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EU Deforestation Regulation, challenges for businesses and authorities and the potential role of Digital Product Passports and Digital Infrastructures

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The assignment

This research project deals with the impact of new EU regulation on supply chains of companies. In the last few years, more and more of this type of regulation has seen the light, and the implications for both companies and enforcement agencies (customs and other market surveillance agencies) are profound.

As a result of this impact, there is a lot of discussion, lobbying and influencing going on towards the regulators in the European Commission. In much of this discussion, however, the *supply chain*-related impact is underrepresented.

We have investigated this issue in the main report for this project: 'Supply Chain Effects of European Regulation' (Erasmus UPT, December 2024).

In the present report, we extend this discussion with a path towards a solution. We argue in this report that the ongoing development of digital product passports can potentially solve many of the informational challenges that come from new European regulation. The digital product passport is primarily being developed for applications in the circularity domain, but we think it can have a wider significance. For this part of the investigation, we have collaborated closely with dr Boriانا Rukanova and prof. dr Yao-Hua Tan from the Technology, Policy and Management faculty of Delft University of Technology who have been working on new digital infrastructures for data sharing and digital product passports for some time.

Abstract

From engaging with the logistics community, as well as in discussions with companies and government authorities two things become evident. First, more and more new regulation requires data and insights from deep into the supply chains of companies placing products on the EU market. As a result, many businesses are deeply concerned how to collect and make available that information for compliance purposes. Secondly, authorities are concerned how they can monitor the implementation of such regulations and trust data that comes from countries way beyond the EU's jurisdiction.

The EU Deforestation Regulation (EUDR) is one example of a regulation that requires extreme levels of transparency and timelines of implementation are approaching fast. Many businesses are facing this regulation with big concerns of what to do and how to be compliant, looking for quick solutions to meet the regulatory deadlines. At the same time, we see relevant developments such as Digital Product Passports (DPP) and related pilots driven by other regulations (e.g. the Ecodesign for Sustainable Product Regulation (ESPR)), with different timelines, which may bring pieces of the puzzle needed to address challenges related to the European Deforestation Regulation (EUDR) but potentially also others. A big question then remains: how to be compliant in the short run to meet the requirements of EUDR, while keeping an eye on the future to avoid investing in silo solutions for every new legislation.

In this paper we will not give a specific solution and answer, as the solutions and answers will depend on the specific company's situation and how companies decide to act. However, what we will do is provide an overview of some current developments, reports, and pilots related to Digital Product Passports. While these developments related to DPP may be very well known for people working in that area, for many parties that have not yet been affected by legislative developments that require DPP but already need to comply with legislations such as EUDR and Carbon Border Adjustment Mechanism (CBAM) this overview may be informative and insightful. It is this audience that this paper aims to reach. We hope that by providing insights into the DPP developments to parties not yet affected and aware of these developments but affected by other legislations, this will allow them to take a broader perspective and rethink their strategies, taking a broader view and a long-term perspective.

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1. Introduction

The European Union is currently manifesting its role as a global regulatory power. It has embarked on a program of broad societal regulations that impacts European businesses. However, some of this regulation has profound consequences for the operations of these businesses outside Europe. This results in significant compliance challenges. At the same time, current European and global developments on trade facilitation (United Nations (UN), World Customs Organization (WCO), World Trade Organization (WTO)) might provide pieces of the puzzle to address these business challenges.

An example of extensive European environmental regulation, and how it eventually impacts businesses, is the Fit for 55 Package. This regulatory package aims to achieve the global environmental CO₂ reductions agreements to reduce emissions with 55% by 2030¹. Part of this is the development of the European Emission Trading Scheme. This has sparked a concern about potential ‘leakage’ of emissions, by bringing goods into the EU market from outside the EU (and thus outside the ETS). In an attempt to address this problem, the EU introduced the Carbon Border Adjustment Mechanism (CBAM). This mechanism took effect from 2023 in a transitional period. It will start charging emission rights formally from 2026, resulting eventually in full payment for emission in 2040. A major requirement of CBAM is to obtain CO₂ emission data from suppliers outside the EU.

This example shows that the regulatory efforts in the EU embrace the idea of ‘the supply chain’, in which suppliers, manufacturers, and traders are transactionally and operationally linked. In the case of CBAM, CO₂ emission data (scope 1 and 2²) need to be collected from producers, transferred downstream, and reported by the party that brings goods on the EU common market. In the context of the EU Green Deal, we see fast development of other new legislation such as the Ecodesign for Sustainable Products Regulation³, and the Battery Regulation⁴ that introduce the requirement for data from deep in the supply chain. In addition, new legislation is being prepared on forced labor⁵ that would require knowledge about practices and working conditions way beyond EU borders. Finally, new geopolitical developments play a role and efforts will be made to increase the EU competitiveness and reduce the administrative burden⁶. We are currently witnessing the development of a new, complex regulatory landscape.

This idea that, for some regulatory requirements, data from deep in the chain may be useful, is not new. For the basic customs requirements of bringing goods onto the EU market, the idea of collecting data at the beginning and along the chain, and carrying this data with the goods to the parties downstream has been the basis of initiatives such as the EU projects ITAIDE, INTEGRITY, CASSANDRA, CORE, PROFILE and so on (see also Heijmann et al., 2020⁷). From these, theoretical and practical tools, such as the Data Pipeline⁸, and the Maersk/IBM Tradelens⁹ initiative were developed. In addition, it has given rise to the Customs Enforcement vision¹⁰, that was developed about a decade ago by Dutch Customs and academia, which also aligns well with ideas developed at global level about business-government collaboration such as in the WCO SAFE Framework of Standards¹¹.

¹ The original agreement was to keep global warming below 1.5°C. the thoughts in 2015 were that this could be achieved by targeting 50% CO₂ reduction by 2030 and carbon neutrality by 2050. See https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4754

² See the GreenHouse Gas Protocol: scope 1 is direct emission from manufacturing, and scope 2 is emission related to, among others, electricity use. See https://climate-pact.europa.eu/eu-climate-action-academy/resources/ghg-protocol_en

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746>

⁴ <https://eur-lex.europa.eu/eli/reg/2023/1542/oj/eng>

⁵ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0453>

⁶ https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en

⁷ See e.g. Heijmann, F., Tan, Y. H., Rukanova, B., & Veenstra, A. (2020). The changing role of customs: Customs aligning with supply chain and information management. *World Customs Journal*, 14(2), 131-142

⁸ See for instance, Klievink, B., Van Stijn, E., Hesketh, D., Aldewereld, H., Overbeek, S., Heijmann, F., & Tan, Y. H. (2012). Enhancing visibility in international supply chains: the data pipeline concept. *International Journal of Electronic Government Research (IJEGR)*, 8(4), 14-33. And Heijman, F.H.A. & Peters, J. (2022). Customs; inside anywhere, Insights everywhere. Trichis Publishing

⁹ <https://www.maersk.com/news/articles/2022/11/29/maersk-and-ibm-to-discontinue-tradelens>

¹⁰ See Heijman, F.H.A. & Peters, J. (2022). Customs; inside anywhere, Insights everywhere. Trichis Publishing

¹¹ https://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/frameworks-of-standards/safe_package.aspx

Despite all these efforts, however, a generic, semi-collective, infrastructure for sharing data along supply chains has not developed. The Tradelens initiative, for instance, was discontinued after an elaborate attempt to perform a global roll out. Instead, businesses often resort to in-company or supply chain initiatives, where they create the visibility and transparency they need – often for specific applications only. In recent years, we see a growing number of such initiatives, as well as platforms offering traceability services. We also witness the development of Dataspaces¹² that aim to organize data sharing in communities of stakeholders but where the participating businesses keep control over their data. These efforts show growing digitalization efforts by businesses, which is an important step forward. But they are still limited when looking at the broader, and more collective transparency requirements that are envisaged by governments, or, for that matter, society.

It goes some way to explain why the new EU regulatory program causes concern for businesses. Each regulation comes with new informational requirements in the supply chain, for which businesses build new solutions. In case businesses cannot do this themselves, a myriad of IT service providers step in to develop solutions in one way or another. The different timelines with which these legislations occur, as well as the different EU policy units that drive the development, makes it difficult to take a more holistic approach. As a result, businesses and their solution providers, are often reacting to meet regulatory deadlines per regulation. It is very difficult to take a step further, and develop solutions that accommodate multiple requirements at the same time, and, potentially, new informational requirements that may emerge in the future. To alleviate this complexity of the multitude of sustainability regulations, The European Commission launched in January 2025 the Competitiveness Compass which contains the **Omnibus proposal**, which aims to better integrate this regulatory multitude, simplify sustainability reporting and reduce the administrative burden. Furthermore, the Commission will facilitate doing business for thousands of small mid-cap companies. The Compass sets a target of cutting the administrative burden by at least 25% for firms and by at least 35% for SMEs.¹³

We observe an interesting development in legislation related to *Digital Product Passports (DPP)* that may offer opportunities to streamline information sharing for environmental and sustainability concerns. The idea of product passports appears in several regulations that promote circularity. For example, the Battery regulation¹⁴ that will enter into force in 2027 introduces mandatory requirements about so-called battery passports. Of particular importance is the Ecodesign for Sustainable Products Regulation (ESPR) which introduces the mandatory requirement for Digital Product Passports that will affect multiple product groups. In particular, a digital passport for textiles are expected to become mandatory in 2027. ESPR is a general regulation, which will be followed by delegating acts for different product groups that will further detail the specific data requirements for these product groups. An interesting development is that DPP is mentioned explicitly in the Competitiveness Compass as one of the key instruments to achieve the administrative burden reduction.

An interesting study related to ESPR is a study of the Joint Research Center¹⁵ of the European Commission. It identified eleven final products groups (among which Textiles and footwear, Furniture, Tyres), and seven intermediary products groups such as iron and steel, and pulp and paper, for which the ESPR mechanism of the product passport could be developed with priority. In addition, three horizontal requirements related to Durability, Recyclability, and Recycled content were also identified for which data should be collected in the product passport. The results of this study are not binding for the European Commission and, in the future, it

¹² E.g. <https://internationaldataspaces.org/>

¹³ https://ec.europa.eu/commission/presscorner/detail/en/ip_25_339

¹⁴ EU (2023) European Parliament and the Council of the European Union Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries. Brussels, July 28th 2023: OJ L191/1. Available at: <http://data.europa.eu/eli/reg/2023/1542/oj%0Ahttps://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52020PC0798>.

¹⁵ EC (2024), European Commission, Joint Research Centre, Faraca, G., Ranea Palma, A., Spiliotopoulos, C., Rodríguez-Manotas, J., Sanye Mengual, E., Amadei, A.M., Maury, T., Pasqualino, R., Wierzgala, P., Pérez-Camacho, M.N., Alfieri, F., Bernad Beltran, D., Lag Brotons, A., Delre, A., Perez Arribas, Z., Arcipowska, A., La Placa, M.G., Ardente, F., Mathieux, F. and Wolf, O., Ecodesign for Sustainable Products Regulation: Study on new product priorities, Publications Office of the European Union, Luxembourg, 2024, <https://data.europa.eu/doi/10.2760/7400680>, JRC138903.

remains to be seen which products groups will be prioritized under ESPR. However, this analysis shows that a significant number of product groups may be affected by ESPR in the future. In all these product groups, the recyclability of products, as well as the sustainability footprint will have to be recorded on the product, in a label, but better, in a digital environment. Data access solutions such as QR codes and RFID will play an important role in linking the physical product to its digital representation. The Ecodesign for Sustainable Products Regulation, which provides these requirements for digital product passports, entered into force on 18 July 2024, and puts forward a timeline along which digital product passport will become reality.

Many companies are starting to prepare for the Digital Product Passports and are engaging in pilot efforts for issuing DPPs. In general, DPPs are essential for improving the recycling process of goods, because they contain data, e.g. chemical composition, a record of the repair events of a good, that are needed to better recycle the good. Projects such as CIRPASS 2¹⁶ foster a variety of pilots with business ecosystems that aim to showcase Digital Product Passport implementations efforts related to textiles, electronics, tires and construction products. However, beyond the green agenda, in the context of priorities related to European competitiveness and trade facilitation¹⁷, digitalization efforts and Digital Product Passports are also considered as providing a basis for further steps forward. Companies also see the potential for a broader application of digital product passports. See e.g. the view of the IT company OSAPIENS, on the scaling potential of the Digital Product Passport¹⁸.

The way in which digital product passports may have a wider application beyond compliance to the specific EU regulation for which it is created, is the topic of this paper. We will examine this potential in the context of the EU Deforestation Regulation (EUDR), which is one of the regulations that will affect businesses in the very near future. While businesses will be trying to find a pragmatic solution to address EUDR compliance and meet regulatory timelines, we argue that it is worth taking broader developments into account. This includes the forthcoming developments related to digital product passports that will affect companies and their supply chains in the more distant future. With this broader view, there may be ways forward to approach the sustainability and circularity concerns, while keeping economic competitiveness and trade facilitation in mind, in a more systematic way.

In this paper we examine the combination of Digital Product Passports with some new thinking about traceability systems and the UN Transparency Protocol (UNTP)¹⁹. We think that, together, these may provide part of the puzzle to address many current and future regulatory challenges. The connection between the two has been already identified and made explicit elsewhere²⁰. There are pilot efforts in place to show how businesses can issue DPPs²¹ and how international supply chains can benefit from transparency systems and the use of verifiable credentials²² using the UN Transparency Protocol²³. As such, many of the ingredients are already there. The issue is that on the one hand the topic is new: while parties already working on DPPs will be aware of the developments, there is still a big awareness gap to be bridged to create more awareness on the topic in the logistics world for example. The second issue is to better understand how these transparency developments can be leveraged to cope with the variety of regulatory challenges, while keeping different time-scales, as well as the short-term and long-terms perspectives into account.

¹⁶ <https://cirpass2.eu/>

¹⁷ https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en

¹⁸ <https://osapiens.com/resources/digital-product-passport/>

¹⁹ <https://unctad.org/news/unlocking-transparency-promise-un-transparency-protocol-global-trade>

²⁰ See <https://uncefact.github.io/spec-untp/assets/files/Short-UNTP-Presentation-63ea170a29d03b2ed5d39853d03dc027.pdf>, slide 6.

²¹ <https://cirpass2.eu/lighthouse-pilots/>

²² <https://www.w3.org/TR/vc-data-model-2.0/>

²³ <https://uncefact.github.io/spec-untp/>

2. New information requirements in border crossing logistics

For many years, international supply chain parties have been working on streamlining logistics processes. There is a range of solutions and traceability systems to follow movements of goods. Authorities have been exploring the potential of logistics data for addressing legislative concerns related to safety and security in projects like FEDeRATED²⁴. As another example, we point to the EU electronic Freight Transport Legislation (eFTI²⁵), which aims to boost digital data exchange in transportation.

The Green Deal, and related sustainability legislations requirements, go far beyond mere logistics data. In this paper, we will discuss the potential for expanding the view of border crossing logistics and the data that has been traditionally the focus of logistics, to include also digital product passports, combined with a verifiable credentials solution. Such a development direction will leverage initiatives in the logistics domain, but enrich them with the new concepts associated with the DPP and Verifiable Credentials. This holds the potential to provide key pieces of the puzzle to address the stream of regulatory requirements that currently are issued by the European Commission. The end results will be a rich pool of information about goods and the movement of the goods which can potentially be used for providing information and proofs for multiple legislations. In this section we will discuss one such requirement, that follows from the EU Deforestation Regulation²⁶.

The **EU Deforestation Regulation** (EUDR) aims to eradicate global deforestation by prohibiting products originating from deforested areas to be brought onto the EU common market. The threshold is that none of the relevant areas should have been deforested after 31 December 2020. The regulation applies initially to the following so-called relevant products: palm oil, rubber, coffee, cocoa, timber, cattle and soy. For timber there was an earlier regulation since 2014, which is replaced by this broader regulatory framework.

The main regulatory idea or concept is that companies provide a so-called due diligence statement (DDS) with every border crossing shipment in which they collect the relevant ‘proof’ that the origin areas where the relevant products are ‘harvested’, are deforestation free. This ‘regulatory idea’ of a *statement of compliance* is not specific for this EUDR; it comes back in other regulations as well.

Art 9 of the Regulation (EU) 2023/1115 specifically lists the information requirements that companies need to include in the DDS:

1. A commercial product description (including, for wood, the name of the species of tree), as well as relevant commodities or products contained therein,
2. Quantity information (mass, and/or supplementary units, volume, nr of items) against the harmonized systems (HS) code,
3. Country of production, and parts thereof,
4. The geolocation of all plots of land where the relevant products where produced,
5. Identification information on suppliers,
6. Identification information on traders, or operators to whom the products have been supplied,
7. Adequately conclusive and verifiable information that the products are deforestation free,
8. Adequately conclusive and verifiable information that the products have been produced in accordance with relevant legislation of the country of production (the so-called *legality condition*).

The party submitting the DDS will also have to submit additional documentation upon request from market surveillance agencies.

²⁴ <https://federatedplatforms.eu/>

²⁵ https://transport.ec.europa.eu/transport-themes/logistics-and-multimodal-transport/efti-regulation_en

²⁶ See https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en. At the time of writing, the implementation deadline was being postponed from 30 December 2024 to 30 December 2025, in major part due to the difficulty for both authorities and businesses to be compliant with the informational requirement in time.

When we review this information, some observations can be made. In some instances, the information is supply chain identification information: country of origin, product identifiers (product name, HS code), quantity measures, identification of suppliers and customers. Much of this information will be similar to what is in the customs declaration and other cross-border documentation that is already required as part of pre-existing regulation. There may be small, but potentially important, differences, though.

The essentially new information requirements are:

- The geolocation of all plots of land,
- The evidence that the products are deforestation free, and
- The evidence that the products comply with all local regulation.

The geolocation information requirements come with a number of challenges for companies. First of all, they have to chart all the relevant plots of land for the initial farmers/growers in so-called polygons (i.e. the data format is a collection of GPS points that can be plotted on a map). This is a complicated task, which means that many small farmers need assistance. The rules in the regulation are complex and contain additional rules for large plots of land, and so on. Creating these polygons results in a lot of work that is currently (2024) ongoing in large parts of the world.

A second issue related to the geolocation information is that in a number of countries, most notably the USA and China, this information is considered ordinance data, that is under the control of the Military. This means this data cannot be shared easily with other governments. This is currently an important stumbling block, for instance, for the trade in paper products (note books, post-its, etc) or wooden garden furniture from China.

Another issue is related to the proof for the status of being 'deforestation free'. This issue has two parts. First of all, the European Commission will build up a database of deforestation risk levels for all countries (and presumably regions) in the world. The geolocations in the DDSs will be checked against this database. Secondly, the current standard for this requirement is to provide satellite observation data to prove that (1) the area was deforestation-free from December 2020 onwards, and (2) that over time, no new deforestation took place in the vicinity of the polygons. Presumably, this information is conferred in the DDS through a compliance statement, with a link to underlying evidence in a company, or some NGO data repository. (Many small companies and smallholders are assisted in this effort by NGOs.)

An extra challenge related to EUDR is that for some products, it has also elements of interconnected supply chains. For instance, for beef, the origin of the meat product needs to be reconstructed, but it also needs to be established that the cattle did not consume food that was grown on deforested land. This necessitates going deep into the food supply chain to identify the origin of the food that these cattle consumed and its location - over the entire lifetime of the cow²⁷.

Finally, the last condition, under point 8. above, while it looks as a sort of add-on, is perhaps the most difficult to fulfil. The regulation contains, in art 2 (40), a list of relevant regulation for which compliance needs to be declared: land use rights, environmental protection, forest-related rules, third parties' rights, labour rights, human rights, the UN principle of free-, prior and informed consent, and tax, anti-corruption, trade and customs regulations. This has become known as the 'legality' requirement.

The challenge with this condition is that rules may be in place, but enforcement may be weak. Through this regulation, business is made responsible for enforcement performance in certain countries, which is, in first instance, the prime responsibility of governments. There are also cases where the regulation is non-existent, or it is not clear what the regulation is precisely, or countries maintain competing and potentially conflicting regulatory regimes (for instance for land use rights). On the other hand, larger companies are already developing reporting approaches, such as for the EU Corporate Sustainability Reporting Directive (CSRD). This

²⁷ See e.g. the beef example in the presentation of UN Transparency protocol <https://youtu.be/dJFryZS2UII> (10.20min). We will introduce the UN Transparency protocol later in this paper. Argentina has taken the initiative to develop an information platform for about 200.000 stakeholders to provide this data in a unified form.

amounts to listing regulatory arrangements on a regional or country basis and stating or measuring the level of compliance. For smaller companies, this requirement is probably a much larger burden.

Reflecting on the challenges related to the new information requirements in the EUDR, we see three things:

1. A significant part of the information requirement is trade and/or customs data that is already collected by companies, and part of this data is carried with the shipments so that it can be presented to customs at the moment of bringing the goods onto the market. The border authorities compliance process (customs and other market surveillance authorities active at the border), therefore, provides a backbone for the informational requirement under EUDR.
2. There is also new information (geolocations, proof of compliance with deforestation or local regulation), that is essentially static in nature. Many companies currently record this information in their sourcing or supplier management systems. To combine this data with data from the customs or trade management departments is a struggle for many companies. Given the nature of the data (GPS locations, map data), many companies require adaptations to their existing IT systems to store this data. A flexible data repository structure might solve this.
3. The fact that some countries are not too keen to share security related data with other governments requires another way of thinking about data verification and trust building. A digital solution for data quality verification, including a formalized mechanism to ‘certify’ the presence and the quality of data without actually sharing it, may be the solution. This comes very close to the ideas behind the UN Transparency Protocol²⁸ and verifiable credentials. Also new approaches like Privacy Enhancing Technologies may offer opportunities for business government data sharing for compliance monitoring²⁹ without businesses having to disclose all the details of commercially sensitive data.

We see solutions on the market that have taken into account the above-mentioned challenges and have set-up solutions for companies to meet as much as possible the requirements of EUDR. An interesting example is the solution offered by Trusty³⁰, who offer a Modular Technological Solution with Geo-Location for Deforestation-Free Supply Chains and Legal Compliance Data Integration. The availability of such solutions already show that a lot is put in place. But more will be needed. For example, tires will be affected by the deforestation regulation, as rubber is one of the priority products for EUDR. But tires may potentially be also affected by ESPR, as tires are one of the 11 priority products identified³¹ in the JRC study related to ESPR. If ultimately selected as a priority product under ESPR, Digital Product Passports will be required. Therefore, looking for solutions to serve multiple legislations will require a next step.

²⁸ <https://uncefact.github.io/spec-untp/>

²⁹ Agahari, W., Rukanova, B., Ubacht, J., & Tan, Y. H. (2024). Multi-Party Computation as a Data Sharing Solution for Compliance Monitoring: An Exploratory Study in the Domain of Battery Circularity. In *CEUR Workshop Proceedings* (Vol. 3737). CEUR-WS.

³⁰ <https://www.trusty.id/>

³¹ <https://publications.jrc.ec.europa.eu/repository/handle/JRC138903>

3. The development of the product passport

The EUDR poses major challenges for businesses on how to prove compliance, and, for governments, on how to check for compliance and to assess the verifiability of claims. In this section we move beyond the border-crossing logistics processes and look at the development of the digital product passport that focus on the product itself.

The DPP is introduced in the EU by regulations such as the Battery Regulation and the Eco Design for Sustainable Products Regulations. But there are other DPP developments at an international level, such as UN ECE developments related to Digital Product Passport³², the UN Transparency protocol³³ and IEEE DPP developments³⁴. In the EU, standardization efforts are ongoing as part of JTC 24 of CEN/CENELEC on Digital Product Passport³⁵. While digital product passports originate in the EU from other legislations than EUDR and initially are targeting other product groups, they may provide interesting avenues to eventually address challenges such as those in EUDR and other legislations.

Product labelling and the product passport

The EU regulatory program, for a large part driven by the European Green Deal and ambitions of the Fit for 55 Scheme and other societal aspirations, will result in a sequence of regulations that all come with new data requirements. These include adaptations or renewal of existing regulation, such as on Fluorinated greenhouse gases (F-gasses) (Regulation (EU) 2024/573), pure environmentally driven regulation (CBAM Regulation (EU) 2023/956), and regulation that is yet to come, for instance on banning products made with forced labour (Proposal for a regulation COM(2022) 453).

Among these regulatory developments is the EU regulation for batteries. This regulation stems from 2006, but was amended in 2020 to include regulation for the surge of batteries for light electric vehicles (bicycles, and so on). The regulation initially focused on sustainable manufacturing and safe use. Part of the packages of measures was a labelling requirement. This labelling requirements, including a prescription of the required information, also contained the requirement to provide, from 2027 onwards, data access via a QR-code. In this way, the regulation already pointing ahead to a structural information solution for products. The 2020 amendment also covered a new issue related to batteries: more effective recycling of the materials in the batteries.

More or less in parallel with this specific product regulation, a much more generic regulatory package was developed on 'ecodesign' of sustainable products (ESPR, Regulation (EU) 2024/1781). This regulation provides a unified framework for the information requirements that the EU can set for specific product groups, with the initial aim to facilitate reuse and recycling. In this regulation, the term Digital Product Passport³⁶ is consistently used for the information infrastructure and information access regime that the EU is envisioning. Against this context, batteries became the first product group to actually implement the digital product passport.

The idea of a product passport is not necessarily new. Communication about product quality has been a feature of the regulatory efforts of the EU and its predecessors since the inception of the EU. The 1980s and early 1990s (but the early efforts, for electrical equipment, go back as far as 1973) saw a lot of product specific compliance regulation. This was integrated in the CE mark in the beginning of the 1990s (Council Directive 93/86/EEC). The CE mark is, in principle, a generic label to signal that the product adheres to all relevant EU regulation. It does not, however, provide much background information on additional issues, such as on the material the product is made of.

³² https://unece.org/sites/default/files/2024-01/ECE-TRADE-481_DigitalProductsPassport.pdf

³³ <https://uncefact.github.io/spec-untpl/>

³⁴ <https://sesec.eu/2024/news-events/news/china-leads-the-ieee-standard-development-for-digital-product-passport/>

³⁵ https://standard.no/globalassets/kurs-arrangement-og-radgiving/standard-morgen-og-andre-arr/digitalt-produktpass/2-jtc24_introduction-for-standards-norway_msc-informasjonsmote-8-feb-espen-o.pdf

³⁶ In the battery regulation, this was still called a Mandatory Battery Passport.

The idea of a ‘product passport’ has also been around for some time. For the recycling of ocean vessels, for instance, a so-called green passport was created through the industry code of practice on ship recycling (August 2001). This regulation was later picked up by the International Maritime Organization, and integrated in the Hong Kong Convention on Safe and Environmentally Sound Recycling of Ships (signed in 2009, and will enter into force in 2025). This Green Passport should not only contain static product descriptives (name of the ship, owner, classification society), but also a list of hazardous materials in the ship’s structure and equipment as well as operational waste (e.g. oil) present in the ship. This information can then help to soundly recycle the ship in approved ship recycling facilities.

Finally, we have already alluded to mechanisms to carry information along the chain for supervision and compliance purposes by government agencies related specifically to taxation and security regulation. Solutions for this type of information provision have been piloted since 9/11, when the scarcity of information provision on international trade gained a lot more attention out of security concerns. Various pilot projects on smart container seals, food and pharmaceuticals monitoring and ideas how additional business data from the source can be used for compliance monitoring of international shipments have been performed over the last two decades (e.g. Tan et al., 2010)³⁷. The DPP developments that are currently evolving take the data collection at the product level a step further, and this offers new opportunities.

The problem with all these product labelling and informational requirements and solutions is that the wide variety of information and data - often presented in a fragmented way - becomes difficult to absorb for users, such as government agencies, recycling companies and consumers. This is recognized in the EU ESPR, where a unified framework is foreseen, at least from the perspective of product sustainability (sourcing of materials, manufacturing, re-use and recycling). While each product might still have its own informational content, the aim is to have a harmonized approach on how information is made available.

Where the ESPR motivates this vision very much from a circular economy point of view, the harmonized approach for sharing data about the products may cater for more needs than initially foreseen. Product-related information requirements (beyond the mandatory data that is currently foreseen), including e.g. those required for fiscal purposes (to determine the accuracy of border crossing tariff charges), may potentially also be shared via the DPP system architecture. Subsequently such data may be made accessible for the some parties (and not for others), and thus facilitate international trade, efficient border crossing, market access and sustainable use and re-use, all at the same time. Taking this perspective, legislations such EUDR may thus benefit from the DPP developments and related data sharing architecture development.

Information verification

Our focus is primarily on border crossing goods flows and the supervision requirements that need to be carried out at certain waypoints in these, often long, transport chains. Import waypoints are obviously borders. However, there are more physical locations where enforcement activities can be carried out. An example is a customs (or bonded) warehouse, where goods can be temporarily stored and exempted from paying duties and taxes, until they are introduced onto the EU market (i.e brought into free circulation). These warehouses can be anywhere within the EU territory.

Much of the new EU regulation in this whitepaper, concentrates on goods ‘placed onto the EU market’. This can be at the border, but also at any place within the EU, if the goods were stored under customs supervision. While the border is a place where goods can be held up for supervision and enforcement activities by border agencies, this is much less the case when goods leave a warehouse.

This problem is often very much a timing issue: supervision *could* take place if the competent authority would be informed on time, and is provided with the right information. In practice, however, procedures

³⁷ Tan, Y. H., Bjørn-Andersen, N., Klein, S., & Rukanova, B. (Eds.). (2010). Accelerating global supply chains with IT-innovation: ITAIDE tools and methods. Springer Science & Business Media.

have often been designed to allow for efficient distribution, and border authorities-related checks will have been done at the entry side of the warehouse, not at the exit side.

Another problem that emerges from the new regulation is that it relies on border authority to verify compliance requirements. While customs is first at the border, performing these checks would possibly go beyond the immediate competences of customs agencies. Much of the tax related supervision of customs is based on verifying origin, value and goods classification. These are data elements that customs can verify by comparing features of the physical good against the accompanying paperwork (trade documents, e.g. Bill of Lading, Transport Booking and customs declarations). For this purpose, customs agencies have elaborate departments specializing in goods classification, value assessment, or even chemical testing.

This is, however, not the case for many requirements that are implied by the new sustainability regulations: e.g. the accuracy of CO₂ data for CBAM, the deforestation free nature of some commodity, or the absence of forced or child labour. For this type of information requirements, the solution is to have the company bringing the goods into the EU make a formal statement of compliance. The correctness of these statements cannot be simply verified by comparing the physical goods against the trade/customs documents anymore. Often, these new regulations require another competent authority to perform these checks, and not necessarily customs.

This results in a second requirement to ensure reliable, trustworthy data in border crossing trade. A DPP could encompass some mechanism of independent verification of the reliability of (some of) the data. This would be a major improvement for many compliance related applications in which information needs to be provided to government agencies. In particular, it would allow border authorities to not only verify the *presence* of some compliance or due diligence statement, but to also *assess the reliability of the data* in the statement. In some specific cases, the actual underlying data would not even have to be shared to be able to assess its reliability.

4. DPP Technology

This chapter provides a brief overview of the technology behind the digital product passport concept. It is not an exhaustive discussion, but aims to provide some basic ideas of the breadth of the development.

Definitions and standards

It is important to highlight that the developments of DPP information architecture are fast-paced and need to be monitored continuously as they are currently taking shape. The standardization work for a DPP system is ongoing in CEN/CENELEC³⁸. It will take some time until that process is complete and the results are made available. In the meantime, based on ESPR requirements, potential high-level DPP systems architectures have been discussed in the CIRPASS project and further developed and piloted in the CIRPASS 2 project. Results of these pilots are still to be made available in the future as well. Therefore, in this section we focus on published results about the DPP system architecture of CIRPASS project to provide some initial insights. Due to the fast speed of development related to the topic, we recommend that the standardization efforts of CEN/CENELEC and pilot results with use of DPP system architecture such as developed in pilots such as in the CIRPASS 2 project are closely monitored in the future.

Due to the reasons above, much of the information on digital product passports and architectures in this section is based on already published work of the CIRPASS³⁹ project. CIRPASS stands for “Collaborative Initiative for a Standards-based Digital Product Passport for Stakeholder-Specific Sharing of Product Data for a Circular Economy”⁴⁰ and has the objectives “(1) To create an inclusive forum of all stakeholders to build a common understanding of a cross-sectoral DPP; (2) Build stakeholder consensus on DPP prototypes in three sectors: Batteries, Textiles and Electronics; (3) Focus on building a cross-sectoral DPP system; (4) Build/align terminology surrounding the DPP”⁴¹. CIRPASS 2 has mobilized a large stakeholder community, defined terms and produced a series of reports in consultation with a variety of experts involved in Digital Product Passport developments and as such provides a good point of departure with references and pointers to further relevant documents and developments. CIRPASS has already been completed, and the work is continuing in CIRPASS 2, where real-life piloting with DPPs is taking place.

In CIRPASS, the digital product passport is defined as

*“... a structured collection of product related data with pre-defined scope and agreed data ownership and access rights conveyed through a unique identifier and that is accessible via electronic means through a data carrier. The intended scope of the DPP is information related to sustainability, circularity, value retention for re-use, remanufacturing, and recycling.”*⁴²

In order to identify what was already happening in industry, the CIRPASS project initiated a survey to identify on-going DPP-related initiatives. This survey showed that there are many digitization efforts ongoing in supply chains⁴³. More than 200 initiatives were identified, many of which were platforms or traceability solutions, covering a variety of sectors. In most cases, these efforts attempted to build on IT solutions that are already in place.

CIRPASS then identified relevant standards for the ESPR essential requirements (see art 9 and 10 and Annex III of ESPR). The areas for standardization are identified as follow:

1. Data carriers;
2. Unique identifiers for people, companies, products, packaging, raw material, etc. and their verification;
3. Physical digital link, look-up mechanism;
4. Access right management;

³⁸ <https://standards.cencenelec.eu/BPCEN/3342699.pdf>

³⁹ Collaborative Initiative for a Standards-based Digital Product passport for Stakeholder-specific Sharing of Product data for a Circular Economy. Duration: 2022-2024.

⁴⁰ [Questions about the DPP? Please see our FAQ list! – CIRPASS](#)

⁴¹ [Questions about the DPP? Please see our FAQ list! – CIRPASS](#)

⁴² <https://cirpassproject.eu/faq/>

⁴³ The data set of DPP-related initiatives is available on the CIRPASS website- <https://cirpassproject.eu/dpp-related-initiatives-dataset/>

5. Interoperability (technical, semantic, organization), including data exchange protocols and formats and Data processing (introduction, modification, update);
6. Data storage;
7. Data authentication, reliability, integrity, data security and privacy.

A data set of related standards⁴⁴ is also available at the CIRPASS website, which is provided as input for the further standardization efforts. At the moment, the European Commission has issued a standardization request⁴⁵ to the European Committee for Standardisation, the European Committee for Electrotechnical Standardisation, and the European Telecommunications Standards Institute concerning digital product passports⁴⁶, in support of the European Union policy on eco design requirements for sustainable products and on batteries and waste batteries.

Note that the DPP standardization has a direct global dimension. When the EU develops standards for DPP, this can be only mandatory within the EU. These standards do not hold for other regions such as the US or China. However, in developing these standards, the EU would need to consider the impact of EU DPP regulation and standards have on other regions. The key issue is that these EU practices should not pose non-tariff barriers for other regions, because this will violate WTO trade agreements. So, the EU has to develop the standards in such a way that they are globally supported (e.g. endorsement by global standardization body ISO) and that companies from other regions outside the EU can easily adapt to these EU standards. The large international companies placing products on the EU market and having to issue DPPs will by their global nature support the global roll-out of these standards; e.g. they will require from their suppliers that they deliver according to the EU standards; e.g. most EV batteries are supplied by Chinese and/or South-Korean companies (CAITL, BYD, Samsung) to European EV car OEMs, and they will deliver these batteries with EU standardized DPPs. Also, alignments is ongoing the between EU DPP developments and global efforts such as the UN Transparency Protocol (UNTP)⁴⁷, which has very active links with the original UN CEFACT program.

Architecture

In the context of digital product passports, a first distinction is made between *DPP System* and the *DPP Data*. The DPP System is about how to share DPP data. Here the goal is to get to a common approach on data sharing, including a fully distributed data sharing infrastructure. The DPP Data covers what is actually shared, and this will be different for the different product categories and regulatory uses of the DPP. As defined by CIRPASS “The DPP-system is the set of IT standards and protocols that will be needed to make the DPPs work (with full interoperability in mind). The DPP-data is the set of information that will be included in each DPP, and that will be product-group dependent”⁴⁸.

In CIRPASS, an initial information analysis⁴⁹ was performed for three product groups, namely Textiles, Electronics and Batteries. Especially for the Batteries, the EU Battery Regulation⁵⁰ already defines detailed information requirements. We will come back to this in a separate section where we will look at the battery digital product passport example. Having in mind that a lot of digital solutions are already being developed by businesses to capture and share data that is relevant for product passports and having in mind the ESPR providing the umbrella for the DPP technology, the CIRPASS project proposed two architectures for DPP data sharing⁵¹. The actual architecture pictures can be found in Wenning et al. (2024, p28 and p.50)⁵².

⁴⁴ <https://cirpassproject.eu/dpp-related-standards-dataset/>

⁴⁵ [https://ec.europa.eu/transparency/documents-register/detail?ref=C\(2024\)5423&lang=en](https://ec.europa.eu/transparency/documents-register/detail?ref=C(2024)5423&lang=en)

⁴⁶ <https://standards.cenelec.eu/BPCEN/3342699.pdf>

⁴⁷ <https://uncefact.github.io/spec-untp/assets/files/Short-UNTP-Presentation-63ea170a29d03b2ed5d39853d03dc027.pdf> (see slide 6 on links EU DPP and UN TP as developed in collaboration with CIRPASS).

⁴⁸ <https://cirpassproject.eu/faq/> (see definitions under DPP system and DPP data).

⁴⁹ https://cirpassproject.eu/wp-content/uploads/2024/06/D2.1_Mapping-of-legal-and-voluntary-requirements-and-Screening-of-emerging-DPP-related-pilots-17-07-2023_new.pdf

⁵⁰ https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en

⁵¹ <https://cirpassproject.eu/wp-content/uploads/2024/06/D3.2v1.9.pdf>, p.28 and p.50

⁵² Wenning, R., Papadakos, P., & Bernier, C. (2024). DPP System Architecture (V1.9). CIRPASS Consortium. <https://doi.org/10.5281/zenodo.12206138>

The DPP system architecture envisages (1) distributed data storage, (2) data resides with the data owner, (3) the use of linked data. In the architecture it is envisaged is that original data resides with the traders or their service providers, and that the actual data sharing is based on the principle of *Linked Data*⁵³. The CIRPASS architecture introduces the concept of a Decentralized DPP Data repositories, which is then treated as a black box to allow for parties to implement this in different ways that are suitable for them with respect to their existing solutions and preferences. The DPP architecture proposed by CIRPASS is flexible and allows for different implementations. Blockchain may be used but is not really required in the architecture and parties are free to select solutions.

The CIRPASS architecture puts a thin layer on top of diversity of existing IT solutions in order to make it possible to address requirements from ESPR. By a *thin layer* architecture we mean that the architecture allows for reuse of a variety systems that companies and supply chains may have in place where they hold data that is relevant for the DPP. All data is stored in the databases of the data owning party, or their service providers, and is shared with other parties via the linked data principle. The key element of the architecture is that data is distributed and it resides in the systems of the economic operator. Data can be accessed via linked data. And in line with ESPR, only a few data elements (e.g. identifier, facility) will be pushed to a centralized DPP registry. Each product would have a physical carrier with a Unique Identifier and a digital link that will link the physical carrier to the data about the product.

A key actor in the architecture is the Responsible Economic Operator (REO), associated with the economic operator that places a product (for which DPP is required) on the EU market. The Responsible Economic Operator needs to register the product in a centralized DPP registry. This centralized DPP registry will contain only very limited information about the product, such as the Identifier of the REO, the product identifier and the facility identifier.

This centralized DPP registry will be linked to the EU Customs Single Window *Certificate Exchange System* (CERTEX)⁵⁴, which allows Customs authorities in EU Member states to check whether a product that is imported in the EU has a registered product passport. Through a digital link to the DPP parties can access the DPP data that is stored in the Decentralized DPP data repositories⁵⁵

The actual implementation can be done via e.g. QR codes; i.e. through scanning the QR code on the product the link to the data can be activated via the QR reading device (this can basically be any smartphone but also an industrial scanner).

The legislation also foresees the *DPP Archive*, as well as DPP *back-up* service providers, so that access to DPP data is possible for e.g. repair/ reuse and recycling, even in cases when an economic operator that issued the DPP is out of business.

The two architectures proposed in CIRPASS differ in a way that one relies on standard state-of-the art internet technology using so-called *Resolvers* to find out where the data linked to this DPP resides. The second architecture (see Wenning et al. (2024, p.50)⁵⁶ relies on another technology, namely *Distributed Identifiers* (DID) and *Verifiable Credentials* (VC)⁵⁷. We will not go into the technical details of this architecture but it is important to highlight that international developments such as the UN Transparency protocol also

⁵³ See for example, <https://www.ontotext.com/knowledgehub/fundamentals/linked-data-linked-open-data/#:~:text=Linked%20Data%20is%20a%20set,is%20an%20example%20of%20LOD.>

⁵⁴ https://taxation-customs.ec.europa.eu/eu-single-window-environment-customs_en

⁵⁵ There may be different ways that the data access to the DPP data can be implemented.

⁵⁶ Wenning, R., Papadakos, P., & Bernier, C. (2024). DPP System Architecture (V1.9). CIRPASS Consortium. <https://doi.org/10.5281/zenodo.12206138>

⁵⁷ See [https://www.w3.org/TR/did-core/#:~:text=Decentralized%20identifiers%20\(DIDs\)%20are%20a,the%20controller%20of%20the%20DID.](https://www.w3.org/TR/did-core/#:~:text=Decentralized%20identifiers%20(DIDs)%20are%20a,the%20controller%20of%20the%20DID.) And <https://www.w3.org/TR/vc-data-model-2.0/#what-is-a-verifiable-credential>

rely on the use of Verifiable Credentials to ensure the trustworthiness of the data. We will discuss the UN Transparency protocol developments in the next section.

As already pointed out at the beginning of this section, it is important to highlight that the DPP standardization request to CEN/ CENELEC is currently ongoing. The CIRPASS project has proposed two architectures of CIRPASS while in CIRPASS 2 these architectures are being further developed and piloted. This piloting will run in parallel with the standardization efforts and further DPP developments at EU level.

The UN Transparency initiatives and verifiable credentials

The origin of the Verifiable Credentials (VC) development is the World-Wide-Web Consortium (W3C), which has developed essentially a digital version of credentials that every person and business may carry: passport, driver's license, degrees and diploma's or formal certificates of incorporation. The basis architecture of the VC contains an 'issuer', an 'verifier' and a 'user'. The user, or holder, of the credentials obtains them from an issuer, who can be a governmental body or a certification organization, and presents the credentials, upon request, to the verifier. The issuer and the verifier have a trusted relationship, and they communicate indirectly, via a so-called verifiable data or trust registry. In this registry, the issuers record the credentials they have issued, and in this same registry, the verifiers can check the elements of the credentials that the user or holder presents to them.

The UNTP proposes that on this generic architecture, the digital product passport can embed verifiable credentials for some, or all of its data content⁵⁸. In addition, so-called traceability events could be recorded in the digital product passport, which allows the building up of a linked data trail where raw materials can be linked to finished products. In this way, the materials information in the products passport need not be actively recorded, but can emerge from the traceable processing of the original materials. Note that this idea goes further than the original EU DPP regulation⁵⁹. However, the UN Transparency protocol allows to create upstream traceability and transparency which will be very useful for validating claims in the EU DPP as well.

This type of technology, in combination with the DPP, could solve some of the problems we have identified in previous sections, such as the unwillingness of countries to share digital location data with other governments. The VC add-on on the DPP could allow for the sharing of the credentials without sharing of the underlying data. This credential could, for instance, be a confirmation of the verification of location data against the EU deforestation database.

⁵⁸ See <https://uncefact.github.io/spec-untp/docs/specification/>

⁵⁹ See slide 6 (produced in collaboration with CIRPASS) of the presentation, <https://uncefact.github.io/spec-untp/assets/files/Short-UNTP-Presentation-63ea170a29d03b2ed5d39853d03dc027.pdf> for the link UN Transparency Protocol and the EU DPP.

5. Example: Battery Pass

One of the first examples of a product category with mandatory DPPs is going to be *batteries*, as the battery regulation (Regulation (EU) 2023/1542) requires from 18 February 2027 each LMT⁶⁰ battery, each industrial battery with a capacity greater than 2 kWh and each electric vehicle battery placed on the market or put into service shall have an electronic record ('battery passport') (p. Chapter IX, Art 77 (1))⁶¹. The battery regulation defines detailed data requirements about data that needs to be included in the Battery passport. This information includes among others (regulation, Annex VI): information on the manufacturer, the type of battery, weight, capacity, chemistry, hazardous substances, extinguishing agents, and critical raw materials in the battery.

This regulation entered into force on 17 August 2023. The existing Batteries Directive will be repealed in 2025. From 2025, the regulation will introduce additional requirements: targets for recycling and material recovery from 2025 onwards, from 2027 batteries should be removable and replaceable at any time from consumer products, and the labelling on the product should be in place to support this (including a QR-code). The research required for implementation of the battery Passport was the topic of the BatteryPass⁶² project.

In particular, the BatteryPass *Attribute Long List*⁶³ defines more than 100 data points relevant for battery passports based on the Battery Regulation. The battery passport is a specifically interesting use case, because it has data elements that require tracking of so-called *dynamic data* on an item level for each battery. Examples of such dynamic data are data elements related to the state-of-health and state-of-charge of a battery. These data elements change continuously during the lifetime of a battery; hence *dynamic data*. Such data is needed to define whether a battery can be re-used or needs to be sent for recycling. But it is also important information that is needed for the safety of the transport of the battery.

This dynamic data is very interesting for several reasons. First of all, unlike *static data* such as data related to the model, certificate data, or manufacturer data, the dynamic data requires access to detailed item level data that changes over time; e.g. the state-of-charge data changes continuously, and is typically only available from the *Battery Management System* in an EV car. For access to such data, the data architecture needs to allow for solutions to make it possible to access such (external) data during the lifetime.

The BatteryPass project has also elaborated on the digital product passport based system that will fulfil the requirements of the regulation. A detailed diagram is available in the BatteryPass Content Guidance (p. 37)⁶⁴. The technical design and operation of the battery passport envisages separate levels: data collection; data exchange, data processing and data access. The system can accommodate the collection of both static and dynamic data.

This example shows the complexity of the data handling that is required even for this first application. The architecture of the DPP should therefore be elaborate enough to facilitate capturing dynamic data in the DPP. At the same time, all data in the DPP should, in principle, be subject to independent verification of the data by a *verifier*. If this works for batteries from 2027 onwards, such an approach should also be flexible enough to capture data – both static and dynamic - in the context of the EUDR.

⁶⁰ Light Means of Transport (LMT). The rest of the world probably uses Light Electric Vehicle or LEV.

⁶¹ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1542>

⁶² <https://thebatteryass.eu/>

⁶³ https://thebatteryass.eu/assets/images/content-guidance/pdf/2023_Battery_Passport_Data_Attributes.xlsx

⁶⁴ https://thebatteryass.eu/assets/images/content-guidance/pdf/2023_Battery_Passport_Content_Guidance.pdf

6. DPP and customs and border authorities' supervision

The EU DATAPIPE project⁶⁵ has examined the potential of digital infrastructures and digital product passports from the point of view of customs and border authorities and its potential for circular economy and sustainability monitoring. The project looks in the future and examines the potential of authorities to use DPP data for compliance monitoring of circular economy and sustainability. The DATAPIPE project produced a comprehensive conceptual analysis and blueprint⁶⁶. While EUDR was not the primary legislation under analysis in the DATAPIPE project, findings are potentially relevant in the context of EUDR and beyond.

One observation in the DATAPIPE report is that there is a great legislative complexity, as there are more and more legislations affecting international supply chains with requirements for circularity and sustainability and there is a digital complexity of accessing the data. Possibilities to access digital infrastructures and transparency systems may allow for accessing data that serves different legislations. Progress is being made both on the business side for setting transparency systems and also on the government side. However, more efforts would be needed on both sides to further enhance the potential. The DATAPIPE project reviewed the possibilities for customs and border authorities by examining the developments on the DPP side, as well as developments as part of the EU Customs reform.

An interesting new development is that the European Commission published the *EU Competitiveness Compass*⁶⁷, in which they emphasize that more *Simplification* is needed to reduce the administrative burden on trade due to the complexity of too many new sustainability regulations. It is argued that all these regulations should be harmonized in a so-called *omnibus* regulation.

The ESPR regulation comes with a specific vision on how the Digital Product Passports need to be aligned with new and existing supervision IT infrastructure. In particular, it mentions the mandatory DPP Registry and the link to the existing EU Customs Single Window CERTEX system, as can be seen also in the CIRPASS architecture⁶⁸. The latter would allow Customs to access the limited DPP data elements that are part of the EU Central DPP registry. This information about the identifiers of product, facilities, economic operators, provides some information for customs risk analysis and can help customs to check whether products have a valid DPP registration.

The integration of new DPP system infrastructure with existing systems such as CERTEX is foreseen in the ESPR legislation. Currently, the CERTEX system is a central data base that stores certificate numbers, and is used by customs at the border to validate whether the certificate number used in the customs declaration actually exist. So, in the DPP context, it would allow customs and other border authorities to check whether a product has indeed a registered DPP in the DPP registry. Note however, that for getting access to the DPP data beyond the limited number of data elements in the centralized DPP registry, authorities would need functionalities to approach this data that resides in the disperse systems of the businesses or their service providers. This capability of accessing dynamic data goes way beyond capabilities of current systems like CERTEX which is only capable to store static data and data that is stored centrally, rather than dynamic data that resides with economic operators. In ESPR it is foreseen that access to the DPP data can be done via a DPP portal. It is likely that the portal requirements for consumers and authorities for accessing DPP data may differ. The functionality of the portal is still under development.

Looking at the future, the full DPP data, beyond what is available in the centralized DPP registry, may become relevant for customs and other border authorities. For example, the state-of-charge level dynamic data is

⁶⁵ <https://www.tudelft.nl/tbm/onderzoek/projecten/datapipe-project>

⁶⁶

https://filelist.tudelft.nl/TBM/Onderzoek/Projects/DATAPIPE%20Conceptual%20analysis%20and%20blueprint_D2.2_PU_FINAL_v1.0.pdf

⁶⁷ chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en

⁶⁸ <https://cirpassproject.eu/wp-content/uploads/2024/06/D3.2v1.9.pdf>, see p.28

essential for the inspection of batteries during transport. The Dutch regulation PGS 37-2⁶⁹ mandates that a transporter can prove at all stages of transport and warehousing that all the batteries it is transporting or stored have a state of charge level as prescribed by the battery manufacturer, and if this information is not available then it should be charged every 3 months between 30%-50%, because below 30% and above 50% there is risk of battery explosions. This implies there should be a periodic online reading of the charge level of the battery. It is to be expected that all EU member states will issue similar regulations. Currently, EU customs are not responsible for inspecting this type of regulation at the EU border, but this might change in the future.

In general, how external business data, that resides in the systems of the economic operators, can be accessed by the authorities is not yet defined in CIRPASS 2. Due to the distributed nature of the data it would require specific capabilities of customs or border authorities in general for accessing external business data. In the DATAPIPE project, a demo⁷⁰ was developed on how authorities may potentially access such external business data. Further piloting would be needed to test these functionalities in real-life pilots. Such developments of how to access additional business data such as Digital Product Passport data are also potentially relevant in the context of the EU Customs reform⁷¹ as well. This holds specifically for developments related to the *EU Customs Data Hub* and the *Trust- and- Check* model. However, as DPP developments affect both products produced in the EU and outside the EU, a solution for authorities for accessing the DPP data may be needed for different authorities that need to access and use the DPP data (also to control the goods that are on the internal market but do not leave the EU borders). For customs authorities, a sub-set of the DPPs, i.e. those that have to do with border crossing activities will be relevant. The DATAPIPE project examined also the issues that governments face with dealing with legislative complexity and digital complexity⁷². In the DATAPIPE project, for reducing the legislative complexity of having to deal with multiple legislations it is proposed to use a common set of concepts (based for example on UN Recommendation 46⁷³) that capture different information requirements of the authorities based on different legislations⁷⁴. These common set of concepts could be then used by the authorities to formulate structured information requests (queries) to the business digital infrastructures and DPPs to obtain data that they need for their monitoring purposes⁷⁵.

Capabilities for accessing external DPP data sources by authorities will still need to be developed. The DPP portal, the EU Customs Data Hub, as well as national innovation efforts of customs in EU member states to access external DPP data sources are still under development and it will be important to monitor the direction of these developments in the future and see what opportunities they provide. Innovation ideas such as the *Data Pipeline* could be a source of inspiration for these innovations.⁷⁶

⁶⁹ <https://publicatierEEKSgevaarlijkstoffEN.nl/publicaties/online/pgs-37-2/2023/0-2-november-2023#7>

⁷⁰ See DATAPIPE short demo video <https://collegerama.tudelft.nl/Mediasite/Channel/datapipe-project/watch/4d5977b967a848509d8f8b0ea11e390c1d>, as well as the DATAPIPE developers' video <https://collegerama.tudelft.nl/Mediasite/Channel/datapipe-project/watch/f3a9265c04e0449db155393c68dd80fc1d>

⁷¹ https://taxation-customs.ec.europa.eu/customs-4/eu-customs-reform_en

⁷² Hofman, W., Rukanova, B. D., Ubacht, J., Tan, Y., Rietveld, E., Lennartz, J., Agahari, W., Chirvasuta, T., & Schmid, J. (2024). Government Accessing Business Data for Compliance Monitoring of Circular Economy: DATAPIPE White paper. (pp. 1-6). <https://doi.org/10.13140/RG.2.2.34052.74885>

⁷³ <https://unece.org/sites/default/files/2022-01/ECE-TRADE-463E.pdf>

⁷⁴ Rukanova, B., Ubacht, J., & Tan, Y. H. (2024, June). Border Crossing and Circular Economy Monitoring in a Global Context: Challenges and Opportunities. In Proceedings of the 25th Annual International Conference on Digital Government Research (pp. 331-340). <https://dl.acm.org/doi/pdf/10.1145/3657054.3657196>

⁷⁵ See also the DATAPIPE GitHub page for examples of queries based on UN Recommendation 46 concepts- <https://github.com/Datapipe-demonstrator/semantic-interoperability/tree/main/UNR46%20queries>

⁷⁶ Heijman, F.H.A. & Peters, J. (2022). *Customs; inside anywhere, Insights everywhere*. Trichis Publishing

7. Reflection on the way forward

Taking CBAM and EUDR as examples, we see businesses and authorities looking for solutions. This search is restricted by the very limited time frame allowed by the regulation before it enters into force. In this short time window businesses need to adapt their IT systems and develop new capabilities to provide additional sustainability data that originate from deep out of their supply chains. This requires verifiable data that often originates in countries way beyond the jurisdiction of the EU. At the same time authorities also need to develop IT systems and capabilities how to monitor these new legislations and how to check that the data comes from valid sources. Driven by these deadlines, businesses and authorities will look for quick solutions for compliance. But at the same time, we know that more will come. New legislations are already there with new deadlines (e.g. 2027 for the battery regulation, ESPR for different product groups will gradually also follow, resulting in mandatory digital product passport for specific product groups). Other legislations like the forced labour regulation proposal⁷⁷ are on the way. Therefore, businesses and governments need to look at the short run, and at the same time keep an eye on future legislative demands and what requirements for data and transparency they will bring.

In this paper we presented an overview of on-going initiatives and developments that may be relevant to make the first steps into this future. Especially in the border-crossing context, where additional data sources for border authorities for safety and security and trade facilitation are considered, new developments such as DPP and the UN Transparency Protocol provide additional pieces of the puzzle. These pieces enable the digitizing and linking of logistics data with DPP product data. Coupled with verifiable data from deep in the supply chain about issues such as labour conditions or deforestation, this will help to streamline and manage new and complex regulatory demands. Some parties that are directly affected by CBAM or EUDR, may have very limited insights into the status of DPP and related developments. In this document we provided pointers to sources and research projects that create more awareness. Beyond that, a broader discussion will be needed about how developments such as Digital Product Passports and supply chain transparency systems, and the use of verifiable credentials, may be used as building blocks for long-term solutions for compliance.

What is needed is:

- (1) Create awareness among businesses, their service providers (both compliance service providers, and DPP and traceability service providers), authorities and policy makers about multiple legislations and a combination of developments: cross-border logistics, DPP, transparency systems and verifiable data developments. Only when such an awareness is created, is it possible to engage in a partnership between trade and government to jointly search for win-win solutions. Pilot projects are essential for testing these solutions, and learning before making further upscaling steps in specific directions.
- (2) For businesses it is clear that more and more pressure will come in the future to show data and assurances from the supply chain partners. Securing access to verifiable data is essential but it is also very hard to obtain. This requires changes in business practices, and discussions and negotiations with their supply chain partners about the data and verifiability of data.
- (3) New capabilities are needed both on the business and the government side. Key questions for discussions would also need to address how these capabilities on the business and government side can be created and which parties, including the European Commission itself, can facilitate this process
- (4) Last but not least, alignment will be key. While many of the legislations we are discussing are European, the supply chains are global. Data that is of value for the EU market surveillance authorities, is often generated outside the EU. Therefore, harmonization and alignment at global level (e.g. EU DPP developments aligned with DPP developments in other regions; e.g. China) is essential to avoid the costs and the burdens of non-interoperable systems.

⁷⁷ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0453>