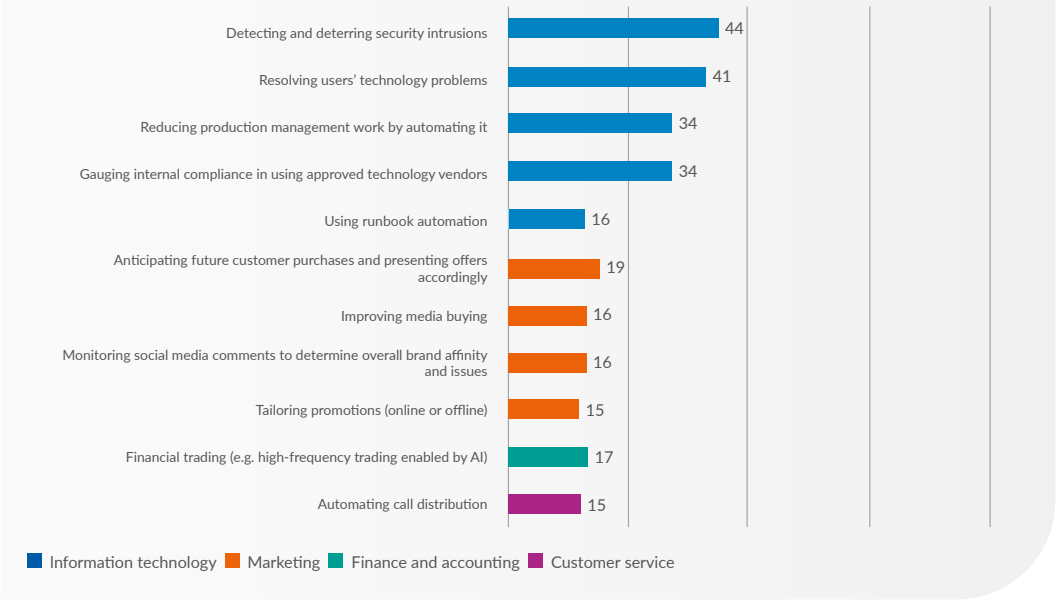
AI is not new; however, it has only more recently received prominence and attention due to a combination of technological developments and events. The accessibility of cloud computing and the large-scale availability of processing power, combined with the exponential increase in data, has brought AI into focus more than ever before.

IoT is one of the newer sources of data that has helped fuel the tremendous growth of AI. IoT is an enabling technology. By connecting sensors and devices to the Internet and managing this centrally through the cloud, there is scope for new opportunities that provide greater insight, allowing for quicker decision-making and response times.

As computer power continues to grow, algorithms and AI models have become more sophisticated and many different use capabilities have evolved. The terms "AI" and "ML" are frequently used interchangeably; however, they are not the same thing. ML can be regarded as a type or sub-set of AI or rather the "application" of AI where machines access data and learn for themselves.

AI is currently being used in a variety of ways around the world. Voice-directed personal assistants and chatbots such as Siri, Alexa and Xiaoice have transformed how people communicate with machines and with technology. Utility companies use AI to forecast electricity demands which allows greater accuracy in planning for high and low periods of demand. Behavioural algorithms are used in thermostats allowing for room temperatures to be adjusted automatically based upon who is in the room. Robots powered by AI run warehouses and automatically replenish stock. AI is being used in weather forecasting, in areas of livestock management and in food safety. The automotive sector has invested heavily in the use of AI in semi-autonomous and autonomous vehicles. The healthcare sector is using AI in medical diagnosis and in-patient data processing. Supply chain and logistics usage is seen in supply and demand forecasting, in manufacturing and in transportation.

Figure 16: How companies around the world are using artificial intelligence



Source: Tata consultancy services survey of 835 companies, 2017[21]

C. How can big data, data analytics, artificial intelligence and machine learning be used in Customs and border management?

Use of big data, data analytics, AI and ML in Customs and border management presents a tremendous opportunity in the cross-border movement of people and on the commercial side. As huge volumes of data are generated by people and goods moving across borders, this group of technologies provides the ability to make sense of this vast and ever-increasing amount of data. These technologies can be used to ingest this data and detect and predict patterns more accurately than humans can. Visual search and facial recognition technology, and behavioural and predictive analytics, which are already being used in other sectors, can also be further tailored for use in Customs and border management.

AI can be used for the following purposes:

- revenue collection models, ensuring that the appropriate duties and taxes are collected at the border;
- classification of products under the Harmonized System (HS), simplifying matters for users and enabling greater compliance and certainty for both Customs and the private sector;
- as part of Customs audits to identify anomalies much more quickly and thereby enable Customs auditors to focus on areas of non-compliance;
- to improve risk-based targeting of commercial shipments, as well as to provide and analyse data during shipment inspections using augmented/mixed-reality glasses in detecting contraband and counterfeit goods;
- analysing container images made by X-ray scanners to improve the efficiency of cargo inspection;
- logistics monitoring and control in Customs warehouses and bonded areas;

21 *https://chatbotsmagazine.com/artificial-intelligence-ai-global-trends-how-the-businesses-can-benefit-ai- today-use-cases-9693c542099e, accessed on 13 January 2019*

- identifying high-risk passengers and vehicles by using visual search and facial recognition technology at the border. This can be further expanded to create intelligent analytics to predict future outcomes, facilitating better risk management and preparedness;
- providing better service by placing enquiry robots for passengers at the border;
- providing Customs duty self-payment services by developing mobile apps at the border, etc.

The WCO has developed a number of tools to support Members in developing their data analysis and data analytics skills. The "Handbook on Data Analysis" (2018) is aimed at presenting a high-level overview of data analytics and, more specifically, what it is, how it works, and how useful it may be to Customs and other governmental agencies. The Handbook offers guidance on how to leverage big data and data analytics, outlines data governance-related issues, and presents some common data analysis tools, such as predictive analytics, cognitive computing and statistical programming languages.

The "WCO Capacity Building Framework for Data Analytics" is designed to help Customs officers develop their organizational and technical capabilities to capitalize on the rapid growth of collected data and gain insights to make better-informed, data-driven decisions. Taking into account a WCO survey on data analytics in Customs, information is provided on how to effectively implement successful analytics initiatives and build the organizational capacity needed to make the most of data analytics. The first step, assessment, and planning prior to implementing an analytics project, is addressed by providing a maturity model to measure the current state of data analytics integration. It discusses what data analytics processes should be in place and why appropriate data management is critical. It also presents the appropriate choice of organizational structure, the type of personnel needed, and the critical behaviours and actions that executives should exhibit. Change management is pointed out as a vital tool in a holistic transformation of an organization towards data-driven decision making.

The WCO has developed a number of tools to support Members in developing their data analysis and data analytics skills.

In the WCO regional workshops on disruptive technologies held during the course of 2021 and 2022, some Members shared their experience on the use AI/ML in Customs. For example, Botswana Customs implement online payment through a mobile app (BURS Mtax) which provides a number of benefits to the trading Community as well as the revenue authority. The Zambia Customs "TaxOnApp" is another example of this type of implementation.

The Nigeria Integrated Customs Information System (NICIS) Smart Fraud Detection is an AI/ML technology designed to assist Nigeria Customs Service Officers in performing risk analysis on the declaration's information, processing a huge amount of data in the shortest possible time.

Azerbaijan Customs are working on a project on declaration processing using AI/ML.

El Salvador Customs has created an "Artificial Intelligence Department" that works on improving a number of processes by implementing AI, such as risk management, image processing and valuation of goods.

Indonesia Customs uses AI/ML for passenger risk management and import risk management purposes. Russian Federation Customs also uses AI for risk management purposes. Japan Customs utilizes AI for risk management and post-clearance audit purposes.

IoT devices can further enhance existing technologies already in place at border crossings by supplying additional data that can be used by AI for rapid decision-making purposes by the Customs officer. The time series data gathered can be analysed to see what patterns and trends emerge, providing greater insight. The advantage of Customs is that it already has a large amount of data at hand that can be further processed to accelerate smart decision-making at the border.

The vision of Globally Networked Customs (GNC) can be realized through leveraging technologies such as blockchain and by applying AI in the end-to-end intelligent monitoring of the entire supply chain. AI can manage the process of who has ac-

cess to what data and when, ensuring that the appropriate levels of control are in place.

D. Benefits and Risks

AI provides the potential to significantly increase economic growth and generate major opportunities for countries. Significant benefits can be gained through the use of AI, creating new jobs, extending people's abilities to perform tasks more accurately and efficiently, providing better services, and enabling even faster innovation to occur, together with putting customers in control to protect their data. Along with benefits come certain risks though, if not managed properly. There is a need for strong ethical principles combined with robust compliance and legal frameworks within which AI operates to ensure that AI is not misused. There is also a need for clear and authoritative guidance on how AI can be used, especially in the context of communication using chatbots. As the use of AI increases, labour market reforms will be needed together with job skills training to meet the new human resource needs as the nature of work changes. In the use of AI there is the need for a shared responsibility between the public and private sectors. AI must be transparent so that there is an awareness of how the technology works and what the rules around its use are.

AI risks also include the use of AI for malicious purposes, and could also create uncertainty and distrust in the accuracy of data. Data security can be easily threatened by malefactors using AI technology. Fake content can be more readily created using AI and introduced into business streams. Exploitation of AI systems could occur, thereby skewing the results. The integrity of the underlying data and information will be paramount.

Additionally, provisions governing the application of AI-based information and determinations, such as HS classification tools, are needed to ensure effective compliance. Access to robust and transparent redress mechanisms will be required to ensure the integrity and ongoing improvement of AI processes.

AI provides the potential to significantly increase economic growth and generate major opportunities for countries. Along with benefits come certain risks though, if not managed properly.

E. Potential Future Use

AI can greatly assist almost every function in government. Implementation of chatbots in government agencies can greatly enhance communication between the government, companies and citizens. Chatbots are interactive applications that are powered by AI and interact with users through natural language. A chatbot could serve as a channel for access to Customs in situations where certain services could be delivered more efficiently and cost effectively. Chatbots can rapidly capture and manage large volumes of user requests and sort through information and databases to deliver results to the user. Routine communication can be automated, questions answered and recommendations made, which would free up officers to focus on higher-value work. The types of government services provided could be transformed and government operations optimized. Predictive analytics for the management of services and assets could be used to forecast demand and measure levels of usage. More effective compliance could be attained in reporting and in collection of taxes and duties.

A number of Customs administrations already use chatbots to respond to the questions they receive on the website. For example, Zambia Revenue Authority uses an AI chatbot "Zax" to engage with taxpayers, alongside other customer service channels including phone, email, and social media etc.

Use of AI with augmented or mixed reality glasses could be employed by Customs for training purposes as well as for shipment inspections and in the detection of counterfeit and contraband goods. Data would be available in real time, enabling officers to make quicker determinations, thereby increasing the number of inspections, accuracy and volume of goods that could be reviewed.

A number of Customs administrations already use chatbots to respond to the questions they receive on the website.

Box 4 : Frequently Asked Questions

1. What is AI?

- AI is a computerized system that exhibits behaviour that is commonly thought of as requiring intelligence
  - systems that think like humans (i.e. cognitive architectures)
  - systems that act like humans (i.e. automated reasoning, learning)
  - systems that think rationally (i.e. inferencing, optimizing)
  - systems that act rationally (i.e. intelligent software agents).
- AI is not just one type of technology but rather a broader term covering multiple technologies which include machine learning, deep learning, computer vision, natural language processing and other technologies, used individually or in combination, to add intelligence to applications.

2. What is ML?

- ML is a subset of AI that provides computers with the ability to learn without being explicitly programmed.
- it is the process of using mathematical models to predict outcomes versus relying on a set of instructions. This is made possible by identifying patterns within data, building an analytical model, and using it to make predictions and decisions. Machine learning bears similarity to how humans learn, in that increased experience can increase accuracy.

3. What is Deep Learning?

- Deep learning is a subset of machine learning algorithms that learns by using a large, many-layered collection of connected processes and exposes them to large sets of examples. This layered structure of algorithms is called artificial neural networks and is inspired by biological neural networks that the human brain uses. Deep Learning helps enable computers to hear, see, speak and even understand natural language commands.
- Deep learning is a method of information processing and a subset of machine learning. The key difference lies in whether humans intervene in the learning process: in machine learning, humans intervene in the analysis of the data and the actual decision-making process. In contrast, deep learning models are able to learn on their own. This happens in that the systems repeatedly link what they have learned with new content. As a result, they expand their learning. In this learning process, the human does not intervene, the analysis is left to the machine.

4. Is AI a new field of technology?

- No. The technology has been developed over several decades. However, due to the greater accessibility of cloud computing, increasing computer processing power and an exponential increase in data, AI usage and development has received greater visibility and use.
- The progress made in recent years is largely based on three developments: the increased availability and amount of data, the growing power of cloud computing, and powerful AI algorithms. Algorithms are systematic instructions for solving a mathematical problem.

5. What can AI do?

- AI can take in more data and detect and predict patterns more accurately than humans can. Use of AI can lower costs and mitigate risks.
- AI will affect almost all areas of our lives and has the potential to make great economic and social progress. It can also help us meet the pressing challenges of our time, in the areas of climate and species protection, for instance. AI supports researchers at the Snow Leopard Trust, for example, in protecting endangered snow leopards.
- AI technologies such as machine learning make it possible to analyse and interpret data volumes, recognize patterns from them and create decision-making bases – much faster than humans can. Patient data can be analysed with the help of AI, for example, and the information obtained can allow drugs and therapies to be tailored to individual patients.

Continuation box 4: Frequently Asked Questions

6. Will jobs be lost due to AI?

- Some jobs will be lost while new ones will be created. Workers will need to gain skills that are relevant in the changing workplace as new skillsets will be required for new markets.

7. What risks does AI pose?

- Workforce inequality could arise through increased automation and use of AI making certain jobs redundant. Privacy and ethical concerns could also arise as a result of the misuse of AI. Bad data could intentionally be introduced into the system.
- The role that AI will have in our lives shows that AI-based systems must be reliable and secure, and they must be able to operate continuously. Not only under normal conditions, but also in unexpected circumstances – and even when they are attacked. The security of artificial intelligence is crucial to its acceptance.
- AI offers enormous potential to improve people's lives. But we will only be able to seize that potential if we ensure data protection in conjunction with the use of artificial intelligence. No one will share their personal data if they cannot be sure that their data is safe. And without this data, AI cannot make informed decisions. To gain consumer confidence, control mechanisms are needed that allow people to decide for themselves how their data is to be used. AI systems may only use personal data in accordance with applicable data protection standards, and must respect privacy.

8. How can Customs implement AI?

- AI can be implemented in different areas and at different stages based on Customs' needs. This may be through software, or through combinations of software and hardware. Specific case studies would need to be created based upon priorities and returns on investment. The initial implementation is usually in areas of IT and in data analytics.

9. What are the prerequisites for AI implementation?

- To implement or integrate AI, intelligent software applications and tools need to be built for Customs use. Software developers and data scientists need to understand Custom's objectives and design applications to suit their needs. Pre-built software services such as vision, speech, language, knowledge and search functions can be leveraged and tailored for specific use or custom software applications, and algorithms can be built for specialized use.
- We can consider seven steps to implementing AI:
  - define a clear use case
  - confirm data availability
  - undertake basic data exploration
  - specify a model-building methodology
  - define a model-validating methodology
  - automation and production roll out
  - update the model periodically.

10. Is AI a stand-alone application/technology?

- AI is not one technology or stand-alone application but rather an umbrella term that includes multiple technologies and applications.

11. What other technologies does AI support and how?

- AI is a broad term and covers a number of different technologies. AI can be integrated with legacy systems as well as with newer cloud applications. AI algorithms can be tailored to meet different Customs needs and types of software applications to perform assignments ranging from basic tasks up to advanced decision-making. AI can drive advanced analytics and operate virtual assistants or chatbots, from computer systems to advanced robotics.
- With the growing data landscape, two of the most common capabilities required to manage as well as extract value out of Customs and trade data are data cataloguing and data warehousing. AI will simplify the ability to

Continuation box 4: Frequently Asked Questions

integrate these two capabilities, giving Customs authorities the freedom to query data on their terms, using either serverless or dedicated options - at scale.
- Data mesh is a democratized approach to managing data from various clouds where various domains operationalize their own data, encompassing data, technology, processes, and organization. Rather than looking at data as one huge repository, data mesh considers the decomposition of independent data products.
- Confidential computing allows Customs authorities to isolate sensitive data while it is being processed, and to secure financial data, protect traders information, run machine learning processes on sensitive information, or perform algorithms on encrypted data sets from multiple sources.

12. In which areas of Customs management can AI be introduced?

- AI can be used in almost every area in which data and decision-making is involved. It can analyse huge volumes of data faster than humans can, enabling faster and more accurate decisions to be taken. It can be introduced in automated kiosks at borders where virtual assistants or chatbots aid in screening passengers. AI can provide information or self-help tools to traders in a 24/7 environment.
- Cognitive Services for Customs agencies help improve compliance and facilitation by enabling Customs officers to make better decisions. Data analytics – for example, automated selectivity rules – has become an increasingly important tool for Customs agencies. ML capabilities help solve general problems such as analysing text for emotional sentiment, analysing images to recognize objects or faces, converting speech (audio) to text, translating the text into many languages, then using the translated languages to get answers from a knowledge base.

13. What kind of changes will AI bring to Customs in the future?

- AI will place more information and data intelligence at the disposal of Customs, which will enable faster decision-making in areas of risk management in the cross-border movement of both people and goods. Through increased automation, certain repetitive tasks can be automated through AI allowing Customs officers to focus on more value-added activities.
- The end-goal of applying various AI components is to enhance Customs operations. Visual search and facial recognition technology, behavioural and predictive analytics, revenue collection models, classification of products, Customs audits, risk-based targeting, analysing container images from X-ray scanners, logistics monitoring, identifying high-risk passengers and vehicles etc. can all be tailored for use in Customs and border management.

14. What can Customs do to mitigate the risks raised by AI?

- Customs can act as “guardians” in a sense, creating and defining the proper regulatory frameworks to control how AI is used for Customs purposes and how the data is gathered and shared with other regulatory agencies, countries, businesses and citizens it interacts with. Customs can develop robust and transparent redress mechanisms to ensure the integrity and ongoing improvement of AI processes. Customs can also work with the private sector to establish the framework around privacy, and the pace and adoption of digital tools.
- Adhering to responsible AI principles and standards is critical to addressing the societal impacts of AI and building trust as the technology becomes more and more a part of the products and services that people use at work and at home every day. AI systems should be fair, reliable and safe, private and secure, inclusive, transparent, and accountable.

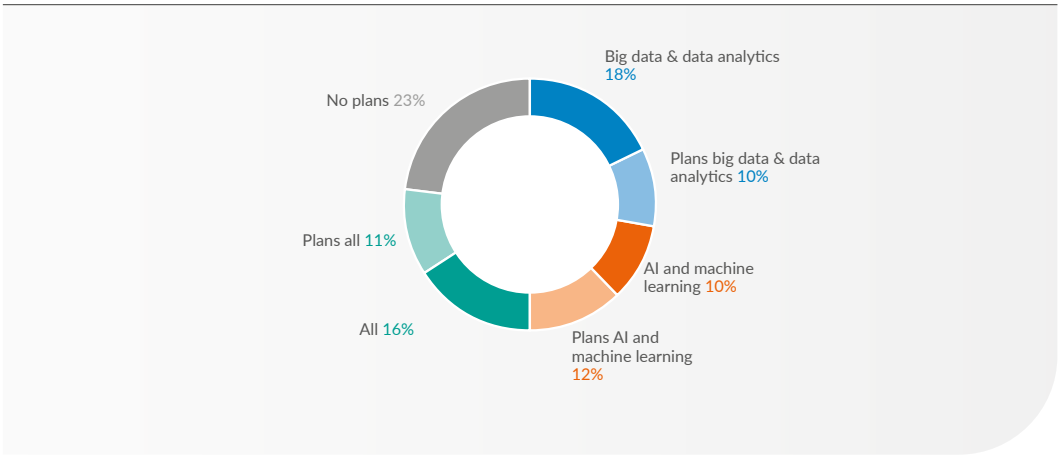
F. Implementation by Customs in 2021

According to the results of the WCO Annual Consolidated Survey 2021 and the WCO-WTO paper "The Role of Advanced Technologies in Cross-border Trade: A Customs Perspective", almost 45% of Customs authorities use either data analytics, or AI/ML, or both. Big data analytics is currently used by 18% of the responding Members, while 10% are planning to introduce it. Another 10% use AI/ML, while 12% are planning to introduce it. In addition, 16% use both data analytics and AI/ML, and another 11% are planning to introduce both. This means a total 44% of Customs authorities are currently using either data analytics, or AI/ML, or both, while another 33% have plans to do so. 23% of respondents currently have no plans to implement these technologies.

Benefits and challenges

The majority of Customs authorities see clear benefits from this group of technologies, with risk management and profiling, fraud detection, and greater compliance being the most prevalent. Facilitating Customs audits and identification of anomalies, and improving revenue collection, were also emphasized by a number of Members. Predicting future trends, enhancing trade facilitation, and improving imaging and visual search technology were also indicated as benefits.

Figure 17: Stage of adoption of big data, data analytics, artificial intelligence and machine learning



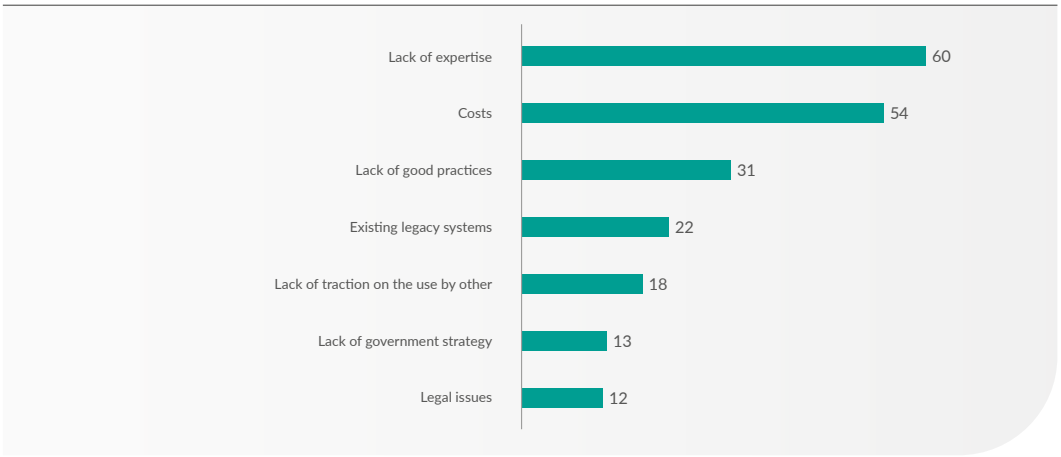
Note: Total respondents numbered 94.

Figure 18: Main benefits of introducing big data, data analytics, artificial intelligence and machine learning

Note: Total respondents numbered 94.

However, lack of expertise is the biggest challenge for Customs authorities in implementing big data analytics and/or AI/ML technology. Other challenges include costs, lack of good practices, existing legacy systems, lack of traction in the use of the technology by other stakeholders, lack of a government strategy, as well as legal issues. Members also highlight other challenges such as data governance issues, data quality, information organization, roles and functions, and existing tool problems.

Figure 19: Main obstacles to adopting big data, data analytics, artificial intelligence and machine learning



Note: Total respondents numbered 94.

Data analytics and AI/ML were considered to have potentially the biggest impact on Customs operations in the future. The survey results show a high level of confidence by Members in a technology that has already been used for some time and the use of which is constantly increasing, in particular for improving the risk management capabilities of Customs.

Areas of implementation

Many Customs authorities have provided information on their respective implementation projects and the case studies for data analytics and AI/ML in different areas.

1. Risk management:
- data mining for intelligence purposes and risk management,
- AI/ML for enhanced risk management processes (inspection results feedback loop, client segmentation, automatic assessment, and upgrade of risk profiling),
- compliance risk scoring in commercial and trade activities,
- identifying low-value courier and postal shipments to improve risk assessment,
- identifying low-risk individuals at borders, and
- automated targeting system.

2. Tariff classification:
- HS classification using AI,
- tariff misclassification and non-compliance with tariff advice.

3. Scanning:
- developing AI-based models for interpreting X-ray images,
- ICT scanners with AI to enhance enforcement capabilities and Customs clearance efficiency.

4. Revenue collection:
- potential anomalies in high-revenue areas, including excise equivalent goods (alcohol, tobacco, and petroleum),
- automate repetitive manual procedures involving revenue protection; one of the procedures involves online research of market prices and deploying AI to assist in conducting intelligent filtering of research results,
- price recommendation data analytics,
- undervaluation and overvaluation anomaly detection,
- enhancing efficiency in using financial and tax data more widely and strategically in order to improve compliance and performance in terms of public revenue collection and the fight against smuggling.

5. Others
- post-clearance audits and controls,
- chatbot for answering online public enquiries,
- chatbot for a physical robot to answer enquiries from travellers at control points,
- misuse of concessions, including: tariff concession orders, by-laws, free trade agreements, origin masking,
- dumping and countervailing anomalous activities,
- refund/drawback non-compliance,

- imports of prohibited goods,
- cross-platform cyber patrol,
- analysing massive volumes of Internet information to identify IPR crime trends,
- implementation of data mining on import,
- trade circumvention graph analytics,
- export/import data analytics,
- a data lake developed for the consolidation and single source of truth of all Customs data; monitoring the service delivery performance in real time, as well as providing historical insights into Customs statistical information for future planning and forecasting,
- develop advance analytics for AEOs.

Ongoing projects

A number of projects have been implemented by Customs authorities in different regions and some of them are elaborated in detail as case studies in the Annex to this Study Report.

For example, the U.S. CBP established the AI Center of Innovation (COI) in late 2020 to act as the catalyst to create the enterprise processes, tools, and infrastructure needed to rapidly develop, test and deploy new AI solutions.

Hong Kong Customs launched a pilot IT system, the Cargo Big Data System (CBDS), in November 2020, aiming to apply big data analytics and artificial intelligence (AI) to cargo clearance to analyse the ever-changing trade pattern and trend in order to effectively combat cross-border smuggling crimes.

Alongside typical risk indicators (such as the code of the goods and its weight description and destination, etc.), Russian Federation Customs use complex risk indicators based on the analysis of big data and the use of AI.

In 2017, Japan Customs started a study on X-ray image analysis with AI. Then in 2019, they started to develop the AI models using big data, including Customs declaration data.

Belgium is implementing the 'Behavioural consequences of tariff changes' (BCTC) project to analyse the impact EU Customs tariff measures have on commodity trade flows. The central goal is to detect fraudulent behaviour by economic operators following the introduction or increase of tariff measures. More specifically, the project aims to detect sudden behavioural changes in an operator's import profile deviating drastically from the "normal" trends observed before the tariff measure was imposed.

Zambia Revenue Authority (ZRA) uses an AI chatbot "Zax" to engage with taxpayers alongside other customer service channels including phone, email, and social media etc. The taxpayer service chatbot uses natural language processing to answer basic questions via a business messenger. These may be questions like "What are Customs duty rates?" or "What are the due dates?", etc.

The majority of Customs authorities see clear benefits from this group of technologies, with risk management and profiling, fraud detection, and greater compliance being the most prevalent.

4. Biometrics

A. What are biometrics?

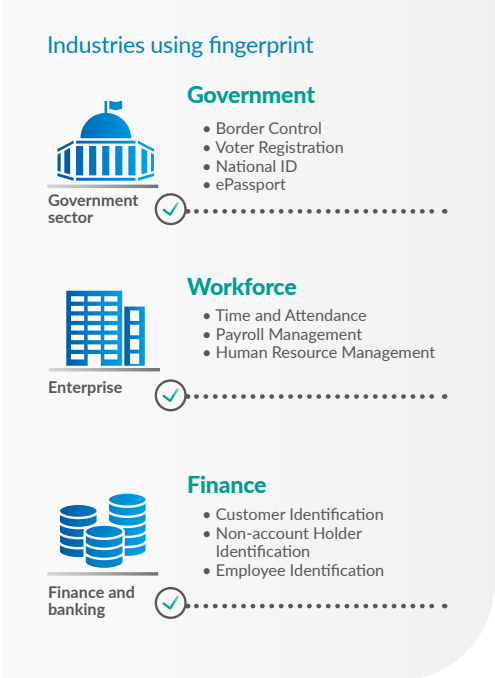
Biometrics is the measurement and statistical analysis of an individual's physical and behavioural characteristics. The basic premise of this field is that every individual person is demonstrably unique and therefore identifiable via his or her physical or behavioural traits.

To understand biometrics, we first need to distinguish between biographic data and biometric data. Typically, governments and other actors seeking to verify identity use biographic data. For example, an individual's date of birth is biographic; this information is specific and permanent about an individual, but is not readily observable from the individuals themselves without them self-reporting it, or it being recorded and reported from another source. Thus, there must be an act to link the recording of the individual's date of birth with the individual. Biographic data includes text data commonly found on the data page of a traveller's passport, such as name, date of birth, and country of citizenship. Biographic data is not unique to the individual. For example, many people share the same date of birth. As biographic data must be transmitted in text, it is also susceptible to error and easy to misuse.

A biometric system, on the other hand, features the use and recording of a physical component of an individual that is unique to that specific individual and does not need to be translated into a textual record; i.e. the information can be collected and identified in its original source (the individual), and does not need to be transitioned to another medium (i.e. text). In the past, due to nascent technology, the only biometric information available to law enforcement and other actors seeking to verify identity was fingerprints. For many years, even this was an inexact science, based more on assessment by trained professionals than on automated identification via computer. This biometric identifier was also subject to human error, poor recording/capturing of fingerprints, and technological limitations in reproducing the recorded print. However, technology increasingly allows governments and other actors to identify and confirm fingerprints automatically via computer. Technology has also produced significant developments in facial recognition technology, DNA, and iris imaging, allowing new sources of information to verify an individual's identity. Besides the above sources of biometric data, other examples can include palm veins, palm prints, hand geometry, and odour/scent. Behavioural characteristics can also serve to biometrically identify an individual. Such behavioural identifiers include typing rhythm, gait, and voice recognition.

Governments and organizations all around the world are choosing biometric technology to combat identity fraud and security breaches, secure confidential data, reduce costs and improve overall user experience. Biometrics is one of the rapidly growing fields in the information technology sector, with fingerprint recognition expected to remain the most dominant form of biometric technology.

Figure 20: Industries using fingerprint



Source: Bayometric[22]

There are a number of examples of how government and private actors are utilizing biometrics to identify individuals. For example, Disney theme parks are now using the biometric measurements (fingerprints) of theme park guests to ensure that tickets issued are being used by the same person over multiple days of attendance. A much larger example is Aadhaar, India's national identity programme, now the largest biometric database in the world. Aadhaar is a 12-digit unique identity number issued to all Indian residents based on their biometric and biographic data. Aadhaar is designed to enable Indian government agencies to deliver public services securely, based on both the biometric data (including fingerprints, iris scans, and facial photographs) and biographic data (name, age, gender, address, parent/spouse name, mobile phone number, email ID) of an individual. The data is transmitted in encrypted form over the Internet for authentication. As of 15 February 2018, Aadhaar had 1.17 billion enrolled members out of India's population of 1.31 billion. A total of 99.7% of India's adult population had been enrolled in Aadhaar, as of December 2021.

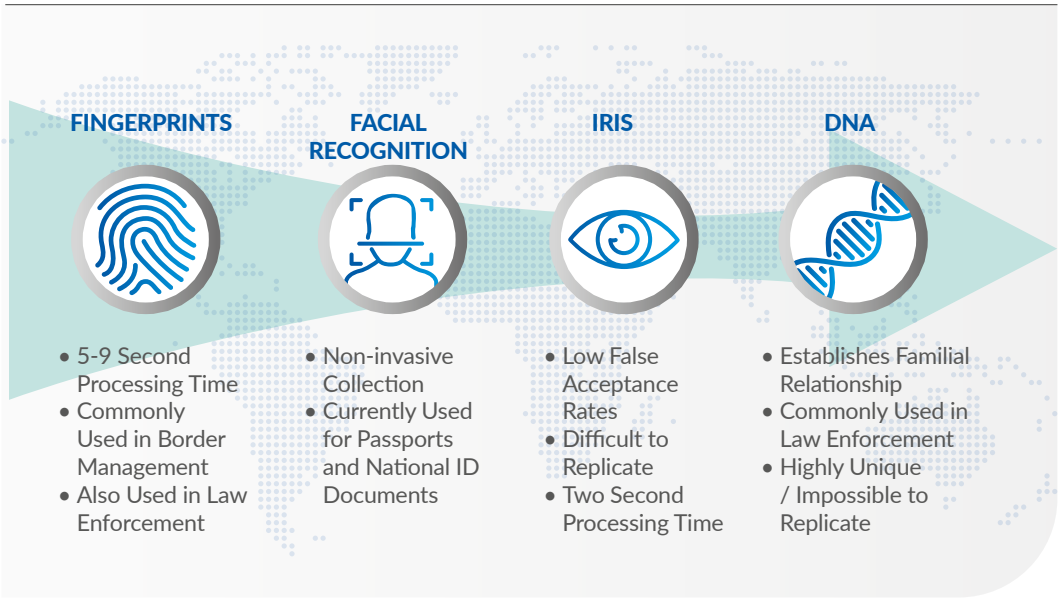
B. Current use in Customs and border management

Customs professionals may ask why biometrics, which is focused on the identification of individuals, is relevant to the core, traditional mission of Customs, which focuses primarily on the movement of physical goods. It is true that biometrics presents a great opportunity for immigration and border security enforcement; however, looking to the future, Customs agencies will also likely find many opportunities in the development of biometrics.

Customs administrations enforce laws/regulations relating to the movement of goods across borders; this inherently includes investigations of individuals associated with those goods, up to and including inspections, and/or investigations, prosecutions, and civil remedies against those individuals. Access to the biometric data of individuals who are engaged in crimes related to trade (goods) can facilitate Customs' efforts to identify, investigate, apprehend and prosecute these wrongdoers. False identities could be more quickly identified through the unfalsifiable records of biometrics. Biometrics thus can be a force maximizer for all law enforcement entities, including Customs. Individuals identified by Customs agencies using biometric information may also alert those agencies to existing warrants or other information that may require additional action.

22 https://www.bayometric.com/importance-of-biometric-fingerprinting-technology/

Figure 21: Fingerprints, Facial Recognition, IRIS, DNA



Source: arcAspicio[23]

In addition, Customs administrations are uniquely situated to demonstrate useful methods for interagency coordination, which biometrics requires. Customs administrations also have a long history of coordination and interagency work, in enforcing laws and regulations for partner government agencies. They are often co-located with immigration agencies, and can work to promote the adoption of and facilitation of such efforts. Customs, as a leader in coordinated border management, is uniquely positioned to bring partners together to leverage the biometric data tool. In order to close information gaps, Customs and immigration agencies should seek to partner with one another to improve data collection, enhance existing systems, and implement automated technology, which will support the identification and targeting of persons of interest seeking to depart countries, as well as enhance the capability to identify immigration violators.

Biometrics enhance identity verification in a border management and homeland security context. DNA is an emerging biometric in this area.

Governments and immigration authorities could be expected to eventually use biometrics at airports. Tokyo's Narita International Airport is testing a new biometric process for the journey from check-in to boarding. The process requires passengers to check in at one of Narita's new biometric kiosks, which captures their facial image and matches it against their passport. From there, they can drop off luggage at an automated baggage drop point that verifies their identity by camera. Cameras at security checkpoints and boarding gates also verify passengers' identities, making it unnecessary for passengers to show paper documents.[24]

In the WCO regional workshops on disruptive technologies held during the course of 2021 and 2022, some Members shared their experience on the use of biometrics.

For example, the Australian Border Force (ABF) uses biometric identification services in visa and border processing. Facial and fingerprint biometrics are already collected from a range of visa and citizenship applicants at offshore and onshore locations. This allows the ABF to handle any risks relating to visa applicants offshore. The ABF also uses SmartGates, which perform an automatic face-to-passport check of the traveller at the Border. Prior to the COVID-19 pandemic, approximately 70% of travellers departing Australia and 50% of arriving travellers self-processed using SmartGates. As part of a broader programme

23 https://www.arcaspicio.com/insights/2009/3/19/dna-the-last-biometric.html, accessed on 13 January 2019
24 https://www.businesstravelnews.com/Global/Narita-Introduces-Biometric-Airport-Journey-Process

in response to delivering a bio-secure border, the Digital Passenger Declaration (DPD) will be replacing the existing Incoming Passenger Card. All travellers wishing to come to Australia will be required to complete a DPD. This will anchor identity through the collection and use of biometrics.

Azerbaijan Customs are also working on biometrics. A facial recognition pilot was completed in 2020 by Huawei at the southern border crossing point with Iran. The system detects frequent border crossers who have criminal charges against them, and the detection rate is 90%.

C. Potential future use

Given that biometrics technology is still in its infancy, additional innovations and uses will likely arise as the technology improves and becomes more ubiquitous. Customs agencies, other government partners and private actors should monitor this field closely to identify additional uses. Some potential uses on include the following examples:

Biometrics enhance identity verification in a border management and homeland security context.

Biometrics can be used to verify identities and control access by Customs operators. Customs agencies frequently operate in or utilize restricted areas and facilities, including ports of entry, secure areas of airports, land ports, and seaports, storage spaces for weapons, vehicles, uniforms, working animals and equipment, and evidence lockers. Customs agencies also often utilize protected computer and other information systems for the storage of, and access to, protected information. Current methods of protection utilize identity cards, passwords, and other information created by or assigned to the individual user. Biometrics allows the opportunity for the creation of a unique operator signature. An operator signature is a biometric mode where the manner in which a person seeking access to a restricted device/system or controlled area must first submit biometric information (for example, a fingerprint or iris scan) to a verification template. Thus, access would be dependent upon the biometric data that only that user possesses, as opposed to a password or biographic data which can be used by any person, including non-authorized users of that information, so long as they possess it. This would greatly enhance the current defences of protected locations and systems when coupled with the existing use of password/identification processes. This would in turn boost not only the personal security of the Customs officers, but also the security of the information, systems, and locations.

Biometrics could likewise be utilized to prevent crime in the international supply chain. It has a potential use in ensuring the identity of Customs actors, including Customs brokers and other licensed freight-forwarders and logistics operators, ship/aeroplane and other conveyance crews, and other actors in the international supply chain. Technologies utilizing webcams, fingerprint readers and retinal scanners could conceivably be incorporated into workstations, entry points, and other portals of restricted access to ensure security/verify identity. This would provide greater protection and significantly decrease identity theft and other security breaches in the Customs environment. This will become increasingly important as many professions, including Customs brokers and other actors in the international supply chain, shift increasingly online.

Biometrics may also reduce the ability of shadow companies to exploit the international supply chain for illegal gains. For example, registered agents for corporations and other importers/exporters could be required to submit biometric identifiers. Shell corporations could be more easily investigated for alleged criminal/civil wrongdoing if governments move towards requiring biometric data of officers/agents during incorporation. Individuals performing the work of such corporations under investigation for alleged violations would be more easily detectable. Unlike biographic data recorded in fraudulent documents, biometric data is not easily substitutable/switchable.

Biometrics' greater reliability and security can be leveraged to strengthen existing security systems/regimes. For example, biometrics could

become an additional factor of consideration in the assessment of authorized economic operator programmes (AEO) and other supply chain security regimes. Actors in the international supply chain may seek to use biometric data to verify their drivers, crew members, and individuals with licences or other certifications, etc. Biometrics may become commonplace in security systems the world over, and eventually become a part of the consideration of AEO certification and mutual recognition.

D. Considerations for establishing a biometrics programme

As Customs agencies and other actors in the international supply chain move toward the wider implementation of biometrics, there are several considerations that administrations must take into account. The realities of biometric data gathering/use, specifically individual habits, stakeholder participation and technological considerations, will guide implementation.

- **Performance of biometrics will also require additional technological developments to ensure reliability:** The quality of biometrics recording can vary depending upon many factors, including seemingly benign factors such as (in the context of facial recognition) the presence of natural light, the type of lighting fixtures, and the height of the ceiling in recording locations. Secondly, governments are already discovering performance differences between travellers from different countries. This includes issues with diverging quality of the images in ePassports. In addition, false rejection rates can vary depending on age and gender. While work may remain to perfect this technology, over the past five years there have been significant gains in the accuracy and reliability of facial recognition technology.

- **Legal authorities/barriers:** Customs authorities need to ensure that they have the legal ability and required protections in place to collect, share, and utilize biometric data. There may be barriers to advancing work between bilateral partners, as these legal authorities are identified and potential methods to update legislation, ensure compliance with existing regulations, or mitigate risks are weighed.

- **Non-compatibility of information-sharing systems between agencies:** Information collected by immigration and other law enforcement entities may not be readily connectible to Customs systems, or useable under Customs authorities/legislation. There can be significant technological, legal, and financial obstacles to addressing these barriers.

- **Physical barriers to implementation:** Airports, seaports, land ports of entry, and other facilities where Customs agencies operate may not be built in a way that is conducive to collecting biometric information, i.e. their construction would have been concerned largely with the immigration aspect of travellers, and not with the needs of Customs. Hardware would have to be updated or replaced to ensure the efficient and safe use of this new technology; the greater security offered by biometrics and its perhaps eventual ubiquitousness may justify these significant resource needs.

- **Expectations and business practices of the trade and travelling public:** Airlines, maritime shippers, and other participants in the international supply chain will need to be involved closely in the development/implementation of biometric information collection and analysis by any government actor. Public education and clear on-site guidance will be necessary in order to ensure the participation of, and compliance by, participants in the international supply chain and Customs processes. Any insertion of new information checks such as biometrics will also need to ensure it is implemented in a way that makes sense for existing business processes, and the value-added is greater than the additional burden of installation, maintenance, and related training.

Biometrics may also reduce the ability of shadow companies to exploit the international supply chain for illegal gains.

- **Sufficient IT and personnel resources**: Implementing agencies will need to ensure sufficient IT resources, including software, hardware, privacy protections, bandwidth, etc. Administrations will need to be quick to recognize any flaws in processes identified by the current testing, and determine reliable and cost-effective biometric solutions.

- **Political will:** Significant time and resources are required to address these challenges. None of this can be accomplished without the support of leadership. The value of biometrics must be clearly demonstrated to ensure the espousal of this technology by Customs agencies and other users. As biometrics becomes more common, it may actually piggy-back onto this process as ubiquitous technology rather than having to be adopted in a separate process.

E. Concerns about security and use of biometric data

Many parties have significant concerns about the use of biometrics, in particular that it may not be limited to mere identity verification. Biometrics can be used to keep airports and seaports secure, but can also be used to identify individuals participating in public protests, as well as to remove anonymity of movement in a world already replete with security cameras and access chokepoints. However, many users have already willingly surrendered a significant degree of privacy due to the benefits of convenience, access, and security it has provided (for example: mobile phones and location technology, credit cards, security cameras).

Any new restriction on access to a location or system inherently creates an incentive to falsify information in order to gain access to it; care will need to be taken that the biometric information submitted originally is accurate, and work will have to be put into the ongoing monitoring of the integrity of these systems. All systems must incorporate features to protect information that is susceptible to security breaches/hacking. We must not become overly confident that biometrics will eliminate identity theft and other forms of fraud in Customs enforcement.

- **Cancellable biometrics:** One advantage of a password or other assigned identifier system over biometrics is that password-based identifiers can be re-issued. If a token or a password is compromised, system administrators can cancel and replace this identifier. This ability is not naturally available in biometrics. If the recording of an individual's face, iris, or other biometric data is compromised through technological error or deliberate sabotage, the individual cannot cancel or be reissued a new verifier; instead, the system has to be updated to clarify that the individual's original biometric data is valid.

Biometrics could likewise be utilized to prevent crime in the international supply chain. It has a potential use in ensuring the identity of Customs actors.

- **Burdens of hardware:** Whereas access to previous systems and locations could be obtained through biographic or password identifiers, biometric data requires the physical presence and participation of the individual from whom the biometric data has been gathered. This can require the installation of hardware in multiple locations to enable the recording and verification of biometric identifiers for individuals seeking to gain access to systems from remote or disparately located workstations. For example, a Customs broker could be required to submit biometric data to confirm their identity, and have to purchase an iris scanner in order to submit this data from their office. This creates a new burden of procurement, and hardware integrity, for governments and other actors in the international supply chain, and could present an unfair burden on small businesses and individuals over larger companies.

- **New danger to individuals:** When individuals seeking to compromise security cannot access secure systems/locations, the limitations of biometrics increase the chance of physical danger to individuals with the biometric information that can access those systems/locations. If the item is secured with a biometric device, the damage to the owner could be irreversible, and potentially cost much more than the property it secures. In a particularly gruesome example, in 2005 Malaysian car thieves cut off the finger of a Mercedes-Benz S-Class owner when attempting to steal a car which required a fingerprint scan to function. This creates a new threat to Customs officers and actors in the international supply chain.

Many parties have significant concerns about the use of biometrics, in particular that it may not be limited to mere identity verification.

- **Merely a stop gap in information/location security:** Creating a new method/system to secure a system or a location inherently creates the incentive to hack or otherwise circumvent that method/system. There are innumerable examples of secured communications and systems belonging to wealthy and powerful government and private entities being compromised by criminal organizations and entities seeking to harm or destabilize these system users (examples: WikiLeaks, Panama Papers), as well as by terrorist organizations and their supporters. It is not unforeseeable that the widespread adoption of identity verification technology utilizing biometric data will in turn beget technology which can bypass these checks (for example, distortion technology to make a face appear to look like another; contacts or other inserts which allow retinas to mimic another person's; or technology to alter or create false records on the otherwise legitimate biometric data collected on individuals). This is the perpetual challenge of law enforcement attempting to stay ahead of the game.

Biometrics can offer innovative opportunities for law enforcement; but it also requires more of the basics that Customs agencies are always seeking to achieve, i.e. coordination, information sharing, and mutual support and trust. International forums like the WCO will be important venues for sharing success stories and cautionary tales on

biometrics, and for establishing the required international standards, fostering cooperation and mutual assistance, and information sharing.

F. Ongoing projects in Customs

A number of projects are being implemented by Customs authorities in different regions and some of them are elaborated in detail as case studies in the Annex to this Study Report.

For example, the U.S. CBP uses biometrics including fingerprints and facial comparison technology for passengers. Another example is Japan Customs, which in April 2019 introduced electronic Customs declaration gates (e-gates) to facilitate smooth entry, shorten the waiting time and reduce congestion at the Customs inspection area. Passengers can now go through the gate smoothly and speedily using an electronic declaration on their smart-phones and the facial recognition system, as long as there is no need for a declaration and they are not subject to inspection.

Biometrics can offer innovative opportunities for law enforcement; but it also requires more of the basics that Customs agencies are always seeking to achieve, i.e. coordination, information sharing, and mutual support and trust.

5. Drones

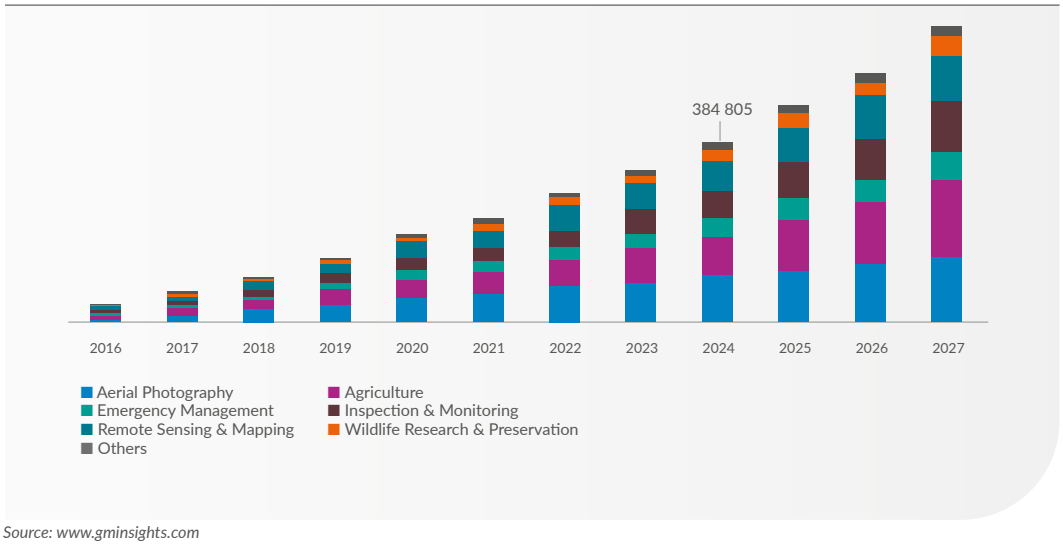
A. What are drones?

According to Webster's dictionary, a drone is an unmanned aircraft or ship guided by remote control or onboard computers. Unmanned aerial vehicles (UAVs) are a component of an unmanned aircraft system (UAS) which includes a UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator, or autonomously by onboard computers. Compared to manned aircraft, UAVs were originally used for missions too "dull, dirty or dangerous" for humans. While they originated mostly in military applications, their use is rapidly expanding to commercial, scientific, recreational, agricultural and other applications, such as policing, peacekeeping, and surveillance, product deliveries, aerial photography, agriculture, smuggling, and drone racing.

The pandemic has accelerated the use of technology in many aspects, but the pre-pandemic period saw a rise in global interest for the use of commercial drone applications across a wide range of industries. However, despite the increase in the use of other disruptive technologies during the pandemic, the drone industry around the world saw a decline in demand for drones. However this trend appears to be temporary because currently the estimated value of the global market for UAV drones is 33.6 billion U.S. dollars, and it is projected to reach 58.5 billion U.S. dollars by 2026, growing at a compound annual growth rate (CAGR) of 13.9% over the analysis period.[25]

Drones are already an integral part of the international trade supply chain, pushing regulators to become more comfortable with the technology, and thereby aiding them in the development of a legal framework that determines the conditions in which they will operate. Studies indicate that the integration of drones in the trade environment can support economic growth. However, integrating them successfully and safely requires all players in the market to be prepared and engaged in the process to ensure that the supply chain can fully realize the benefits. In the trade environment, modes of physical delivery of goods are being continually re-defined. Delivering goods in remote areas where there is poor to no infrastructure is expensive, but on the other hand, even in highly populated areas where there is infrastructure, delivery is equally costly. For

Figure 22: Global commercial market size, by applications, 2016-2027 (units)



Source: www.gminsights.com

25 https://www.strategyr.com/market-report-uav-drones-forecasts-global-industry-analysts-inc.asp

that reason, suppliers are constantly looking to solve the 'last mile' problem and drones are being tested not only for domestic deliveries, but even for cross-border deliveries. Some express service providers and postal operators who tested or piloted the use of drones for parcel deliveries at the local level in nearby areas just a few years ago have turned into success stories. For example, Amazon and Alibaba have turned their interest in the use of drones into business, with Amazon working on safely and efficiently delivering packages to customers within 30 minutes or less. In early 2020, Swiss Post transported laboratory samples by drone as part of regular ongoing hospital operations. This came after completing over 2,000 test flights in May 2019.[26]

Integration of drones in the trade environment can support economic growth.

Some ports are also integrating these new technologies in their daily operations. For instance, the port of Durban has undergone a pilot project that seeks to modernize its infrastructure and operations. The South African port has deployed an arsenal of both air and submarine drones to capture information, monitor, and inspect the condition of the port's infrastructure, vehicle traffic, and seabed to avoid operational risks and ensure the quality of their services.[27]

B. Use of drones for cross-border delivery of goods

Drone technology allows a high level of autonomy. Using GPS signals for navigation and Wi-Fi for communication, some models require human operators to guide the vehicle manually by remote radio control, using on-board cameras that can act as digital eyes over several kilometres, depending on battery life. Other, more sophisticated vehicles can follow entirely pre-programmed take-off, flight, delivery and landing routines without human intervention.

Further technical benefits that trigger assumptions of increased use of those new delivery modes are related to the lower weight of unpressurized drones, leading to big drops in fuel consumption, and less noise and faster turnaround time in comparison to conventional aircraft, for instance. The Delft University of Technology designed an unmanned containerized cargo freighter, called ATLAS, that can reduce the cost of shipping by air, and the time required for inter-modal transfers and transport on the ground. The lift-generating body of the design helps to make it more fuel-efficient compared to a conventional design. Dronamics, a Bulgarian company, has successfully created and tested an unmanned drone, named Black Swan, capable of transporting up to 350 kg of cargo at distances of up to 2,500 km at nearly 80% of the cost of any other air freighter currently in use.[28] Running on 100% synthetic fuel and needing at least 400 metre-long (unpaved) runways, the Black Swan offers logistics companies the opportunity to deliver same-day services to even the most out-of-reach communities. [29]

Prototypes are now being developed of drones capable of carrying 10 to 30 tonnes (10,000 to 30,000 kilograms) of cargo that could fly from China to Europe in 12 hours with optimal fuel consumption, and which could serve airports that freighters or cargo-friendly wide body passenger aircrafts do not serve at present.

With these developments, the potential for the use of more developed generations of drones for the commercial delivery of consignments within a country and across borders at a marginal cost is not too far-fetched. Drones can play a very important role when it comes to making an urgent and efficient delivery to a remote place - be it medicines for a critical patient or an urgent spare part to a shut-down oil rig. Drones could equally be useful in first- and last-mile delivery, and thus improve and supplement the overall efficiency of

26 https://www.post.ch/en/about-us/news/2020/experts-issue-a-good-report-for-swiss-post-and-matternet-drones-to-take-off-again
27 https://maritimafrica.com/en/african-ports-the-obligatory-march-towards-digitalization/
28 https://www.dronamics.com/unveiling
29 https://www.dronamics.com/unveiling

the supply chain. The use of drones can also be expected to appear in cross-border deliveries in neighbouring countries, notably in regions which lack adequate road transport infrastructure.

C. Regulatory issues

The successful case studies relating to drone technology for deliveries demonstrate that the application is still mostly limited to pilot projects, short-term initiatives, and prototypes. The main reason for this is that the effective use of this technology cannot be explored any further without an enabling environment. The December 2018 Gatwick Airport drone crisis that lasted for 38 hours, disrupting the flights of some 120,000 passengers, showed some of the challenges posed by this new technology. The major hurdle in this area is the unavailability of a drone policy framework for developing drone regulations. In order to operate in one common air space, a holistic approach for manned and unmanned aviation is of the utmost importance. The relevance and availability of the drone technology depend on whether the regulatory environment enables the safe use of drones and on developing a framework that will determine the conditions in which the technology will exist. Global standards on safety, privacy and data protection need to be reviewed, potentially updated and/or developed. Equally, thought must be given to developing an aeronautical data exchange, processing, and synchronization network that accounts for the unique requirements of drones, while at the same time internationally harmonizing drone regulations, potential certification standards, and operational procedures.

Some civil aviation authorities, for example in the U.S., the EU, China and the UAE, have already started developing a new set of rules and regulations related to the movement of drones. In one such proposal, a drone that weighs less than 25 kilograms and flies at an altitude of lower than 150 metres will be exempt from airworthiness certification but will still need to register with the respective civil aviation authority. Those weighing from 25 to 150 kg will have to go through airworthiness certification before they are allowed to operate. All flights performed by drones will be required to submit a flight plan before an aircraft takes off.

Another proposal under discussion is to create an airspace between 60 to 120 metres above the ground for high-speed drones to operate out of line-of-sight, while smaller, slower drones would be restricted to flying below 60 metres. A 30-metre airspace between 120 and 150 metres would be a "no-fly-zone", which would serve as a buffer between drones and conventional aircrafts. All drones would be connected to the Internet, so they could be tracked and receive warnings if they are in danger. Further, to avoid mid-air collisions, drones must be able to communicate with each other and should have the capability, like traditional aircraft, to "sense-and-avoid" another object in the air.

The International Civil Aviation Organization (ICAO) has been working on safety standards for large drones/remotely piloted aircraft systems (RPAS). The ICAO's Aviation Security (AVSEC) Task Force on RPAS recently identified numerous security challenges (including the issue of cross-border operations) that need to be addressed in the near future. These issues will be discussed at future ICAO AVSEC Panel meetings.

D. Potential impact on Customs

Drones are already being used by some Customs administrations for surveillance and monitoring purposes.

The use of drones in the Customs environment no longer belongs to the "generation next". Drones are already being used by some Customs administrations for surveillance and monitoring purposes. For instance, Dutch Customs are increasingly using drones to monitor port areas and coastal regions. This involves surveillance not only to combat drug smuggling but also to provide aerial assistance during arrests. Drones are mainly used in the port area of Rotterdam, but plans are under way to use them more nationally.[30] A remote-controlled drone with a

30 https://www.dronewatch.eu/dutch-customs-are-increasingly-using-drones-to-combat-drug-smuggling/

high-definition camera for underwater surveillance has been used by Dubai Customs since August 2020. The drone can go as deep as 50 metres to perform a detailed scan of a boat. With a range of about 30 metres from the controller, it can travel at a speed of 15 kilometres per hour. Dubai Customs use the drone to inspect the wooden boats coming into Dubai.[31]

However, while there are budding opportunities for the use of drones as a mode of delivery, there are also challenges. Clearly, Customs need to monitor, analyse and comprehend emerging developments in the use of drones and related regulatory developments and come up with an appropriate policy response, together with potential adjustments of Customs procedures and requirements, where needed.

Customs can delve into these developments from two perspectives – as a user and as a regulator. In the law enforcement area, drones are seen as the next logical technological evolution. As already mentioned, Customs may potentially use drones for surveillance in inaccessible and hazardous terrains, closing the gap, if there is one, in border surveillance in those areas. Equipped with infrared and high-resolution imaging, drones can be effective in border and maritime surveillance, in particular for monitoring suspects, curbing cross-border smuggling and drug trafficking, and nuclear, biological and chemical sensing and tracking.

U.S. Customs and Border Protection have advanced the exploitation of drone data through their existing digital forensics capabilities. As drones continue to be utilized more extensively in the smuggling of illegal contraband, and in counter-surveillance by Customs and immigration officials, data retrieved from drones is becoming a necessity for both law enforcement and intelligence use. Drone data is not easily accessible like the data in traditional electronic devices used in the Customs environment. The need for ever-evolving digital forensic techniques is beyond question. Collaboration across the WCO and WTO memberships could vastly improve the pace and quality of data exploitation for everyone.

Another area to explore is the Customs regulatory perspective, and what is required to meet the current and emerging challenges, especially in the context of the potential use of drones for the cross-border delivery of legal and illegal goods. In terms of threats, drones themselves could potentially be used for cross-border air attacks. In addition to security concerns, another emerging threat is the use of drones for smuggling, including the cross-border delivery of drugs. In 2015, 12.7 kg of heroin were found to have been smuggled across the border into the U.S. using drones. In the five years following this seizure, U.S. Customs and Border Patrol have reported 170 similar drug-smuggling incidents involving the use of “narcodrones”. [32]

Customs need to monitor, analyse and comprehend emerging developments in the use of drones and related regulatory developments and come up with an appropriate policy response.

31 https://www.thenationalnews.com/uae/2021/10/21/gitex-2021-underwater-drone-helps-dubai-customs-catch-drug-smugglers
32 https://www.businessinsider.com/how-mexicos-cartels-are-using-drugs-for-attacks-drug-smuggling-2021-5?r=US&IR=T

In 2021, Dubai Customs' drone monitoring unit spotted and seized a container in Jebel Ali in which illegal pills were hidden among spare motor parts. In the same year, Dubai Customs officials thwarted around 398 attempts to smuggle drugs into Dubai.[33]

There are several other examples. For instance, Customs officers in southern China's technology hub Shenzhen discovered a group of criminals using drones to smuggle 500 million yuan (USD 79.8 million)-worth of smartphones from Hong Kong to Shenzhen.[34] The smugglers usually operated after midnight and only needed seconds to transport small bags holding more than 10 phones using the drones. The gang could smuggle as many as 15,000 phones across the border in one night. Regulating the use of drones has become an important task for China, the world's largest manufacturer of consumer drones. Acting on tips, law enforcement officers from both sides discovered the operation in February 2018 after months of investigation. It was confirmed that the gang apprehended had been operating since 2016.

Another area to explore is the Customs regulatory perspective, and what is required to meet the current and emerging challenges, especially in the context of the potential use of drones for the cross-border delivery of legal and illegal goods.

Drug cartels are using unmanned drones to carry drugs across the southern border, challenging the U.S. technological ability to stop the advance.[35] Border Patrol agents are increasingly worried about the threat from drug-cartel-flown drones, after agents spotted 13 drones suspected of carrying drugs across one section of the U.S.-Mexico border in just one four-day period in November 2017. Cartels all along the border are using drones, though the San Diego sector has been among the most active in reporting on the traffic. In August 2017, the U.S. government arrested a 25-year-old American citizen who admitted he was the pick-up person. Police seized just under 6 kilograms of methamphetamine, worth an estimated USD 46,000, and also seized the drone, a Matrice 600 Pro, which sells for about USD 5,000, can take off with a 6 kg load, and can fly at 65 kph.

Heroin smugglers from Pakistan have been using drones to drop contraband into Indian villages along the Punjab border.[36] Smugglers were recently found using drones in Punjab's Gurdaspur. The report cited that a plastic bag consisting of narcotic substances was found flying at a height of 200 metres. The drone flew back to Pakistan without dropping the package after it was noticed by the police. According to the report, drug smugglers have been adopting newer methods for ensuring the delivery of narcotic substances across borders.

It is a well-known fact that untaxed cigarettes have been one of the biggest issues in the daily life of European Union Customs officers. In February 2022 the Lithuanian State Border Guard Service captured an unmanned aircraft that had entered the territory of Lithuania smuggling around 1,000 packets of cigarettes. Similar incidents were reported the previous year at the Lithuanian border with Belarus, where nine unmanned aircraft smuggling cigarettes were detained by Customs officials.[37]

These cases are a serious warning sign, and Customs must consider how it can prevent smuggling carried out with the use of drones.

During the 40th Session of the Enforcement Committee, a panel discussion elaborated on

33 https://www.thenationalnews.com/uae/transport/
34 Retrieved from https://www.chinadailyhk.com/articles/192/48/173/1522315752387.html on 3 December 2018
35 The Washington Times – 2 janvier 2018.
36 Retrieved from https://www.timesnownews.com/india/article/border-security-forces-latest-headache-pakistani-smugglers-using-drones-to-deliver-drugs-across/236762 on 3 December 2018
37 https://border-security-report.com/border-guards-took-over-a-drone-from-belarus-which-was-smuggling-cigarettes/

emerging security issues, noting that, with the development of new technologies, changes to supply chains, and threats posed by new and innovative terrorist attack methodologies, it was important that Customs were able to respond in order to protect society and to address emerging risks relating to the international movement of goods and terrorist actors. Among the new emerging threats that were addressed was the increase in the availability of drones. It was acknowledged that, whilst these disruptive technologies and new forms of commerce presented opportunities for trade, they also presented opportunities for terrorists to acquire weapons or their components.

New technologies do, however, give Customs a range of tools to address smuggling, such as the availability of geospatial data and other new data sets which provide Customs with potential new sources of intelligence to inform their risk profiles.

The March 2016 PTC had noted that, with technological advancements and increasing sophistication, drones could soon be used for cross-bor der deliveries of goods; delegates recognized that Customs was the agency responsible for cross-border movement of conveyances which included drones. In this context, some delegates had opined that, in addition to the other issues raised, some other regulatory issues related to the use of drones for cross-border e-commerce delivery to buyers/consumers directly, instead of airport-to-airport services, and control of cross-border movement of unmanned drones (as some of the existing regulatory requirements are designed for conveyances with drivers/pilots) needed to be further explored in harmony with existing regulations, and in close cooperation with civil aviation, other relevant government agencies and private sector stakeholders.

In conclusion, the March 2016 PTC had agreed that there was a need to carry out further research on the topic, in particular exploring more practical experiences and related policy developments, as well as monitoring and coordinating the work being done in this area by other international organizations (e.g. ICAO).

6. Virtual, augmented and mixed reality

A. What are virtual reality, augmented reality and mixed reality?

Virtual reality, augmented reality and mixed reality are technologies that either create a fully simulated world or add digital artefacts to the physical world; both of which can be useful tools for Customs training purposes.[38] Virtual reality is on one end of the spectrum, being a fully immersive technology. On the other end of that spectrum is augmented reality, where digital artefacts are added to the physical world. With mixed reality, digital artefacts are projected in the physical world.[39] Those artefacts can interact with and exist alongside physical objects. This allows the merger of both the physical and digital worlds. The following gives further clarity to the differences between the different (immersive) technologies:

- Virtual reality fully immerses the user in a virtual environment through the use of a headset, allowing them to interact with and manipulate digitally rendered objects.
- Augmented reality projects digital objects into the user's field of vision via a mobile device or headset, keeping the user in the physical world and allowing them to be 'heads-up' and hands-free.
- Mixed reality is the fusion of augmented and virtual realities, offering the user the ability to manipulate and interact with digital objects while still being engaged in a physical environment.

Different large organizations and enterprises are developing products using these technologies to address an array of issues and challenges. While virtual reality has been commonly associated with the video game industry, it presents revolutionary applications to healthcare, product design and development, and training, and offers new ways to approach certain processes. Examples of virtual reality headsets that have been in circulation are Meta's Oculus Quest 2 and Xiaomi's Mi VR Standalone.

Both of these virtual reality devices are wireless all-in-one headsets, meaning that they do not need to be tethered to an external processor. Although the headsets have been geared towards entertainment, allowing users to enter an immersive viewing environment, devices like the Oculus Quest 2 include wireless controllers, pairing users with virtual reality-compatible video games or fitness programmes. With the device being a product of the largest social media platform, it offers new channels to connect users and allows for new ways to socialize and interact through cyberspace.

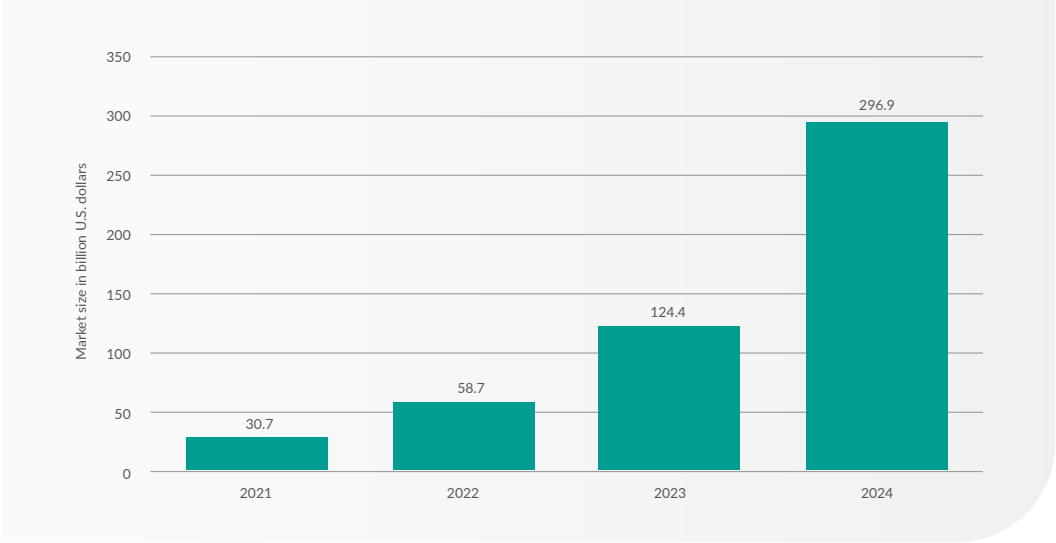
Like virtual reality, augmented reality and mixed reality products are also being developed with the intention of using them in business settings. Examples of such products are Google Glass, spectacles that also come with AR and VR capabilities, and HoloLens, a pair of mixed reality smartglasses developed and manufactured by Microsoft.

38 https://en.wikipedia.org/wiki/Immersive_technology
39 https://en.wikipedia.org/wiki/Mixed_reality

Augmented and mixed reality devices, like those used for virtual reality applications, are untethered. However, unlike VR headsets, augmented and mixed reality devices superimpose auxiliary information in the user's general field of view in a holographic fashion. This allows users to remain hands-free and 'heads-up' as they perform certain tasks. The applications of these devices are, at the moment, boundless, as they can be applied to a multitude of sectors from healthcare to education and across multiple service lines.

Over the next decade, these technologies are expected to grow exponentially as they permeate throughout different sectors, industries, and service lines. Although virtual and augmented realities will bring about varying levels of economic growth, a PWC report[41] exploring these technologies suggested that the economic contributions of augmented reality will be significantly higher than that of virtual reality by 2030.

Figure 23: Augmented reality (AR) and virtual reality (VR) market size worldwide from 2016 to 2024 (in billion U.S. dollars)



Source: Statista[40]

Over the next decade, these technologies are expected to grow exponentially as they permeate throughout different sectors, industries, and service lines.

40 https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/
41 https://www.pwc.com/seeingisbelieving

B. Existing practices

Virtual, augmented and mixed reality are used in different industries and domains, most commonly in a learning environment. These kinds of applications are slowly growing in the Customs domain as well.

The use of virtual reality solutions for Customs training purposes has been successfully employed by government bodies like Dubai Customs, where virtual training is used to improve inspectors' efficiency in identifying prohibited items (WCO link). The virtual training programme offers inspectors the chance to hone their skills and knowledge of their duties and responsibilities in a low-risk virtual environment while following a progression system.

Other applications of virtual and augmented reality devices can be found across both the public and private sectors. For example, the Dutch Ministry of Defence uses virtual reality to simulate environments where soldiers can train in specific capabilities, e.g. shooting practice. This technology can lower the costs of training while enhancing its effectiveness.[42]

The WCO Virtual Reality Training project, which uses virtual reality to train Customs officials, was launched with financial support from CCF-Korea in 2021. Using a virtual reality environment, officers are trained through a game-like virtual container cargo inspection process. The project is based on the belief that the adoption of disruptive technologies is critical to keep pace with the latest trends and the opportunities they present to improve Customs in every way, and will continue to look for more options to enhance Customs expertise. Additional training courses on topics such as e-commerce are currently under development and will be added to the course collection. Feedback to date has been encouraging, and the continued inclusion of virtual reality courses is widely seen as the future of online training and capacity building activities.

DHL has used augmented reality to help employees find the right products when order picking.[43] Boeing has used the same technology to give instructions to employees who are assembling aeroplanes.[44]

NASA uses a prototype mixed-reality headset to transport people virtually to the Moon and to Mars.[45.] The technology is also used to view objects in the places in which they will be used, e.g. a Moon lander or Mars Rover.

C. Potential future use in Customs and border management

There are different potential future uses in Customs and border management for virtual, augmented and mixed reality. Augmented and mixed reality can be used to project visual assistance in the physical world, e.g. when doing a physical inspection. This assistance can be in two forms. The first is general assistance that is provided in advance to all employees. The second is the possibility that the assistance is provided by someone who can see what the Customs officer sees, in real time.

Virtual reality can have a more enhanced use in training Customs officers. Different kinds of training environments, simulations, and scenarios can be created that are difficult to recreate in the physical world - the machine room of a large container vessel, for instance.

The U.S. Customs and Border Protection (CBP) Office of Trade, for example, is exploring the role of augmented reality not only for training simulations, but also to protect intellectual property rights on American imports and fill knowledge gaps that may exist between experience levels. According to a CBP publication,[46] while the application of this technology is still in progress, it is expected that Customs agents will benefit from the use of augmented reality headsets by making a library of searchable goods readily available for agents to compare and identify counterfeits with

42 *https://magazines.defensie.nl/landmacht/2017/10/10_op-missie-in-virtuele-wereld (in Dutch).*
43 *http://www.dhl.com/en/press/releases/releases_2017/all/logistics/dhl_supply_chain_makes_smart_glasses_n ew_standard_in_logistics.html*
44 *https://www.theverge.com/2016/7/14/12189574/boeing-google-glass-ar-building-airplane-parts*
45 *https://www.nasa.gov/feature/jpl/mixed-reality-technology-brings-mars-to-earth*
46 *https://www.cbp.gov/sites/default/files/assets/documents/2020-Jun/Augmented%20Reality_0.pdf*

3D renderings. Because these technologies have been integrated into headset devices like Microsoft's HoloLens, agents can perform their duties hands-free.

Extended use of these technologies has multiple applications for the public sector, and, in the realm of Customs, they can be used to perform efficient security screenings by reducing common risks and errors that can occur during regular checks.[47] Facial and behavioural recognition software can alert Customs agents of potential risks when dealing with individuals attempting to cross borders. Other services these devices can provide are to identify and assess vehicles (e.g. warning agents if a vehicle is lower to the ground than it should be in the case of smuggling), as well as provide translating services if interacting with foreign-speaking individuals.[48]

Finally, another potential use is the visualization of big data sets. Big data is hard for a layman to visualize and manipulate. When using mixed reality, data can be projected in the physical world as digital artefacts that can be manipulated as real objects.

Virtual reality, augmented reality and mixed reality are technologies that either create a fully simulated world or add digital artefacts to the physical world.

47 https://www.accenture.com/_acnmedia/accenture/redesign-assets/dotcom/documents/global/1/accenture-g20-yea-report.pdf
48 https://www2.deloitte.com/content/dam/Deloitte/us/Documents/public-sector/us-fed-augmented-government.pdf

7. 3D printing

A. What is 3D printing?

3D printing, or additive manufacturing, is a process of making three-dimensional solid objects from a digital file, using a 3D printing machine and raw materials such as plastic, metal, nylon, or others.

3D printing is widely used for industrial, medical, construction and consumer goods. The technology is also at the early stages of adoption within the automotive and aerospace sectors, along with some applications in the consumer electronics sector for the manufacture of cases and covers for smart phones, tablets and other portable devices.

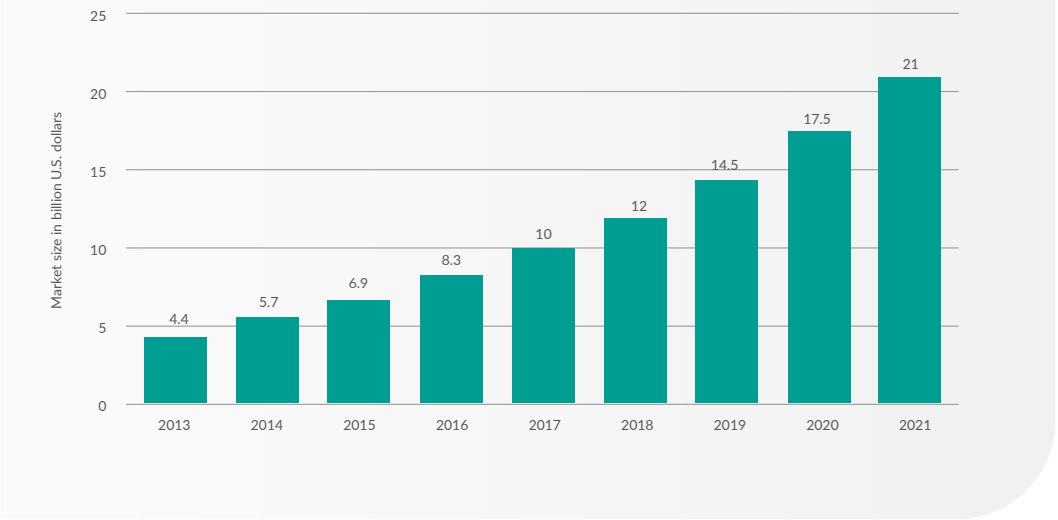
The 3D printing market is growing rapidly. In 2020, the worldwide market for 3D printing and manufacturing was valued at around USD 12.6 to 17.5 billion and has since been projected to continue growing at an annual rate of 17% up to 2023.[49] According to some reports around 1.4 million 3D printers were shipped globally in 2018, with an estimated 8 million units to be shipped in 2027.[50] As 3D printers become more affordable and capable of manufacturing more complex products, it is expected that both consumer and producer demand will rise. Consumer-friendly models are already on the market and sales of personal 3D printers have indicated growth rates of 200% to 400% from 2007 to 2011.[51] Increasing demand and vast potential applications have led some analysts to estimate that the 3D printing industry could add anywhere from USD 230 billion to USD 550 billion per year to the global economy by 2025.[52]

Although 3D printing accounted for less than 0.1% of global manufacturing revenues in 2018, it has experienced an average annual growth rate of 26.9% over the last three decades (WEF, p. 26).[53] Computer-aided design (CAD) software and the market for on-demand parts and services are expected to almost triple. Discrete manufacturing is seen as the dominant industry for 3D printing.

3D printing is widely used for industrial, medical, construction and consumer goods.

49 https://www.statista.com/statistics/315386/global-market-for-3d-printers/
50 https://www.statista.com/statistics/370297/worldwide-shipments-3d-printers/
51 https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/disruptive%20technologies/mgi_disruptive_technologies_full_report_may2013.ashx
52 https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/disruptive%20technologies/mgi_disruptive_technologies_full_report_may2013.ashx
53 https://www.weforum.org/reports/mapping-tradetech-trade-in-the-fourth-industrial-revolution

Figure 24: 3D printing market size worldwide from 2013 to 2021



Source: Statista[54]

Traditionally, material objects (ranging from computer chips to sweaters to automobiles) have been built in factories controlled by a single corporate entity that designs the product, manages its supply chain, produces it and sells it, directly or indirectly. 3D printing is about to kick off an era of digital transformation that will redefine such classic models.

3D printing is a technology that could upend manufacturing modes, supply chains, business models, customer relationships and even entrepreneurship itself. 3D printing could do to physical goods what cloud computing is doing to digital services; what the PC, Internet and smart mobility have done to computing; and what outsourcing has done to software development and business processing. That is, take mass distribution and innovation to the next level, while realigning the very geography of work and trade.

Technology has brought dramatic increases in industrial productivity since the dawn of the Industrial Revolution with the use of steam engines and waterpower, followed by the application of electricity, assembly lines, electronics and automation. Today, we are in the midst of a fourth wave of technological advancement – the digital industrial technology known as Industry 4.0[55] presents a transition from a centralized to a decentralized, highly flexible, personalized and digital smart mode of production and services.

In time, 3D printing could lead to a shift towards more digital and localized supply chains and lower energy use, resource demands and related CO_2 emissions over the product life cycle. However, full realization of the potential of 3D printing depends on overcoming a number of obstacles. The necessary material technology is still nascent and building complex objects is slow. There are also regulatory issues that need to be addressed before 3D printing can be widely adopted in the consumer market. Finally, although declining in

54 https://www.statista.com/statistics/796237/worldwide-forecast-growth-3d-printing-market/, accessed on13 January 2019.

55 Industry 4.0, also known as the Fourth Industrial Revolution, refers to the rapid and exponential technological change that has permeated throughout several industries and facets of social life. Technological breakthroughs, like AI, robotics, IoT and 3D printing, alongside advancements in quantum computing and biotechnology, have presented new opportunities and challenges for consumers and producers alike.

recent years, the cost of printers, materials and scans is still relatively high, especially for deployment in micro, small and medium-sized enterprises (MSMEs).[56]

There are nine pillars of Industry 4.0: big data and analytics, autonomous robots, simulation, horizontal and vertical system integration, the industrial Internet of Things, cyber-physical systems, the cloud, additive manufacturing (3D printing), and augmented reality. Among these, 3D printing has a crucial role.

B. Potential impact on Customs and border management

3D printing is one of those technologies where there is no evident benefit of use by Customs. However, some believe it will have a potentially important impact on the work of Customs in the future.

Discussions on the growing area of 3D printing were launched by the Virtual Working Group on the Future of Customs (VWG FC) at the October 2015 PTC Meeting. China, as the initiator of the topic, submitted a paper which formed the basis of a very intense and fruitful discussion.

Some of the questions which were brought up included:

- is Customs the proper/legally responsible government agency in the area of 3D-printed products that are not imported/exported goods but are printed at national level (sometimes these products have been designed by an overseas company and/or the software instructions come from abroad);
- how to deal with the growing number of new economic operators: the owners of the 3D printers;
- how to safeguard IPR for 3D printing;
- how to ensure security etc.

Delegates felt that the topic of 3D printing fitted very well into the task of the PTC and the VWG FC to explore what might have a significant impact on the role and responsibilities of Customs in the future.

Some delegates felt that the enhanced use of 3D printing would probably have more impact on movements on the domestic market rather than across borders and that, based on current legislation, that might mean 3D printing could have more implications for other governmental agencies rather than for Customs (e.g. tax administrations, national police, etc.). Questions were raised as to whether Customs would nevertheless be involved in monitoring the virtual supply chain, and if so, how this could be achieved, including whether existing legal instruments were sufficient to cover such responsibilities. In general, the cooperation of Customs with tax authorities and other relevant agencies, possibly as a new dimension of coordinated border management, was regarded as important in this field.

Several delegates also stressed the possible implications of 3D printing for origin, valuation, IPR and security, while one Member stressed that it should not present new restrictions in cross-border trade. Other delegates indicated that there might be revenue implications, especially VAT implications and, in addition to the legal issues already addressed, there might be a need to redefine the term “goods” in the future - which might be relevant to Customs responsibilities in 3D printing overall.

Delegates felt that this topic required more research, including looking into the existing legal frameworks and tapping into what already existed, such as whether comparable experiences were already in place (e.g. related to music downloads, that could assist further).

The PTC agreed that there was a need for more research on the topic, especially regarding the legal implications, including by exploring the coverage of existing legal frameworks (such as those regarding music downloads) as well as what other international organizations (OECD, WTO etc.) were doing in this regard. It further agreed that research on 3D printing within the VWG FC would continue in the intersession and that it would report to the PTC at its meeting in March 2016.

56 *WTO World Trade Report 2018: https://www.wto.org/english/res_e/publications_e/world_trade_report18_e.pdf*

The increase in 3D printing would accelerate the movement of raw materials and reduce the movement of finished products across borders which, on the other hand, would have revenue implications.

In the intersession, members of the VWG FC shared relevant materials available in open source, including papers provided to the Secretariat by a number of partner organizations such as the OECD, WTO and UN OCHA. Two members of the VWG FC volunteered to develop research papers based on the available material. (These research papers are available in Annexes I and II to PTC document PC0444E1a.)

The results of the research generated forth several relevant conclusions:

- It was noted that 3D printing would subvert global trade flows and accelerate the transforming role of Customs from duty collection to social protection, mainly IPR, public safety and security. Key elements to consider included the reduction of the movement of physical goods across borders and the increase in the movement of raw materials as opposed to finished products.
- 3D printing did not present anything essentially new to current Customs rules and procedures. Instead, most of the legal issues surrounding 3D printing concerned intellectual property rights such as copyrights, patents, industrial designs and trademarks. Nevertheless, Customs was advised to keep abreast with all the new developments (technical, legal or otherwise) in the 3D printing industry. And if there was the political will, Customs should also discuss how the scope of Customs legislation could eventually be widened.

The results of the research did not intend to conclude the discussions on the implications of 3D printing on Customs; they confirmed that the answer to this question was not straightforward and that at that point it was still too early to identify how 3D printing would progress and impact Customs business in the future. However, a few main themes emanated from the two research papers:

- An important element relating to the cross-border exchange of digital files for 3D printing, referenced by both research papers, was the WTO Moratorium on the imposition of Customs duties on electronic transmissions, which dated back to 1998 and had been extended at each Ministerial Conference since then. This meant that increased exchange of digital files for 3D printing purposes across borders would not have revenue implications, at least not for the time being.
- The increase in 3D printing would accelerate the movement of raw materials and reduce the movement of finished products across borders which, on the other hand, would have revenue implications. These assessments resonated with reports looking into the potential acceleration or deceleration of trade as a result of 3D printing. A 2019 World Bank report[57] analysing 35 partially 3D-printed products found positive effects

57 *World Bank Report: https://openknowledge.worldbank.org/handle/10986/32453#:~:text=The%20analysis%20finds%20that%20trade,%2D%20and%20high%2Dincome%20countries.&text=The%20results%20counter%20widespread%20views,supply%20chains%20and%20reduce%20trade*

on trade. A 2017 report by ING's International Trade Analysis[58] team estimated that nearly a quarter of global trade could be displaced by 2060 if 3D printing replaced half of conventional manufacturing among a 1-2% decrease in physical trade by 2030, respectively. An August 2021 report by ING's International Trade Analyses team revisited its previous estimates and reassessed that by 2040, if 3D printing made up 5% of global manufacturing, this would lead to a negative growth rate of -4.5% or 0.2 percentage points less trade per year for the next two decadess.[59]

- As 3D printing becomes more widespread, disruptions to established supply and production chains will ensue and new trade trends will occur. A similar observation was made by the WTO in its 2018 World Trade Report, noting the decline in trade of digitizable goods (e.g. sound recordings, video games, and literary works) from 2.7% of total goods in 2000 to just below 1% (0.8%) in 2016 as result of the digital revolution.[60] The WTO report suggested that the prevalence of new technologies and capabilities would alter established practices and, in the case of 3D printing, demand for transport and logistics services would most likely decline, and that it would be possible to substitute production of certain goods domestically; thereby driving down trade costs. This would, therefore, lead to a cascading effect in the overall global trade system as global value chains could become shorter and reshoring practices be encouraged (see WTR2018). Ultimately, the long-term effects on global trade, whether positive or negative, however, are still too early to determine as the scope of 3D printing remains limited.
- IPR implications are seen as an important element to bear in mind. However, how this would impact Customs work was not clearly defined.
- In terms of legal implications, it was conjectured that the envisaged decrease in Customs revenue would not seem to be a strong reason for overhauling Customs legislation. Instead, digital blueprints could become taxable items, which would not necessarily impact Customs but possibly (also) tax administrations. Other national agencies, such as the police, anti-drugs and standards agencies, could be well suited to dealing with security issues relating to 3D printing.
- Finally, apart from national laws, it was noted that there were many international conventions and treaties, particularly those signed under the auspices of the WIPO and the WTO, that could contribute to the orderly management of 3D printing across the globe, e.g. the WTO TRIPS Agreement and Dispute Settlement Understanding, and the WIPO Copyright Treaty, Patent Law Treaty, Trademark Law Treaty, Washington Treaty, Paris Convention and others.

During discussions at the March 2016 PTC, diverse views were shared on 3D printing. Some delegates argued that Customs dealt only with tangible goods and that, therefore, digital transmissions should have no implications for Customs work, even though it was still important to keep a close eye on developments in the future.

Others were of the view that Customs needed to monitor the cross-border movement of intangible goods too, or to at least look into this new means of manufacturing and identify whether the same rules would apply, for instance, in de-

The long-term effects on global trade, whether positive or negative, however, are still too early to determine as the scope of 3D printing remains limited.

58 ING Report: https://think.ing.com/reports/3d-printing-a-threat-to-global-trade
59 https://think.ing.com/reports/3d-printings-post-pandemic-potential/
60 https://www.wto.org/french/res_f/publications_f/world_trade_report18_f.pdf

termining the origin of goods. Some delegates felt that Customs still had an important role to play in monitoring cross-border movement of intangible goods. In conclusion, the March 2016 PTC agreed that, even though for the time being no duties were being imposed on intangible goods, this did not mean that Customs had no role to play. Furthermore, it was agreed that the topic of 3D printing and its implications on Customs was not to be closed at that point in time, but was to be revisited in the light of any relevant future developments.

An item regarding the role of Customs in the taxation of intangible goods was subsequently placed on the agenda of the December 2018 Policy Commission. The objective was to discuss the issue of the imposition of Customs duties on intangible goods and provide policy orientation, given the ongoing WTO moratorium on the imposition of duties on electronic transmissions, and to consider possible approaches and associated legislative and operational requirements for the collection of Customs duties on intangible goods, to examine Customs' role in non-fiscal areas such as security, admissibility, IPR and illicit trade in the context of growing digital trade, and to provide guidance on the way forward. At the request of several delegates, it was decided not to take up this item for the time being. However, several other delegates stressed the importance of this subject and considered that a future discussion could be useful in order to have a better understanding of the role of Customs regarding intangible goods from a wider perspective. The outcomes of such a discussion would also have implications for the role of Customs in cross-border transfers of 3D printing digital files.

As a 2021 OECD trade policy report[61] noted, measurement challenges remained in assessing the overall impact of 3D printers, and suggested that the WCO's creation of HS heading 84.85 would allow for better monitoring of machines for additive manufacturing (3D printers) and their impact on trade.

There were no further discussions on this matter after the March 2016 PTC, other than those already indicated in this section. However, in relation to the 2021 OECD trade policy report, the new heading 84.85 for additive manufacturing (3D printers) was created as part of the 2022 edition of the WCO Harmonized System (HS 2022) and entered into force internationally on 1 January 2022. Once a country implements HS 2022, it will enable better national monitoring of 3D printers and their impact on trade. While many countries implemented HS 2022 on 1 January 2022, others will take some months before they have implemented the new edition of the HS and start statistical reporting under HS 2022 provisions. It will therefore take some time before international statistics on this are available but, as more and more countries implement it, increasing information on trade in these machines internationally will be accessible.

61 *OECD Report: https://www.oecd.org/publications/3d-printing-and-international-trade-0de14497-en.htm*

IV. Strategy behind technology

A. Developing and implementing new technology

There is a need to harness the latest technologies as traveller and trade growth, including e-commerce, has significantly outpaced the typical Public Service volution, challenging conventional operations, programme policies and legislation. Drivers for technological change in Customs organizations include the following:

- **Global environment:** Becoming a leader in trade facilitation and Customs services in the marketplace
- **Accountability:** Enhancing accounting capabilities and internal controls
- **Efficiency and service delivery:** Making it easier for client and business interaction
- **Business simplification:** Reducing barriers to trade and lowering costs for importers
- **Technology:** Increasing productivity and improving decision-making capabilities while supporting trade fraud and evasion detection.

Technologies such as blockchain, biometrics and artificial intelligence are more than business enablers, they set expectations for our stakeholders and change how we work. It is essential, however, to focus technological changes on those key to an organization's mandate, as otherwise there is a risk of over-committing.

Innovation is key to developing and implementing new technology and can include:

- Reviews of the latest technologies
- Establishing partnerships with the private sector, between countries and with academia
- Considering the global ecosystem
- Keeping people, processes and change management at the forefront

Innovation initiatives require a clear process to properly review and assess the ideas. Some initial ideas will be of low value, unfeasible or already in the works. The process must allow for the appropriate gating and filtering of ideas to allow the "right ones" through to pilot and potentially full production/implementation.

Options for the implementation of emerging technologies must be evaluated based on the services required and the needs of the organization. Commercial-off-the-shelf services on hosted platforms may be the right solution for one line of business within an organization while a purchased platform with services built internally may be the right solution for another.

Organizations must also evaluate the potential time to market, security requirements, the need for product customization as well as the size and knowledge of their development team when determining the right technological fit. There is also a need to continuously re-evaluate technology strategies and plans over the course of projects as new technologies may be more relevant and cost effective.

The high rate of failure in large, multi-year IT-enabled projects has resulted in organizations moving away from large IT system development and instead selecting technologies that can easily migrate to new hardware in the future. Organizations are looking to aggressively standardize on key platforms by buying the software once and using it multiple times. Furthermore, system dependencies are being decoupled and large monoliths broken down in small sub-systems to allow for scaling, enhancement and re-use of individual components.

Where possible, organizations have moved or are moving away from waterfall approaches to project management and towards more rapid prototyping and design thinking. These iterative approaches are focused on understanding the problem from the point of view of all stakeholders, going through many iterations of ideate, build and test.

To allow iterative project management approaches to lead to success, key performance indicators need to be defined at the outset and assessed as prototyping unfolds. This includes having quantifiable measures of system performance, effectiveness and suitability to document whether what is being delivered offers the expected quantifiable outcomes. If so, documenting the extent to which it does so allows scope for small adjustments so as to deliver more capabilities in the long run. Positive qualifiable outcomes are obtained through iteration, where incremental changes hone the product more and more closely towards user expectations.

Key to these methodologies is the principle of failing fast and recovering quickly. The fidelity of the solution increases with each iteration as what worked is kept and what failed is reworked in the next iteration. Ideas are tested through a phased approach to gain insight while managing immediate pressures, as outlined by a sample timeline below:

- **Phase 1 - Proof of Concept (1-3 months):** Carrying out mini experiments with the individual pieces to see what might work;
- **Phase 2 - Prototype (3-6 months):** Putting the pieces that worked in the Proof of Concept together; framing the end-to-end solution/response; understanding the glue that frames the response (i.e., policy, new class of employees, training, infrastructure, technology, etc.); multiple iterations that increase in fidelity each time;
- **Phase 3 – Minimum Viable Pilot to Production (1-2 years):** Real life in the field and addressing immediate pressure; opportunity to see what works and what does not work in a real-life context; fixing what does not work while the pilot is running (iterate the pilot fidelity); informs the implementation of a national product.

Regardless of the size of the project, test-driven system development is crucial to gain agility, boost product quality, and reduce delays between releases as well as errors during handoffs. This is achieved by developing tests before their associated features, thus inherently increasing test coverage. Doing so ensures that each feature meets the intended use before it is fielded, new features being developed by disparate teams are tested against the existing features and that all features function as expected before being fielded. The concept of continuous integration enabled through automation, including automated testing, ensures that the tooling is in place to orchestrate testing and deployment, thus reducing manual intervention, delays and human errors. These pieces are essential to boost design thinking and improve velocity between iterations.

Customs organizations are using these kinds of new methodologies to implement the disruptive technologies outlined in this Study Report. The Canada Border Services Agency (CBSA) is, for example, developing prototypes using design thinking, one of which was deployed at the Ambassador Bridge, between Canada and the US, in September 2018 to remotely process commercial vehicles as part of the Secure Corridor Concept - Trusted Trader pilot. The pilot tested the technology's ability to reduce the processing times of trusted, low-risk commercial trucks at the Primary Inspection Line by up to 50%, increase truck volume throughput at the port of entry, and reduce the administrative burden on border service officers (BSOs) by removing manual processes. This would contribute to an overall reduction in average border wait times for commercial carriers leading to reduced costs to industry partners.

Highlights of this initiative included:

- A design thinking approach that was taken from concept to prototype to pilot, introducing technology quickly;
- Key performance indicators identified to measure new technology against existing processes;
- A combination of technologies used to automate the capture and input of commercial passage information into CBSA systems, removing the administrative burden from the BSO and allowing for greater decision-making focus; and
- Mounted on installations around the primary inspection line (PIL) lane, technologies to be evaluated include:
  - RFID (radio frequency identification) – collecting and authenticating passage information
  - Licence Plate Readers – collecting plate information
  - CCTV – monitoring drivers
  - VoIP – two-way audio interaction.

Since the inception of the Secure Corridor in September 2018, the pilot has successfully demonstrated that commercial processing can be modernized by leveraging existing technology to effectively offer a touchless border experience and minimize the requirement for trucks to idle in line-ups at the PIL lane. The CBSA is now transitioning the Secure Corridor pilot to a project with a goal to automate more trusted commercial lanes, thereby allowing for more efficient processing coupled with an increase in truck throughput capacity in designated Secure Corridor lanes. The Secure Corridor project aligns with the Government of Canada's Economic Recovery efforts and the Agency's modernization agenda and supports the CBSA's priorities of public and officer safety, security and trade facilitation.

Consequently, beginning in 2023-24, the CBSA will expand the suite of Secure Corridor technologies to 12 additional commercial lanes at six of Canada's busiest ports of entry.

Given the success of the Secure Corridor pilot, the CBSA will also be outfitting all land commercial lanes with modern technology such as licence plate readers and a single interface for BSOs that will greatly improve the efficiency of primary processing. This will impact 44 commercial lanes at 13 of Canada's largest ports of entry, representing 90% of the land commercial volume.

B. Cooperation with other stakeholders

Cross-border supply chains today are very complex and involve multiple public and private sector stakeholders. Even though significantly important, Customs is only one of the stakeholders in the supply chain. Digitalization of processes has greatly advanced in the logistics and transportation sector, as well as in the e-commerce domain. Customs administrations can to a large extent not only benefit directly, but also learn about the application of different technologies to ensure that their procedures are more effective and efficient. Furthermore, connecting to already digitalized supply chains with readily available data from reliable sources contributes to greater trade facilitation and compliance, which are both ultimately important objectives of Customs.

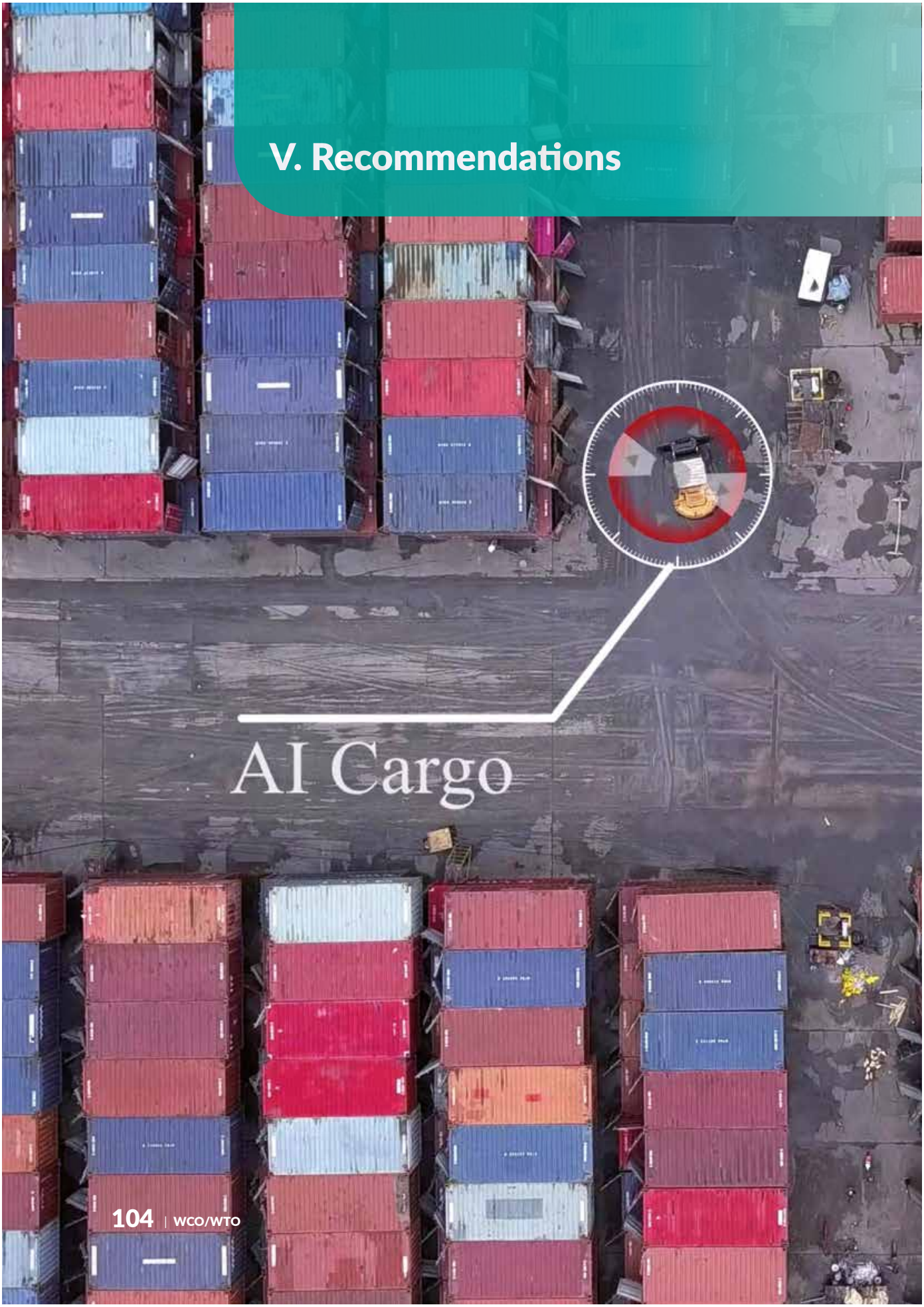
National Trade Facilitation Committees (NTFCs), an obligation under the WTO Trade Facilitation Agreement, bring together Customs and other border agencies, the private sector and other stakeholders. Their aim is to monitor TFA implementation and identify the need for modernization projects and initiatives. They may serve as a relevant vehicle in driving innovation in the border management domain.

Apart from Customs and industry, academia and research institutions are often involved in innovative projects and programmes which contribute to addressing some of the challenges and requirements in the area of border management. These research projects allow for active and conscious thinking about topics for which there is a real need for knowledge and insights from the Customs and other border agencies' side. On the other hand, they aim to provide an overview of the supply chains from the science and companies side. Collaboration between the government, companies and education promotes the collection, sharing and application of knowledge and research, to the advantage of Customs.

An example of the types of fruitful collaboration between Customs and other stakeholders can be found in the case study by the Dutch Customs in the Annex to this Study Report, under 'Collaboration: Industry – Science – Research'.

Connecting to already digitalized supply chains with readily available data from reliable sources contributes to greater trade facilitation and compliance, which are both ultimately important objectives of Customs.

V. Recommendations



This section provides a set of recommendations regarding the introduction and scaling up of technologies by Customs. These recommendations were provided by Customs, the private sector and academia in discussions held on different occasions in the last four years, including at the October 2017 Permanent Technical Committee, the annual dialogue held between the Private Sector Consultative Group and the Policy Commission in June 2018, the WCO technology conferences and regional workshops on disruptive technologies held in 2021 and 2022, the WTO 2018 research workshop and the 2019 and 2021 Global Trade and Blockchain Forums.

These recommendations include:

General observations

- **There are tangible benefits to embracing technology.** However, there is also a need to gauge and evaluate these technologies, ascertain whether they have been fully developed, and test their functionality before investing a great deal of energy, time and public resources in them.
- **It is not a matter of choice for Customs whether or not to embrace and fully exploit the potential of disruptive technologies and keep abreast with their everyday progress and improvements.** If it does not do so, Customs is faced with the risk of "losing the war" against fraud and criminal activities.
- **There is a need to establish a common understanding of the scope of disruptive technologies in the Customs context.** Not all aspects of, for instance, robotics would be relevant in the Customs environment. Furthermore, some of the technologies, such as 3D printing, might impact Customs and its work, but would not present a benefit for its improved functioning, and Customs would probably not find any particular opportunity for using 3D printing in its work.
- **Technology can help Customs complete its work more efficiently and manage trade flows and controls.** It should not erode the human element needed to ensure progressive engagement between trade and Customs. Disruptive technologies need to be utilized and deployed in an optimal manner. They can be used to build Smart Customs and virtual borders, and can boost interconnectivity with business operators. They should be geared towards enhancing efficiencies, focusing on trade facilitation, optimal use and deployment of resources, and ensuring a secure supply chain.
- There is a **need to move away from transaction-driven processes and focus on the availability of data**.
- **One of the greatest benefits is that technology generates a pool of data (big data) that could be used for better decision-making**. With the appropriate use of artificial intelligence and data mining, the effectiveness of the availability of data can be brought to a higher level.
- **The use of technology in Customs should be needs-driven, rather than driven by its availability**. Technology could help modernize Customs procedures and processes.
- Systems developed today should be **flexible and future-proof**.
- Customs need to develop a **strategy** to keep up with the speed in which information technologies are developing.
- **Digital identity issues** are important for international trade.
- **Individual country assessments and cost/benefit analysis** should be carried out, as well as **pilots** and sharing of results.

Cooperation

- **Other border agencies need to be supported in 'catching up'** in the digital transformation process in order to ensure maximum efficiency at the borders.
- There is a **need to ensure a holistic approach** that would examine issues in a cross-cutting manner.
- **There is a need to ensure regular engagement between Customs and private sector on emerging trends or technologies and their impact on the Customs environment**. Customs should strengthen cooperation with the business sector through, for example, on-the-job training for special Customs experts on disruptive technologies.
- There is a need for more **involvement of the private sector**. **Close interaction between the different stakeholders** involved in international trade from both the public and the private sector side **is needed**. Private sector solution providers could be invited to share their findings in the WCO and the WTO, and the WCO and the WTO could reach out to the private sector to see how things work on the ground. **Information sharing** between Customs and

the private sector should be enhanced and there should be **more engagement with start-up companies**.
- **New public private partnerships and arrangements could be explored**, especially in terms of addressing the use of technologies in the e-commerce environment.
- There should be greater involvement of **Academia**.

Standardization

- There is a **need to implement existing standards and to fill gaps in standards** to address the digital island problem and to ensure interoperability.

Legislative work

- A new **legal framework** may need to be drawn up for the use of new technologies.

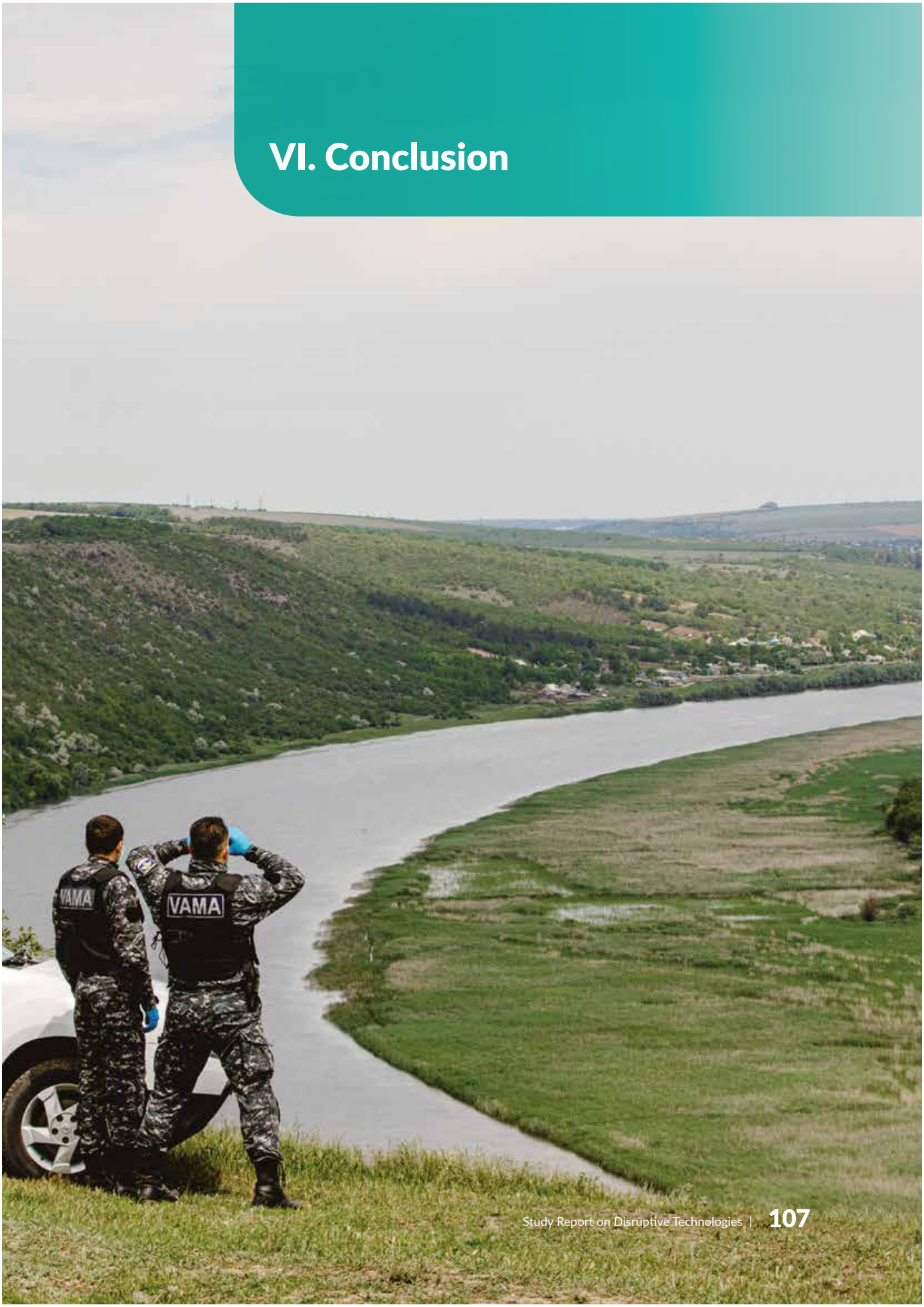
Awareness raising, capacity building, and IT infrastructure.

- **Using the latest technologies requires a cultural shift within the administration, not only at management level, but also by other staff.** A change management action plan should be developed and a new recruitment strategy put in place, as new skills would be required for deploying these technologies.
- **Awareness raising and building digital skills** and **expertise** on the new and emerging trends. Specialized training, a focus on cultural change programmes, as well as creating a new study or academic centre which could develop analyses, reports and forecasts for the use of disruptive technologies in Customs and/or specialized innovation departments could be useful.
- **Digital infrastructure** needs to be further improved in some regions.

Experience sharing and joint work

- Holding **joint IT conferences**, carrying out **joint research, pilot projects and jointly developing standards**; developing **best practices and compendiums would be useful**.
- **The WCO working groups should be used** as effectively as possible to this effect.
- The **need to ensure a holistic approach** that would examine issues in a cross-cutting manner.
- The **need for further exchanges of experiences** through events and shared platforms, such as the WCO CLiKC! Platform.

VI. Conclusion



VI. Conclusion

The findings from the Study Report and the case studies provided in the Annex reflect a high level of Customs interest and activity in the testing and implementation of three groups of technologies in particular. Over half of the Members that responded to the WCO's 2021 ACS are already using IoT, AI, and ML, while only two respondents are currently deploying blockchain technology. Information on numerous pilot projects and PoCs shared by the Customs administrations and other stakeholders show the interest in expanding the use of these technologies, as well as the confidence in the benefits they will bring to Customs in achieving its objectives and supporting cross-border trade.

This Study Report intends to further raise the awareness and knowledge of WCO and WTO Members of the use of disruptive technologies in international trade and particularly in the border management environment, including the relevant international standards, the benefits and opportunities, and the challenges and gaps identified. It is also intended to serve as an important source of information and a basis for policy actions that will ensure Customs' contribution towards the paperless trade agenda and implementation of the WTO Agreement on Trade Facilitation.

The Study Report will remain a living document intended to contribute to well-informed decision-making in this domain.

ANNEX - The case studies

Contents

1. Australia: Australia's experience with biometric technology[62]

The Department of Home Affairs and Australian Border Force strive to develop innovative biometric strategies and technology to ensure and promote a prosperous, secure and united Australia. The Enhanced Biometrics at the Border (EBatB) technology refers to the mobile technology employed at all Australian international airports and that which is used for compliance operations. This technology allows Australia Border Force Officers to conduct one-to-many biometric checks using fingerprint scans. The mobile hand-held devices capture fingerprint impressions of travellers and persons of interest and searches these against Australian immigration and law enforcement data. The information gained from a fingerprint scan can help officers in establishing a traveller's identity or determining whether they are of character or security concern. This capability builds on the capacity to quickly manage travellers of interest, with the scan taking less than 30 seconds to complete, while also allowing the majority of travellers to move seamlessly across the border.

Australia has been collaboratively working alongside Canada, New Zealand, the United Kingdom and the United States (partner countries) to facilitate travel and secure borders using biometrics. One way this occurs is by sharing information on visa applicants via the Secure Real-Time Platform (SRTP), an automated information exchange platform that enables anonymized fingerprints of visa applicants to be checked against a partner country's biometric holdings. Initially, this exchange was piloted through a manual process, where partner countries were able to send low volumes (approximately 15,000 per year) of fingerprints for checking. The SRTP provides the capability for high volumes of visa applicants to be checked. Prior to the impact of COVID-19 pandemic on international travel, this increased to approximately 2.1 million queries processed per year. Increases will be likely, due to new cohorts and volumes being agreed between partner countries, additional partner countries possible, and technically thanks to the agility, capacity and speed of the newly implemented Enterprise Biometric Identification Services (EBIS) backend capability.

2. Argentina and Brazil: bConnect project (blockchain)[63]

bConnect is a blockchain implemented by Mercosur Member countries with nodes in Argentina, Brazil, Bolivia, Paraguay and Uruguay.

The bConnect project uses the open source project Hyperledger Fabric as a blockchain platform, which allows implementing permissioned blockchain networks (i.e. participants must be identifiable and authorized). It is a network focused on corporate use, with a general purpose, not oriented to crypto currencies. The platform's architecture allows smart contracts (in Fabric they are called "chaincodes") to be written using conventional programming languages: java, javascript or golang.

It uses encryption techniques so that each participant can handle the ledger securely and with no central authority. Once a block is added to the blockchain, it is extremely difficult to change or delete it.

It is a peer-to-peer network, which means there is no central node or any other hierarchy. The information is stored in a distributed way and new data is added to the system only after getting consensus from participants.

62 *Submitted in 2019 and updated in 2022.*
63 *Submitted in 2022.*

bConnect main features:

- Network members: Argentina, Brazil, Bolivia, Paraguay and Uruguay.
- Number of nodes: 6 peers (transaction validators) and 3 orderers (block producers).
- Consensus algorithm: Raft.
- Single channel.
- Chaincode written in javascript.
- Transaction backup policy: at least 2 members must backup the transaction.
- Average response time to confirm a transaction: 3.5 seconds.
- Available networks: testnet and production.
- Available applications - gateways - to facilitate the integration between existing systems and blockchain services.

The bConnect project was launched in July 2019. In May 2020 the test net was implemented and in October of the same year the blockchain production.

The implemented chaincode allows exchanging records of Authorized Economic Operators. Member countries are testing the integration of their systems with the blockchain services.

The implemented blockchain shown to be robust, with a very high performance and suitable for cases that require sharing information between organizations.

A second project went under analysis in 2021. This includes the Reference Tables of each Member State, so that they can be exchanged by blockchain. The plans for 2022 are to begin with their use in a testing environment so as to pass on to production later.

The possibility of implementing bConnect in the international transit SINTIA system is also under study. This case requires a more thorough analysis, as international transits are covered by the Latin American Integration Association Land Transport Agreement (ATIT – for its acronym in Spanish). This Agreement goes beyond Mercosur countries. In addition to Argentina, Brazil, Paraguay and Uruguay, Bolivia, Chile and Peru have also subscribed to it. It is to be noted that the SINTIA system is already working among some of the Member States. The SINTIA system is currently based on web services.

Finally, in 2021 a bConnect governance protocol was agreed upon. Its main points include:

- bConnect's administration is carried out on the basis of consensus among the Member States.
- Taking into account that the bConnect network is a project implemented by sovereign administrations there is no incentives policy.
- The involved source codes, "smart contracts" in particular, will be hosted in the servers of one of the MERCOSUR Member States.
- The responsibility for the development and maintenance of the smart contract must be shared among the network members.
- The approval of a new version of the smart contract, including changes to the rules, shall be made based on consensus.
- The deployment of a new version of the smart contract in the network, both testnet and production is a shared activity. Consequently, it must be updated in all the countries for it to be valid and in force.
- The data packages travelling through the bConnect network must follow the WCO Data Model and the MERCOSUR MODDA, as appropriate.
- The inclusion and deletion of members from a bConnect network will depend on the approval of the Member States, holders of the involved data. In this way, each Member State can set bilateral channels in the bConnect network with other countries, as long as there is no data from other Member States in these channels.

3. Belgium: Project description BCTC 'Behavioural consequences of tariff changes' (AI)[64]

Context and goals

This project analyses the impact E.U. Customs tariff measures have on commodity trade flows.

The central goal is to detect fraudulent behaviour of economic operators following the introduction or increase of tariff measures. These protectionist policies aim at protecting the European Union's internal market by shielding domestic producers and industries from foreign competition. Often attempts are made to evade the imposed tariffs using different fraud mechanisms, resulting in the loss of revenue for the Union and damaging involved European industries.

Based on historical data, two plausible fraud mechanisms are currently investigated, i.e. the declaration of a false country of origin, a false commodity code, and the combination of both. More specifically, the project aims to detect sudden behavioral changes in an operator's import profile thereby deviating drastically from the "normal" trends observed before the tariff measure was imposed.

Methodology

The following paragraphs each describe more into detail the different analysis steps taken in the project.

1. Entity resolution

As economic operators tend to import goods under different identities or names, in a first step all similar entities are grouped together based on text mining. This allows the reconstruction of an operator's import profile as accurately as possible.

2. Selection of tariff changes

Next, the database containing all tariff measures is analysed over time. Only measures that increase the tariff rate imposed on the import of the exact same commodity from the exact same origin at a certain point in time are kept for further analysis. It is expected that an increased rate gives an incentive to operators to declare false commodities and/or origins in order to evade the elevated duties imposed on the product and/or origin they effectively import.

3. Shortlist of plausible misclassification codes

In order to reduce the number of commodity codes (and consequently the number of import profiles per operator) to be considered, a list of potentially beneficial commodity codes for further analysis is compiled. A commodity pair, consisting of the commodity code entered on the declaration and the correct code it masks are thus added to the list.

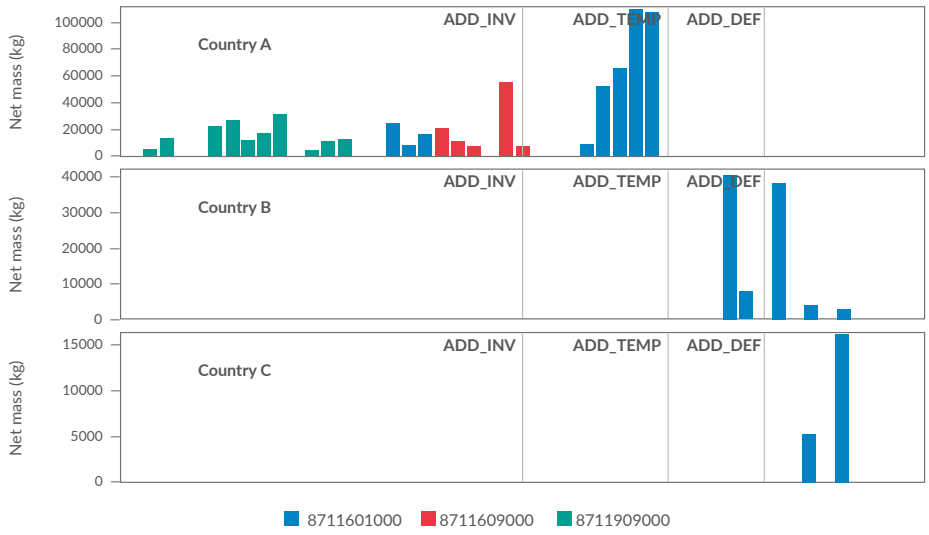
4. Detection of changes in import profiles

When an increased tariff rate for a certain product and country of origin is imposed, we expect to observe changes in the trade flow profile of a fraudulent operator when comparing import patterns before and after the introduction of the measure.

One of the most important characteristics of an operator's trade flow profile is the net mass imported of a particular product from a particular country of origin. The net mass imported before the introduction of the tariff measure is used to model the expected behaviour of the operator after the introduction. When the model is considered of good quality (i.e., it can describe the tendencies in the behaviour sufficiently accurate), it is used to make predictions about the import behaviour of the operator for this product and origin simply carrying on his economic activities as if no tariff increase was imposed. Predictions

64 *Submitted in 2022.*

Figure1 : The figure represents the evolution of the imported Net Mass from each country (Y axis), for three specific commodity codes (Coloured bars) over time (X axis). ADD_INV, ADD_TEMP and ADD_DEF signal respectively the moments at which an Antidumping investigation was launched, the introduction of a temporary duty, and the validation of a definitive anti-dumping duty.



that don't match the observed declared consignments (within certain boundaries), are considered as a first indication of fraud. Indicators of changes in behaviour are based on simple before/after comparisons of means, interrupted time series analyses and forecasting models.

Figure 1 above exemplifies the change in an operator's trade flows this analysis seeks to detect. Before anti-dumping duties were imposed on e-bikes from Country A, the operator was a very active importer of the described good. This abruptly changed after the introduction of the tariff raise. The e-bikes this operator imports no longer originate from Country A, but from Country B and Country C which raises questions about the correctness of these declared origins.

5. Construction of additional features

Unfortunately, many operators show deviations in their import profiles after a tariff change that are not necessarily related to this tariff change. Selecting all possible deviations in import profiles results in too many false positives.

Additionally, it is of the utmost importance to select only the most risky consignments for actual verification.

To this end, several product- and operator-dependent features are considered.

i. Operator-dependent features

To characterize the incentive of an operator to evade increased duties linked to the import of a particular commodity from a particular country of origin, we determine to what extent that product is key to the operator's economic activities.

To that end, an economic segment is determined for each commodity code under study. The segment groups together commodity codes that are frequently imported by the operators importing the commodity of interest. The more an operator's import profile overlaps with the economic segment, the higher the financial implications of the increased duties on his business and hence the stronger his incentives to commit fraud. Consignments deviating from an operator's normal

profile are therefore more likely to be selected in case of higher overlap.

Also indicators related to an operators' non-conformity in previous controls are included.

ii. Product-dependent features

The product-dependent features reflect how similar the declared commodity is to the characteristics of the commodity linked to the tariff change, in terms of unit price (statistical value/net mass) and the weight per supplementary unit (if available). The more a selected consignment fits in the product distributions of the commodity code of interest, the larger the probability of false denomination. Figure 2 below illustrates this clearly.

Finally, a binary indicator that describes if a declared product belongs to the segment of a commodity related to an increase in tariff change or not (described in the paragraph above) is also created.

6. Selection of operators and consignments

The selection of a consignment depends on (1) whether it belongs to an import profile that shows a deviation from its expected trend, (2) how similar it is to the potentially evaded commodity, and (3) whether or not the operator importing the commodity and the commodity itself belong to the segment of the potentially evaded commodity.

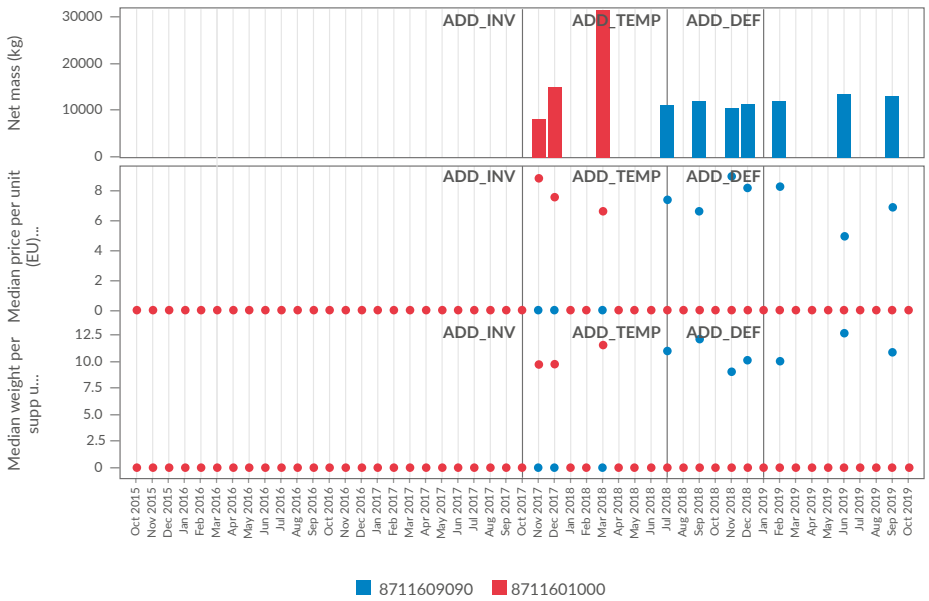
To further narrow down the number of selected consignments for control, a calculation of the potential duty loss in case of non-conformity is made. Articles selected for control are subsequently sent to the appropriate services who perform the a posteriori controls.

Conclusions and future work

The first feedback on controls showed promising results. The rate of non-conformity was substantially higher compared to the average non-conformity rate of a posteriori controls. Also the method automatically analyses all profiles simultaneously.

Continuous improvements will be made based on received control results and reports, and when enough feedback is available a supervised model can be trained using the created features, which will make manual analysis of declarations per operator in the future unnecessary.

Figure 2



4. Brazil: Artificial intelligence in Brazil's Customs[65]

Since 1997, all Brazilian import declarations have been registered in Brazil's Integrated International Trade System (Siscomex). If any errors are found when an import declaration is inspected by a Customs officer before clearance, a rectified version of the declaration is registered and both versions are kept indefinitely.

Since 2014, an artificial intelligence system called SISAM (a Portuguese acronym for "Customs Selection System through Machine Learning") has been learning from the huge Siscomex database and analysing every new import declaration that is registered in the country.

For every item in an import declaration, SISAM estimates the probability of about 30 types of errors. These include false descriptions of goods, errors in harmonized system (HS) codes, errors in the declared countries of origin, missing import licences, inapplicable tax regimes, incorrect preferential tariff and "ex-tariff" claims, use of the wrong rates for the calculation of import duty, tax on manufactured products, social contributions and anti-dumping duties.

Most importantly, SISAM has the ability to explain, in natural language, how it calculated the error probabilities. For example, suppose SISAM says "The declared HS code has a 90% probability of being wrong because the description of the goods is incompatible with it". The officer may read the description and conclude that, for a subtle reason that escaped the system's analysis, the description is actually compatible with the HS code and could ignore the suspicion. On the other hand, if SISAM says "The declared HS code has 90% probability of being wrong because this importer has been caught committing this error several times and, in each of those cases, the descriptions of the goods were also wrong", the officer will certainly want to inspect the goods physically. So, the same probability causes completely different effects depending on the explanation given.

Errors are found in more than 75% of the import declarations that are selected by Customs officers for physical inspection following a suggestion from SISAM. However, this outcome is influenced by the natural intelligence of the Customs officers. To evaluate SISAM without human influence, we ran the system over a dataset containing 624,517 items which had all been inspected by Customs officers in the past and compared the system's predictions to the results actually observed.

To save space, in Table 1, we only show recall rates for errors in HS codes, which is the most important and difficult of the errors that are currently handled by SISAM. Recall rates for other types of errors are all similar or better. More results can be found online[66].

In Table 1, we can see that selecting the one percent of goods with the greatest error probabilities, we can capture 22% of all existing errors in HS codes, which represents more than a twenty-fold gain in relation to random selection. Consistent with international standards, in Brazil more than 95% of all import declarations are cleared without being stopped for inspection. SISAM's suggestions are only one of the criteria used to select the remaining 5%.[67] Thus, recall rates for selection rates below 2% are the ones that matter for deciding if an import declaration will be cleared automatically or assigned to a Customs officer for verification. In the latter case, the officer in charge of the declaration still has to choose which items will actually be inspected. This officer also counts on the help of SISAM. For him, depending on his workload, inspecting 5% to 100% of the items in an import declaration can be reasonable. So, the fact that SISAM offers significant advantages for any selection rate is very convenient.

65 *Submitted in 2019 and reviewed in 2022. By Jorge Eduardo de Schoucair Jambeiro Filho, Head of Artificial Intelligence for Customs Systems, Department of Federal Revenue of Brazil (jorge.jambeiro@rfb.gov.br)*

66 *Jambeiro Filho, Jorge. Artificial Intelligence in the Customs Selection System through Machine Learning (SISAM). Prêmio de Criatividade e Inovação da RFB, 2015.*

67 *Coutinho, Gustavo; Jambeiro Filho, Jorge. Brazil's New Integrated Risk Management Solutions. World Customs Organization News, 86. June 2018.*

Table 1: Recall Rates for Errors in HS Codes

Selection Rate	1 %	2 %	5%	10%	20%	50%	75%
Recall	22 %	34%	52%	66%	81%	96%	99%

Table 2: Reason for selection

SISAM	HS Code	Weight	Incomplete description	Undeclared link	READ subsequent to shipment	Foreign Exchange coverage	Other
31.62 %	16.78%	12.80%	5.93%	5.46%	2.49%	0.97%	23.96%

Customs officers can use any criterion to select an import declaration for inspection. The most common reason for selections appears in Table 2. The fact that Customs officers choose to perform more than 30% of all their work based on the information produced by SISAM really shows its usefulness.

We consider the spontaneous comments of Customs officers who use SISAM very important. They are generally positive and point out particularities of the benefits of the system: "With this system, we catch errors that would certainly escape among the thousands of good imported daily"; "With SISAM I can analyse more import declarations"; "The explanations appear to have been written by a real person"; "SISAM is particularly good when I have to inspect big import declarations"; "With SISAM, novice officers become productive much faster"; "I cannot conceive of ever working without it again".

SISAM has been running for four years and recently we received some reports that it is not as easy to catch errors using it as it once was. This effect was predicted at the beginning of the project since importers whose errors are regularly being caught have an incentive to change their behaviour. Reports from another of our initiatives confirm that this change is actually happening.

The Customs Mesh is a project that currently does not use SISAM. Instead, a team of Customs Officers use data warehouse queries in an attempt to find errors that have passed undetected during Customs clearance. The first problem tackled by the Customs Mesh were the errors in HS Codes. After two years, we received the following report: "In conformity with what had been reported on several occasions, one reason for us having so much difficulty in finding 'raw material' for the Customs Mesh as regards to the tax classification of goods was a change in the behaviour of some taxpayers due to SISAM". Making it difficult to find errors after Customs clearance is a good effect of the use of SISAM before and during clearance. This effect is not a problem for the Customs Mesh team, which will just move its focus to more complex errors.

We are aware that the errors that are most difficult to detect are probably still there, and that some importers have probably learned to become more deceptive. To counteract this, we plan to use more information sourced from our internal revenue service about importers and their associates, and to integrate SISAM with other artificial intelligence initiatives that will be mentioned below.

SISAM is not simply an application of available artificial intelligence techniques. Its central technology is Bayesian Networks with Smoothing Hierarchies,[68] which were, from their origin, developed to circumvent difficulties in the application of machine learning to Brazil Customs' problems. Since then, the technology has been extended to:

- handle combinations of nominal attributes, quantitative attributes, free text and time in the same problem;
- apply supervised and unsupervised learning at the same time, and
- adapt to legislative changes without invalidating old knowledge and even without requiring retraining.

68 *Jambeiro Filho, Jorge ; Jacques Wainer. HPB: A model for handling BN nodes with high cardinality parents. Journal of Machine Learning Research (JMLR), 9:2141–2170, 2008.*

In recent years, concerns about ethics in the use of artificial intelligence[69] have become common. The greatest concern is the so-called black box problem, which is the impossibility of understanding how and why an artificial agent arrived at a conclusion. To mitigate this problem and improve transparency, SISAM generates summarized explanations for its users as part of its normal work. SISAM also has the ability to produce logs representing its full reasoning process, which makes the system completely auditable. This turned out to be important when ethical concerns about SISAM were explicitly discussed in the University of Florence[70].

SISAM is implemented in Java and uses no machine learning tools or libraries. To handle a knowledge base of 8.5 billion patterns, extracted from 150 million imported items, SISAM has load balancing and distributed learning capacities. This allows it to be updated automatically each day without stopping.

SISAM's test version gained the ability to detect under- invoicing and over-invoicing, which is relevant for its use in the fight against illicit financial flows[71]. Table 3 shows results for under-invoicing. Measured recall rates are generally better for more extreme errors, that is, when the declared prices are 3 times smaller than real prices, it easier to detect the problem than when the declared prices are only 1,5 times smaller than real prices, for example. Results for over-invoicing are similar.

Albeit the measured recall rates are better for miss-invoicing than for errors in HS Codes, they only reflect comparisons with errors that were caught in the past by Customs Officers. We believe that miss-invoicing escapes from Officers much more frequently than errors in HS Codes what makes our confidence in such measures limited. We think that SISAM's predictions, at least initially, won't be as good as one could expect based on Table 3. However, with time, Customs Officers will check suspicious cases pointed by SISAM and, with such feedback, the real performance will improve.

The miss-invoicing probabilistic models are intensive in processing and require a substantial expansion of SISAM's hardware platform from 7 machines with 24 vCPUS and 64GB each to 10 machines with 64 vCPUS and 256GB. Such requirement delayed the release of these models for production and only in 2022 the expansion has been authorized. Migration to the new platform is ongoing.

After many years with SISAM in production we have identified its main weakness: only learning from Siscomex database. This database very is rich and has given SISAM a great initial advantage, but is doesn't contain all important information. After Customs Clearance, Customs Officers, tend to look for errors that appear repeatedly in many Import Declarations and, after finding them, they don't rectify declarations, one by one, on Siscomex. Instead, they register their findings in another system, called e-Safira and SISAM never comes to know about that.

Moreover, if SISAM suspects an error, but a Customs Officer identifies the suspicion to be unreasonable and overrules SISAM before the Import Declaration is selected for inspection, SISAM never can observe that, if selected, that Import Declaration would have been cleared without a

Table 3: Recall Rates for under-invoicing

Selection Rate	1 %	2%	5%	10%	20%	50%	75%
Recall for 3 times smaller prices	58%	62%	75%	93%	95%	100%	100%
Recall for 2 times smaller prices	45%	52%	69%	85%	93%	100%	100%
Recall for 1.5 times smaller prices	35%	45%	59%	73%	87%	100%	100%

69 *Bostrom, Nick, et Eliezer Yudkowsky. "The ethics of artificial intelligence." The Cambridge handbook of artificial intelligence 316 (2014): 334.*

70 *Köche, Rafael. L'intelligenza artificiale a servizio della fiscalità: il Sistema di selezione doganale attraversol' apprendimento automatico (SISAM). Il ragionamento giuridico nell'era dell'intelligenza artificiale, Florença, 2018.*

71 *Choi, Yeon Soo; McGauran, Rachel (rédacteurs). Illicit Financial Flows via Trade Mis-invoicing, World Customs Organization Study Report, 2018.*

rectification. This prevents SISAM from learning and it may insist in the same wrong suspicion repeatedly.

In 2021, SISAM has been integrated to e-Safira and a new interface was implemented, that allows Customs Officers to inform SISAM that a certain suspicion is wrong without selecting the Import Declaration for inspection. Both feedbacks are transformed into virtual rectifications of Import Declarations. That means that new versions of real Import Declarations are not created in Siscomex, but for the Artificial Intelligence everything goes as if they had.

Virtual rectifications decreased how much the AI would need to be adapted to handle the new feedback, but we still had to make a significant change in our probabilistic modules. Before the change, SISAM assumed that any Import Declaration item would have been either completely checked or not at all. Now SISAM accepts that the correct values for some fields may be known while the values of other fields of the same item are not. This is required, because, in contrast to what happens during Customs Clearance, Customs Officers that examine SISAM's suspicions before selection for inspection tend to only analyse the field under suspicion. After Customs Clearance, analysis also tends to focus only on specific fields and e-Safira only tells SISAM that certain fields were wrong, not that the others were right. The version of SISAM that handles virtual rectifications is still in tests.

In 2021, SISAM was integrated with another system, Classif, whose role is to help importers to find correct HS codes for their products. It works allowing searches over HS Codes descriptions, explanatory notes and other useful material. Now, Classif also suggests HS Codes based on SISAM's analyses. We were careful not to generate suggestions using all information normally considered by SISAM. Suggestions are based only on goods descriptions, not on the importer history, similar importers behaviour, vendor history, manufacturers history and some other insightful fields. This prevents ill-intentioned taxpayers from finding out which errors SISAM can detect and which it cannot by trial and error. Classif is also careful not to show probabilities and not to explain the suggestions to the users.

In addition to SISAM, Brazilian Customs officers count on ANIITA[72], which is a tool that includes expert systems that highlight risk factors in import declarations, export declarations, express couriers and postal consignments. Expert systems are based on rules created by humans. They are simpler to implement, easier to execute and immediately scale up the application of human knowledge. They are an indispensable resource in every fraud detection domain. In our experience, the key points for successful expert systems are the flexibility of the rules, the provision of the ability to create rules for both regional and national experts under an adequate privilege control scheme, and a sharing mechanism that allows good rules to be propagated from region to region and possibly become national.

Brazil Customs has two other artificial intelligence initiatives, both related to computer vision. The first, called BATDOC[73], looks for mismatches between import declarations and auxiliary documents, such as invoices and bills of lading, which become available as digital images, after an import declaration is selected for inspection. It detects divergences in company names, addresses, prices, quantities, HS codes, incoterm codes and others. It applies optical character recognition to the auxiliary documents, identifies relevant fields and performs comparisons. Currently, the auxiliary documents are not made available before the selection of import declarations for inspection. Consequently, SISAM cannot use BATDOC's results in its suggestions. We expect that the rules will change, and that the presentation of auxiliary documents will be required for all import declarations. Till the begging of 2022, this change had not yet happened.

The second initiative, called AJNA[74], focuses on the analysis of container x-Ray images. All containers leaving or entering the country through Brazil's largest port (Port of Santos) are scanned and all images are transferred to a single server for later analysis. Using the Python SciKit-Learn

72 *Jambeiro Filho, Jorge ; Jacques Wainer. HPB: A model for handling BN nodes with high cardinality parents. Journal of Machine Learning Research (JMLR), 9:2141–2170, 2008; Coutinho, Gustavo; Aniita – uma abordagem pragmática para o gerenciamento de risco aduaneiro baseada em software, Prêmio de Criatividade e Inovação da RFB, 2012.*

73 *Barbosa, Diego de Borba. Batimento Automatizado de Documentos na Importação –BatDoc. Prêmio de Criatividade e Inovação da RFB, 2016.*

74 *Brasílico, Ivan. AJNA – Plataforma de Visão Computacional e Aprendizado de Máquina, Prêmio de Criatividade e Inovação da RFB, 2017.*

library[75] and TensorFlow,[76] we started building models to detect cargo inside allegedly empty containers. We also started to use random forest regressors[77] pour to predict the total weight of the cargo inside a container from the images and using convolutional auto encoders[78] to measure the divergence between the image of a container and the images of similar ones containing the same type of goods.

In 2021, AJNA was targeted to drug detection and, for the sake of starting with a limited problem, we focused specifically on drugs concealed in the engines of refrigerated containers (reefers). In this task, we employed a deep neural net, implemented with Tensorflow, based on Efficientnet-B4[79] and pre-trained with the Imagenet dataset.[80] Two hundred layers of the pre-trained model were unfreezed to allow the adaptation of the model to our dataset, which is composed of x-Ray images and not typical photographs. We employed SHapley Additive exPlanations (SHAP)[81] to, besides indicating if there are drugs, indicate where they are.

We built a study dataset with images that had been examined by humans, who had indicated which ones contained drugs and which ones did not. The positive cases had all been confirmed by physical inspections. We took such indications as the ground truth for the presence of drugs.

We had a lot of negative examples, but only 13 positive ones. We measured results using a 13-fold cross-validation process, forcing each positive image to be in a different fold. We run the process five times with different initial weights and generated single recall curve combining all probabilities obtained.

The results of our measures are in Table 4.

The recall curve is steep till a selection rate of 2%, but, after 5%, gains are much more modest. This indicates that the model was able to capture some drug patterns in the images, but not others. We hope that this problem will be mitigated when we have a bigger training set with many more positive images. An API to allow all bonded warehouses in Brazil to send x-Ray images to a central point has already been developed and is expected to enter production in 2022.

Besides increasing out dataset, we intend to use the images we have more intensively. Since the same reefers cross our borders multiple times, several images of the same reefer engine are available. Knowing what changed between two images is obviously helpful to detect concealed drugs, however, differences in x-Ray intensity, in angles of x-Ray beans and in the speed of the truck carrying the container during the scanning process make comparisons between two images nontrivial.

Table 4: Recall Rates for Drugs in Reefer Engines

Selection Rate	1 %	2%	5%	10%	20%	50%	75%
Recall	50 %	54%	58%	64%	70%	85%	92%

75 *Pedregosa, Fabian, et al. "Scikit-learn: Machine learning in Python." Journal of machine learning research 12.Oct (2011): 2825-2830.*

76 *Abadi, Martín, et al. "Tensorflow: a system for large-scale machine learning." OSDI Vol. 16. 2016.*

77 *Cootes, Tim F., et al. "Robust and accurate shape model fitting using random forest regression voting." Conférence européenne sur la vision informatique. Springer, Berlin, Heidelberg, 2012.*

78 *Guo, Xifeng, et al. "Deep clustering with convolutional autoencoders." International Conférence sur le traitement des informations neurales. Springer, Cham, 2017.*

79 *Tan M, Le Q. "Efficientnet: Rethinking model scaling for convolutional neural networks". International conference on machine learning (2019) pp. 6105-6114. PMLR.*

80 *Deng, J. et al., 2009. "Imagenet: A large-scale hierarchical image database". IEEE conference on computer vision and pattern recognition (2009), pp. 248–255.*

81 *Strumbelj, Erik; and Kononenko, Igor. Shapley sampling values:. "Explaining prediction models and individual predictions with feature contributions." Knowledge and information systems 41.3 (2014): 647-665.*

We made experiments aligning images with two methods offered by the Kornia library:[82] one based on Image Registration[83] and another based on LoFTR matching.[84] Our best visual results were obtained using an internally developed algorithm based on Image Warping,[85] which we implemented with Tensorflow. This algorithm looks for the best alignment between the images and, simultaneously, looks for the best colour adjustment to lead one of them to match the other. Results were visually good, however not perfect, and we are still working to escape some local optima that cause trouble for some cases. We expect to improve results in Table 4 using this algorithm to generate composed images in a pre-processing phase and use them to train the neural network.

Besides the detection of drugs in refers, we intend to use this algorithm to detect rip-on/rip-of operations in cases where more than one image of the same cargo is available. For example, in Customs Transit operations we have the image obtained when the cargo leaves one bonded warehouse and another when it enters the other bonded warehouse. With agreements to exchange images with other countries, we may also have two images of the same cargo in import or export operations: one obtained in the exporter country, and another obtained in the importer country, one of them being Brazil.

We keep plans of using AJNA and SISAM together in the detection of divergences in import or export declarations in respect both to the quality and the quantity of goods.

Artificial intelligence provides important tools for our risk management environment. Some of these tools have been in widespread use for several years and keep being improved. They have influenced human behaviour for the better, both for Brazil's Customs staff and taxpayers. Other tools have entered production only recently but have already shown great potential.

82 *Riba, Edgar; Mishkin , Dmytro; Ponsa, Daniel; Rublee, Ethan Bradski ,Gary R. "Kornia: an Open Source Differentiable Computer Vision Library for PyTorch". CoRR, abs/1910.02190. 2019.*

83 *Image Registration. Available in 07/03/2022 through https://paperswithcode.com/task/image-registration.*

84 *Sun, Jiaming et Shen, Zehong et Wang, Yuang et Bao, Hujun et Zhou, Xiaowei. "LoFTR: Detector-Free Local Feature Matching with Transformers". CVPR, 2021.*

85 *Wolberg, G. "Digital image warping: IEEE Computer Society." (1990); "Image warping." Wikipedia, Wikimedia Foundation, 07 mars 2022, en.wikipedia.org/wiki/Image_warping.*

5. Canada: Biometrics - the experience of the Canada Border Service Agency (CBSA)

	Who?	Where?	Why?
Primary	ePassports holders	**10** airports with kiosks	Identity verification 1:1 match against chip image
	Enrolled foreign nationals	**8** airports with kiosks	Identity verification 1: many search against enrolment database. Once search complete, 1:1 validation between fingerprint ID on file against traveller's fingerprints.
	NEXUS (trusted travellers)	**9** airports with kiosks	Identity and membership verification 1:1 match against enrolment database
Secondary	Enrolled foreign nationals	**16** airports with biometric equipment and 15 land sites.	Identity verification 1: many search against enrolment database. Once search complete, 1:1 validation between fingerprint ID on file against traveller's fingerprints.
	Foreign nationals (permits, asylum claims, removal and arrest)- enrolment of biometrics	**119 LiveScan devices including portable units; 37 airports, 9 inland offices and 73 other locations including land sites.**	Identity verification 1:many search against criminal and immigration databases

Canada Border Services Agency | Agence des services frontaliers du Canada

Canada

6. China: Chinese Customs on the way to digitalization - new solutions for new challenges (AI)[86]

In recent years, China Customs has kept on resolving the contradiction between ever-growing Customs control workload and insufficient regulatory resources through technology and innovation. Some examples are presented below.

1. AI-based NII image recognition system

Based on the expertise of Customs officers who carry out Customs inspections using NII devices, this system utilizes artificial intelligence technology to learn information on goods and articles from massive historical H986 (Large scale container X-ray scanner) and CT (Computed Tomography) inspection images and forms automatic recognition algorithms. With large volume of information on goods, articles and means of transport, the system can automatically recognize images and alert Customs officers to carry out image reviews or physical inspections. Through continuous optimization, the ultimate goal of this system is to replace human beings with machines in the field of NII inspection.

Working closely with experts in this field, China Customs has established the mechanism of image-collection, image-labelling, algorithm-training, test-appraisal and iterative optimization. The vehicle digital subtraction image warping algorithm is based on the fact that the vehicle structure of the road port is relatively stable, so the historical images of the same vehicle during a certain period from the same inspecting device are used as references for intelligent comparison. Any abnormal situation will be prompted to the reviewer. The Image & Declaration comparison algorithm can effectively compare the image and declaration of single-item and double-item Express mail, the comparison range not only limited to the name of the items, but also quantity and weight.

During the pilot period, the algorithms work well in the detection of light-weight ivory, guns and their components, and other dangerous weapons. In the field of drug identification and luggage compartment findings, the algorithms have also been greatly improved. At present, the optimized system has been smoothly integrated into the Customs NII inspection operation process with an increasing coverage rate. A large amount of contraband articles have been seized, and accordingly Customs control has been improved. Now we are working on the standards of images and their recognition, aiming to solve compatibility problems of different brands and types of machines.

2. Intelligent Passenger Face Recognition System

This system applies face recognition technology and integrates with the low-temperature detection system for quarantine and inspection. It has been applied to various Customs by installing face recognition cameras in control areas, which are divided into three: Customs alerting area, Customs processing area, and Customs reexaming area. Key passengers (including blacklist passengers, multiple cross-border passengers and high-risk passengers for inspection and quarantine) walking through these three operational areas will be spotted and Customs officers who are equipped with hand-hold mobile devices and face recognition devices will stop them for further investigation. An information database of passengers have been set up and gradually expanded, making it possible to filter and analyze relevant pictures and videos. Customs therefore can perform risk analysis, profiling, and query statistics, etc.

At present, the alarm accuracy rate of the system is over 99%. It plays a vital role in fighting against "high-risk traffickers", and a number of smuggling gangs have been apprehended. At the same time, due to the characteristic of being "non-intrusive", the efficiency of Customs clearance for passengers has been greatly improved. In the future, China Customs will explore more possibilities to make passengers' inspection smarter and provide better services for inbound and outbound passengers.

86 Submitted in 2019 and updated in 2022.

7. European Union: Blockchain@TAXUD – Trusted Data Sharing[87]

Why DG TAXUD is exploring decentralized systems

IT systems are instrumental for the implementation of taxation and Customs policies in the European Union. More than sixty trans-European systems are operated and maintained for the implementation of existing policies and new ones are being designed and developed to support upcoming policy initiatives.

Taxation and Customs IT systems exhibit today a significant complexity which leads to high costs and operational risks. Distributed ledger technology such as blockchain provides a new, simplified way to design and operate such complex environments where multiple independent entities, such as national authorities and economic operators, interact.

DG TAXUD (Directorate General for Taxation and Customs Union) is convinced that new IT concepts and technologies such as blockchain are key for our future, and can inspire a different approach in future policy building and policy implementation. Many national taxation and Customs administrations are involved in prototypes using blockchain, and building on their experience will facilitate this process. DG TAXUD is currently investigating the use of this technology in support of the VAT eCommerce Directive as well as for other suitable case studies.

Use case: Proving integrity and ensuring trust in IOSS VAT identifiers through a decentralized registry

Distributed ledgers present significant opportunities to ensure trust in data shared between institutions in the taxation and Customs domains. Therefore, in 2020 DG TAXUD started the development of a pilot to validate the technical, operational and legal possibility of using the European Blockchain Services Infrastructure (EBSI, a pan-European network of distributed nodes funded by the European Blockchain Partnership) to support such case studies.

This pilot addresses the sharing of IOSS VAT identifiers as mandated by the VAT eCommerce Directive. In a nutshell, the data will flow from the Member State of Identification to other Member States via a network of Hyperledger Fabric nodes (facilitated by ordering services specific to the Fabric protocol). The way it works can be summarized as follows:

Following a request from an economic operator (or his representative), the taxation authority of the Member State of Identification will allocate an IOSS VAT identifier, publish it without delay to the Customs authorities of all EU Member States and will call an EBSI node to publish its fingerprint (more precisely, a salted hash of it) on a blockchain.

The EBSI node will call other EBSI nodes to obtain their endorsement of the proposed information, then submit it to the EBSI Fabric Ordering Service. After verification, the EBSI Fabric Ordering Service will create new blocks containing the endorsed information and distribute them to the peers on the blockchain network.

Following a Customs declaration under the import scheme, the Customs authorities of the Member State of Importation can then verify the integrity and validity of the shared IOSS VAT identifier on the blockchain (by calling their local EBSI Node).

87 *Submitted in 2022.*

8. European Union: Use of blockchain technology to create trust in the digitization of a Customs procedure: the ATA blockchain proof-of-concept[88]

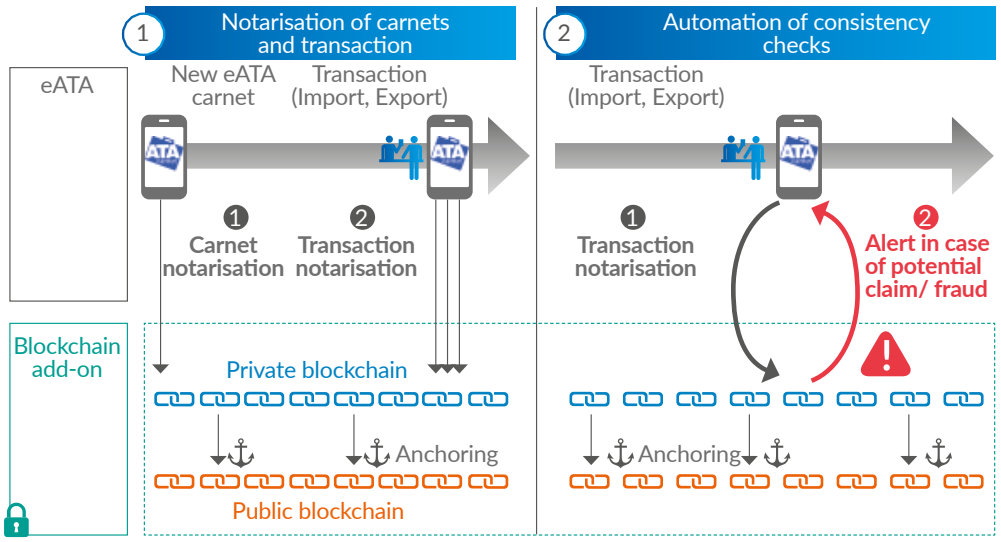
Given its role in shaping policies and developing operational systems for the EU Customs Union in collaboration with the Member States, in early 2017 DG TAXUD embarked on an exploratory activity to study the applicability of the blockchain technology in both the Customs and taxation domains. In the fields of Customs, the exploration of the potential of the blockchain technology has focused on the so-called notarization service where a blockchain platform could be used as a third-party holder of the truth about the information generated by the stakeholders active in the supply chain. Such an approach involves only a hash of the actual data being stored on the blockchain, guaranteeing the true version of a document at any given time. In this context, the hash function is a fundamental part of blockchain technologies, also known as the digital fingerprint of a document. Obtained by an algorithm which does not permit reverse engineering of the original document from the fingerprint, the hash ensures that even a single comma change in a document would result in a totally different fingerprint.

At the heart of the supply chain complexity lies an inherent lack of trust between the supply chain participants (e.g. shipper, freight forwarder, importer, etc.) and public authorities. The blockchain notarization service could contribute towards achieving a proper balance of trade facilitation and border security by creating additional trust between the different stakeholders involved. In this context, the notarization feature has the potential to offer a multitude of applications and DG TAXUD is just setting off on its exploratory journey of discovery. To this end, the EU Customs authorities are assessing the technology with a business mindset: beyond the hype, studies are ongoing to assess practical cases where this technology can contribute to reducing complexity in the supply chain and improving business to government interactions for the benefit of economic operators, citizens and public authorities.

The ATA goods passport ("Admission Temporaire"/ Temporary Admission) is an international Customs paper document that mainly permits the duty-free temporary admission of goods for up to one year.

ATA goods passports have been issued and accepted in more than 71 countries. The eATA project aims to digitize the temporary admission process by providing worldwide electronic data exchange between countries or Customs unions (ATA partners).

88 *2019 Version, updated in 2022.*



In June 2017, a partnership between DG TAXUD and the International Chamber of Commerce (ICC) was established whereby DG TAXUD launched a proof-of-concept (PoC) using blockchain technology to interface with the ICC Mercury II pilot solution. The business objective of the PoC was to bring an extra layer of trust.

Therefore, on top of the architecture proposed by ICC, an additional, independent layer of trust was studied in the PoC.

The PoC had concluded successfully by mid-2018 and demonstrated that the distributed ledger technology (Ethereum test network in this case) could be used to ensure the integrity and traceability of carnets and transactions through an anchoring mechanism on a private blockchain platform combined with periodic anchoring on a public blockchain (effectively achieving independent notarization).

The information stored on the blockchain test network is only the hash of the carnets or transactions and some metadata, thus allowing automated consistency checks to be performed on carnet movements, which is also something else which has been learned from the PoC, i.e. use the Blockchain Ethereum Smart Contract technology in these business contexts.

DG TAXUD concluded on this PoC activity by sharing lessons learned to benefit stakeholders who are active in the digitization of the ATA carnets procedure.

For more information on Blockchain@TAXUD activities, please contact: zahouani.saadaoui@ec.europa.eu.

9. European Union: iBorderCtrl – European Union's smart decision to facilitate and secure border check points with biometrics[89]

More than 700 million people enter the EU every year – a number that is rapidly rising. The huge volume of travellers and vehicles is piling pressure on external borders, making it increasingly difficult for border staff to uphold strict security protocols – checking the travel documents and biometrics of every passenger – whilst keeping disruption to a minimum.

To help, the EU-funded project iBorderCtrl is developing an "intelligent control system" facilitating – making faster – border procedures for bona fide and law-abiding travellers. In this sense, the project is aiming to deliver more efficient and secure land border crossings to facilitate the work of border guards in spotting illegal immigrants, and so contribute to the prevention of crime and terrorism.

iBorderCtrl system will collect data that will move beyond biometrics and on to biomarkers of deceit.

The iBorderCtrl system has been set up so that travellers will use an online application to upload pictures of their passport, visa and proof of funds, then use a webcam to answer questions from a computer-animated border guard, personalized to the traveller's gender, ethnicity and language. The unique approach to 'deception detection' analyses the micro- gestures of travellers to figure out if the interviewee is lying.

This pre-screening step is the first of two stages. Before arrival at the border, it also informs travellers of their rights and travel procedures, as well as providing advice and alerts to discourage illegal activity.

The second stage takes place at the actual border. Travellers who have been flagged as low risk during the pre-screening stage will go through a short re-evaluation of their information for entry, while higher-risk passengers will undergo a more detailed check.

Border officials will use a hand-held device to automatically cross-check information, comparing the facial images captured during the pre-screening stage to passports and photos taken on previous border crossings. After the traveller's documents have been reassessed, and fingerprinting, palm vein scanning and face matching have been carried out, the potential risk posed by the traveller will be recalculated. Only then does a border guard take over from the automated system.

At the start of the iBorderCtrl project, researchers spent a lot of time learning about border crossings from border officials themselves, through interviews, workshops, site surveys, and by watching them at work.

It is hoped that trials about to start in Hungary, Greece and Latvia will prove that the intelligent portable control system helps border guards reliably identify travellers engaging in criminal activity. The trials will start with laboratory testing to familiarize border guards with the system, followed by scenarios and tests in realistic conditions along the borders.

As a consequence, the partner organizations of iBorderCtrl are likely to benefit from this growing European security market – a sector predicted to be worth USD 146 billion (EUR 128 bn) in Europe by 2020.

Project details:

- Project acronym: iBorderCtrl
- Participants: Luxembourg (Coordinator), Greece, Cyprus, United Kingdom, Poland, Spain, Hungary, Germany, Latvia
- Project No: 700626
- Total costs: EUR 4 501 877
- EU contribution: EUR 4 501 877
- Duration: September 2016 to August 2019

89 Submitted in 2019.

10. Guatemala: Hardware and software in the modernization of a Customs office – the case of Guatemalan Customs in the incorporation of technologies[90]

Prior to 2019, the Guatemala Customs Service did not have a comprehensive strategy for its modernisation. Instead, it had multiple dispersed efforts, without a cross-cutting coordination approach that could be implemented with maximised efforts and available resources. In this process the Customs service was able to identify the following lessons learned, which would be valuable to share with other Administrations. They are described below, in this Disruptive Technologies Compendium:

- A technological modernisation process in customs must always have a link between the "software", which is all the interfaces, applications and systems used to automate the processes of customs staff, and the "hardware", which refers to all the devices, machines and equipment that are applied to the processes. Guatemala had experiences of acquiring cameras with container code recognition (CCR) technology, but there was no interface with which to receive the data and validate it with the customs computer system.
- The incorporation of devices, machines and equipment in Customs does not in itself solve the problem; all these devices must automate some key activity of the process, they must be interoperable with the systems, generate validations, avoid human discretion, generate records and logs of the transactions, comply with the conceptual and functional definitions set out, and above all, be supported by a regulation that governs their operation. Guatemala did receive a donation of RFID antennas and tags for means of transport, but there was no clear idea of which activities in the process would be automated or what functionalities this technology would have.

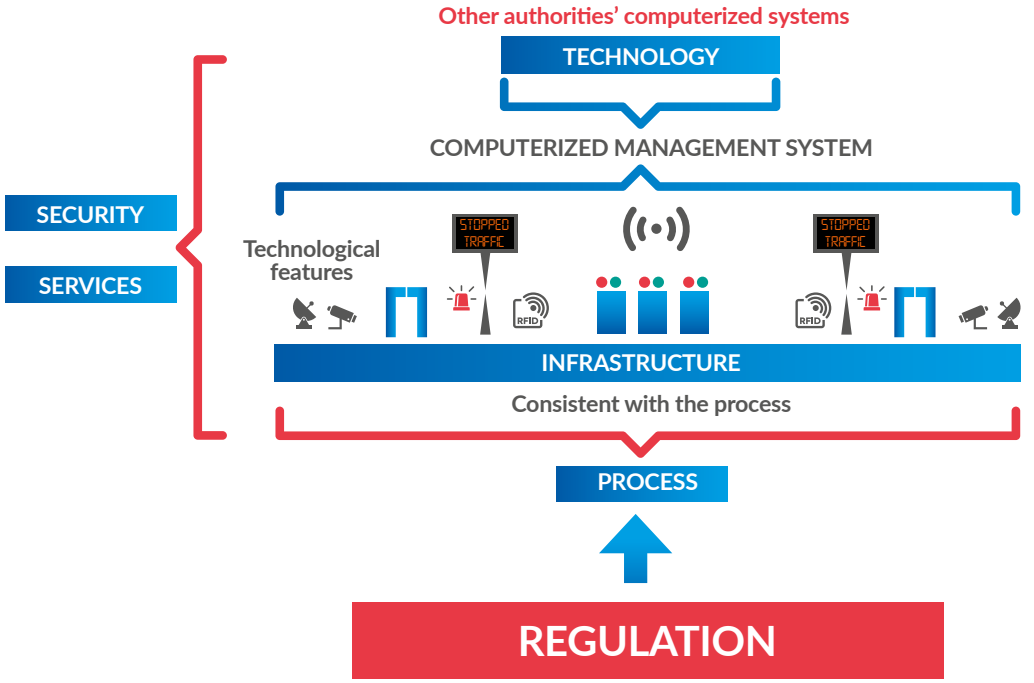
Following the implementation of the Integrated Customs Modernisation Programme (MIAD), these lessons have been resolved with the following principles:

1. Every process is made up of regulations that govern it, the infrastructure where it is implemented, the technological equipment that supports the process and the human resources that implement it, all operating as an indivisible coordination.

   This diagram, drawn up by Guatemala Customs, shows the customs modernisation philosophy that it has adopted, where everything stems from the regulations, and processes are improved, infrastructure is adapted to the process, and technology is incorporated, all in accordance with these regulations. Finally, this is complemented by security schemes and by change management in human resources, capacity creation or building, or the incorporation of a new resource.

2. First, the process is surveyed, the current situation is determined (AS IS), the activities, parties involved, and the way in which these are carried out (manual or automated) are mapped out, measurements are taken (times, quantities, transactionality), and the process is documented. With all of this information, the analysis begins, while identifying opportunities for improvement, the activities that will be eliminated because they do not add value, and those that will be subject to automation, all under the model of the improved process, i.e. the expected situation (TO BE).

90 *Submitted in 2022.*



Source: Guatemala Customs.

3. Having defined the expected situation, it can be determined by that point whether it is necessary to make changes to the infrastructure where the process is implemented, or to incorporate technology both in terms of the systems, applications and interfaces, as well as in terms of the devices and equipment to be incorporated. In Guatemala, WS information exchange services were set up between customs terminal operators and Customs, in order to exchange manifest and goods declaration information and use the radioscopic images produced by the X-ray equipment to index the container number (which is extracted by taking a photograph with cameras using CCR technologies) and the goods declaration (if available).

   With this data, the customs image analyst can improve their risk management, and the system in the exit modules of the customs area has a validation element that does not allow the removal of the cargo if the radioscopic image has not been validated. Another example has been the use of the electronic tag for internal customs transits, for which geosatellite geofences were set up in the port areas and on the road routes so that the containers in transit could not leave the controlled area without having the geolocation signal of the tag activated, as well as through a monitoring centre to control circulation and the container's timely arrival at their destination.

Guatemala is working on adopting the IATA electronic waybill model, adapting a port community system with blockchain technology, extending the use of electronic files in all customs procedures, and digital signatures to avoid the use of paper. It is also committed to placing automated lanes at the entrance and exit of port areas and in control areas in secondary zones, incorporating the use of RFID technology for regular seals and to identify means of transport, in order to have a series of data validations in the systems that allow processes to be automated and simplified.

11. Hong Kong, China: HK Customs applied big data technologies in analyzing trade patterns and combating smuggling[91]

Hong Kong Customs has launched a pilot IT system, namely Cargo Big Data System (CBDS), in November 2020 aiming to apply big data analytics and artificial intelligence (AI) on cargo clearance to analyze the ever-changing trade pattern and trend in order to effectively combat cross-border smuggling crimes.

The prime objective of the system is to process and analyze the huge amount of cargo data of different transport modes as well as vehicle crossing records to spot high risk cargoes and conveyances. The system applies advanced AI technology like text analytics to process the unstructured free-text cargo data (e.g. goods descriptions and company names). Coupled with other high-end analytical tools such as pattern analysis, network analysis, as well as data visualization, the capability to discern suspicious patterns and hidden relationships among entities is significantly strengthened.

The system also focuses on the application of other big data technologies like web crawling and latent semantic analysis to analyze the latest smuggling trends in an efficient manner. A multitude of smuggling related information can be crawled from the public domain automatically, together with the in-depth semantic analysis on the crawled data, thorough analysis on the latest smuggling trend is achieved.

The pattern and network analysis on cargo and conveyance, as compared with the conventional methods, are significantly enhanced in terms of efficiency and effectiveness through the application of big data analytics and AI technologies in CBDS. The system enables frontline officers to conduct diversified analysis to cover a wider spectrum of enforcement targets in order to identify high risk consignments and vehicles. By increasing the risk assessment capability and focusing on high risk subjects, the legitimate trade can also be facilitated with faster Customs clearance.

CBDS is a pioneering system which adopts cutting-edge big data and AI technologies on risk assessment and cargo clearance in Hong Kong Customs and sheds light on further development of a production system.

91 *Submitted in 2022.*

Figure 1. Trade Pattern Analysis

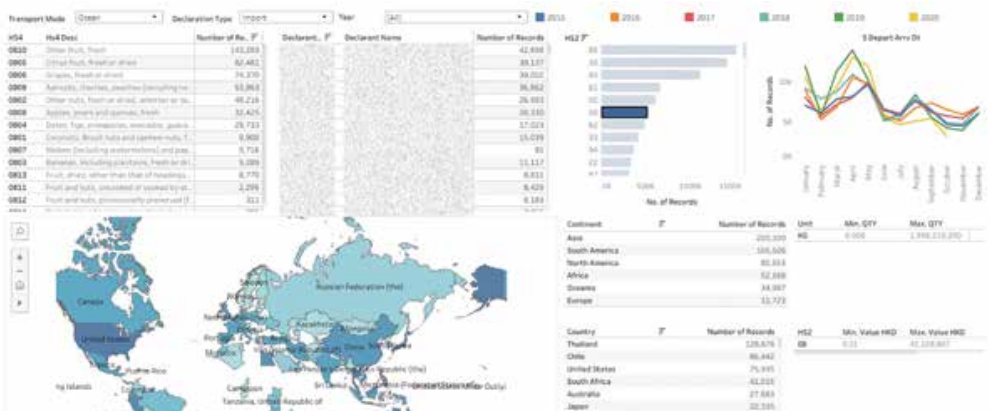
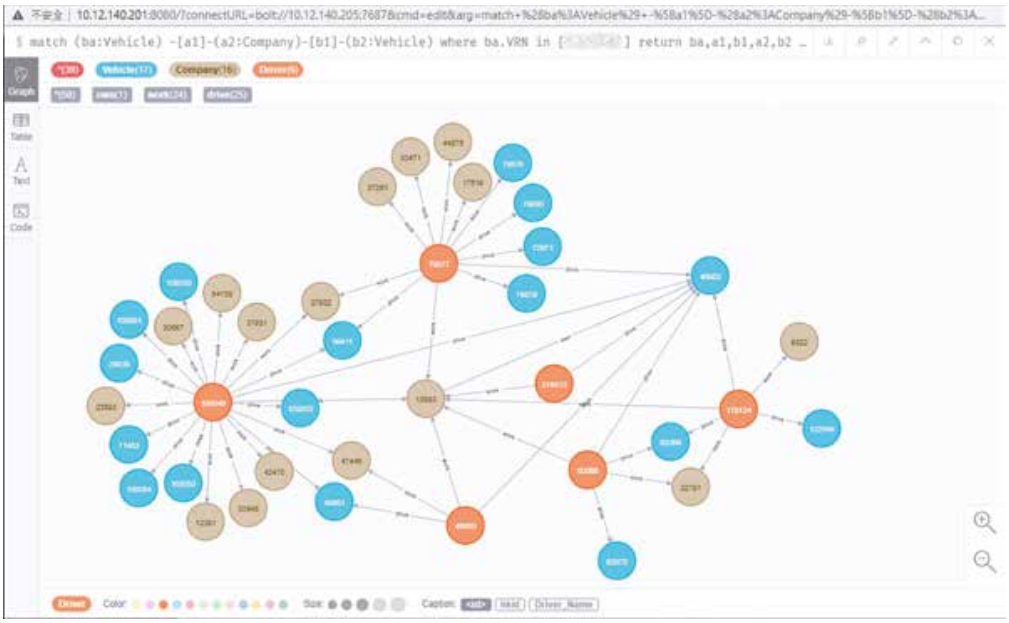


Figure 2. Network Analysis



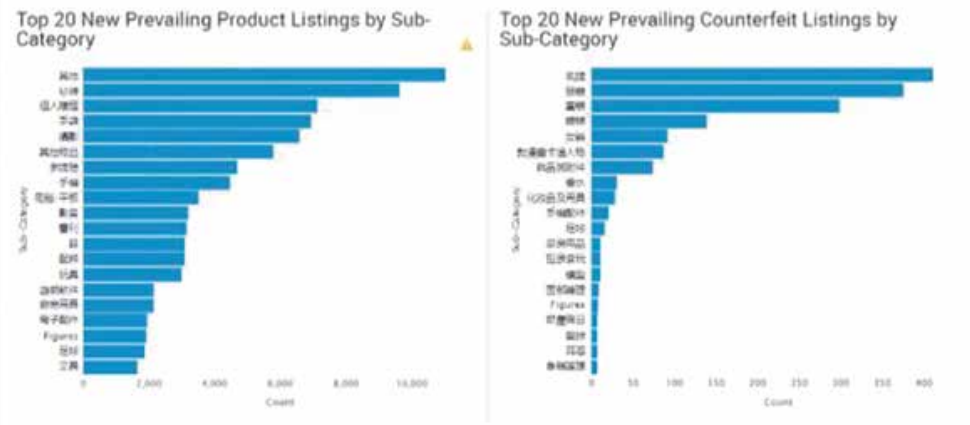
12. Hong Kong, China: HK Customs applied big data technology in combatting online intellectual property crime[92]

Hong Kong Customs launched an IT system in December 2017, called the "Big Data Analytics System", which is the first of its kind that applies big data technology for Hong Kong Customs to analyse and monitor the changing trends of online intellectual property (IP) crimes, including counterfeiting and piracy activities.

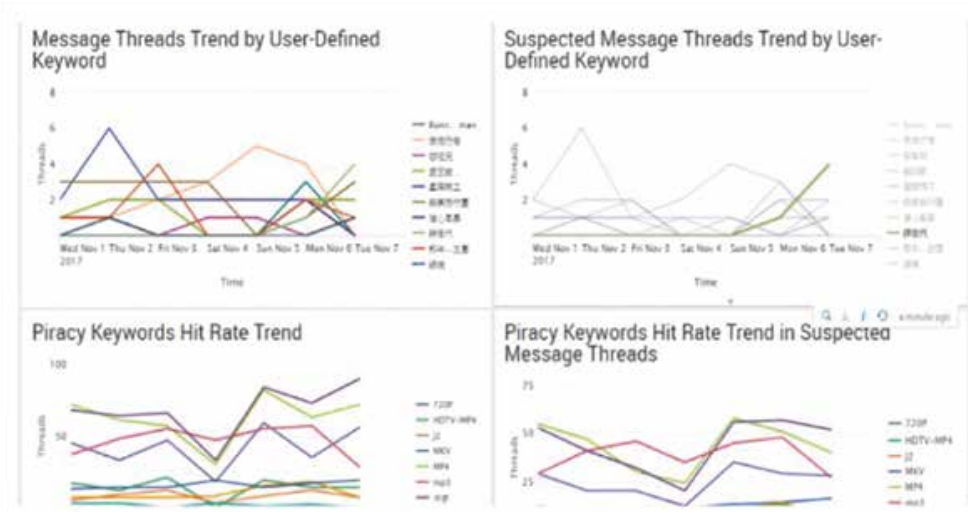
The purpose of the system is to strengthen capability in detecting online IP crimes in an efficient manner. The system helps to keep investigators abreast of the latest Internet jargon, hot topics, popular gimmicks and trendy gadgets on the Internet. It also helps identify platforms and messages that have a higher risk of being associated with IP crimes such as the sale of counterfeit goods, movies, music etc.

The system collects huge volumes of public domain information from various online platforms. The system uses machine learning to analyse and collate the collected data to yield meaningful results. The technology is particularly helpful in analysing Chinese language messages, which are more challenging than those of Latin-based languages. The system enables Hong Kong Customs to stay vigilant about the prevailing trends of online IP crimes, to detect them more effectively, and to combat them in a more targeted manner.

Given the rapid growth of online platforms and the boom in e-commerce, Hong Kong Customs has taken into account the scalability and expandability of the system to be ready for future operational needs. The computation capacity of the system, including processing speed and storage capacity, can be expanded easily in a modular manner.



92 *Submitted in 2019.*



With the assistance of the system, Hong Kong Customs will be able to protect against online IP crimes effectively despite the increased challenges that come with the ever-changing infringement activities.

13. Italy: Internet of Things in Italian Customs. The implementation in the port of Bari [93]

Abstract - establishing universal interoperability on the internet of things field is a prerequisite for its proliferation. Unfortunately, ensuring interoperability is a complex endeavor. During a conference, which was held on 18 June 2019 in Rome, Italian Customs and Monopolies Agency (ICMA) presented the "Special Project for digitization of Customs procedures in national ports". With this initiative, the ICMA intends to contribute to a greater development of traffic in Italian ports with the use of advanced technologies (such as internet of things (IoT)) and simplifications for the operators. The objective is that of achieving a seamless logistics chain in which, for example, goods can be Customs cleared at sea, and pass rapidly the port through gate automation, to be sent to their destination by way of a fast corridor. This should allow often-congested port areas to be cleared quickly. The implementation of the project envisages the collaboration of Port Authorities and the ICMA has devised and made available the "Interoperability Model for digitization of port Customs procedures" that contains general technical standards and data for the development of the digitization of port procedure based on IoT Technology. The case study represents the implementation in the port of Bari.

93 *Submitted in 2022.*
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I. Introduction

During a conference, which was held on 18 June 2019 in Rome, the Italian Customs and Monopolies Agency (ICMA) presented the "Special Project for digitization of Customs procedures in national ports". The project aims at the complete digitalization of Customs procedures in Italian ports for goods transported by both rail and road and which involves all the main institutional bodies in the port sector. The project is based on the logic of the Internet of Things, that is, the extension of the Internet to the world of objects. The objects through special devices make themselves recognizable and through special readers provide, to the right holders, data and information relating to themselves or to other objects. In particular, through an IOT_ID code (unique identification code generated in the UUID [94] format (universally unique identifier) of the moving object) issued by the ICMA, in interoperability with the Port System Authorities, it allows the automatic tracking of vehicles and goods in the 'port area' with consequent advantages for operators and reduction of obligations according to the "ONCE" principle.

The goal is to optimize the multimodal movement of goods in order to increase the competitiveness of the port system in the trans-European network and to attract new traffic flows. It is necessary to arrive at a greater standardization of Customs processes, re-engineering them, making them simpler and more homogeneous on theterritory; in fact, the European context sees, in the development of the network of trans - European corridors TEN - T, a fundamental objective, to be taken into account and inserted into the national port system in a competitive way, developing advanced services based on 4.0 technologies in cooperation with the other actors of the port cycle, including Customs. The first implementation of the project was carried out in the port of Bari. The implementations are gradually extending to all the other Italian ports.

II. Methods

The monitoring of moving goods is possible by sharing the following information:

- Information on the goods, i.e. the identifier of the Customs declarations;
- Information on the intermodal transport unit (ITU) associated with goods (combination of one or two among: vehicle license plate, BIC code of container, ILU code of the track, SWAP box identifier, seal number or goods identifier on electronic manifest of departing/ arriving goods)

These two sources of information are combined, creating a unique identifier defined, in the logic of the Internet of Things, "IOT_ID", which is generated by Customs information systems, and is exchanged through interoperability among the subjects envisaged by the process in question, in the planned logistic nodes.

In the processes that are always considered, with regard to the logistic nodes, the following elements are always considered:

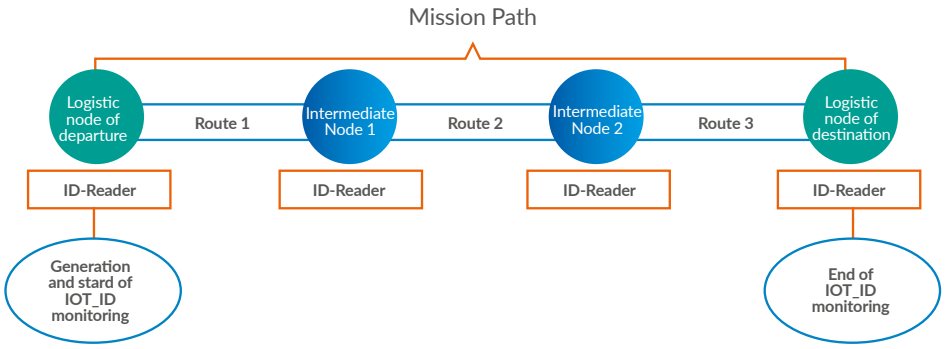
- A logistic node of departure. This is the logistics node where the IOT_ID is generated.
- A Destination logistic node where the IOT_ID has generated a definitive status, because the process that requires the ITU tracking has ended.
- A Mission path that is covered by the IOT-ID in the journey between a logistic node of departure and a logistic node of the destination.
- An ID-Reader that represent the reader ("OCR", "RFID", "BARCODE" type device) used for detecting the IOT-ID or information related to it when passing through the logistic nodes.

It could be also included (and normally it is):

- One or more intermediate logistic nodes that represent a physical place included in the "Mission path" and distinct from the departure and destination logistic node, where the IOT-ID logistic tracking is carried out because required by the Customs processes.

94 *RFC 4122 - A Universally Unique IDentifier (UUID) URN Namespace https://datatracker.ietf.org/doc/html/rfc4122*

Figure 1. The IOT-ID path, from generation to the end of its mission.



In each port, we can thus create different routes (or mission paths) linked to the goods and the failure to respect them generates alarm signals.

III. Logistic nodes, interoperability and hardware

The implementation in the port of BARI (financed by National Operational Program (PON) Infrastructures and Networks 2014-2020[95])

The following pictures focus on the logistic nodes considered in the implementation of the port of BARI and on the Technologies equipped as represented in logistic node (2):

Customs gate «della Vittoria» [96]; Port (1) gate «Marisabella»(2); Parking area «Marisabella»(3); Gate of port facility to the Wharf «San Vito AC 1» (4); Gate of port facility to the Wharf «San Vito AC 3» (5); Gate of port facility to the dock «Levante» (6); Gate of port facility to the Wharf «Ridosso» (7); Gate of port facility to the dock «Ponente» (8).

It was necessary to equip the port gates and other nodes shown in Figure 2, inside the port, with detection equipment, to be connected to the telematics network present in the port. In this way it was possible to create an integrated system that allows the data of an ITU to be detected at the nodes and transmitted them to a data center of the Port Community System (PCS). Once processed, the information collected (e.g.: vehicle license plate, container codes (BIC codes)) is exchanged,

Figure 2. The Logistic nodes considered in the implementation of the port of BARI.

Figure 3. The Technologies equipped on logistic node (2) (Port security gate «Marisabella»).

95 *PROG 0101 Digitalizzazione procedure nel Porto di Bari – ADM https://ponir.mit.gov.it/interventi/its/352-porto-bari-aida?highlight=WyJkb2dhbmUiXQ*

96 *RFC 4122 - A Universally Unique IDentifier (UUID) URN Namespace*

through interoperability services between the information systems of ICMA (AIDA) and the local PCS. The data exchange and the position of the logistic nodes are regulated through[97] :

1. A General Interoperability model for the digitization of Customs procedures in ports that defines actors, perimeter, interoperability services-model and specifications, logistics processes taken into consideration and annexes:

a. A preliminary design scheme. This scheme is used to define the processes (AS IS and TO BE), timing, risks, GANTT and all is needed to set up the project from the beginning of the installation and beyond.

b. The assessment model to define the routes (mission paths) allowed by the type of process considered and the nodes where the detection of the intermodal transport (ITU) unit will be carried out (using IOT) with data exchange between authorities.

c. A standard scheme of service agreement for data exchange among authorities (in particular between Customs and port Authorities).

Consequently, the information detected at the nodes (e.g.: vehicle license plates and container codes), once processed, are exchanged, through interoperability services between the information systems of ICMA and PCS.

The plate and BIC code data are retrieved through cameras:

- Devices for plate reading are equipped with a color context and an IR camera with 3 Mega Pixel resolution and it detect 60 images per second, identifying and validating the number plates of vehicles in transit. The data is then processed by an AI algorithm recognizing number plates from 28 EU countries, various non-EU countries, Arabic characters and finally trailers, Kemler codes (identifying dangerous substances transported by road) and special plates for Italy;
- BIC code reading cameras. The reading of the BIC container codes is carried out through the use of two different cameras: DOME for the reading of the BIC container on its sides and BULLET for reading from above;

and then processed by an AI algorithm on a centralized system.

IV. Processes and routes

The processes taken into consideration (and the consequent routes) can be summarized as follows (the figures show the nodes considered by type of process):

- Export of containerized goods on container ships

The goods transported pass through the Customs Gate “della Vittoria” (1) and through the Marisabella Gate (2). They are directed to the Marisabella parking (3) if the transporter of the goods does not have the access permissions, otherwise they continue inside the port. The goods pass through the port facility gate to the dock “Levante” (6) and are then loaded. The “Customs Status” is checked and addressed at each node.

Figure 4. Flows of containerized goods destined for export.

- Export of goods for EXTRA EU embarkations on ferries

The goods transported pass through the Customs Gate “della Vittoria” (1) and through the Marisabella Gate (2). They are directed to the Marisabella parking (3) if the transporter of the goods does not have the ticket to be purchased in area A (EXTRA EU boarding ticket). Once the tickets have been obtained, the goods pass through the Gate of port facility to the Wharf «San Vito AC 1» (4) or through the Gate of port facility to the Wharf «San Vito AC 3» (5) (depending on the docking position of the ship). The “Customs Status” is checked and addressed

97 https://www.adm.gov.it/portale/en/modello-di-interoperabilita-per-la-digitalizzazione-delle-procedure-doganali-nei-porti

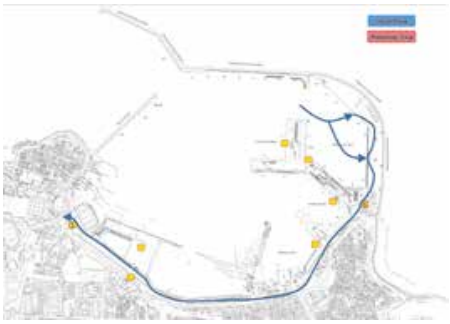
at each node (it should be noted that in exceptional cases, goods could also be loaded from nodes 7 and 8).

Figure 5. Flows of goods for EXTRA EU embarkations on ferries.

- Import of containerized goods from container ships

These goods disembark in the dock "Levante" and pass through the Gate of port facility (6) after acquiring the appropriate Customs declaration for transit or importation. They are then destined to exit through the Customs gate «della Vittoria» (1) manned by the financial police. The "Customs Status" is checked and addressed at each node.

Figure 6. Flows of containerized goods imported



- Import of goods from EXTRA EU ferries

The goods disembark in the dock San Vito and pass through the Port Facility «San Vito AC 1» (4) or «San Vito AC 3» (5) (depending on the docking position of the ship). After acquiring the appropriate Customs declaration for transit or importation they are then destined to exit through the Customs gate «della Vittoria» (1) manned by the financial police. The "Customs Status" is checked and addressed at each node (it should be noted that in exceptional cases, goods could also be disembarked from nodes 7 and 8).

Figure 7. Import of goods from EXTRA EU ferries

V. Conclusions

The project thus implemented was the first of its kind in Italy and ADM is investing in extending the solution, adopted in the port of Bari, to the main Italian ports allowing greater control for anti-fraud purposes and standardization as well as speeding up of Customs processes through 4.0 technology.

14. Japan: Japan Customs' approach to maximize the benefit of technological and innovative development[98]

1. Japan Customs' approach on new technologies

International trade environment is rapidly changing day by day and, because of this change, the Customs role and operation is getting complex and diversified. For instance, the surge of cross-border flow of small packages due to growing e-commerce transaction, expansion of free trade agreements (FTAs), sophisticated modus operandi used by transnational crime organizations, ongoing threat of international terrorism while ensuring smooth flow of goods even at the time of natural disaster have quite an influence to Customs and we are facing various tasks and challenges in our daily operation.

On the other hand, the progress and innovation in the area of technologies are outstanding. As discussed in a variety of occasions of global Customs community, there are emerging technologies, such as blockchain, IoT, AI, machine learning, drone and virtual reality, being implemented in many fields of business and they have a potential to renovate Customs works.

Against this backdrop, Japan Customs has drawn up "Smart Customs 2020" in June 2020 to effectively respond to ever changing environment and to make Customs' work further sophisticated and efficient as a medium- to long-term vision. It consists of four keywords which are "Solution", "Multiple-Access", "Resilience", and "Technology and Talent". Japan has been actively engaging to find ways to best utilize cutting-edge technologies even before this initiative, and now they are incorporated into "Smart Customs 2020", which is comprehensive and medium- to long-term vision, so that we are able to explore the way to introduce new technologies in Customs operation in more structured manner with future changes in mind.

2. The example case studies in Japan Customs

- AI X-Ray

Since 2017, Japan Customs started a study on X-ray image analysis with AI. The processes from research level to practical one was a quite long journey, where creation of AI learning model, continuous improvement on accuracy of image analysis, development and improvement of the proto-type machine took in. It was necessary to collect large amounts of X-ray images for AI to learn and a number of trials were made again and again to improve the accuracy of image analysis. One point that should be noted is the importance of feedback from frontlines at the piloting stage. Functional specifications and processing speed needs to be adjusted into required level at the actual operation of frontlines. And now, AI X-ray will be in practical use which automatically identifies and sorts high-risk and low risk items in post.

- Big-data and AI

In 2019, we started to develop the AI models by using Big Data including Customs declaration data. We are exploring to apply them in various areas of Customs operations, for example, supporting the targeting and selection of importers subject to on site audit in the area of post-clearance audit (PCA), and supporting the examination and inspection at the stage of Customs clearance.

- The Electronic Customs Declaration Gates (e-Gates)

Since April 2019, we have introduced the electronic Customs declaration gates to facilitate smooth entry, to shorten the waiting time and to reduce congestion at the Customs inspection area. Currently, the gates are available in the arrival area in main airports of Japan (Narita, Haneda, Kansai, Chubu, Fukuoka, Shin-Chitose, and Naha). With this, passengers can go through the gate smoothly and speedy by electronic declaration through smart-phones and facial recognition

98 *Submitted in 2022.*

system, unless no need of declaration or subject to inspection.

3. Human Resource Development

As we mentioned above, the "T" in the context of Japan Customs' SMART concept, means not only T for "Technologies" but also for "Talent".

To apply cutting edge technologies such as AI in Customs businesses, it is necessary to develop officials who are of broad and deep understanding in the field of data-science, who can bridge the gap between Customs businesses and the domains of IT systems.

To develop personnel who are well-versed in the field of data science, which is necessary for understanding and mastering cutting-edge technologies such as AI, general training and professional training is quite important. Simultaneously, we are moving towards recruiting individuals with grounding in cutting-edge technology, and securing personnel who can bridge the gap between business and systems when deploying cutting-edge technologies and systematizing operations.

15. Kenya: Application of Biometrics Technology in KRA iCMS system-Bonds Execution Process[99]

The Customs and Border Control Department of Kenya Revenue Authority (KRA) needed to replace its Customs Management System- "Simba" which had been in place since 2005. The new system, Integrated Customs Management System (iCMS) has re-engineered processes that facilitate trade better and has enhanced compliance. In addition, it was also expected to address challenges the department was experiencing with the Simba System.

According to the WCO Glossary of International Customs Terms 2018, a bond is an undertaking in due legal form, by which a person binds himself to the Customs to do or not to do some specified act. The department had experienced numerous challenges with bonds executed to guarantee performance of certain conditions. The bonds would have been issued in lieu of taxes and whenever conditions were contravened e.g. dumping of transit goods, the department would not be able to get the taxes payable since the guarantor or in certain cases the principal would claim that they were not responsible for the executed bonds and therefore not liable to pay the taxes due. This was despite the department having in place specimen signatures of principals and guarantors and verification being done at the point of bond execution where a legal form signed by the principal and guarantor was presented. The department therefore sought to implement in iCMS a Bonds Execution process that could not be repudiated and therefore biometrics were included in the implementation.

The bond application process starts with an application by the bondholder being made in the iCMS. credentials to access bond application are given based on one's PIN. PIN information is pulled directly from the ITAX system, where all taxpayers in Kenya are registered. The application is then reviewed by a KRA officer before being availed to the guarantor the bondholder has selected in the application. This is done through an integration with KENSWITCH, a service aggregator. The department works with an approved list of approximately 50 guarantors (banks and insurance companies) and it was deemed more efficient to integrate with KENSWITCH to provide a platform where all guarantors could review and approve bond applications. It is on this platform that biometric processing was included as part of the approval process by the guarantor.

99 Submitted in 2022.

The on boarding of guarantors onto the KENSWITCH platform starts with identification of signatories of the guarantor by KRA who can approve bond applications. This signatory information (names, Identification, email addresses) is relayed to KENSWITH by KRA. The guarantors are advised to buy a URU DIGITAL PERSONA 4500 –FINGER PRINT SCANNER. This device is used to capture fingerprints which are stored in the KENSWITCH database and is also used to scan the fingerprints at the time of approval. Each bond application undergoes a two-step process, review and approval. The approving officer confirms approval by scanning his fingerprints. If it matches the data available in the database, then the approval is successful and the same information is relayed to the iCMS system including the name of the approving officer. Another measure that was added on the KENSWITCH platform is that all actions on a bond application are relayed to a group email.

Once an approval is received from the Guarantor, the Bond application undergoes further processing which includes uploading of a legal physical document signed by both the principal and guarantor and witnessed by a KRA officer. The physical document was maintained since it is provided in the Law as legal changes are pursued to include acceptance of digital receipt of the guarantor's approval.

Since the bond execution process has been implemented in July 2019, the department has not had a case of a fraudulent bond. A few of the initial challenges were that the guarantors were not happy with the application fee being changed by aggregator per application for use of the platform, but the cost was lower than having to deal with claims of fraudulent bonds that would lead to protracted wars with the Customs and Border Control department. To deal with cases of absence of approvers, each guarantor is allowed to have more than one approver. There were also cases where one's fingerprints could not be read well due to age or those who use water a lot, and this was mitigated by having a functionality to retake the fingerprints.[100]

100 Prepared by: Maureen Ojowi
Reviewed by: Frank Orondo

16. Kenya: Regional Electronic Cargo Tracking System (IoT) [101]

The physical escorts era

The advent of cargo monitoring using Electronic Cargo Tracking Systems (ECTS) was necessitated by a myriad of challenges that Kenya Revenue Authority (KRA) faced in relation to movement of goods under Customs control. These challenges include cargo theft, diversion of transit goods into the local market, loss of cargo security, difficulty in monitoring compliance, delays in cargo movement leading to increased cost of business and leading to significant loss of revenue.

Previously, the KRA relied on physical escort of trucks in moving in a convoy by officers to the various exit points. The average trip duration from Mombasa to Malaba/Busia, under the physical escorts system, was about ten days.

Figure 1. A convoy of trucks moving under physical Customs escort

The era of multiple commercial vendors

In 2014, KRA engaged third party providers of tracking services. There were eight such providers under an umbrella body called the Electronic Cargo Tracking Systems Providers Association of Kenya (EPAK).

They were mandated to provide a real time view of transit cargo form the release point to border stations. Cargo Monitoring Unit staff had logins to all the eight service providers systems to monitor any incidents and violations while cargo transited from release to exit stations.

The effect was a reduction in trip duration to between two to four days, reduction in cost of monitoring per diem payment to escort officers and police, ensured efficiency in the turnaround time, reduced cargo theft and diversion among just to mention but a few. However, the saved time would be wasted at the borders of exit due to disarming and arming protocols in the country of exit and country of entry. In turn, the trip duration would increase to about seven days on average.

Lack of systems control in addition to vendor control over arming and disarming operations meant compromised data security and inaccurate information. Instances of doctored journey maps, loss of data transmission, frequent systems down time, long transmission intervals compromised security over cargo leading to loss of cargo. The need for a robust solution to address these challenges was inevitable.

The era of RECTS

Three revenue authorities (Kenya, Uganda, and Rwanda) through a tripartite head of states meeting in 2017 resolved to starting a Regional Electronic Cargo Tracking System (RECTS) that would be hosted by the Revenue Authorities to ensure data safety, offer an end-to-end tracking across the borders of partner states as well as offering tailored solutions for cargo tracking and monitoring.

Bsmart Technologies was contracted as the sole provider of the new regional system. The system has four main components, namely the dry cargo seals and wet cargo efuels, the arming teams at the release points, the Centralized Monitoring Centre located at the head and the Rapid Response Units, twelve in number along the transit corridor. All teams work on a 24-hour basis to ensure real time monitoring of cargo in transit. In addition, there is a reconciliation unit that reviews all transit cargo movement documentation

101 *Submitted in 2022.*

to ensure compliance with regulations governing their movement and any malpractices detected are addressed.

Benefits realized

1. Transit duration reduced to three to four days on average, hence reduced transit time.
2. Increased revenue from the interceptions by Rapid Response Units.
3. Enhanced in control over data to ensure data integrity.
4. Enhanced regional collaboration and integration of Joint Technical Working Groups.
5. Real time monitoring of cargo in transit and increased incident response times within 60 minutes.
6. Reduced cargo diversion cases.
7. Reduction in cost of doing business.

Ongoing enhancement initiatives

The joint technical working groups of the revenue authorities are continuously reviewing the operational modules of the RECTS system considering the operating environment and proposing enhancements aimed at increasing operational efficiency.

There are plans to establish additional Rapid Response Units along all transit corridors to increase presence and monitoring of goods under Customs control. This entails resource allocations to all RECTS components to ensure they are well equipped and staff are adequately skilled to undertake cargo monitoring responsibilities .[102]

Success stories - pictorials

Figure 2. A RECTS officer responding to an incident involving an overturned transit fuel tanker

Figure 3. Five motor vehicles destined to South Sudan monitored through RECTS were diverted into the local market but were traced and recovered at a homestead in Rongo bearing fake number plates

102 *Prepared by: Abraham Omonya-Supervisor Bungoma RRU*
Reviewed by: Ferdinand Amaumo- Assistant Manager RRU Field Operations

17. Korea : Korean Customs boosting its data analysis capacity with data mining[103]

With the exponential growth in e-commerce, the number of small parcels cleared by Customs has skyrocketed, stretching the limits of Customs enforcement capacities. Korea has a tax- exemption system and simplified Customs procedures in place for "low-value goods," and there is reason to believe, for example, that criminals sneak in smaller quantities of goods in separate consignments to avoid reaching the de minimis thresholds above which duties and/or taxes become payable.

To address this challenge, the Korean Customs Service (KCS) decided to boost its data analysis capacity by bringing together Customs officers trained in data mining and Customs experts dealing with the clearance of express cargo and postal items. Based on the outcomes of their discussions, IT experts from the private sector who have been working with Customs' IT systems for years then reviewed the actual analysis tools and methods, and trained officers conducted a two-month long project.

Based on their experience, the hypothesis formulated by risk analysts was that operators (in an effort to avoid paying duties/taxes) were importing items in multiple small parcels, using a number of different addresses and contact numbers. In other words, compliant importers use one name, one phone number, and one address for all their operations, while non-compliant importers use a series of names, phone numbers, and addresses. To confirm the hypothesis, records of importations that were transported via express and postal services were extracted for a three-year period. Then, search tools were used to mine the data in order to identify specific information such as phone numbers and addresses. Datasets containing the refined data, including the consignee's name, address and phone number, were then created for analysis purposes.

Among the suspicious cases that came out of the analysis was an importer who had reported 123 different phone numbers and 127 different addresses. To facilitate data-reading, the analysis team converted the addresses into geographic coordinates. Several visualization techniques were used. For example, the datasets were analysed using ORA, a network analysis tool, to examine correlations and relationships.

By inputting information such as phone numbers, descriptions of goods and the exporting country into the visualization programme, analysts were able to identify importers' different addresses. Data on seven suspicious importers showed that they were using a specific region of Seoul, Korea's capital, as their address, which indicated that they might be importing items in multiple of small parcels with false destination addresses across this region.

"Garbage in, garbage out" is a well-known maxim relating to the need for "good" information for meaningful data analysis. The expression emphasizes that the quality of output is determined by the quality of input. The KCS has learned through experience that Customs officers tend to be nonchalant about the importance of the quality of data in Customs as much as about the quantity of it. In light of this, the KCS plans to conduct automatic data cleansing when data is recorded in its database by adopting artificial intelligence technologies.

Another lesson learned is the importance of "domain knowledge." During the project, one IT expert from the private sector said that a task which took one week to complete by Customs officials would have taken one month by a layperson. In other words, domain knowledge matters a lot when analysing data. Therefore, Big Data analysis of Customs-related topics should remain within the purview of Customs.

This project was a short-term pilot project aimed at testing how data analytics could enhance risk analysis. It was applied to express cargo and postal items to identify commercial fraud, but the KCS believes that the same methodology could be applied to other areas. For example, criminals trying to import high-risk cargo, such as narcotics and weaponry, tend to file an import declaration with a false address in order to hide their iden-

103 Submitted in 2019.

tity. The KCS plans to invite a larger number of IT experts to enhance the tools used during the project in order to make them fit the Service's analytical needs. The KCS will continue to conduct a yearly project to train Customs officers in data mining and invite a larger number of IT experts to make them fit the KCS's analytical needs. These solutions will be integrated into KCS's system for utilization in actual investigations.

More information: kcsmcd@korea.kr

18. Korea: Operation of KCS Big Data Platform[104]

Korea Customs Service (KCS) has been striving to apply new technologies, including Big Data analytics and AI, to Customs service and developing blockchain-based or AI X-ray e-commerce platforms. However, it was necessary to create a new integrated system to move forward with innovative work based on all the data in the whole area of Customs, such as clearance, investigation, and audit going beyond the current system. To this end, Korea Customs started developing a 'Customs Big Data Platform' encompassing infrastructure, portal, and analysis models.

A Big Data Promotion Group was launched in 2019. Korea Customs established its hardware infrastructure best suited to collect, manage, analyze and provide Big Data, a transition from Customs Data Warehouse, which mainly stores and searches data. The Big Data platform is different from the current import and export clearance system, and it is primarily used for data analysis. The platform analyzes vast data that accounts for hundreds of gigabytes while ensuring a seamless clearance computer network. The platform is armed with all the necessary infrastructure, such as the Hadoop ecosystem multi-core GPU. It is designed to readily respond to an increase in data in the future.

In the early 2020s, the 'KCS Big Data Portal' was set up to allow all Customs officers to access through their internal network and use analysis model or carry out data analysis. Furthermore, users can access directly through a web browser without downloading any programs. This is the strong point of making the best use of Big Data, and there is no need to create each access route to the Big Data project. In a nutshell, users can access one portal to see every project.

13 Big Data analysis models and 11 models were developed in 2020 and 2021, respectively, building around the big data platform. The model offers real-time analysis results, including millions of express cargo imports and enterprise risk levels created by machine learning. It enables immediate identification of various risk factors in trade procedures, which would not have been possible in the current practices.

The analysis model produces tangible and practical outcomes in risk management. Korea Customs successfully detected high-value illegal foreign currency transactions by looking into the company's foreign currency transfer data in 2021 and seized paper companies that illegally used other people's names to avoid dispositions on default of duties by analyzing purchases and sales reported to the National Tax Service. The model was also more accurate in analyzing data as it focuses on not only the field experiences but also company risk level when selecting importing companies subject to inspection.

One of the striking aspects is that it provides a structured analysis model and helps users conduct analysis work on their own. When users access the portal, all Customs officers can write Python code, use software, and design analysis projects in a virtual model. Big Data Promotion Group provides necessary data and expertise to Customs officers in the field when they need to create data ideas. In 2020, 50 data analysis models (made by Customs officers themselves) were

104 *Submitted in 2022*

Figure 1. Future of KCS Big data

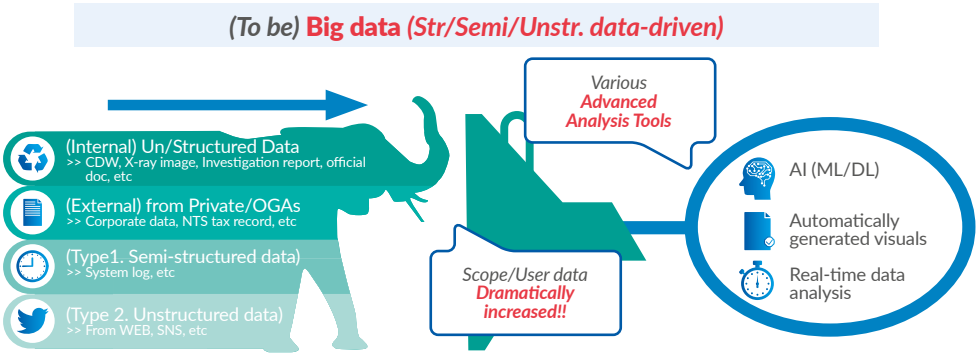
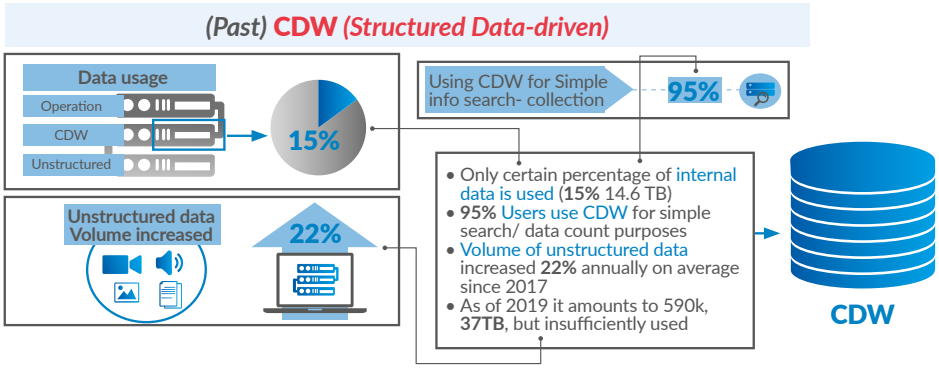


Figure 2. Past practice



shared in the portal. This can increase efficiency and reduce the cost compared to the private-run project.

In the near future, Korea Customs will improve the platform by adding some functions and expanding training programs for Customs officers to equip them with domain knowledge. In this sense, Korea Customs will continue to create data-based Customs culture at work. New algorithms are being developed with the rapid development of Big Data analysis and artificial intelligence. It is expected that such a platform will be the stepping stone to leveraging new technologies in Customs service.

19. The Netherlands: Collaboration: Industry – Science - Research[105]

1. Overview

With its operations, Customs is part of a network of contracting ministries, other EU Customs services, national enforcement partners, (international logistics) businesses, education and science. Each player in the network influences the others through its operations. Collaboration is therefore vital. Customs collaborates in many areas: with EU and non-EU Customs services, with commissioning ministries and enforcement partners, as well as with businesses, education and science. The tripartite dialogue between businesses, government and science is an important distinguishing feature for the Netherlands. This document describes the collaboration with businesses, government and science.

Consultations between Customs and industry of an international, national or interregional Customs character are conducted under the umbrella of the Customs Business Consultation Committee (ODB), the National Committee on Trade Facilitation (NCTF). The NCTF therefore fulfils a pivotal role in the collaboration with businesses. The Netherlands Food and Consumer Product Safety Authority (NVWA), the Human Environment and Transport Inspectorate (ILT) and several commissioning ministries participate in this consultation as well. Based on the feedback from the ODB and businesses through the 'Good Service Certificate', Customs monitors the practical implementation of the balance between enforcement and facilitation. A strategic development agenda has been established within the ODB, in which common goals are formulated for the medium term.

In addition to the NCTF, Customs participates in other public-private partnerships. For example, Customs participates in the public-private security platform at Schiphol Airport; Public Safety Schiphol. In the port of Rotterdam, Customs chairs the Mainport Consultation Table. Customs further takes a seat at the Port Discussion Table and participates in the Integrity Port Programme.

The future vision includes development domains such as auto-detection of data and goods, green, blue and yellow channels and strengthening the balance between enforcement and facilitation. Research within these domains is often shaped in projects within the triple helix science, businesses and government-Customs services. This is conducted under the flag of Top Sector Logistics and in European research projects. Customs has drawn up a research agenda that supports the realization of the vision "pushing boundaries".

In the field of knowledge development and education, Customs works together with educational institutions, in which research forms the basis for the development of educational material and, as part of which, Customs and industry, insofar as possible, jointly develop and acquire knowledge in order to gain mutual understanding and insight into each other's processes. This way, students in these courses become closely involved with Customs and the challenges that Customs faces.

2. National Committee on Trade Facilitation

Good logistics are of national importance to the economy of the Netherlands. Contributing to the competitiveness of the Netherlands and the EU is one of the core tasks of Customs. Minimizing disruptions in the logistics chain caused by the regulatory and administrative burden and enforcement activities is important. However, enforcement by Customs is and remains necessary. In EU cross-border goods traffic, Customs, businesses and other enforcement services are all so to speak interlinked. As such, there is a common interest, in that parties are dependent on each other's 'performances'. If one party does or omits something, it has an effect on the other and therefore on the logistics chain as a whole. In order to achieve the best possible balance between enforcement and trade facilitation, close collaboration with businesses and other enforcement services is therefore of great importance. The ODB brings the partners together to discuss matters and collaborate at a national level.

105 Submitted in 2022.

Within the NCTF, Dutch Customs and representatives of the business community discuss issues related to the EU cross-border goods traffic in the broadest sense of the word. Equality and mutual transparency are the basis of each dialogue. The parties understand each other's responsibilities, interests and wishes and coordinate these where possible. This way, finding an optimal balance between enforcement and trade facilitation is always a joint effort.

The collaboration between Customs and industry is solid. The Dutch government has registered the NCTF at the World Trade Organization (WTO) in the form of a National Trade Facilitation Committee[106]. That is why, depending on the agenda items, representatives of other government bodies join the ODB on a regular basis.

Within the triple helix Government-Business-Science, Top Sector Logistics works on (the optimization of) operations, research and education.

2.1 Topics of conversation

The agenda of the NCTF includes items related to Customs logistics and Customs clearance. These can be topics of an operational character, but also themes of a more strategic character. In addition, matters are discussed such as adjustments to IT systems and implementation periods for legislation and regulations. Individual issues are never discussed in the ODB.

2.2 Government representation

Customs chairs the NCTF as part of its coordinating task, designated by law, within the framework of supervising EU cross-border goods traffic. The Directorate-General for Allowances and Directorate-General of Customs of the Ministry of Finance, the Ministry of Foreign Affairs/Foreign Trade and Development Cooperation and the Ministry of Economic Affairs and Climate are all represented in the ODB. The Netherlands Food and Consumer Product Safety Authority (NVWA) and the Human Environment and Transport Inspectorate (ILT) participate in their roles as other border agency, insofar as this coincides with the duties of Customs.

2.3 Business representation

Joining the NCTF is reserved for relevant chain partners of Customs: umbrella organizations that operate nationally and that play a role in cross-border Customs logistics. After all, they are affected in their processes and procedures by the topics discussed in the ODB. Sector associations and industry organizations are not directly involved, due to the limited relevance of the total scope of topics that are discussed. They are represented through their umbrella organization VNO-NCW/MKB Nederland.

3. Business development agenda

3.1 Business needs

Dutch businesses have a great interest in a well-functioning European common market. According to the business community, this does not necessarily mean that, in the field of Customs and clearance, uniform procedures are applied throughout the EU. The implementation must be able to anticipate local circumstances, related to modality, volume and degree of compliance of businesses. With regard to the latter, businesses can see an important role for the EU in terms of providing more space, more recognition and more facilities for companies that meet high internal quality standards. In addition, Europe should focus more on enforcement in the logistics chain and the framework of standards of the World Customs Organisation (WCO), in which smart and secure trade lanes are yet to be incorporated into European legislation.

3.2 Strategic Development Agenda for Customs and Industry

In 2017, representatives of the business community in the ODB, supplemented by representatives from the main ports of Rotterdam and Schiphol Airport, agreed a Strategic Development Agenda with Customs. This approach consists of four themes:

- Services and knowledge level
- Trade facilitation and supervision
- Information technology
- Coordinated border management.

106 *Pursuant to Article 23 of the WTO Trade Facilitation Agreement.*

These themes concern Customs enforcement as well. Some of the associated actions fall under service provision, others under supervision. The Strategic Development Agenda for Customs and Industry contains both short-term and long-term actions.

4. Collaboration between science and research

In order to realise the vision "pushing boundaries", Customs is pursuing a research agenda in which initiatives are being developed in the domains of auto-detection of data and goods, green, blue and yellow channels and strengthening the balance between supervision (strengthening enforcement) and facilitation (easing the regulatory and administrative burden). Research is coordinated administratively through the Innovation Coordination Group. This includes scientific and applied research under the top sector logistics and EU Framework Programmes. The Innovation Coordination Group further pursues an agenda that focuses on innovation, market exploration in numerous areas and the deployment of Proofs of Concept to test the applicability of innovative products.

4.1 Customs research agenda

The Customs research agenda aims to provide structure and direction to the research needs of Customs. Structure by indicating what the need consists of, thereby indirectly defining along which lines research needs run. Direction, by indicating which research goals are served and indicating the importance at strategic, tactical and operational level. This way, research can be linked to a priority.

The aim of this research agenda is twofold. On the organizational side, the step is being taken towards active and conscious thinking about topics for which there is a real need for knowledge and insights about issues from the Customs demand side. On the other hand, it aims to provide an overview of supply from science and companies. The triple helix, which stands for collaboration between government, companies and education. To take advantage of the potential for innovation and economic development in a knowledge economy, government, industry and knowledge institutions must work together. This promotes the collection, sharing and application of knowledge and research.

The agenda aims to provide an overview, insight and coherence in research related to not only technological innovations, but also to the broader policy spectrum of Customs. As is clear from the above, research can be conducted internally or externally. Being innovative or not.

4.2 European Research

For about two decades, Customs has been participating in research initiated by European research programmes, such as the Horizon Europe[107]. research and innovation programme. Calls for research are issued periodically by the REA, the agency of the European Commission charged with issuing research and supervising the use of funds made available. Calls are tendered for by consortia of companies, governments and research institutes.

Customs regularly participates in these EU-funded research programmes, which fall within the EU framework programmes under the theme of 'Secure Societies', which in turn comes under the main theme of Security & Citizenship. The objectives of this funding are EU science excellence, EU leading industry and responding to societal challenges. The 'work programme' is drawn up by the European Commission, partly on the advice of Project Advisory Groups, in which science, government and industry participate, and the project and contact groups that operate under the Customs 2020 programme in which the European Customs services work together.

Customs often participates in a consortium as end user, i.e. as drafter of specifications and tester of what is ultimately developed, or as a party with a directly interest, in which research results can directly contribute to the task performance of Customs. Participation from Customs never involves the contribution of financial resources, but time in the form of knowledge, expertise and (end-user) tests, i.e. an in-kind contribution.

4.3 National Research

TKI Dinalog, the Top Consortium for Knowledge Innovation of the top sector logistics, conducts scientific research on logistics issues, in collaboration with the Netherlands Organisation for Scientific Research. In addition, projects and practical

107 *To be succeeded by Horizon Europe.*

studies are financed by the implementing organisation Connekt, through the Ministry of Infrastructure and Water Management. The request for these studies is issued by from, among others, the Trade Compliance & Border Management network, the action line of Top Sector Logistics, which is under the direction of the ODB. Within this line of action, the ODB drew up a long-term agenda in 2014, Innovation in Supply Chain Compliance (ISCOM).

As regards participation by Customs, studies are conducive to the frontier vision. The commitment of Customs is provided in the form of an In-Kind contribution and a commitment in time, with an allowance from subsidies for travel and accommodation costs for some studies. Scientific research calls were issued under this agenda in 2015 and assigned to IT and data-related issues for the purpose of optimizing cross-border goods traffic. Employees of universities conduct doctoral research on this. Customs has issued 'Letters of Support' for this. In addition, implementation studies have been issued, in which Customs has participated in research consortia. By participating in a research consortium, Customs can exchange ideas and innovate with participating parties as equal partners, outside the inspector's business relationship.

Research fits into the long-term agenda of Customs and contributes to the role of Customs in protecting the EU, because better aligned processes and procedures simplify enforceability and to strengthen competitiveness, because digitization of processes demonstrably leads to a reduction in the administrative burden. This concerns independent scientific research, which does not lead to binding positions of or for Dutch Customs.

4.4 Request from science future collaboration

Customs has been collaborating with knowledge institutions for years on topics such as designing secure supply chains, the development of new supervision models, the logistical impact of supervision activities and the joint analysis of risks in chains.

During the preparation for the Strategic Long-Term Plan of Customs, it emerged that these collaborations were often formed on an ad hoc basis. In view of the existing long-term collaboration, a more structural agreement on collaboration between Customs and knowledge institutions is desirable for the scientific institutions. To secure the structure, process and plannable research products on need to have basis, Customs is creating a knowledge and research hub for universities (of applied sciences). This hub will function as a service for universities (of applied sciences) for requested knowledge and research products as well as counterpart for interesting and promising developments in the Customs arena.

5. Cooperation with education

For about a decade now, Customs has been working with educational institutions on shaping Customs-related education in the public education system. This development follows on from the long-term goal of Customs and the Tax and Customs Administration Academy and the need of the business community to develop and offer Customs-related education in the public system, in which ultimately young graduates can be recruited 'at the gate' in the long term, with the right competencies of a Customs professional. On the one hand, employees who enter the labour market after completing such a study only need limited additional training. On the other hand, this promotes the development of the subject, because universities (of applied sciences) always link education to research. In addition, an offer of subject-oriented training courses in the public system leads to the presence of the Customs subject in the education market, the place where future staff must come from, which leads to familiarity and thus attractiveness as an employer. To secure this achieved results Custom is creating focus points for internships off which excellent interns have an attractive perspective on a Customs career. The current staff is offered to top-up their educational level and acquire state of the art knowledge in their professional area of expertise within the applicable competency framework. Customs aims for educational grow of (potential) staff and in the Customs environment hand-in-hand with educational professionals.

20. The Netherlands: Deep learning and other avenues for innovation in Dutch Customs[108]

The Dutch Customs Administration (DCA) participates in European research and development projects to address mid- to long-term challenges. Together with other Member States these challenges are brought to the attention of the European Commission. For the use of non-intrusive inspection technology, key challenges exist in the automated signal interpretation of existing technology, the design of a flexible architecture of non-intrusive inspection technologies addressing each threat scenario appropriately, and the development of novel non-intrusive inspection technologies to make up for the current lack of capabilities.

In 2013 the ACXIS project started its work on automated x-ray image comparison for cargo. The work led to the world's first container x-ray interpretation algorithms. The added value of the use of the algorithms was validated in a controlled study incorporating the effect of learning by doing. The project resulted in the wish of the DCA to further develop algorithms with, amongst others, its key suppliers, something that is visible in the current tender documents. In the meantime, more Customs administrations have taken up the challenge of developing deep learning algorithms. The need for accessible databases of image material in a unified file format (in the meantime developed under the WCO), declaration data and inspection results is a known prerequisite for automated x-ray image interpretation.

Customs administrations are confronted with a plethora of threat scenarios on entry or exit. Since the late nineties, x-ray image interpretation has been the technology of choice to confront these scenarios. As much as x-ray inspection is used, its limitations are known among experienced end-users. The C-BORD project (see www.cbord-h2020.eu/) addresses the need for the x-ray to be accompanied by a suit of technologies that in combination deal with the threats more efficiently and effectively than x-ray alone. Evaporation-based detection, advanced radiation detection, next generation x-ray inspection, tagged neutron inspection and photo fission were all combined in a C-BORD control street set-up to study their added value in September 2018.

But European Customs administrations want to be in the position to choose from a range of applicable products and to devise tailor-made architectures. To that end, the COSMIC project looks into the detection of chemical, biological, radiological and nuclear materials through the use of dedicated sensors and muon interaction, in combination with x-ray inspection.

108 Submitted in 2019.

21. The Netherlands: Dutch Customs Real Time Information System (CRIS) uses machine learning and cognitive data mining[109]

Introduction

The Dutch Customs Administration (DCA) participated in the European Commission (EC) funded CORE project. During the CORE project the Data Pipeline concept was tested in demonstrators. The demonstrators showed that shipping documents in global trade (B2B) and supply chain event information can be shared through the Data Pipeline concept and can be made available to government inspection parties by participating companies. The DCA can use this information, in combination with the readily available declaration information, to enhance the risk management process and for de-risking shipments in the targeting process. The goal from a government perspective is to secure and further facilitate global trade, mainly by increasing efficiency and effectiveness in the inspection processes, without the need to request additional information on a case-by-case basis while goods are held.

CORE Dashboard

The DCA has been using a dashboard created by Intrasoft under the CORE project. This dashboard aggregates the information that was sent to the Data Pipelines and provides secure access to the information based on several unique identifiers, for example, a container number. During the CORE project the DCA found that the Data Pipeline information was of added value in the targeting process, but that further integration with internal and external data sources was necessary to optimize the workflow from a targeting officer's perspective.

CRIS

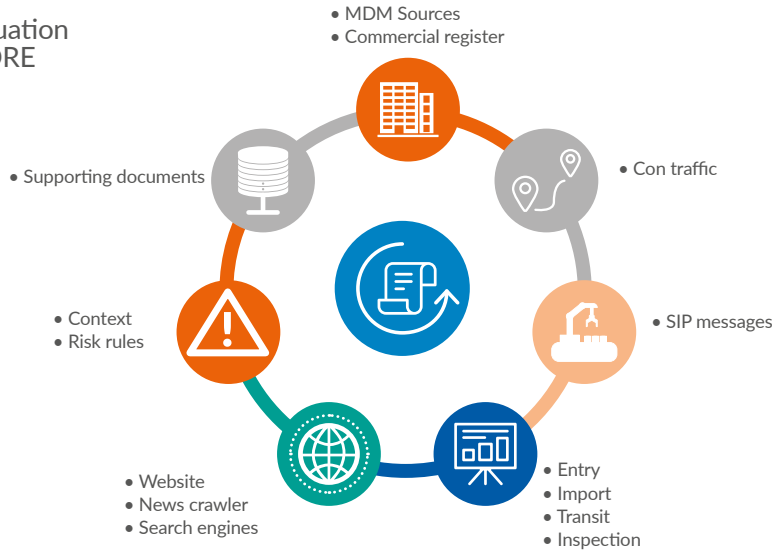
In the second half of 2017 DCA management decided to invest in a Proof of Concept for a national implementation of the CORE dashboard. This system is called Customs Real Time Information System (CRIS). CRIS incorporates all the information that is provided by the CORE Dashboard and supplies the targeting officers with targeting information found in other data sources. The DCA developed CRIS internally using Watson Explorer Technology, based on machine learning and cognitive data mining, to filter the enormous amount of data and to present it in a workable format to the verifying officer amongst others, the aforementioned targeting information includes: data about parties in the supply chain as registered in the Dutch national register of commerce, container status messages (Contraffic), internal Master Data Management (MDM) sources, historical compliance figures, declaration and targeting information. By providing a single 360-degree view to the targeting officers with all relevant information, targeting has been made more efficient and consistent and has been significantly improved over manual collection.

Production

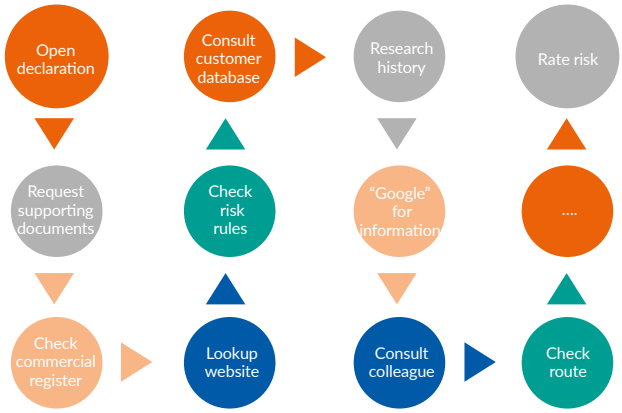
Due to a series of IT obligations this project was put a bit on hold, and will be implemented in a wider approach on the use of data via a platform. Dutch Customs are currently conducting a study on feasible technical solutions for the future.

109 Submitted in 2019 and updated in 2022.

CRIS situation after CORE



Current situation



22. Nigeria: The Future of Nigeria Customs Service (NCS) – e-Customs project (AI)[110]

The e-Customs Initiative involves the complete automation of all Customs Procedures and Administration to enhance the Statutory Revenue Generation and Trade Facilitation roles in the National Economy. This has become imperative for the Nigerian Customs Service against the background of such challenges ranging from duty evasion, inadequate monitoring systems, smuggling of goods across the borders, inflow of banned items, manual administrative processes etc. which its current ICT Infrastructure and Operational Systems like the ASYCUDA++ and the Nigeria Integrated Customs Information Systems (NICIS) have not completely tackled and addressed. In other words, the deployment of e-Customs will address the limitations of NICIS II and many more.

The e-Customs is an integration of applications, platform and hardware involving an all-in-one nationwide import, export, transit and excise Management system aimed at blocking loopholes, using the new technologies including Big Data, Artificial Intelligence (AI) to enhance the ICT system and fasten the Customs automation process.

Objectives

The main objective of the e-customs project is to provide world class fully automated ICT solutions, others are:

a. Providing an end-to-end ICT platform to digitalize all Customs business processes and procedures;
b. Upgrade and update Customs ICT infrastructure to world class standard;
c. Address critical operational challenges and loopholes;
d. Modernize all related Customs infrastructures, business premises covering the Customs Area Commands, Border Stations, Zonal Headquarters and the Customs Headquarters.

Deliverables

The major deliverables of the E-Customs Project are:

a. A Unified Customs Management System (UCMS);
b. E-Port System;
c. Non-Intrusive Inspection (NII) Scanners;
d. Risk Control Center (RCC);
e. Mobile Enforcement;
f. Electronic Cargo Tracking System (ECTS);
g. Intelligent Gate (iGate);
h. Excise Automation;
i. Paperless Customs (Office Automation System, Human Resource Management, Document Management System and Asset Management System);
j. Infrastructure upgrades (Customs Data Centre and Customs Network);
k. Marine Deployment;
l. Capacity Building.

Benefits of e-Customs

Consequently, the e-Customs project will provide benefits for the Service and Nigeria as an entity by:

a. Improving revenue generation and protection by proper management of cargo manifest, thereby, preventing undeclared cargo and revenue losses;
b. Improve security at the borders by controlling the imports, exports and transit of goods;
c. Reduce tax evasion and smuggling by reengineering core processes and procedures;
d. Improve the accuracy of the import declaration price and reducing price fraud, maintaining the fare trade environment;
e. Improve the efficient of the economic statistics;
f. Better supervision and enforcement by blocking smuggling and evasion loopholes;
g. Improve clearance efficiency and reducing cost;
h. More accurate NCS statistics for Government economic planning;
i. Promote national economic development level and investments;
j. Facilitate NCS to be connected globally;
k. Provide technology for best practice in NCS;
l. Better public perception of NCS as a world class organization

110 Submitted in 2022.

m. Improve ease of doing business and trade facilitation in Nigeria;
n. Encourage technology tourism and better multi-agency collaboration;
o. Enables more professionalism in NCS in terms of personnel and processes;
q. Introduce Efficiency, Transparency and a Predictive trade facilitation business processes and procedures;
r. Share digital data among Partner Government Agencies (PGA) in the trade chain to enable them conduct their internal business processes and other Security agencies to address National Security Challenges;
s. Enable NCS possess full capacity for Supervision, Regulation, Enforcement and control of all its core functions as given by the Act.

Conclusion

In conclusion, the e-Customs system will provide comprehensive monitoring and facilitation of each stage of the trade process. Also, the office application is designed to enhance the overall efficiency of NCS. It is worthy of note that these end-to-end solutions are all integrated and will provide future proof technology based on projections in technology evolution and equipment lifecycle. The project will also address challenges of legacy systems which have separate isolated platforms, integration challenges, poor network connectivity and security loopholes.

23. New Zealand: Biometrics - the experience of the New Zealand Customs Service[111]

The New Zealand Customs Service has deployed an automated border control system using facial recognition to process passengers arriving and departing at Auckland, Wellington, Christchurch and Queenstown airports in New Zealand. This system, known as SmartGate New Zealand, was initially deployed in 2009 and consisted of separate kiosks and gates. Since 2009, the system has gone through multiple improvements, with changes to the facial recognition algorithm, the cameras and, most recently, the gates themselves. The current system has dispensed with separate kiosks and instead uses two stage gates. Each traveller approaches the gate and scans their ePassport at a passport reader in front of the gate. The system then captures their demographic details and facial image from the ePassport chip and records their answers to any Customs declaration questions. After confirming the authenticity of their ePassport, and their eligibility to use the system, the first barrier door opens and the traveller moves forward towards the second barrier. A totem with three cameras at different heights captures multiple images of the traveller as they move towards the second barrier. A facial recognition template is developed from multiple images captured by these cameras and matched against a facial recognition template generated from the chip image of the traveller. If the match score passes the operational threshold for that location then the second barrier opens and the traveller moves on to the rest of the airport. If no facial template of sufficient quality can be generated, or if the match score is below the threshold, then the second barrier will not open and the case is referred to an officer for decision or, if there is still potential for a mismatch, the passenger is referred for manual processing.

At present, the SmartGate New Zealand system is available only to travellers aged 12 years and older who hold ePassports issued by Australia, Canada, China (excluding Hong Kong), France,

111 *Submitted in 2019, updated in 2022.*

Germany, Ireland, Japan, New Zealand, South Korea, Singapore, Netherlands, UK and the U.S.[112]

Since its initial deployment in 2009, the New Zealand Customs Service has made it a priority to monitor and understand the operational performance of the SmartGate system. A biometric performance tool is used to generate regular reports with full detection error trade-off curves and performance separated by appliance, by location, by country of origin and various other factors. Several lessons have been learned over almost eight years of performance monitoring.

Firstly, performance varies substantially by airport location. Even at the same airport, the performance of the SmartGate system in the arrivals precinct may be quite different from the performance in the departures precinct. A lot of this seems to be related to illumination factors such as the amount of natural light, the type of lighting fixtures and the height of the ceiling in each location. Secondly, there are substantial performance differences between travellers from different countries. Much of this seems to be related to the quality of the images in the ePassports issued by each country and to the rules they enforce to ensure ICAO compliance of these images. Thirdly, younger travellers experience a much higher false rejection rate in the facial recognition comparison than older travellers. This is one of the reasons why there is a minimum age to use SmartGate in New Zealand. The rejection rate for travellers younger than 12 is very high. Finally, every algorithm and camera version tried so far shows a consistently higher false rejection rate for females than for males. Since all algorithms tested showed this bias, it is at least partially due to females being intrinsically more difficult to match using facial recognition, but since different algorithms showed this to different extents, it is also partially due to the way the algorithms were designed.

24. Peru: Peruvian experience in using blockchain technology for mutual recognition of AEOs – the CADENA tool[113]

Authorized Economic Operator (AEO) programmes are extending all around the world and along with them the signing of more AEO Mutual Recognition Agreements (MRAs).

When two countries exchange a short list of AEO companies to be reciprocally recognized, it is not a difficult task. However, it can become quite complex if the agreements involve multiple countries with thousands of companies.

Peru, together with Costa Rica and Mexico, participated in a pilot project named CADENA, which uses blockchain as a possible solution for the challenges described. CADENA is a platform developed by Microsoft with the sponsorship of the Inter-AmericanDevelopment Bank. In the meantime, five more countries joined the project: Colombia, Chile, Guatemala, Bolivia and Ecuador.

The overall goals of CADENA are to solve the challenge of exchanging data on AEO companies under the MRAs and to gain experience with the new technology in the Customs environment. Blockchain enables users to share a single view of the status of an AEO certificate in real time, and is designed to allow all users access to company information depending on permissions. Transactions are validated and shared among nodes which operate in a cloud environment.

Each Customs administration inputs the information on its AEO programme, according to pre-determined parameters. As soon as a new AEO is

112 *Although the above information remains accurate, COVID-19 has significantly disrupted the use of eGates in New Zealand. This included eGates being closed to all travelers in March 2020, and at the time of writing only limited reopening's for approved quarantine-free travelers since then.*

113 *Submitted in 2019 and updated in 2022. Further information on the CADENA project is provided by the Inter-American Development Bank further below.*

registered into the CADENA platform, every user can access the information via a web application.

Under the non-blockchain procedure, Peruvian Customs informs other Customs administrations about a new AEO company on a monthly basis, so there can be up to 30 days delay for a newly certified AEO company to obtain the benefit from an MRA.

It is expected that this pilot will eventually allow the CADENA platform to integrate with the IT systems of each Customs administration to ensure that benefits can be accessible in real time.

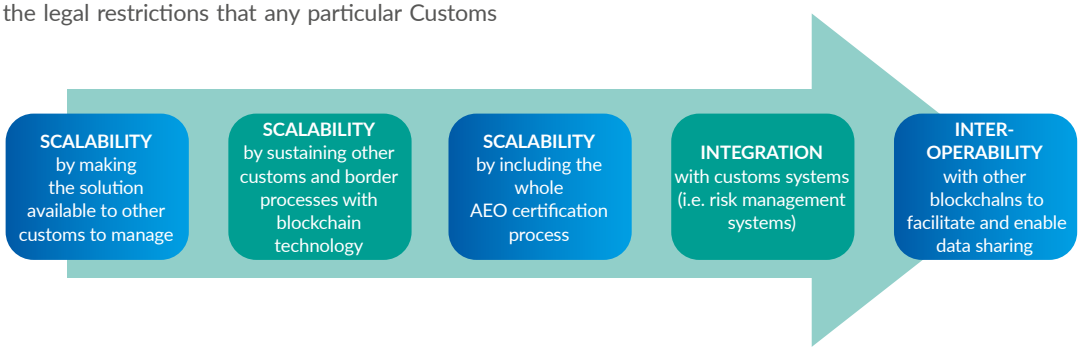
Currently, this tool is being tested by the eight above-mentioned countries. The advantages increase as more countries use it.

Some considerations to take into account include the legal restrictions that any particular Customs administration may have regarding sharing of information. Peru publishes a list of its AEO companies, (unless otherwise instructed) so that there is no legal restriction to the use of CADENA.

The CADENA project is now in the test net environment in LACChain net. Countries now are deciding to move to the main net. Recently, SUNAT[114] obtained the "Business Creativity" award in Peru that is given to those initiatives with a great impact in serving the population.

ROAD AHEAD:

The use of blockchain to exchange information and grant benefits in real time in MRAs, is a potential solution.



114 Superintendencia Nacional de Aduanas y de Administración Tributaria.

25. Russian Federation: Advanced technological solutions used by Customs Authority of Russian Federation (big data analytics)[115]

In the Russian Federation, the Risk Management System (hereinafter – RMS) emphasizes the use of digital technologies, advanced technological solutions and intellectual data analyzation system. This is spurred on by the fact that Russia has the longest border – including land, sea and waterways borders with 16 countries across 11 time zones.

Due to those geographic features, the RMS must ensure effective and reliable control of goods being moved across the territory of Russian Federation.

For that purpose, the Centre of Monitoring and Control of Federal Customs Service (FCS) of Russia, which is responsible for the administration of RMS is using a complex information software that allows for identification of risk automatically and immediately in any part of the country during any Customs procedures: provision of pre-arrival data, arrival/departure, transit, temporary storage, declaration of goods, their movement in the course of e-commerce, post-clearance control.

For that purpose more than 1600 risk indicators are being used to determine high-risk level when it comes to prohibitive and control measures, the classification of goods, application of Customs duties, intellectual property protection, Customs procedures, the estimation of Customs value, control over radioactive materials.

Alongside typical risk indicators (such as the code of the goods, the weight of the goods, the description of the goods, its destination and such) Customs Authority of the Russian Federation use complex risk indicators based on the analysis of big data and the use of AI.

Among such risk indicators: dynamic, semantic, end-to-end and dependent risk indicators:

1. For dynamic risk indicators the parameters may change based on the periodic analysis of data using algorithms. Dynamic risk indicator is a predetermined algorithm that compares characteristics of the object to dynamic, changing set of data.

   For example – the difference between Customs value index declared and weighted average Customs value index across the country or particular region.

2. Semantic risk indicators allow the analysis of information based on its meaning and are oriented towards the validity of the data provided by the participants of foreign economic activities.

   Customs authorities can regulate the accuracy of the search and enter a text fragment into the search system. Semantic risk indicators allow analyzing information, provided by the foreign economic activity participant by comparing it to a reference sample.

   For example a search for a specific license plate of the vehicle (that can incorrectly declared), or a trademark, included in the intellectual property registry (with the use of technologies of comparison, sensitivity threshold and relevancy index).

3. End-to-end risk indicators allow for the examination of data provided during various Customs procedures. For example – during the Customs declaration of goods it allows for the analysis of pre-arrival data and data declared upon arrival. Similarly it allows for comparison between data declared upon departure and data declared in export Customs declaration.

   Customs Authority of Russian Federation use a highly effective end-to-end risk indicator which checks whether or not inspection systems were used in relation to objects of control (declarer of the data, sender, receiver, transport means, goods, containers) during a certain period of time.

115 Submitted in 2022.

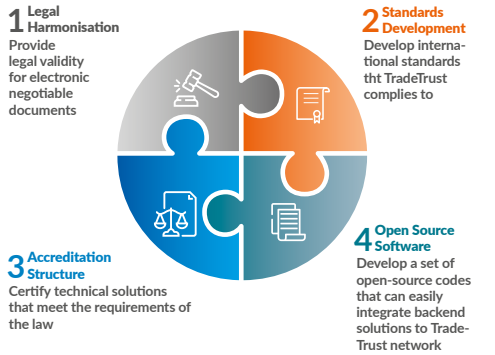
4. Dependent risk indicators function based on the fact that they block the need for certain measures to be undertaken during Customs control process, based on the effectiveness of such measures having been used previously. For example dependent risk indicators can block the use of risk minimization measures if previous use of such measures in relation to same goods was ineffective.

The Centre of Monitoring and Control of FCS of Russia is aiming to develop and implement new mechanisms and innovations that will lead to increased effectiveness of Customs control.

26. Singapore: Use of blockchain technology to accelerate trade digitalization through TradeTrust[116]

Singapore's Infocomm Media Development Authority spearheaded the development of TradeTrust, an interoperability framework which comprises a set of globally accepted standards that enables governments and businesses to utilize public blockchains to ensure that documents issued can be verified in terms of their source and authenticity. It allows electronic trade documents including transferable ones to be verified and exchanged across disparate digital trade platforms and ecosystems. The TradeTrust framework comprises of four key components.

Figure 1: Four key components of TradeTrust



Based on the framework, the underlying technology shall support the two categories of documents used in trade today:

a. **Transferable documents:** Trade documents that entitle the holder to claim the performance of an obligation or ownership (e.g. bills of lading, bills of exchange, etc.). In 2017, The UNCITRAL Model Law on Electronic Transferable Records (MLETR)[117] was introduced to enable legal use of electronic transferable records (ETRs) that are functionally equivalent to transferable documents. The ETRs would need to satisfy the requirements of singularity, exclusive control and integrity. Blockchain technology can be used in the implementation of ETRs. For example, the ERC721 provides a smart contract API used for non-fungible tokens (NFTs) that supports transfers of ownership whilst being able to provide satisfaction of key functional requirements of the MLETR.

b. **Normal documents/Verifiable documents:** Regular trade documents that are non-transferable and do not confer ownership (e.g. invoices, packing list, certificate of origin, etc.). Blockchain and verifiable credentials which utilize cryptography are capable of producing immutable documents with tamper-evident credentials. This allows normal documents to be verified for its authenticity, integrity and provenance which can help to reduce fraud and lead to higher efficiency and cost savings.

116 *Submitted in 2022.*
117 *https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic_transferable_records*

The framework not only enables interoperability across different digital trade platforms and ecosystems but it also allows for documents to still be verifiable between digital and physical forms. Leveraging blockchain's decentralized approach, TradeTrust is able to mirror the decentralized nature of global trade and is designed to be scalable and readily adopted without requiring expensive integration or IT infrastructure upgrades.

Digitalizing trade processes is not only a technology challenge but would also need to consider business needs, standardization and law. To do so, Singapore has adopted the United Nations Commission on International Trade Law's (UNCITRAL) Model Law on Electronic Transferable Records (MLETR) into its legislation, a move that provides electronic trade documents such as electronic bills of lading (eBLs) the same legal standing as their paper-based counterparts. Further to this, Singapore has established partnerships such as Digital Economy Agreements (DEAs) with trading partners, creating common frameworks and rules for digital trade that will enable companies to connect with their partners abroad more seamlessly. Additionally, collaborations with international organizations like the International Chamber of Commerce (ICC) and SWIFT help to assure global players of Singapore's robust and holistic approach to shifting trade from a paper-based system to a digitally enabled one.

Here are some examples of successful TradeTrust pilots conducted under various efforts such as Government to Government collaborations, industry-led pilots and private-public partnerships.

Case Studies on Transferable Documents

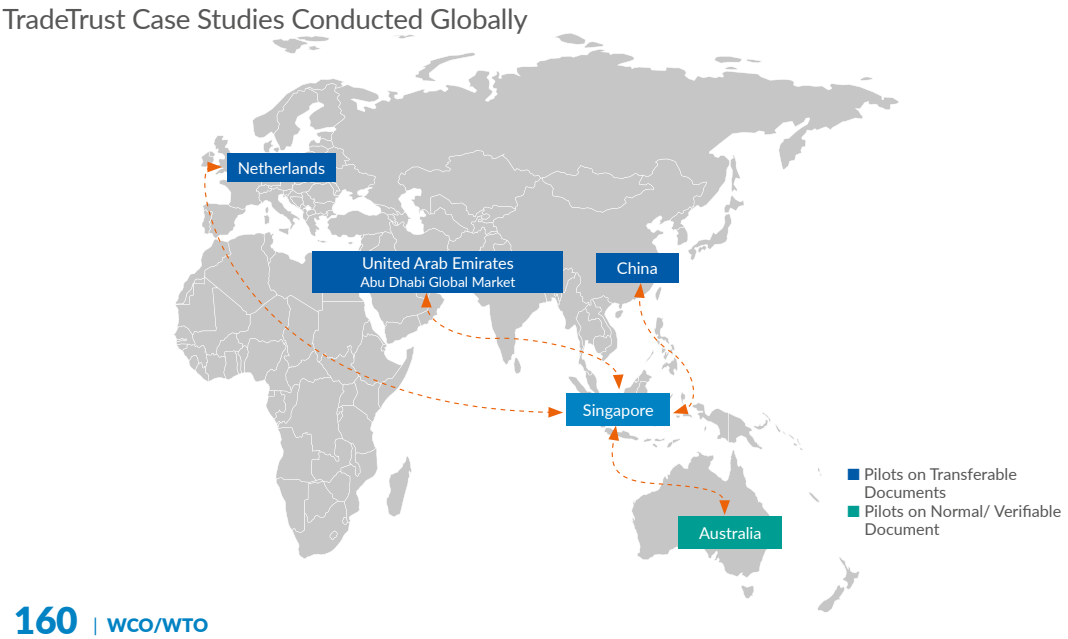
Case Study 1: Singapore-Rotterdam eBL Collaboration

In January 2021, Singapore and Rotterdam, Netherlands, completed a trial using an eBL to shadow a live shipment. This shipment was carried out by Ocean Network Express (ONE) in collaboration with Olam and used two different digital platforms, i.e. #dltledgers' and NaviPorta to perform the title transfer and surrender transactions. Both platforms leveraged the TradeTrust framework as the underlying technology to facilitate these transactions.

Case Study 2: Trade Financing Pilots to Promote Digital Trade between Singapore and China under Singapore – China (Shenzhen) Smart City Initiative (SCI)

Enabled by IMDA's TradeTrust framework, banks, shipping lines, buyers, sellers, platform service providers and fintech companies have collaborated on successful technical pilots on trade financing using simulated electronic Bills of Lading

Figure 2: TradeTrust Case Studies



(eBLs). UOB, together with its Shenzhen Branch in China, and their clients have successfully concluded two digital trade financing technical pilots. DBS Singapore, DBS China and their client have also conducted a third successful technical pilot. The successful pilots conducted in second half of 2021 demonstrated how key maritime trade documents like the eBL could be used across different trade financing platforms and jurisdictions. Businesses between Singapore and Shenzhen can also soon enjoy expeditious cross-border trade financing transactions as the SCI continues to deepen technological cooperation and test policy innovations between both cities.

Case Study 3: World's first digital trade financing pilot between MLETR harmonised jurisdictions, i.e. between Singapore and Abu Dhabi Global Market

IMDA, the Monetary Authority of Singapore (MAS) and the Financial Services Regulatory Authority (FSRA) of Abu Dhabi Global Market (ADGM), in collaboration with commercial partners, DBS Bank, Emirates NBD and Standard Chartered, have successfully concluded the world's first cross-border digital trade financing pilot of its kind. The pilot announced in November 2021 used IMDA's TradeTrust framework to facilitate the transfer of electronic records between jurisdictions that have adopted the UNCITRAL MLETR. This harmonizes the legal recognition of digital documents such as eBLs across both jurisdictions and complements the larger global trade movement by the G7 economies on adopting electronic transferable records in international trade.

Case Study on Normal/Verifiable Document

Case Study 4: Singapore and Australia Blockchain Pilot

The Australian Border Force (ABF), IMDA, and Singapore Customs along with industry participants, have concluded a blockchain pilot which was first launched in November 2020 to prove that trade documents can be issued and verified digitally across two independent systems, reducing cross-border transaction costs. The blockchain pilot was initiated as part of the Singapore-Australia Digital Economy Agreement to make cross-border trade simpler between the two countries. The pilot successfully tested the interoperability of two digital verification systems – the ABF's Intergovernmental Ledger (IGL) and IMDA's TradeTrust Reference Implementation using the certificate of origin (COO) as a first test case.

Both systems used the TradeTrust framework as the foundation to achieving interoperability without all parties having to wait on one another to implement expensive point-to-point nor hub-spoke-type system integrations that are slow to implement and difficult to scale. The decentralized architecture of the systems can also be used on other trade administration documents such as the sanitary and phytosanitary certificates, certificate of non-manipulation and others.

What's next

The successful pilots have created critical milestones towards achieving fully paperless trade and have garnered much interest from both governments and businesses internationally. In 2022, plans are underway to conduct full paperless live transactions where shipments will use eBLs recognised by law in lieu of their paper equivalents.

Concurrently, more pilots with other countries will also be conducted to advance new trade lanes leveraging the TradeTrust framework. Other ongoing efforts to broaden the use of TradeTrust include plans to enhance the current software to connect to more blockchains in addition to the Ethereum blockchain.

The TradeTrust software, which is part of the framework, is freely available under open-source licensing terms so as to make it easier and less costly for the industry to adopt. Singapore sees this as a public good to help practitioners reduce the friction and inefficiencies in cross-border trade. Ultimately, the objective is to scale up the use of the TradeTrust framework so that widespread paperless trade can finally happen thus achieving supply chain transparency, increase in efficiency and the potential unlocking of billions of dollars of cost savings in the long term.

27. Thailand: Use of blockchain technology to enhance Customs and shipping services[118]

Thai Customs Department is in the process of implementing Blockchain technology in Customs procedures for maritime shipment. The Department is working with IBM Thailand Co. and logistics provider AP Moller-Maersk to introduce a digital platform called "TradeLens" to modernize shipping industry in Thailand. This will help support the Thailand 4.0 policy as well.

TradeLens, jointly developed by IBM and Maersk, digitalizes formerly paper-based shipping processes and documentation by adopting Blockchain technology to enable efficient and accurate container tracking and information sharing among platform members. The system is also customized to meet various demands of shipping community since it relies on "Smart Contract" that allows maritime shipping stakeholders e.g. import and export operators, shipping companies, ports, the Customs Department, to jointly and more efficiently manage data and documents relating to transaction such as tracking and verification etc. in an instantaneous manner.

TradeLens facilitates information sharing with document structures that each group of stakeholders are required to provide inputs or update information – an open-standard system for maritime shipment in which all parties can access data on the same platform, resulting in instantaneous and immutable end-to-end data. Additionally, the platform is extremely secure and all data cannot be changed while containers are in transit. In this regard, Blockchain technology is utilized for data integration in logistics industry in order to increase transparency and efficiency of workflow by offering collaborative management viewpoints to all related parties, without omitting personal details and facilitating real-time access to information.

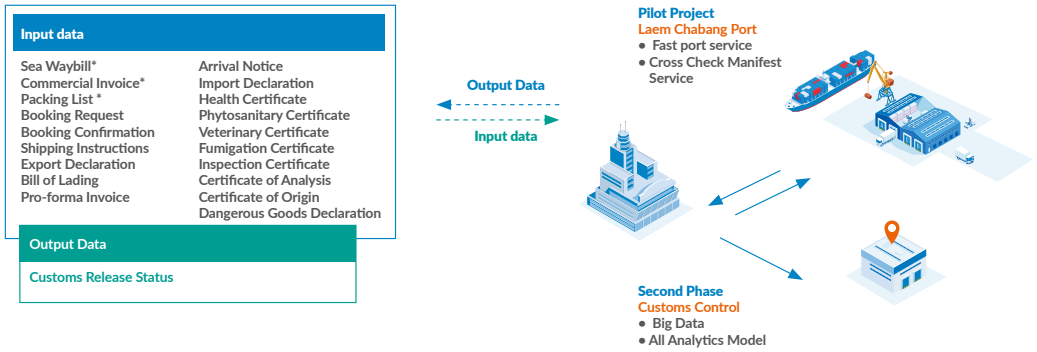
The adoption of TradeLens platform brings about the replacement of many old and time-consuming procedures while enhancing and speeding up shipping operations. The digitalization of maritime trading and documentation through TradeLens provide Thai Customs Department with an automatic and immutable tracking tool in order to track shipping status, verify details of shipping containers as soon as they depart the port of origin or arrive at the destination port, and are delivered to their final destination. As a result, Thai Customs Authorities will have more time to preparing to process the shipment which enables more efficient and thorough inspections for fraud and forgery.

The platform will also lead to a more secure, transparent and efficient Customs workflow. All stakeholders in the global supply chain system will positively benefit from TradeLens since they will be granted rights to promptly access shipping information such as date of receipt, or a particular Customs procedure document. In contrast to the traditional paper-based operations of shipping business, the record of all transactions is now able to share within the network and permissioned parties can access the data real-time through Blockchain technology.

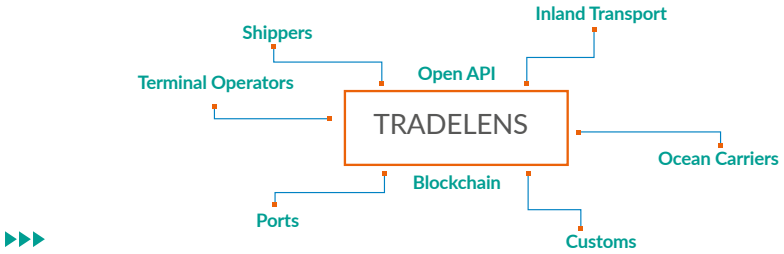
Moreover, TradeLens will help Thai Customs Department to be more efficient in risk management, expedite Customs process and reduce operation costs and also save time for end users. Customs clearance and revenue collection processes will be more consistent and transparent. This will create better customer satisfaction and also enhance the role of Thai Customs Department in promoting national trade and economic stability by facilitating greater ease of doing business.

In the first stage, TradeLens system will be initially implemented at Laem Chabang Port in Chon Buri province as a pilot project and it is expected to be expanded to Bangkok Port in the next phase.

118 Soumis en 2022.



THE APPLICATION OF BLOCKCHAIN TECHNOLOGY TO CUSTOMS PROCESS



Customs Work Process

The role of Thai Customs Department is to verify data and monitor activities throughout the whole shipping route made via pilot shipping ports. Then, Thai Customs Department has to submit information of the containers' clearance status once the containers are no longer in custody of the Customs. During the go-live or the actual launch, information such as container number or date and time of clearance will be analyzed in the computer system of Thai Customs Department and fed into TradeLens system both for imports and exports via maritime shipment.

Thai Customs Department and IBM will collaborate in developing data linkage and data exchange with TradeLens system to ensure that Thai Customs Department can provide data exchange across the systems efficiently, safely, and promptly according to operational standards.

Benefits for Private and Public Sectors

1. increase efficiency of pre-arrival Customs clearance procedures
2. facilitate trade and promote maritime shipping system
3. increase efficiency of risk management
4. build customers' trust and satisfaction
5. save cost and time and create transparency

28. United Arab Emirates: E-commerce (blockchain) [119]

Objective:

To transform Dubai to a world-class e-commerce hub that will benefit Dubai's Economy and e-commerce ecosystems, encourage e-commerce to establish regional headquarters and set up distribution facilitates in Dubai in-order to serve the region. More specifically, the objectives are:

- To identify & certify e-commerce companies;
- Provide 100% visibility to Customs on the e-commerce transactions;
- Regulate goods return by linking trader and Customs system to accept returns;
- Provide benefits to certified e-commerce companies;
- Benefit UAE economy indirectly through promoting e-commerce.

Platform:

Dubai Customs has developed an innovative cross-border e-commerce platform built on blockchain technology. This platform is set to develop the e-commerce trade ecosystem by connecting major e-commerce players like e-commerce companies, logistics companies (3PL, 4PL), courier and government authorities and free zone. The platform is built on the WCO's e-commerce framework, which includes the below principals. It helps develop mutual trust, fair e-commerce market, collaboration, automation and provides benefits to stakeholders, all based on the following principles:

- Advance Electronic Data and Risk Management;
- Facilitation and Simplification of Procedures;
- Measurement and Analysis;
- Partnerships;
- Legislative Frameworks[120].

High-level process:

An e-commerce / logistics company will submit an E-Commerce Order with transport details to the e-commerce platform, which will automatically identify the declaration type and send a Declaration Creation Request to the Declaration system. The Declaration system will send back a clearance message after risk assessment within fraction of time. The Integrated Gate Pass System of respective Free Zones will automatically issue a Gate Pass without any human intervention in case of land movement. To complete the end-to-end process, the last mile delivery company will provide delivery confirmation on the e-commerce platform that will help to initiate the return process, in case the customer wants to return goods or goods are undelivered by the courier company. Claims requests are processed automatically for Refunds and claim system (RNS) without any physical document submission, if goods are moved from a free zone to the Rest of the World (ROW) /Gulf Cooperation Council (GCC) countries.

Benefits[121]:

- Diminished a challenge "End to end real time visibility of the e-commerce order" until it is delivered.
- Solved the "Goods Return" problem by linking e-commerce orders & return orders with Customs declarations.
- Increased efficiency by eliminating declaration preparation time. Paperless and faster transactions.
- Enhanced Transparency, by providing 100% visibility and traceability to all partners on e-commerce transactions.
- Controlling Safety and Security Risks and Increasing Compliance, deters fraud.
- Prevents revenue leakages and improves valuation and HS code classification processes.
- Reduced delivery time (automated declarations, automated returns and refunds, automated low value goods declaration consolidation).
- Validated provenance along the supply chain.

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119 Submitted in 2022.
120 An E-commerce Policy was already released by Dubai Customs.
121 Benefits will be available to companies who will join the platform.

29. United Arab Emirates: Internet of Things[122]

Objective:

Vessel tracking aims to deliver a capability for tracking cargo movement over sea, and therefore helps improve the operational efficiency in risk management and risk mitigation, as well as ensure the overall safety of the society and economy by providing tools to intelligence teams for monitoring suspicious journey routes. It enables profile creation on the go, and helps planning ahead for inspections so as to allow for proper allocation of resources.

Business Process:

- Vessel tracking receives risky declaration and Dubai Customs Risk Engine;
- Present notifications to Control Room Inspection officers on risky transactions;
- Enable officer to start/stop tracking of suspected vessels;
- Allow officer to view associated Risk/Manifest and Declaration details.

Benefits:

- Enhanced inspection performance (inspection process, cargo targeting, data analysis, optimize workforce);
- Preventing revenue leakage through cargo targeting procedure;
- Better risk mitigation;
- High quality data;
- Maintaining the confidentiality of the vessel information;
- Visibility of international marine traffic;
- Preventing illegitimate trade.

Who collects the data and where does it come from?

Dubai Customs integrated Vessel Tracking System uses Marine Traffic (https://www.marinetraffic.com/)" data services to receive the live location of vessels periodically. The Marine Traffic system uses IoT technologies to collect the data transmitted via the AIS (Automatic Identification System). The AIS-Receiving stations that comprise the Marine Traffic network pick-up such data and store in the Marine Traffic central database. In case a vessel is sailing in remote area and its location cannot be received through AIS-Receiving stations then "Marine Traffic" uses Satellite Tracking capabilities to track the position of vessel. Dubai Customs receives the data through an integration mechanisms for the targeted vessels.

122 *Submitted in 2022.*

30. United Arab Emirates: The Federal Customs Authority (FCA) of the UAE is increasingly using the latest technologies such as drones, 3D CT, scanning devices, and virtual robots[123]

The FCA vision is to be a leading Customs administration to improve community protection and trade facilitation. The FCA strove to become one of the first Customs agencies in the world to use the latest technologies to accomplish their vision.

Over the last few years, new technologies such as drones and AI, have increasingly been used by the UAE government for a range of activities such as Customs and security protection. At the Government Summit held in February 2014, the UAE introduced the "Drones for Good" award to encourage the development of drone-related technology. Along with other activities, drones are used in Dubai Customs for surveillance of suspicious activity and inspection of trade vessels in Dubai Creek. Additionally, Dubai Customs has launched a new sophisticated smart inspection device that features 3D CT scanning as part of its ongoing efforts to keep abreast with the latest technologies. The system is used to considerably enhance inspection performance and enables inspection officers to work more efficiently. As a result of the new technology, Dubai Customs inspection officers made 1,628 drug seizures in 2017 compared to 1,347 seizures in 2016.

Another good example is the 'Smart Refund Initiative' that was shortlisted for the final stage of the Hamdan Bin Mohammed Programme for Smart Government Award. The initiative uses robotic process automation technology that requires no human intervention. Not only does the intelligent system eliminate human errors in data entry, but it also reduces the time needed to refund Customs insurance from seven to nine minutes to just one minute. Moreover, the initiative has reduced processing costs by 80% which translated into AED 23.5m in savings. The initiative has helped increase Customs declarations processed to 702,000 between January and September 2017. Dubai Customs also introduced a Virtual Corridor system which has improved the goods transfer process from port-to-port. The initiative coincided with the Smart Transformation Strategy of Dubai Customs and Smart Dubai. It has eliminated site visits, reduced duty deposits and resulted in savings of AED 358 million.

FCA plans to furnish all entry points with the latest and most advanced scanning and inspection devices. This will require mobile and fixed drug and explosives detection devices that will be used to check containers, vehicles, luggage and people. The package will include the 'Ionscan 500DT' which is used by security professionals to detect a wide range of substances and is adaptable as threats and needs change.

FCA will continue implementing the latest practices and innovations to support legitimate trade and enhance Customs controls.

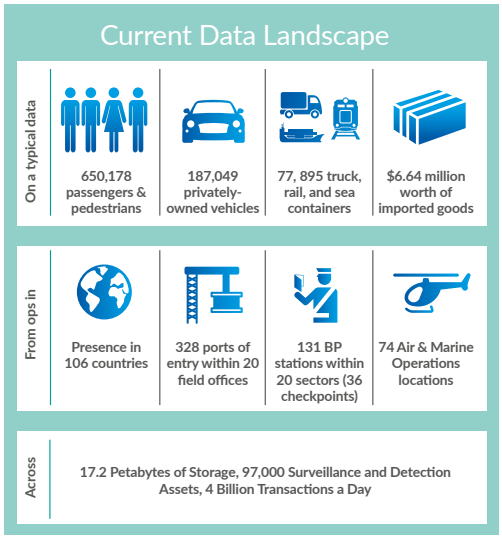
123 *Submitted in 2019.*

31. United States: ENTERPRISING AI @Customs and Border Protection (CBP) AI Center of Innovation (COI)[124]

Every day, the Customs and Border Protection (CBP) captures massive amounts of data from the 650,178 passengers and pedestrians; 187,049 incoming privately owned vehicles; 77,895 truck, rail, and sea containers; and $6.64 million worth of imported goods processed at U.S. ports of entry. CBP's vision is to operate as a data-driven organization where the mission is at the forefront, and we leverage technology to provide real mission outcomes. Artificial Intelligence (AI) capabilities are becoming increasingly important to CBP's mission and ability to effectively respond to emerging threats. It is critical that CBP is positioned to rapidly meet the technical needs of both current and future initiatives with AI solutions that take AI projects from the lab to operations safely and efficiently.

To build on CBP's many successful pilots and individual projects, we are taking a holistic enterprise view that focuses on the intersection of the case studies, data, techniques, people, technology, and culture. A comprehensive understanding of this intersection is essential to driving significant adoption of AI technologies and resources throughout the enterprise. CBP's goal is and always has been to augment the current level of staffing through automation of routine tasks so the workforce can focus on more complex problems (e.g., blocking illicit trafficking, stopping or capturing watch-listed individuals, facilitating mass population migration during a humanitarian crisis).

CBP's experience piloting multiple AI capabilities across mission and support offices made it clear there was a distinct need to enhance CBP's AI maturity and readiness to deploy AI-backed capabilities to production operational case studies. To do so, CBP established the Artificial Intelligence Center of Innovation (COI) in late 2020 to act as the catalyst to create the enterprise processes, tools, and infrastructure needed to rapidly develop, test, and deploy new AI solutions at the speed of the mission.



The enterprise benefits include:

- The ability to rapidly deploy new AI/Machine Learning (ML)-based products and capabilities to meet emerging mission needs.
- The ability to rapidly and effectively train new AI/ML models to meet the operational accuracy standards required by CBP's mission.
- Enterprise preparedness for government-wide and/or agency-wide AI/ML reporting requests.
- Establishment of close partnerships with leading industry providers of AI/ML services, such as data annotation/training.
- Establishment of guidelines for the ethical use of AI/ML capabilities across the enterprise.

To be laser focused, the scope of the AI COI will be limited to a select set of CBP priorities that have been identified as the highest-impact support areas required for driving maturity of AI capabilities across the CBP enterprise. The AI COI's scope can be divided into two primary categories — core services and enterprise responsibilities. Core services will be provided to CBP customer

124 *Submitted in 2022.*

organizations on an as-requested basis to accelerate, enhance, or otherwise benefit AI projects across CBP. Enterprise responsibilities will encompass a limited number of activities that will be centralized within the AI COI to offer a higher degree of enterprise coordination and standardization for AI-related activities.

CORE SERVICES:

DATA COLLECTION AND CURATION: To build and train CBP AI models, data (e.g., imagery, video, text) will be gathered across all available CBP sources managed and organized by the AI COI through a centralized repository to provide access to labeled/annotated data. This will enable CBP customer organizations to rapidly train and deploy AI-based capabilities within their individual organizations.

CAPABILITIES AND PRODUCTS: The AI COI will pilot new cutting-edge capabilities and products that deliver value and mission-effectiveness for CBP. Outcomes of project/product evaluations will be made available to all CBP mission offices and support organizations to reduce potential duplicative efforts and encourage coordinated future procurement decision-making and enterprise scaling.

ENTERPRISE SERVICES:

DATA ARCHITECTURE AND STANDARDS: The AI COI will be built around an AI infrastructure that connects the centralized repository to end users to enable ease of access to annotated data. Data within the repository will follow standards and policies to ensure consistent data quality, data compatibility, and reduced data redundancy with operationally relevant mission data that is compliant with CBP quality and standards.

OUTREACH, COMMUNICATIONS, AND REPORTING: To establish the enterprise AI community that focuses on each part of CBP understanding their criticality to AI adoption and maintaining the enterprise view into the AI portfolio. Outreach, communications and reporting are key accelerants for adoption and expansion of AI at CBP.

ETHICAL STANDARDS AND REVIEWS: To establish operationally relevant enterprise frameworks, methods, tools and practices to evaluate and mitigate risks associated with the use of AI capabilities (e.g., bias, lack of understanding, and commercial company involvement).

CBP's 24/7 mission reaches globally and the quantity, types, size, and distributed locations of data are highly complex. AI is critical to the ability to bring all data to a centralized cloud and to process and train models at the speed of the mission. Through our AI COI efforts, we envision leveraging AI and future advances fully in a safe, secure, and consistent manner that is appropriate to our mission — with our responsibility of ethics and equity at the forefront.

32. United States: Biometrics - the experience of U.S. Customs and Border Protection (CBP) [125]

In the United States, U.S. Customs and Border Protection (CBP), using biometrics and facial comparison technology, is leading efforts to streamline and transform the travel process. Since receiving the mission in 2013, CBP advanced an entry/exit strategy by conducting a series of experiments, which resulted in CBP developing a realistic and achievable biometric exit plan. Through these pilots, CBP determined that facial comparison technology is the best biometric approach because it is unobtrusive and can be performed quickly with a high degree of accuracy. CBP built a facial biometric matching service using biographic Advance Passenger Information System (APIS) manifest data and existing photographs of travellers. This robust cloud-based service leverages the APIS data to create a pre-positioned "gallery" of face images from U.S. Government holdings. The galleries are smaller, more manageable data sets that can be segregated based on flight or cruise. These photographs can come from passport applications, visa applications, or interactions with CBP at a prior border encounter where CBP typically takes a photograph.

A comprehensive entry/exit system that leverages both biographic and biometric data is key to supporting CBP's mission. Adding biometrics provides greater assurance about the information already collected by CBP and will allow for future facilitated processing upon both entry and exit. Biometrics is the key to not only enhancing security and unlocking benefits, but also enhancing the traveller experience. Across all modes of travel, air, sea, and land, CBP's long-term vision for seamless end-to-end travel leverages a traveller's face to streamline identity verification. However, fingerprints remain a foundational aspect of CBP's biometric system. As fingerprints scans have proven to be an effective law enforcement tool, CBP will always continue to capture fingerprints as the initial identification biometric during first-time encounters with travellers.

CBP continues to work with travel industry stakeholders, such as airlines, airport authorities, and cruise lines, to incorporate biometric technology into their business operations and achieve full implementation of biometric exit, despite the COVID-19 pandemic and the resulting impacts to global international travel. This partnership with industry is critical to achieve affordability and ensure that biometric exit does not have a detrimental economic impact on the air travel industry. Stakeholders have attested that using biometrics leads to faster boarding times, enhanced customer service, better use of our staffing, and faster flight clearance times on arrival.

CBP is leveraging advances in technology from the biometric exit solution to transform the entry process by using facial comparison technology. With a faster and more secure clearance process, airports, airlines, and travellers benefit from shorter connection times and standardized arrival procedures. Security is increased by reducing the imposter threat while increasing the integrity of the immigration system. CBP has deployed the use of biometrics for arriving travelers at 205 U.S. airports by upgrading the software application it uses to now include a facial biometric check. CBP was able to manage costs of this new capability, by using existing hardware, including camera technology that has helped to reduce the financial burden for CBP. As of January 18, 2022 CBP has identified 52 imposters at 14 airports.

Similar to the air exit environment, CBP is pursuing public-private partnerships with the cruise line industry and is actively engaged with several cruise lines to utilize facial biometric processing for closed loop cruises with operations at eleven locations. Additionally, CBP is actively piloting capabilities at the land border in both the pedes-

125 Submitted in 2019 and updated in 2022.

trian and vehicle environments to determine the best long-term approach for a comprehensive biometric entry/exit capability. As of January 18, 2022, CBP has identified 1,156 imposters on pedestrian entry using the biometric matching service.

CBP continues to expand the integration and use of biometric checks for commercial truck passengers with the goal of matching images against existing databases to enable CBP officers to efficiently verify the identity of commercial truck occupants to expedite the primary clearance process into the United States. CBP is now working to expand this capability through the use of Radio Frequency Identification Readers, Multi-Energy Portal Drive-Through Imaging Systems, and Advanced Next Generation Radiation Portal Monitors.

CBP is committed to protecting privacy and ensuring the integrity of its matching service. In developing the biometric matching service, CBP implemented a privacy by design approach to ensure that CBP embedded data protection into its use of facial comparison technology. CBP employs four primary safeguards to secure the data to include secure storage, a brief retention period, irreversible biometric templates, and secure encryption during data storage and transfer. CBP has a rigorous process in place to review data and metrics associated with biometric facial comparison matching performance. CBP's biometric matching service utilizes a number of tools to minimize and mitigate potential algorithmic bias to include using diverse training sets and matching against a limited set of faces based on the flight, cruise, or border crossing. CBP will continue to work with its partners and subject matter experts to develop methods to address any performance variations within the system.

33. Zambia: A case of Zambia Revenue Authority Using AI Chatbot (ZAX)[126]

A chatbot is a computer program that simulates human conversation, either via voice or text communication. This simulated conversation with a user happens in natural language through messaging applications, websites, mobile applications or by phone using natural language processing (NLP). It is one of the most advanced expressions of human-machine interaction using AI.

Zambia Revenue Authority (ZRA) uses a chatbot to engage with taxpayers alongside other customer service channels of phone, email, and social media etc. The taxpayer service chatbot (Zax) uses natural language processing to answer basic questions via a business messenger. These may be questions like "What are Customs duty rates?" or "What are the due dates?" etc. The information is pre-captured into the system and the chatbot uses key words to respond to questions. The information on the chatbot is managed by the Customers Support Unit working in collaborations with various divisions to ensure that relevant and updated information is fed into Zax.

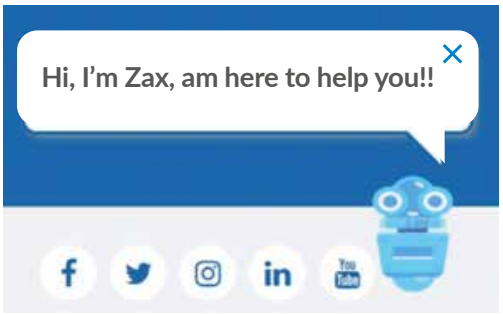
We are now in the age of automation; the rise of AI is already evident in the form of chatbots. These AI-powered interfaces can simulate human conversation and engage with taxpayers. They interact with clients, guide them to the right information and answer queries. As a result, they help ease the workload of taxpayer advisors.

Implementing chatbot technology brings a diverse range of benefits. The taxpayer service experience is smoother and boosts user satisfaction as solutions are provided faster.

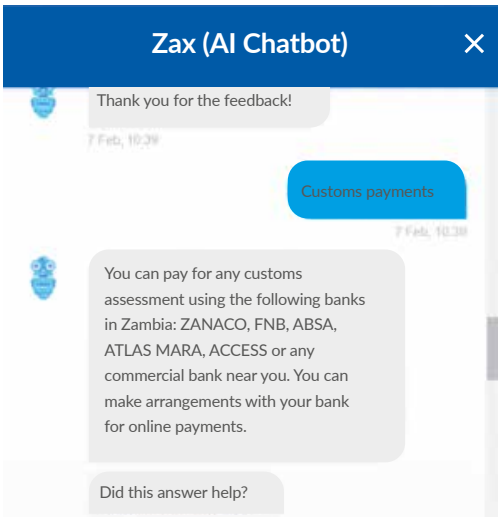
126 *Submitted in 2022.*

The ZRA chatbot (Zax) is able to provide instant advice in the context of a conversation, which is a far more engaging way for taxpayers to seek help with frequently asked questions.

The chatbot and support services were provided by a software company called Engati corporation. The local support services are provided by the ICT department.



Taxpayer advisors are humans and are bound by human limitations. Chatbots are machines. They can work around the clock. They can help 24/7, whenever customers need it, and at their convenience. As for taxpayer advisors, chatbots can ease their workload, freeing them up to focus on other issues.



One of the biggest challenges with using chatbots in taxpayer support comes with interpreting the messages and understanding the user's intention. Programming flexible algorithms for interpreting the intention of the message is a top priority when making a chatbot. However, with advances in artificial intelligence and NLP technologies, sophisticated algorithms such as Google's Bidirectional Encoder Representations from Transformers (BERT) and Multitask Unified Model (MUM) are being developed, capable of understanding sentiment, context and meaning in text, making this human machine conversation interaction even better.

The other challenge is for ZRA to keep abreast with the information needs of the taxpayers and regularly feed Zax with the much needed information. This is achieved through the frequently asked questions that are used to capture relevant information.

34. The Cross-Border Research Association: PEN-CP project[127]

PEN-CP, the Pan-European Network of Customs Practitioners – EU Horizon 2020 funded Customs security practitioner project – acts as a European Customs innovation boosting network, powered by an innovation-centric online platform, and tailored innovation intermediary services. The project consortium consists of 13 Customs administrations - nine EU and four non-EU - supported by four research and administration partners. PEN-CP focuses on accelerating innovation efforts across three core Customs technical areas: Data and risk management; Detection technologies; and Laboratory equipment – both stand-alone, as well as in combinations. We have a broad variety of innovation and knowledge instruments in use, including Prototype grants, Challenge competitions, Innovation awards, Annual studies and Expert reports. Across our activities, we aim to connect innovation-spirited Customs officers, helping them to 'find friends in Customs innovation'. The vision is to become a solid & permanent Customs innovation boosting network, helping to accelerate both incremental and radical innovations, for the direct benefit of Customs administrations in Europe and beyond.

I. PEN-CP SET-UP & FEW FUNDAMENTS

PEN-CP is an EU Horizon 2020 funded Customs practitioner network, which kicked off in August 2018, and, with the current mandate, will finish in 2024. PEN-CP Customs partners include administrations from the following 13 countries: Albania, Austria, Belgium, Estonia, Hungary, Ireland, Latvia, Lithuania, the Netherlands, North Macedonia, Norway, Slovak Republic, and United Kingdom (UK Border Force as the official PEN-CP partner). Next to these, PEN-CP has another four partners for research and administrative purposes: TU Delft, the Netherlands; University of Lausanne, Switzerland; ARTTIC, France; and CBRA, Switzerland (the project administrative coordinator & the innovation intermediary -secretariat).

An element in the heart of our project is called POP, the PEN-CP Online Platform. The content and features on POP-platform are manyfold, to support achieving the ambitious Customs innovation boosting goals of the project. First, customs user needs and requirements regarding new innovations, across the three main technical areas, and sometimes even beyond, are collected and stored as PUNIs, PEN-CP User Need Ideas (around 65 entries in total, status March 2022). If you are interested to learn about our PUNIs, in particular about the ones which are already lined up for follow-up innovation boosting activities in PEN-CP, please feel free to contact us by email: pen-cp@cross-border.org

Second, PSIMs, PEN-CP Security Innovation Monitoring items, keep track of a broad variety of Customs relevant innovations, solutions, projects and patents (near 450 entries in total, growing steadily).

Third, following priorities and requests by PEN-CP partners, the PUNI-PSIMs matchmaking takes place by a team of 2-4 experts, first picking a specific high-priority PUNI, and then searching for all possible PSIM matches, including solutions, projects and patents.

Fourth, the POP-platform has a couple of sections covering more generic information needs of our partners, namely the PEN-CP Information Observatory, PIO, focusing on Customs relevant news, events, reports, research papers etc. (over 300 entries total, March 2022); as well as data on relevant companies, research institutes etc. (near 450 entries); the PEN-CP Archive for all kinds of project document and files; and a set of event management pages, covering the full life-cycles of PEN-CP Annual Events – from event announcements, registrations and agenda updates; to sharing pre-readings materials, individual presentations and final (post-event) handouts.

127 *Submitted in 2022.*

Fifth, the three PEN-CP Expert Teams, PETs, have their dedicated workspaces in POP-platform for document and workflow management, as does the PEN-CP Extended Management Team, PEMAT, as it is called in short. Without a surprise, such team-level sections on POP-platform increase the efficiency and quality of the innovation boosting and project administration work carried out by the PET and PEMAT teams.

Regarding monitoring, dissemination, outreach and interaction with the outside world, PEN-CP has opted for an active approach in social media and other online channels. We benefit strongly from the likes of Twitter, LinkedIn and Facebook for example when announcing new calls for Expert Reports, Challenge Competitions or Prototype Grants, and when disseminating information about finalized studies and reports.

We have published so far 11 issues of the PEN-CP Magazine, our flagship dissemination instrument, with a wide reader base, both inside and outside the PEN-CP consortium. PEN-CP Magazine articles cover a broad variety of topics as interviews, announcements, technical readings, concept descriptions, visions, and more. You can find all past issues for downloading here: https://www.pen-cp.net/download-pen-cp-magazine .

II. PEN-CP IN FULL ACTION DURING YEARS 2018-2021

The three technical Customs themes have played a central role in PEN-CP, from day one of our project; and below, we introduce the corresponding PEN-CP Expert Teams, the PETs, as we call them

- PET-1 Data and risks (6 active members from 5 different administrations, status March 2022)
- PET-2 Detection technologies (6 active members from 6 administrations)
- PET-3 Laboratory equipment (5 active members from 5 administrations)

Each PET-team is chaired by a seasoned technical expert from PEN-CP Customs partners, while secretarial support is provided by PEN-CP research and administrative partners.

The overall PET-menu includes the following innovation facilitation and boosting activities:

- Collecting, iterating, elaborating and fine-tuning on Customs User needs and Challenges, the PUNIs; aiming to the adequate degree of detail and clarity so that next-step innovation boosting actions can be successfully triggered.
- Matchmaking between prioritized PUNIs versus Security Innovation Monitoring items, the PSIMs; aiming to discover any existing technologies, solutions and projects which might be of instant use/ benefit for Customs.
- In the context of high-priority PUNIs, without "instant solutions on the markets": iterating and allocating one or more PEN-CP Innovation Instruments, the PINs, in order to start tackling the Customs challenge/ PUNI on hand; could trigger follow-up action such as Expert report, Crowdsourcing ideas, Challenge competition, or Prototype grants.
- Identifying Customs needs and priorities for technical or process standardization, and formulating such topics to be part of the PEN-CP Standardization roadmap (note: actual standards development is out-of-scope for PEN-CP)
- Preparing and proposing specific discussion points and messages, PEN-CP Briefings, towards a variety of key stakeholders, including the following: DG TAXUD, DG HOME, DG REFORM, CELBET, CLEN, WCO, Horizon Europe program, and parallel Customs-relevant Research and Innovation projects and networks.

Thanks to the activeness of numerous experts in PEN-CP, both within and outside the PET-teams, we can next share examples on completed and on-going knowledge creation and innovation boosting and influencing actions, focusing on following six PEN-CP instruments and key components: Innovation Awards and Prizes, Expert Reports, Annual Studies, Training Materials, Standardization Roadmap and Customs Voice.

The purpose of the PEN-CP Innovation Awards and Prizes is to bring in limelight the most innovative solutions and, to some extent, solution ideas, in the context of a broad variety of challenges contemporary Customs administrations are facing. During years 2019 to 2021, we have executed three sets of Customs Innovation Award calls, all with somewhat different scopes, submission formats, and scoring criteria.

For example, in 2019, we introduced a broad innovation award scope, named as "Improvements

in existing solutions and technologies, and introduction of new solutions and technologies; improvements in existing processes, as well as introduction of new processes (PCIA-2019)", attracting seven submissions by different PEN-CP partner administrations. Then, following the voting performed during PEN-CP Year-1 event in Budapest, the submission by UK Border Force on "Using a human security radar screening passengers on the move" was selected as the winner (all PCIA-2019 submissions can be checked in PEN-CP Magazine 11, pages 19-29).

For the third awards, in 2021, we invited the global Customs community to join our Customs Innovation Award action under following thematic: "Actions and ideas from Customs that demonstrate innovative approaches to data quality; with two tracks: one for tested solutions and other for novel ideas (GCIA-2021)". The winners of the GCIA-2021 will be announced during spring 2022.

While we still plan to run a few "Customs only Innovation Awards" from 2022 onwards, our main focus will shift next towards "PEN-CP Innovation Prizes", where the winners will come from the external innovator communities, including start-ups and scale-ups; small, medium and large companies; research organizations and Universities etc. More information is coming by summer 2022 – please stay tuned for the updates!

The purpose of PEN-CP Expert Reports is to fill knowledge gaps among our Customs practitioner network, either (i) per stand-alone information needs or (ii) as step-1 action in an (anticipated) longer chain of knowledge creation and innovation boosting actions. Between years 2019 and 2021, the following five Expert Reports were triggered by PEN-CP partners and completed by the selected external experts; and, it is important to note that all reports listed below have a variety of follow-up actions attached to them, either already implemented or at least outlined:

- "Mapping of European start-up/scale-up landscape (ER1)";
- "Future of Customs communication toolboxes: useful features and user experiences (as two reports, ER2&ER3)";
- "Review of databases on laboratory techniques and methods for the analysis of new materials or products (ER4)";
- "Mapping national innovation calls in three EU Countries: Sweden, Germany and Spain (ER5)".

Annual Studies are the flagship knowledge creation instruments in PEN-CP, and so far, we have produced and published two of them. The first study "Enhancing Customs Risk Management with External Data" explores the data landscapes of today's Customs world, arguing that external data can enrich actual declaration data, providing additional data elements for Customs to verify and base risk assessment on. The second study, "Customs Innovations for Fighting Fraud and Trafficking in Cross-border Parcel Flows", showcases Customs innovations tackling the challenges of cross-border parcel controls, from around the world.

According to the PEN-CP internal procedures, the detailed scope, priorities and research questions for each study are discussed and agreed by the PEN-CP partners, before the full launch of a new study. At the moment, we are either working on, or about to launch, following four studies, with several Customs experts in PEN-CP as co-authors, study panel members etc.:

- "Estimating the size of illicit markets — techniques and examples for collecting evidence on the volume and value of illegal trade" (this is already 75% completed, missing the examples/ mini-cases section)
- "Set of past EU-funded research and innovation projects (from 2005 till 2020): assessing benefits for the Customs community, with evidence of upscaling and uptake of project outcomes" (on-going study)
- "Green Customs — a conceptual framework and examples of initiatives from around the world" (recently launched)
- "Smarter borders through clever innovations – blueprint/ roadmap study" (detailed scoping still to take place, planned for our Year-3 event in April 2022).

As we all are aware, training and developing personnel is essential to the future success of Customs administrations, in Europe and beyond – thus production and trials in innovative training materials fall into the mandate of PEN-CP. The first two PEN-CP training modules under production are:

- "Seal inspection training images and videos", and
- "Comparison of X-ray images against Customs declaration information".

In addition, as of April 2022, we will have over 50 hours of self-learning content in "Customs data analyst" e-learning course, ready for pilot learners to study and test; materials strongly reflecting the actual research and experimenting outcomes of the 3.5 year long EU Horizon 2020 project PROFILE (which just finished, at the end of February 2022).

The PEN-CP Standardization roadmap paves the way for future standardization ambitions and activities within the broader Customs domain, including but not limited to Customs Data analytics, Detection technologies, and Laboratory equipment, i.e. the three technical themes of PEN-CP.

The final PEN-CP activity area presented from years 2018-21 is called Customs Voice, where the purpose is to influence various policy and business stakeholders and communities, to the direction PEN-CP Customs partners find it beneficial. Below we share examples of three types of PEN-CP consultations, where either full implementation cycles or at least concrete preparatory steps have already taken place:

- Feeding high priority user needs/ PEN-CP PUNIs to Horizon Europe and other Customs relevant Research-Development-Innovation funding programs – a pro-active consultation cycle was first introduced during summer 2019, and, it has continued with regular feeds of draft ideas and topics into future Work Programs.
- Submitting statements and suggestions in the frame of Customs-relevant EU policies, roadmaps, directives and the likes – PEN-CP has contributed for example during the EU Critical infrastructure protection - open consultation (spring 2021).
- Sending common messages to and interacting with specific Customs-relevant industry sectors – preparatory steps have taken place in the frame of Raman manufacturers, and first internal discussions are currently taking place regarding seals manufacturers.

PEN-CP plans to continue with Customs Voice activities every now and then in the future, based on topics and opportunities the Customs partners find of importance to them.

III. KEY AMBITIONS & ACTIVITIES FROM YEAR 2022 ONWARDS

PEN-CP plans to continue implementing the Customs knowledge and innovation boosting activities presented and discussed so far, also from year 2022 onwards, as part of our Horizon 2020 contract and work plan – prioritizing activities where Customs partners see the biggest potential use and benefit for them. As mentioned earlier, PEN-CP has multiple advanced innovation instruments in hand, specifically the four listed below:

- Prototype grant;
- Challenge competition;
- PEN-Hackathon;
- PEN-Tournament.

Proactive outreach towards various research and innovator communities is gaining increasing priority and momentum in PEN-CP work, for the coming months and years. One of our intentions is to increase the awareness and knowledge of external innovators about Customs business, concrete challenges, and practical constraints; in order to increase their interest to research, develop and supply innovative technologies and solutions for Customs use in the future. During this process, we could also run few 'Crowdsourcing ideas' exercises: collecting out-of-the-box ideas from forward-thinking innovators. Then, we intend to take multiple steps to achieve our long-term goal of 'PEN-CP supporting Customs officers across Europe to form contacts and stay in touch with research and academic communities'. Examples of concrete activities we plan to execute in the future include the following:

- Bringing innovative start-up and scale-up communities closer to the 'Customs world'.
- Scouting for ideas on innovative technologies and solutions from specific industry sectors.
- "Customs as an exciting scientific and engineering discipline" – promotional videos and other materials targeted for University Professors, (future) PhD students etc.

"Sharing is caring" lies in the heart of PEN-CP philosophies, no question on that. Sharing information about Customs challenges and user needs (PUNIs); about solutions available in the markets

(PSIMs); about promising innovations already in use by Customs (Customs Innovation Awards); and many more topics and items has become the business-as-usual for PEN-CP, during the past three years. At the same time, systematic sharing of certain types of Customs knowledge and wisdom still remains to be initiated; and, based on the outcomes of the PEN-CP Exploitation plan survey (round-1 during summer 2021), moving forward we are opting to invest efforts in sharing & caring across the following areas:

- Sharing technical test sheets/ test data;
- Sharing information on actual user experiences;
- Sharing solution ideas;
- Resource pooling.

The key principles PEN-CP is committed to follow include 'Collaborative and Complementary' – within such a frame, we share next few views on our plans to 'scale-up the tangible collaboration with multiple key stakeholders', naturally aiming towards 'two-way benefits' between the other parties and PEN-CP:

- EC DG TAXUD is our key stakeholder already from the times before PEN-CP proposal was submitted and accepted. We are very grateful for the continuous communications and support with TAXUD officers. Moving to the future, additional collaboration opportunities may emerge particularly in the frame of the CCEI implementation (Customs Control Equipment Instrument).
- Regarding EU Customs expert groups and networks, PEN-CP welcomes collaborative activities particularly with CELBET (Customs Eastern and South-Eastern Land Border Expert Group) and CLEN (Customs Laboratories European Network): co-defining objectives and scopes for example for Prototype Grant and Challenge Competition calls could become one fruitful way of working together.
- Defacto birthplace and home for the European security practitioner networks, EC DG HOME, with the Community for European Research and Innovation for Security, CERIS, has been and will be our closest partner across a variety of current and future Customs, border management and supply chain security research and innovation activities in Europe – including identifying and iterating high priority Customs topics for new Horizon Europe calls.
- Since the last 1-2 years, PEN-CP has had the pleasure to interact also with EC DG REFORM – and, we keep welcoming opportunities that the Technical Support Instrument managed by DG REFORM would provide to best advance with the Customs innovation agendas across Europe.

PEN-CP looks also forward to further knowledge creation and innovation boosting activities with the World Customs Organization, WCO. From the PEN-CP coordinator side, we would also like the opportunity to thank WCO for the exact 20 years of Customs research and capacity building collaboration: it was in April 2002 when our first meeting about the WCO Customs Data Model study took place at WCO premises in Brussels.

For more information on PEN-CP, please visit: www.pen-cp.net ; or email to pen-cp@cross-border.org

35. The Cross-Border Research Association: PROFILE project – Improving Customs Risk Management through Novel Data Analytics and New Data Sources[128]

PROFILE is a recently completed research and innovation project in Customs risk management, funded under the EU's Horizon 2020 program. The project involved 14 partners from eight countries across Europe: five Customs administrations (Belgium, the Netherlands, Sweden, Norway and Estonia), and nine well-known technology providers, research institutes and universities. The 3.5-year long project was coordinated by the Swiss-based research institute Cross-border Research Association.

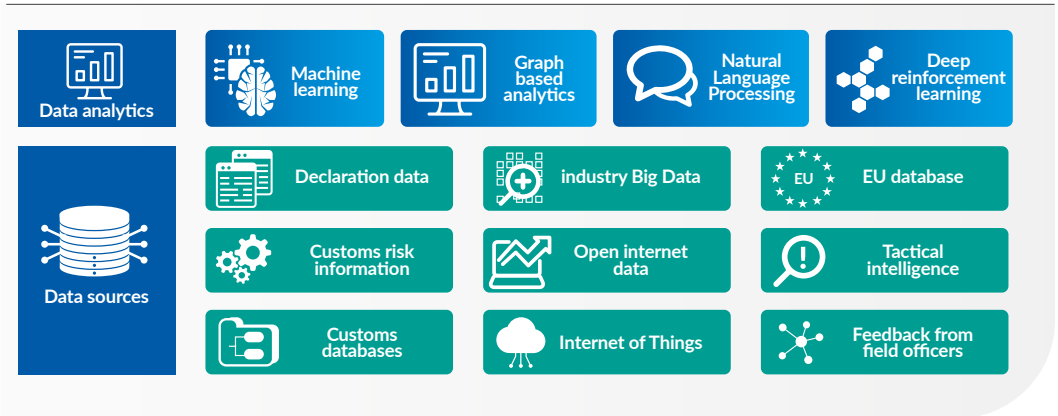
The PROFILE vision, dating back to year 2017, builds on machine learning, natural language processing, and graph-based modeling techniques, with the aim to enable Customs administrations to collect and organize unstructured data; to mine and visualize large datasets; and, to make better use of control feedback and inspection outcomes. Key layer in the PROFILE vision is to trial out and make use of a variety of data sources – both more traditional Customs datasets, as well as more novel external datasets.

By the end of the project, PROFILE succeeded to deliver tools, techniques, and strategies for our Customs partners to improve data-driven Customs risk management. Examples of PROFILE innovation outcomes are grouped and briefly presented next, under the "three PROFILE legacy pillars".

Pillar I — Data analytics & data sources

Innovations of the first pillar include a Customs information portal that helps Customs to compare the declared value of imported e-commerce goods against prices of similar goods sold online. The first pillar innovations also encompass techniques for exploiting data from e-Commerce platforms for Customs risk assessment purposes. PROFILE also developed a process for using documents and data from the TradeLens industry platform to monitor trade – case Dutch-based tire importer. In addition, PROFILE developed and tested an interactive user interface for visual data analytics; a deep learning model with su-

Figure. PROFILE framework for researching and exploiting data analytics and data sources towards better Customs risk management



128 *Submitted in 2019 and updated in 2022.*

pervised and unsupervised learning capabilities; an autoencoder model for the detection of outliers and anomalies in Customs declarations; and Natural Language Processing and Random Forest techniques for the validation of declared commodity codes.

The second aspect of PROFILE Pillar I is the variety of data sources that can be made available for Customs. Data, as we know it, is the number one commodity of digital Customs and the key enabler of risk-based Customs controls. PROFILE research made use of various Customs datasets, in particular Entry Summary Declarations (ENS), import declarations, and control feedback. For example, the Belgian Customs provided around 8 million Single Administrative Documents (SADs) and some associated control feedback records; and, Dutch Customs made available around 1.5 million ENS and some related control feedback records, all for the benefit of PROFILE research activities.

Besides these Customs datasets, PROFILE explored the potential of external data for Customs risk management. By PROFILE definition, external data is any information lies outside Customs systems and that is not readily available for Customs. External data come from a large number of sources, for example third party data sharing platforms, data analytics and service providers, and open internet.

PROFILE acquired access to several data sources that contained information for example about EU-bound containers (INTTRA), container ships (eeSea) and about traders & importers (Dun&Bradstreet and Orbis). Several concrete results were achieved during this research, including these two highly relevant ones:

- **INTTRA:** from the same time period and the same geographical scope, PROFILE research team managed to complement thousands of ENS messages with commodity code data, using the INTTRA shipping instructions dataset. In concrete terms – and, of course in this specific research context – we were able to find complementary commodity codes for approximately 6% of ENS records.
- **Dun&Bradstreet and Orbis:** our case study focused on the ownership information, checking if companies with poor records of Customs compliance happen to have the same ownership base. For instance, the researchers identified two seemingly unrelated companies with poor track records, which were in fact owned by the same entities; this turning out to be a novel information for concerned targeting officers.

Pillar II — Architectures & semantic technologies

PROFILE Pillar II innovation outcomes include: semantic data modelling and graph analytics for Customs risks; data linking between Customs

Table. External data sources explored during PROFILE research

External data source	Description
INTTRA	Data on global sea container logistics: container bookings, shipping instructions and container tracking events
TradeLens	An industry platform where supply chain parties can share digital datasets such as commercial invoices, packing lists, Bills of Lading and sea waybills
eeSea	Data on liner networks, port-to-port transit times, vessel schedules, vessel forecasts, vessel on-time reliability, ports and terminals
Dun&Bradstreet	Verified information on business entities worldwide: contact details, sectors of activity, size, legal status, financials, corporate linkages, and various risk scores
Post*Code database of the Universal Postal Union (UPU)	Postcodes and addressing data at town, locality, street, and delivery-point levels on 192 countries
Bureau International des Containers (BIC)	Reference databases of shipping containers, container owners, depot locations and operators, and more.
"29 country databases" (accessed via Datasur)	A tool for querying & exploring publicly available detailed data on national import and export flows

data sources and external data; new and improved practices for cleansing data for Customs risk assessment purposes; a new risk model and process for enriching Entry Summary Declarations; a process for comparing exports and imports between an EU and non-EU country; and, a novel machine learning pre-processing procedure tailored to Customs data. Here are some key findings and recommendations regarding the second pillar:

- For data linking of Customs data and external business data, it is recommended to use a semantic model. The FEDeRATED model, under development in an EU project for digital co-operation in logistics, provides a useful grounds for data linking, including for Customs purposes.
- For applying the semantic model, it is necessary to: complement the node with a semantic adapter; investigate the governance; develop a roadmap for adoption of semantic architecture; and, address the issue of distributed data management.
- It is recommended to extend EU Customs Data Model and UN/CEFACT and make links to ontologies, including links also to the above-mentioned FEDeRATED model: having ontologies aligned with each other will enable smooth data transformations in the future.

Pillar III — Management of data analytics departments

Under the third pillar, PROFILE developed two evaluation frameworks that capture key concepts, requirements and evaluation approaches on how Customs can make better use of data and data analytics. The first one is "the Evaluation framework for data analytics in risk management", which shows how Customs should combine Customs-specific expertise with data analytics competence at the management and operational levels. "The PROFILE data analytics value analysis framework" provides insights for Customs that seek to incorporate data analytics into their risk management processes and to evaluate the value that data analytics could bring to their operations. Derived from these two frameworks, and other PROFILE outcomes particularly under Pillar III, following two recommendations can be made:

- From the operational perspective, a recommendation for Customs management is to encourage close collaboration between data scientists, Customs officers with specific domain knowledge and IT people.
- From the research standpoint, a recommendation is to conduct research in an environment closely connected to the operational Customs processes and to collaborate among Customs administrations to gather sufficient amounts of data for the development of reliable analytics.

In addition, PROFILE strongly proves that there is also a need for clear legislative guidelines for data sharing, protocols for accessing and using data, and for a secure data sharing environment.

Conclusions and way forward

PROFILE innovation outcomes represent a wide range of useful solutions that Customs can exploit to improve risk assessment. These innovations comprise technical algorithms and software, visualization tools, strategies for cooperation, techniques for data management, and conceptual frameworks, all tested in practice. Besides concrete innovations, PROFILE discovered also valuable lessons on approaches that do not easily work for Customs that wish to become more data-driven organizations. Critical success factors include close cooperation between Customs and technical experts, meticulous data preparation, and proactive tackling of any issues hindering the joint efforts by Customs, technical partners, and suppliers of external data. Last but not least, capacity building, with innovative, well-structured Customs data analyst training materials is a key, when moving forward on the digital Customs journey.

More information www.profile-project.eu ; profile@cross-border.org

Project partners
Belgian Customs and Excises Administration
Dutch Customs Administration
Estonian Customs Administration
Norwegian Customs Administration
Swedish Customs Administration
Netherlands Organization for Applied Scientific Research (TNO)
Norwegian Defence Research Establishment (FFI)
Swedish Defence Research Agency (FOI)
Joint Research Centre, EU (JRC)
INLECOM Systems Ltd, United Kingdom
IBM Ireland Ltd, Ireland
Delft University of Technology, Netherlands (TUD)
University of Lausanne, Switzerland
Cross-border Research Association, Switzerland (CBRA)

36. FIATA : The FIATA electronic Bill of Lading (eFBL) – Bringing trust and security through digitalization[129]

The International Federation of Freight-Forwarders Associations (FIATA) launched its new digital strategy in June 2020, aiming to facilitate the exchange of data between freight-forwarders and their stakeholders within the supply chain. One of the first focus of FIATA's digital strategy was the digitalization of its Negotiable FIATA Multimodal Transport Bill of Lading (FBL), the only negotiable multimodal standard bill of lading, in conformity with the UNCTAD/ICC Rules for Multimodal Transport Documents.

Taking a collaborative and inclusive approach, FIATA, together with representatives from its members, experts from different international organizations and representatives from software providers, initiated its eFBL project in summer 2020. The key objectives of this initiative were to provide an easy access for freight-forwarders to the digital version of the FBL as well as to reinforce the security and trust around the document, by strengthening the compliance control over the companies issuing the document and digitally protect the document against fraud risks.

The solution, which will benefit the whole industry, allows freight forwarders to issue secured and authenticated eFBL through Transport Management System (TMSs) and other software, already part of their daily processes, while allowing stakeholders, including Customs authorities, to verify at any time the validity of the document, the identity of its issuer, as well as the integrity of its content. Each document will be registered by FIATA on a private immutable ledger and will therefore be traceable through its audit trail.

The eFBL will reduce the risks of fraud as all freight-forwarders issuing eFBL will have to go through a Know-Your-Customer process and will be authenticated as valid freight-forwarding companies with a valid liability insurance, as per the FIATA Bill of Lading Terms & Conditions. All document issuers will require a FIATA Digital Identity as a pre-requisite to issue eFBLs, their profile will be used to identify them, when issuing the document.

Stakeholders, including Customs Authorities, will have the possibility to access at any time the eFBL audit trail, through the QR code stamped on the document or by uploading the electronic document on FIATA's dedicated verification page. They will be able to verify that the document received is a valid document, registered by FIATA, which was issued by a valid company (registered company with a valid liability insurance) and to ensure the document hasn't been modified or tempered with.

The eFBL technical specifications are available as open source for all software providers, it includes the eFBL data standards, aligned with the UN/CEFACT Multi Modal Transport (MMT) Reference data model to facilitate its interoperability, as well as a dedicated API service, allowing software providers to connect to FIATA services to issue secured and authenticated eFBLs.

The eFBL is a pragmatic solution which is meant to evolve together with the legal status of digital documents. The document can be issued/shared as a printed document, as a PDF and eventually as pure data.

The technical and operational feasibility of the eFBL solution were confirmed through a seven months Proof of Concept, involving 19 freight-forwarding companies and seven software providers (AKANEA, Bolero, eCustoms, eDox Online, CargoX, Cargowise, TradeWindow) which took place in spring 2021. The official launch of the solution is planned for February 2022.

For more information please visit FIATA's website: https://fiata.org/what-we-do/digitalization/projects.html Contact: digital@fiata.org

129 Submitted in 2022.

Figure 1: Process to issue and verify eFBLs:

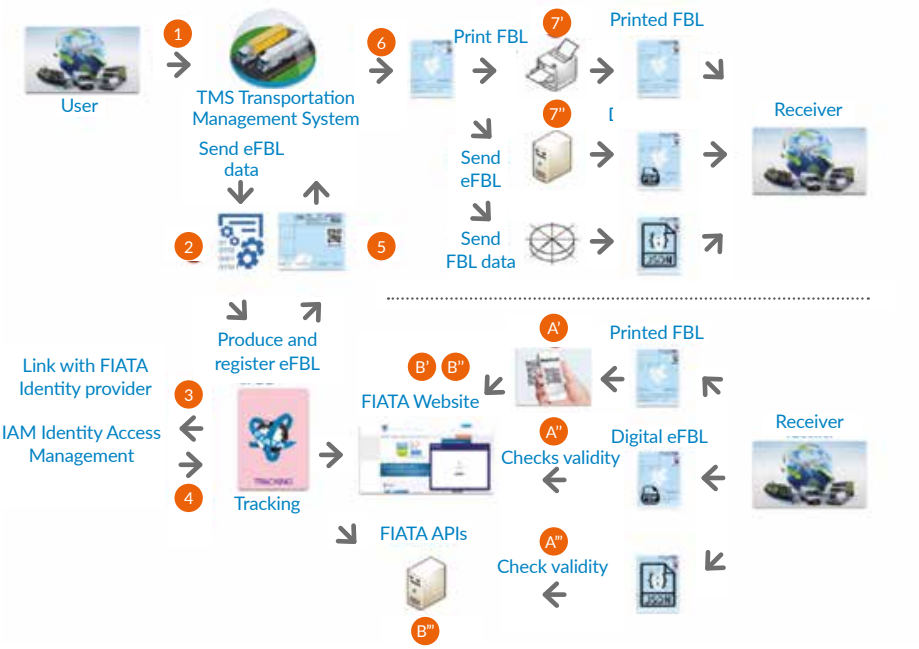
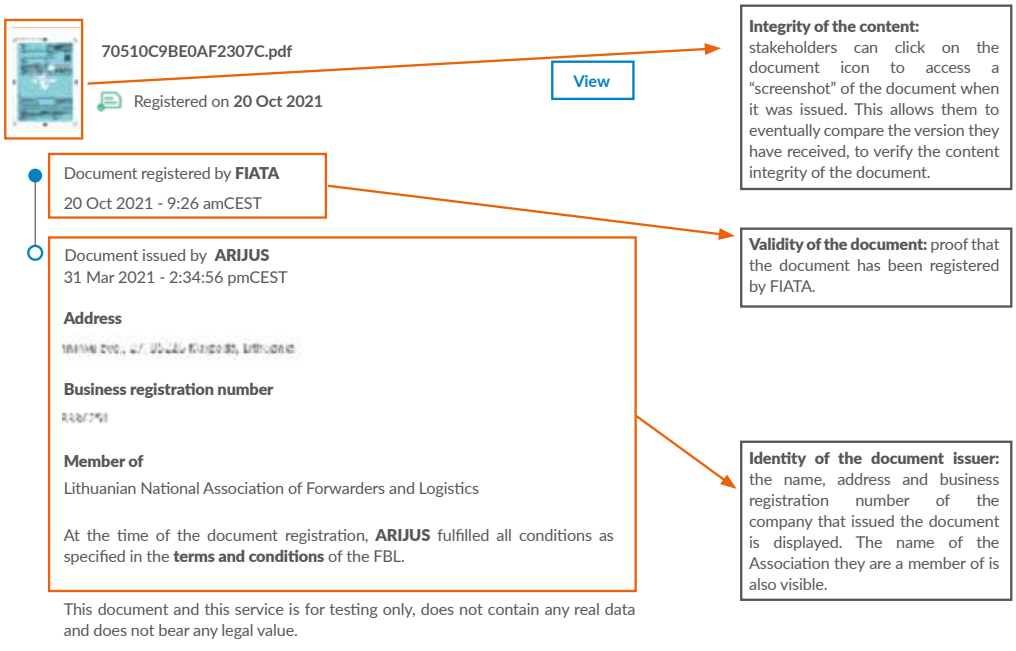


Figure 2: eFBLs document audit trail, accessible to all stakeholders interacting with the document



37. GeTS Asia Pte Ltd : Using AI for HS codes and Customs compliance - Binal and Calista[130]

BINAL, an international logistics systems provider headquartered in Japan, was looking out for partners with solutions to complement its Terminal Oriented Support System (TOSS) in order to provide a more comprehensive and integrated solution for their customers.

The solution came in the form of CALISTA intelligent advisory (CIA), an AI-powered platform designed to accurately identify HS codes and provide associated Customs compliance advisory for over 180 countries, as well as ensure minimal landed costs and Customs duties/taxes for exportation. This greatly reduces time and manpower spent on manually searching for accurate HS codes for different types of goods, calculating duties and taxes, and keeping up to date with changing cross-border trade requirements.

Through machine learning, CIA adds value to BINAL's TOSS System by providing its customers with preferential duty/tax information, Customs control information and guidance in leveraging Free Trade Agreements (FTAs) when preparing trade documents in TOSS System.

CIA is equipped with API integration which allows for easy setup and configuration. This greatly reduces the time spent and minimizes technical bugs that may arise during the system integration.

Through system integration with CIA, BINAL's customers can now seamlessly search for HS/tariff code and relevant trade compliance regulations when they are preparing their trade documents on the TOSS system.

CALISTA, enables the orchestration of logistics, compliance and financial requirements of trade and supply chain seamlessly, smartly and securely. With linkages to more than 60 Customs nodes, 90 ocean carriers and NVOCCs, 50 ports, 10,000 freight forwarders and access to trade advisory in over 180 countries, CALISTA processes more than 40 million transactions annually. Using CALISTA, stakeholders can benefit from streamlined trade and supply chain processes, optimal data reuse, connectivity across multiple Customs nodes, improved authenticity of data flow and access to accurate and up-to-date status visibility.

130 Submitted in 2022.

38. Inter-American Development Bank: IDB supports Latin America and Caribbean countries in the CADENA and LACCHAIN projects (blockchain) .[131]

CADENA

CADENA is an application based on blockchain technology that helps to facilitate and secure international trade through the efficient exchange of data between Customs administrations and, potentially, between other government entities and the private sector. CADENA´s design and implementation was funded by the Inter-American Development Bank (IDB) through an inclusive co-creation proves with eight Customs administrations (Chile, Colombia, Peru, Mexico, Costa Rica, Ecuador, Bolivia, and Guatemala). As of August 2021, CADENA is fully operational, and Customs administrations are validating its functionalities with real data for the next two months.

In general, CADENA provides three general benefits:

1. Improves the operational implementation of binational or multilateral Mutual Recognition Arrangements (MRAs).
2. Improves the management of AEO programmes.
3. Contributes to strengthening the security of supply chains by ensuring that AEO information with regard to certifications, suspensions, and cancellations executed by a Customs administration are shared in real time with those Customs administrations that have signed an MRA, so they can take the appropriate measures.

Among the specific benefits of CADENA are the following:

- Point-to-point automation of data exchange through the digitization of AEO certificate status.
- A secure, reliable, and traceable mechanism to exchange data associated with AEO certificates that makes it possible to maintain all the shared records related to each AEO certification over time (a historical record) in an unaltered manner.
- Data integrity and access control though authentication of Customs officers tied to specific roles and authorizations.
- Transparency of data associated and exchanged.
- Potential reduction of time and costs for trade operators by guaranteeing that the application of the benefits both at origin and at destination will be automatic from the moment they receive the AEO certification from Customs administrations which have signed an MRA.

LACChain

LACChain is the blockchain infrastructure where CADENA (the application) is deployed.

LACChain[132] is a global public-private alliance promoted by the IDB Innovation Laboratory (IDB Lab) to develop the blockchain ecosystem and network in Latin America and the Caribbean. The purpose of this initiative is to promote integration and economic and social development within the region by using blockchain technology. Some of the benefits of using LACChain as the blockchain infrastructure for CADENA are:

1. LACChain enables a unique blockchain-based ecosystem and network, built, and maintained by the public and private sectors. It facilitates a regional blockchain technological infrastructure based on universal standards, national policies and regulatory frameworks, data privacy policies, and the need for the users identification/ authentication with sovereign identities at the blockchain network level.
2. LACChain provides autonomy and sustainability to its participants and allows the scalability and interoperability of the solutions and applications deployed on the network. It provides the necessary blockchain infrastructure to develop and strengthen the architecture of applications such as CADENA.

131 *Submitted in 2022.*
132 *https://www.lacchain.net.*

Unlike public blockchains -such as Bitcoin- or private ones, LACCHAIN is a third way that offers the option of a permissioned public blockchain, which combines the best features and functionalities of public and private models. LACCHAIN main characteristics are its open, public, and decentralized nature, low cost for the user, because -it is not based on transactions cost,- not anonymous, bonded to laws and regulations and not based on the use of cryptocurrencies.

LESSONS LEARNED

When designing and implementing a blockchain application one should be considering the following issues: Sustainability, Governance and Administration, Adaptability, Privacy, Security, Integration and Scalability. The selection of the blockchain infrastructure is crucial in this regard.

CADENA has been designed and developed as a Proof of Concept (PoC) during two phases. One of the virtues of iterating on a PoC to develop and implement new technologies is the ability to test, validate, and make improvements in subsequent phases. CADENA benefited from its iterative nature due to its two-phase development. For this reason, the evaluation of CADENA's PoC requires a comprehensive approach that includes the two phases developed.

CADENA v.0, or first phase, served to successfully validate the properties and benefits of blockchain technology for the exchange of data between Customs. In this phase, four Customs administrations exchanged data of their AEO certified companies through the CADENA application in an automated, secure, and real-time manner.

However, despite the success of CADENA v.0, the importance from an evaluation point of view was the identification of longer-term challenges. These revolved, mainly, around the technological infrastructure design -a private blockchain- which supported the application architecture.

CADENA v.1, or second phase, benefited from the fast evolution of the blockchain technology itself. Taking advantage of the synergies of LACChain, CADENA v.1. was transformed and conceived using an architecture based on a public permissioned blockchain. In the table no. 1, the main differences between CADENA v.0 and v.1 can be compared.

Here is how the challenges identified during the first phase (CADENA v.0) were resolved during the second phase with CADENA v.1:

Sustainability

The permissioned public blockchain does not require dependence on any provider for the development or maintenance of the technological infrastructure. Each Customs administration can permission a node in the LACChain infrastructure,[133] and each Customs administration can also opt for a deployment of the CADENA application in the cloud with the provider of their choice or an on-premise deployment on their own servers.

Governance and administration

CADENA v.1 only requires establishing governance at the application level. The Customs administrations that make up CADENA have established a technical and functional coordination structure, open to the participation of other Customs that eventually decide to use CADENA. Likewise, the technical coordinators of the IT areas at each custom have established a shared repository structure in a Github to document the entire evolution process of the CADENA application contributing to the code co-creation process and facilitating the incorporation of other Customs to CADENA. On the other hand, the administration of the LACCHAIN network is completely decentralized, with the members of the alliance responsible for the support and maintenance of the network infrastructure for all the users.

Adaptability

The CADENA application can be visually and functionally customized to the needs of each Customs administration. Only core functions, roles structure and data sets already agreed during the

133 *LACChain has a free NET Test where CADENA is being developed and implemented. Eventually, LACCHAIN will offer a Main NET service by subscription - not by transaction - whose legal and financial viability is being established. According to the entities that support the birth and development of LACCHAIN, the Main NET will operate without profit and the subscription will be used exclusively for the support and maintenance of the infrastructure with the guarantees of service and operation 7/27/365.*

Table 1. Main Differences between Cadena v.0 and Cadena v.1

CADENA v.0	CADENA v.1
Private blockchain network.	Public-permissioned blockchain network.
Centralized infrastructure components dependent of a provider.	Decentralized infrastructure components nondependent of a provider, individual subscription of each country in its own cloud or local server.
Centralized administration of the application.	Autonomous. Managed by each country.
Predetermined smart contracts, changes subject to the consensus among Customs.	Open source smart contracts for easy inclusion of new Customs.
Application update to be carried out by the consensus of the countries.	Possibility of customized the application according the needs of each country.
Authentication of users at the application level.	Authentication of users at the application and at the node level.
Security and privacy at the application level (involves and requires the role of the general administrator or provider).	Security and privacy at the application and at the blockchain level (self-sustaining - the role of a general administrator is not necessary).
Single application, with two replica nodes.	Standard application with the possibility of being customized, one node for each Customs, permissions at blockchain level (execution of smart-contracts).
No option for Customs to interact with other nodes nor run other applications though the node (there is no node independence through Customs).	Facility to develop other digital solutions and application with other nodes within the network (independent node owned by Customs).
Blockchain with limitations in scalability (it is necessary to deploy a new module in the application with permissions from Customs, role played by an administrator).	Blockchain with potential to be scalable (easy inclusion of other Customs).
Blockchain limited in interoperability capacity.	Blockchain with interoperable scalability potential

design phase that incorporate international standards must be maintained. Customs can incorporate other functionalities and customize the web application of the solution.

Privacy

The new architecture of CADENA v.1 does not have a hierarchy for its administration. Each Customs administration has complete autonomy over the administration of users and roles. This solves the issue of data privacy requirements in each entity by not requiring a third party and central administrator. Additionally, the data can reside in the preferred location that each Customs administrator, such as the cloud of the provider of their choice or on premise at their own servers. For the exchange of data, bilateral private channels are established, while in Blockchain only the result of applying the "hash" function is stored, which is the manifestation of the existence of said data or transactions. LACChain provides the service of replication and validation of said information.

Security

One of the pillars that strengthened CADENA v.1 is its security features as LACCHAIN integrates an identity component developed based on international standards.[134] Each Customs administration

134 *W3C De-Centralized Identifiers https://w3c-ccg.github.io/did-spec/ ; W3C Verifiable Credentials Data Model https://www.w3.org/TR/verifiable-claims-data-model/ ; The De-Centralized Key Management System (DKMS) https://github.com/WebOfTrustInfo/rwot4-paris/blob/master/topics-and-advance-readings/dkms-decentralized-key-mgmt-system.md*

exercises sovereign control of each transaction, which can be verified by its counterpart when establishing the smart contracts. And at the same time, each transaction is registered with a validated identity according to the established business roles and authorizations in the management of the AEO program in each country.

In addition, the active participation and contribution of Customs administrations in the design and implementation process has made it possible to carry out a test to verify the cybersecurity level of the application. For this, a black box and gray box testing methodology has been used: OWASP Testing Guide v4 (OTG) and OWASP API TOP 10. The test identified vulnerabilities at the API level that were resolved.

Integration

CADENA v.1 comes with an API component that allows data to be integrated into Customs systems. In addition to the real-time information exchange between Customs, the possibility of automating the entry of said information to national risk management systems completes the Customs control process and provides facilitation benefits to companies.

Scalability

The autonomy, independence and adaptability of CADENA v.1 allows a quick and easy scalability should other Customs decide to use CADENA, as well as other public and private users. It also lays the foundation to exchange other types of cross-border data such as certificates of origin, phytosanitary, transit data and data of the export or import declaration, among others, between Customs and between Customs and government entities and with private companies.

Other lessons learned

- Use international standards (e.g. sets and formats of data to be exchanged).
- Pay attention to national regulations, processes, and international guidelines.
- Narrow proof of concept to a specific challenge that requires multi-stakeholder interactions to test, validate, and grow with other capabilities and actors (start small to grow bigger).
- Propose inclusive co-creation processes in which business, technical and even legal areas participate to guarantee the regulatory alignment, the functionality of the processes and the technological viability of the solution.
- Consider the proof of concept as a process of learning and knowledge creation about the potential of the blockchain technology.
- Keep yourself engaged in the global technical discussions and contribute with your efforts at an international level while trying to identify additional functionalities to the PoC.
- Iterate and establish milestones for functional and integration tests to identify areas for improvement.
- Opt for open source solutions and document them in shared repositories (Githubs).
- Be willing to be flexible and take some risk in proofs of concept. Accept the challenge of validating stages while finding and incorporating unidentified technical solutions at the beginning of the proof of concept.
- Develop a strategy to validate the cybersecurity level of the application and its components.

39. Port of Rotterdam International: Blockchain solution Quay Connect streamlines the trade and Customs clearance process into the United Kingdom (UK)[135]

Each year, around 360 billion euros worth of goods are exported from the EU to the United Kingdom (UK) .[136] Brexit has led to sharply tightened Customs formalities resulting in more administration and additional costs for exporting goods to the UK.

Prior to leaving the EU, goods moved freely between the continent and the UK, with little or no formalities. For example, goods produced or imported into the EU could be sold within the UK, without the need for additional health and safety checks at the border. On 31 January, 2020, the EU and UK agreed on the terms and conditions under which the UK would leave the EU and the new arrangements between the partners in the so-called Withdrawal Agreement and Political Declaration. A transition period keeping most of the pre-Brexit arrangements in place officially ended on the 31 December 2020. On Christmas Eve 2020, the EU and the UK struck a last-minute deal on how to regulate future trade. This new regulation, as laid down in the Border Operating Model,[137] constitutes a phased approach towards tariff-free, quota-free access to each other's markets for goods — but not services. However, the actual implementation of the model comes with a considerable administrative burden for both exporter and importer. Not only are they required to declare their goods upon import, but also these goods are now subject to more extensive checks from UK Customs (HM Revenue & Customs),[138] as well as other authorities, such as the Border Force[139] and the Department of Environment, Food, and Rural Affairs (DEFRA).[140] As part of this phased approach, new regulations were introduced on the 1 January 2022. The exact implementation, however, differs per port in the UK. Add to that the complex Rules of Origin, the individual trade deals that exist between the UK and the rest of the world, the pandemic, and global supply chain issues and it is easy to see why many importers and exporters have trouble in meeting these new Customs requirements. Companies who do not meet the requirements face delays, additional paperwork, and fines. It was for this reason that a new service called Quay Connect, a solution for automated Customs clearance, was developed on Naviporta; the neutral blockchain platform for the logistics industry.

First service on the Naviporta platform

Quay Connect is developed in collaboration between Port of Rotterdam Authority, Blocklab,[141] Azarc,[142] and the operator of CCS-UK,[143] British Telecom.[144] Built on Naviporta, Quay Connect provides a seamless and direct interaction between the system of the exporter, the Dutch port community system (PCS) 'Portbase' and the UK Cargo Community System (CCS). CCS connects the various members of the cargo community in a digital and distributed way. This community includes not only the HMRC, but also freight forwarders, importers, and haulers.

All this together, ensures secure, reliable, and fast verification of information thereby creating a seamless and fully automated flow of information between all involved parties resulting in considerable savings in both time and money. The following steps have been integrated in the solution:

135 *Submitted in 2022.*
136 *Parliament.uk, 2021.*
137 *UK Government, 2021.*
138 *https://www.gov.uk/government/organisations/hm-revenue-Customs*
139 *https://www.gov.uk/government/organisations/border-force*
140 *https://www.gov.uk/government/organisations/border-force*
141 *www.blocklab.nl*
142 *https://www.azarc.io*
143 *https://www.ccs-uk-ug.org/index.php*
144 *https://www.bt.com*

- Preparing, submitting, receiving, and handling of the required Customs documents in a digital fashion.
- Document management of the required underlying documentation such as packing-list, sales order etc.
- Tracking and tracing of the shipment using an intuitive user interface.
- Creating and signing e-CMR, providing immediate digital proof of pick-up and delivery the shipment.

Common frame of reference for all involved parties

The blockchain infrastructure by Naviporta[145] allows for assets, such as documents, and datasets, originating from the often siloed systems operated by the various cargo community members, to be uniquely registered based on their cryptographically generated hash key without revealing any sensitive data on the blockchain. Moreover, users of Naviporta remain in full control of their data as the infrastructure does not store any of their data on the infrastructure ensuring strict neutrality and at the same time analysis and monetization of user data is completely excluded. All this results in a common frame of reference over the siloed systems for these assets, which in turn enables the generation of several proofs. These are:

- Proof-of-existence: by publishing the hash of the asset on the Naviporta blockchain, a company provides proof that this document existed at a given point in time.
- Proof-of-integrity: when a company shares the underlying asset with a cargo community member, this member can verify whether this asset is the same as the asset that has been registered on the blockchain. Even the smallest change will result in a different hash key for that asset thereby providing evidence that the asset has been tempered with.
- Proof-of-origin allows authorized users to retrieve the origin of an asset registered on the Naviporta blockchain.
- Proof-of-ownership allows authorized users to verify who is the owner of a particular asset.

Furthermore, various oracles such as Portbase or CCS are connected to Quay Connect, thus ensuring that validated data is available throughout the various process steps. This in turn facilitates automation of the import Customs formalities, providing unprecedented levels of workflow automation without the need for all the cargo community members to use the same system. The user interface not only provides information about relevant tracking points within the Customs declaration process, such as declaration submitted, approved etc., but also whether the goods have been picked-up and delivered. These features help improve customer service.

The practical implementation

Speed is crucial for the export of perishable goods which is why Brexit has had major implications for the agri-food sector. On both sides of the border, the involved trading parties have experienced a 3% increase in costs. This has an impact on the entire chain, from buyer to retailer to consumer. It was for this reason that Quay Connect has initially been put to the test by the agri-food sector and has been piloted in collaboration with the Dutch Fresh Produce Centre[146] and ABC Logistics[147]. Daco Sol, Programme Manager Logistics & Supply Chain at Dutch Fresh Produce Centre says this: 'Quay Connect is a game-changer for the whole industry, but especially for companies that export fresh goods to the UK. This digital service fosters trust, transparency and greater efficiency in the logistics chain that focuses on exports to the UK.

ABC Logistics is one the first commercial users of the platform. The company exports fruits and vegetables from all around the world to the UK and benefits from fully automated and digitised flow of documentation. The first live shipments have already been carried out, resulting in the following advantages:

- Cost savings between 30 – 60% per Customs clearance
- Faster and more efficient processing of documents and goods (>20% faster)
- Less manual work
- Lower risk of errors
- Better insight into the status of the cargo

145 *https://naviporta.com*
146 *https://freshproducecentre.com*
147 *https://abclogistics.nl*

About Naviporta

Naviporta is an open and neutral platform underpinned by blockchain technology and with interoperability at heart. Initiated by Port of Rotterdam Authority, the platform secures neutrality by launching a global consortium with leading port authorities. Naviporta envisions to empower shippers, freight forwarders, and logistic service providers to make every (container) shipment easier, more efficient, and more sustainable. The power of the network is that each company connects just once and is automatically connected to many other digital solutions. In the near future, additional services will be joining the platform and hereby introduced to the market, enabling shippers and logistics companies to further optimise their supply chains.

40. Usyncro: Multimodal blockchain platform for logistics digitalization[148]

The problem: synchronizing the supply chain looking for efficiency

According to United Nations data, up to 20 percent of the cost of transportation is due to avoidable inefficiencies. A shipment can involve from 20 to 50 procedures, taking into account relations with banks, insurance companies, warehouses, inspectors, etc. It is necessary to overcome the frequent use of manual processes based on paper, fax, courier services, etc., as well as the lack of coordination between the different actors and their IT systems.

Usyncro was created with the objective of streamlining the processes related to the shipment of goods through the digitalization and connectivity of all the actors in the supply chain. Usyncro is a cloud-based SaaS solution that provides a collaborative, open and secure platform for a global, interoperable and independent environment that encompasses all the actors in the supply chain.

The process is standardized and simpler, traceable and transparent thanks to blockchain technology. Information extraction is automated thanks to AI and ML. It brings security through the use of a unique code generated by blockchain technology and synchronization to the entire supply chain.

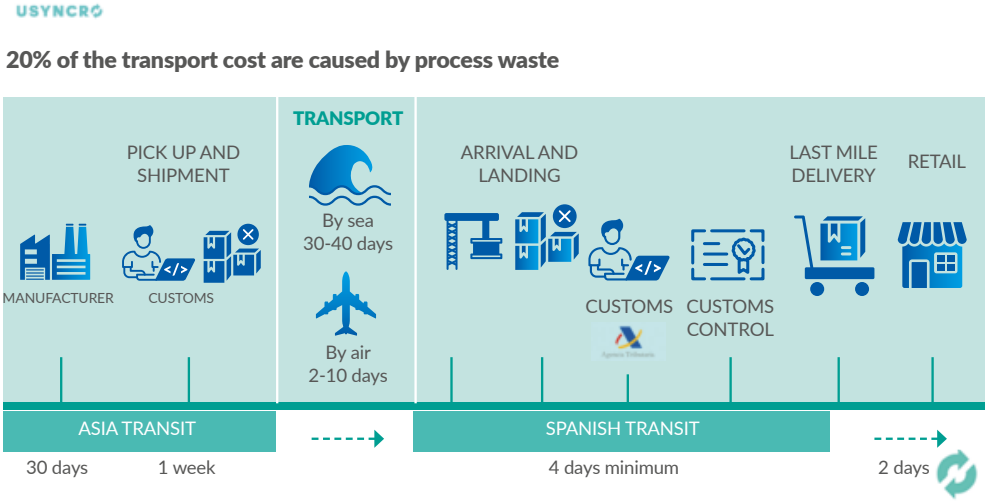
The information related to the transaction file is available to all participants (even from mobile devices) based on the permissions granted on the platform, eliminating the use of paper and generating a tracking of the file on the platform itself.

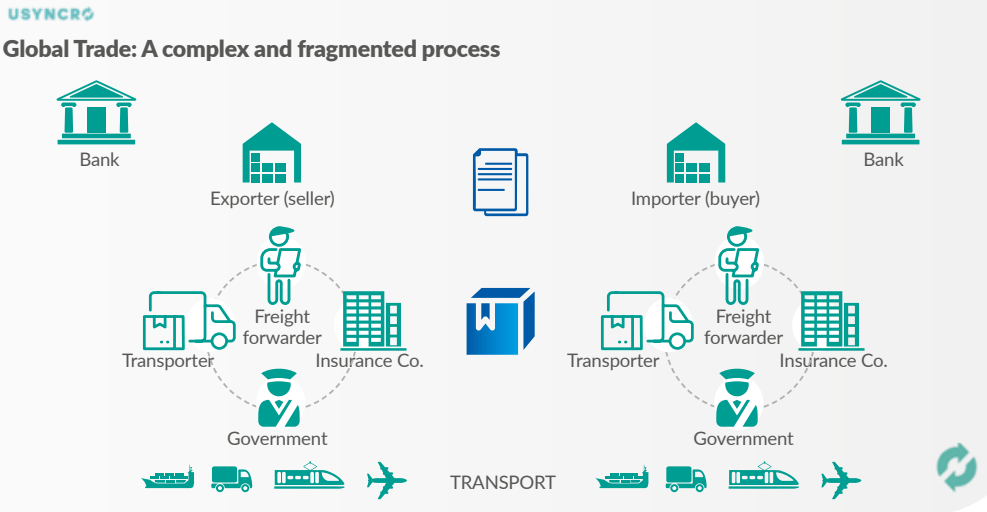
It is a globally scalable business model, accessible 24x7 from anywhere in the world, and with a very high recurrence. International trade is growing year by year and is valued at a market volume of more than 10 trillion dollars.

Some advantages of using Usyncro

- Reduction of the time spent per file by more than 80%.
- Streamlining of procedures with the Customs office with which we are connected.
- Reduction of errors in the procedures.
- Creation of centralized repositories of information and documentation associated with the files, accessible even years after the file has been closed (the data is the property of the client).
- Drastic reduction in the use of paper, eliminating the need for its physical storage.
- Automation of interactions between all participants in the international trade operation.
- Synchronization with other management systems through an API that allows bi-directional automation of data.
- Immediate accessibility to file information from anywhere with just an internet connection, even from mobile devices and Smartphones.

148 *Submitted in 2022.*





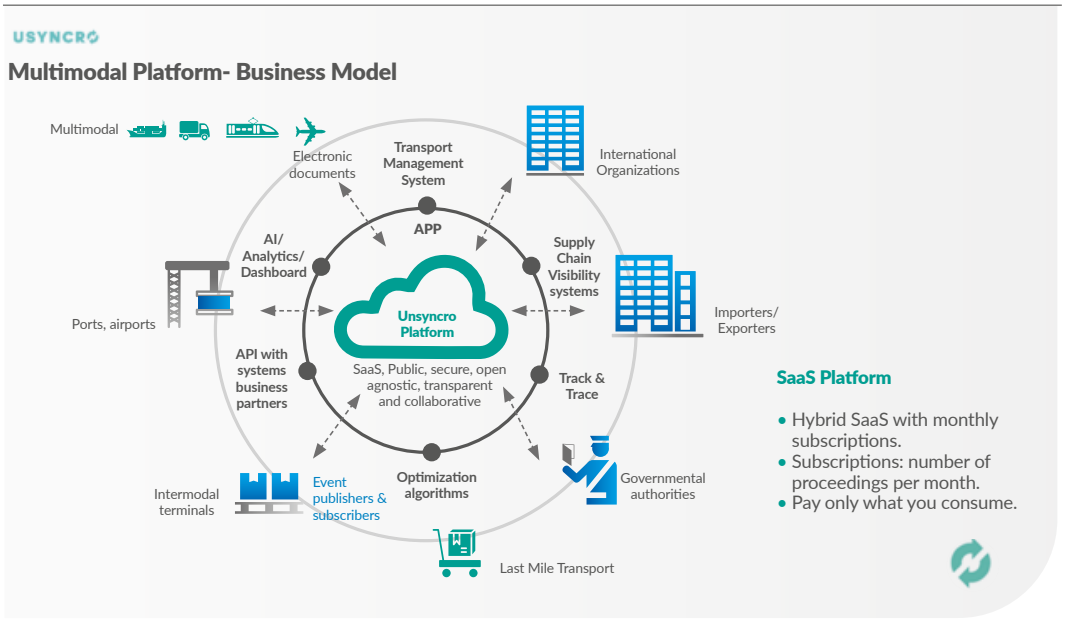
The Strategic partners

Spain's AEAT (State Tax Administration Agency) Customs services are integrated into Usyncro and are used regularly with the companies that belong to the platform, speeding up Customs processes.

The company is also working with different governmental and economic institutions in Latin America as well as with the United Kingdom to streamline Customs processes. It also works with numerous associations and federations representing actors in the areas of transport, logistics and Customs.

The Marketplace

Beyond Customs-related procedures, Usyncro is extending its services to land and air transport, thus building a multimodal and interoperable platform. It offers other value-added services from third parties such as insurance of goods; financing of operations through BBVA; and tracking of goods.



In the immediate future, there will be a platform for multimodal transport control, sustainable packaging, calculation and optimization of routes to save CO_2 to reduce the carbon footprint associated with the transport of goods.

In addition to continuing to rely on Artificial Intelligence for route optimization, Usyncro will include 5G connectivity and the use of satellites to control the goods, being able to visually trace the shipment on the map with a geolocation system.

What is next? Usyncro Space

In the future Usyncro will launch Usyncro Space which aims to contribute to the efficiency of satellite-related processes and the evolution of the sector through the use of blockchain technology. To this end, it will incorporate this technology, guaranteeing the security of communications, providing agility in document management in the regulatory field and coordination between the different actors in the space environment.

On 13 January 2022, progress was made in this line, with the first monitoring of processes via Blockchain for the launch of the picosatellites of the Spanish company Hydra Space.

With the reference of the solution applied to Supply Chain management, Usyncro proposes blockchain technology to provide the sector with its principles of collaboration, interoperability, independence, security and sustainability in the management of space shipments.

usyncro.com

41. Wave : Digitizing bills of lading using blockchain – Wave BL[149]

WAVE BL is a blockchain-based digital courier platform that mirrors the traditional process for transferring original paper documents—electronically. WAVE BL's solution enables instant, encrypted and authenticated transfer of unique digital trade-related documents.

WAVE BL's workflow for using digital documents is identical to the old paper process, but the steps of printing, signing, attaching, sealing, and sending documents with a courier are all replaced with one single click.

WAVE BL uses a blockchain ledger to securely transfer possession and record title, including the times at which these actions were performed. Having such a record enables the parties to a transaction to verify the timeline of transfers, as well as the authenticity of the documents.

WAVE BL's solution supports the transfer of digital documents such as Bills of Lading throughout every step of the trade process: from issuance by the carrier, through transfer to the exporter, banks, and importer, to its final surrender to the carrier.

The case study below examines WAVE BL's use in a complex trade transaction, which also included a Letter of Credit issuance process. A letter of credit (LC) is a financial tool banks use to support global trade; it is a bank's commitment that a buyer's payment to a seller will be received on time and for the correct amount. In order to make that commitment, the bank requires an LC process in which the seller must submit various trade documents as reference. While traditionally these documents have been submitted in paper form, WAVE BL enables near-instantaneous submission of original digital documents.

Case Study:

In 2020, Fonterra, one of the world's leading international dairy processors, completed its first electronic presentation for a shipment from New Zealand to China using WAVE BL's blockchain-based technology with HSBC as the banker.

This fully digital end-to-end Letter of Credit presentation, in which digital documents were cryptographically signed and presented using WAVE BL's platform, is an example of the regular flow of documents between companies and banks during the international exchange of goods.

On 21 September 2020, the carrier issued its electronic Bill of Lading for a shipment of milk powder and sent it to Fonterra. Fonterra added additional trade documents and presented the digital envelope to HSBC New Zealand. HSBC verified that the documents and commercial terms matched the Letter of Credit and eUCP600 rules, and forwarded them to the issuing bank, HSBC China. HSBC China then sent the documentation to Sichuan New Hope Trading, which surrendered the Bill of Lading back to the carrier and released the cargo. The entire documentation presentation was digital and completed in under 24 hours – instead of the typical weeks from beginning to end for regular paper documentation.

This speed and efficiency was something Fonterra had sought to achieve for years, but until recently the right technological solution did not exist to support its wide-ranging activity.

Since WAVE BL's founding and until writing this article, users issued over the platform more than 95,000 electronic Bills of Lading. Also, four of the top carriers use WAVE BL's solution and promote its global adoption.

WAVE BL's customers report that the advantages of switching to digital document transfer have included:

- Reduced document delivery times (from days or weeks to minutes).
- Major savings on courier and demurrage costs.
- Increased efficiency and workflow effectiveness
- Less manual work.
- Increased reliability, as customers can be confident that documents will not be forged, damaged or lost.

149 Submitted in 2022.

42. WCO and RTC Korea: Gamification learning and new technology (virtual reality)

Hongyoung CHO, Mi JANG / RTC Korea

As COVID-19 began to spread globally in early 2020, opportunities were created for the Regional Training Centre (RTC) Korea to respond efficiently to the unprecedented challenges impacting on Customs' role – in particular, by training staff through a transition towards the introduction of gamified learning, with new technology and a new communication platform.

It should be noted that the change was driven by growing requests and expectations for highly engaging learning content which was coming from Korea's "MZ" generation – a term coined in Korea to refer both to millennials (those born between 1980 and 1995) and to generation Z (those born between 1996 and 2010).

As part of the long-term strategy to drive innovative ways of capacity building, RTC Korea has been working on developing and utilizing digital-friendly content. This includes Virtual Reality (VR)-assisted physical inspection and Harmonized System (HS) classification using quiz applications familiar to the MZ generation of Customs officials. The aim is for the latter to gain practical knowledge, but also to improve their level of satisfaction when training.

Virtual Reality-assisted training

Against this backdrop, RTC Korea and the WCO, financially supported by CCF-Korea, initiated a joint project to develop a high-definition and immersive learning program where learners can get hands-on experience of import inspection, a fundamental and traditional Customs operation. RTC Korea formed the dedicated team, in collaboration with the Capacity Building Directorate of the WCO. The work included scenario development, the study of reference materials (including international standards), and maritime port and warehouse visits with developers and others.

In September 2021, RTC Korea opened the VR Experiential Centre and successfully implemented a VR import inspection program in both English and French, the two official languages of the WCO. The program was also installed at WCO Headquarters in November 2021. The Capacity Building Directorate hosted the opening event to demonstrate how Customs officials are able to learn physical inspection procedures virtually.

Contents and components of the VR training

Through this VR-based learning content, trainees are able to carry out their mission, examine declared documents and experience import inspection procedures in a 3D container yard and a bonded warehouse for Customs inspection.

During the process, they can choose one of three different scenarios to handle situations that officials might face in detecting smuggled items such as drugs, intellectual property right (IPR) infringing items, and explosives.

To make the program more immersive, gaming elements (such as hidden missions to search illegal items) and rewards for performance have been added, and learners reminded of risk factors using the WCO Risk Management Compendium. Real seizure cases are presented at the end of the program in order for trainees to understand its objectives and to enhance learning effectiveness.

All the devices required for the learning experience come together and are installed in the kiosk, with the trainee wearing a headset and using a hand-held controller.

The other equipment installed is a high memory computer and two sensors to track VR devices and locate the trainee's moves, guaranteeing a quality experience for the trainee.

TV screen on the kiosk provides co-experience opportunity for spectators.

To make the program easily accessible for officials without these devices, WCO is planning to upload onto the CliKC! platform a screen version or mobile version which can be played simply with a computer keyboard at a desktop computer, or on an individual mobile phone.

Dr. Kunio Mikuriya, WCO Secretary General, experiencing the VR program (9 November 2021)

Dr. Taeil Kang, Director of the Capacity Building Directorate, with development team members

Survey and responses from users who have experienced the program

The survey makes clear that the program has drawn huge attention within Customs. The responses and interest from officials who have experienced the game-based programs is immense. Below are some quotations from the users surveyed.

> *"The VR import inspection program is really immersive, as if I was actually inspecting imported goods."*
> *"If VR learning programs are developed for more areas of Customs work, it would definitely be helpful to learn and practice work skills in a fun and immersive way."*

How the VR training program will be further improved and expanded in the future

The experiential version of the VR import inspection content which has currently been developed is expected to be used in import inspection training from the start of 2022 in order to measure its effectiveness.

WCO is working with RTCs to distribute a full set of VR training equipment to all RTCs in the six regions, making it available to as many Customs officials as possible around the globe.

To counter the shortcomings of this version, a low-cost version (which can be used on PCs or mobile phones) is expected to be uploaded onto the WCO CliKC! platform to provide remote learning environments.

In the mid-term, the program will serve as a new forum for distance communication and a learning solution using the Metaverse across platforms, where users are connected with each other in a cyber community and set up training sessions with 3D content from any device available (e.g. mobile, laptop or notepad). WCO and RTC Korea plan to examine the possibility of additional development of augmented reality (AR) content, which has many strong points in terms of variety and degree of difficulty in content development.

Learn HS classification as you play!

The Korea Customs Service (KCS) and RTC Korea have been looking closely at how to enhance learner engagement, breaking away from conventional ways of delivering information on the intricacies of Customs administration.

As part of the initiative to develop game-based learning content for Customs work, the Korean-language version of a video game has been launched to teach Customs officials HS classification. This training module – the "HS Code Game" – is a new learning method which is being conducted on a trial basis. It engages internal specialists and the MZ generation in the development process, as HS classification is a relatively difficult field for Customs officials to learn.

Feedback from Customs officials

The pilot content enables users to learn easily and quickly a chart of 97 HS chapters through actual pictures of items. By adding competitive elements, such as the opportunity for users gaining high scores to proceed to a higher level (4 digit-headings), the content is designed to enable new recruits to study HS classification more easily, based on game play. The WCO and RTC Korea have plans to enhance the official language versions (English and French) of the HS Code Game so that it is highly efficient and makes learners more receptive to learning. Discussions are ongoing to upload it onto the WCO CliKC! platform as a way of contributing to the creation of a new global learning ecology.

HS Code Game users were quoted as saying:

"This could be the Squid Game of the Customs field if the Game can be used in other countries."

"I can study HS codes more efficiently, which used to be the least efficient part of the time thatI spent."

Many of them are eagerly anticipating more opportunities to participate in further content development. When Customs officials across the world experience it in person, they will immediately understand why users have been so enthusiastic about the programs.

Way forward

As a regional centre specializing in ICT, RTC Korea, in close cooperation with the WCO, will continue to incorporate into various Customs fields the latest learning trends both home and abroad, such as digital transition and micro-learning.

In this way, RTC Korea will develop "Smart Customs Learning" that serves two ends: learning and having fun, in line with WCO capacity building policy. It will thus contribute to the up-skilling of Member Customs officials and play a leading role in helping the global Customs community.

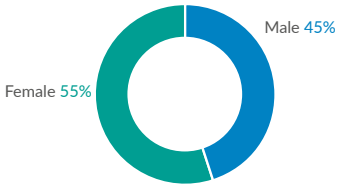
Image of the "HS Code Game"

Ms. Anna CHO, Head of RTC Korea, at a press interview (24 November 2021)

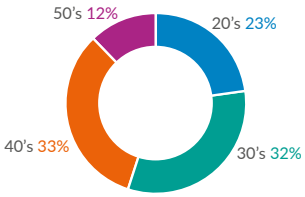
Users' reactions to VR-based import inspection program (120 users)

1. Features

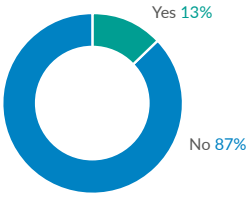
Gender



Age

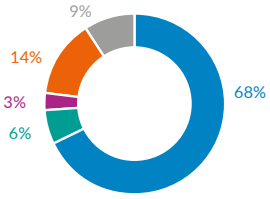


Have you experienced VR over the past year?

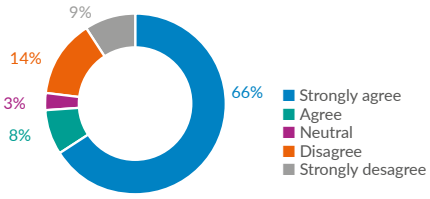


2. Responses after the VR experience

The program is highly immersive

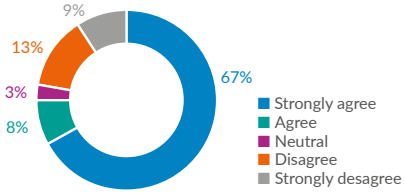


I will recommend it to others.



3. Requests for further development

VR content needs to be further developed



What type of VR content should be created?

List of boxes and figures

Boxes

Figures

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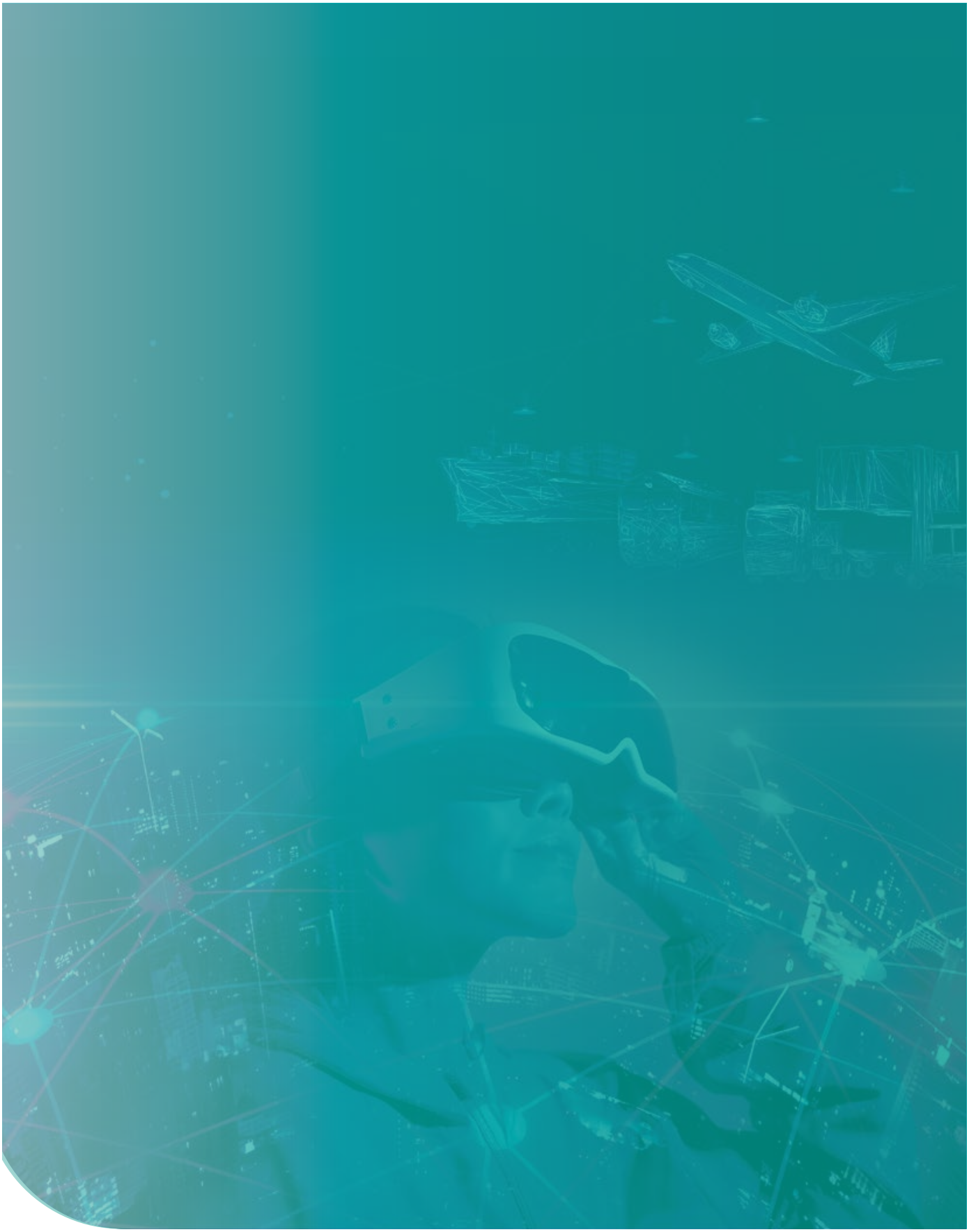

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