trustrace

WORK PACKAGE: PIONEERING DIGITAL PRODUCT PASSPORTS

TRANSFORMING TEXTILE INDUSTRY STANDARDS

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Project manager: TrusTrace, supporting project management: Circularista
Start date: 2022-10-01
End date: 2024-08-30
Project participants: TrusTrace, Kappahl, Marimekko, SIS Swedish Institute of Standards, GS1 Sweden, Cirularista, 2B Policy, TexRoad Foundation, Trimco Group, Rudholm Group

ABSTRACT

In alignment with the EU Strategy for Sustainable and Circular Textiles, the Ecodesign for Sustainable Product Regulation (ESPR) mandates that all textiles sold within the EU by 2027-2028 must be accompanied by digital product passports (DPPs). These passports provide comprehensive information about the product and its materials throughout its lifecycle, necessitating a robust technical architecture and infrastructure to facilitate seamless data sharing across the value chain. Our pilot project is innovating the DPP system.

Through our groundbreaking Trace4Value initiative, we are piloting the entire technical architecture and infrastructure of the DPP system. Over 3000 pilot products from leading brands Kappahl and Marimekko have been equipped with ID carriers storing crucial supply chain and transparency data. The ID carrier, a QR code, was attached to the garments in the production stage, by Kappahl and Marimekko suppliers. By scanning the QR code with a mobile device, consumers and stakeholders can instantly access detailed product information. Our DPP system adheres to global standards for interoperability and employs decentralized data storage across two platforms.

1. GOALS AND OBJECTIVES

The goal was to successfully pilot a scalable and interoperable DPP system in the textile industry, from the production of the garment to the sharing of data to the consumer.

To reach the goal the project aimed to achieve the following objectives:

- **Identify and Gather Required Data:** Determine and document the essential data attributes necessary for comprehensive DPPs in compliance with EU regulations and industry standards. Identify and gather available data.
- **Establish Data Infrastructure:** Develop and implement a robust data infrastructure system capable of supporting the storage, management, and validation of DPP data across the product lifecycle.
- **Implement Unique Product Identification:** Attach unique digital carriers, QR codes, to over 3000 garments, linking them directly to their respective DPPs.
- **Involve Stakeholders:** Engage relevant stakeholders, including label providers and suppliers, to pilot the DPP in a live operational environment.

- **Enable Consumer Accessibility:** Design and deploy a user-friendly consumer interface that allows seamless access to DPP information via scanned QR codes on garments, ensuring transparency and engagement.
- **Extract Insights and Share Learnings:** Utilize analytics to gain actionable insights into user interactions with DPPs and share key learnings.

These objectives aligned with the project's overarching goal of implementing DPPs in the textile sector, with a strong focus on data management and integrity, accessibility, and the dissemination of knowledge.

2. BACKGROUND

The project was initiated in response to broader initiatives outlined by the European Union (EU) aimed at achieving ambitious climate targets and fostering sustainability across industries. At the heart of these efforts is the European Green Deal, introduced in 2020, which commits the EU to reducing net greenhouse gas emissions by at least 55% by 2030 and achieving climate neutrality by 2050. Central to the Green Deal is the Circular Economy Action Plan 2020 (CEAP), which emphasizes sustainable product design, consumer empowerment, product lifecycle extension, and waste reduction.

Specifically, within the textiles sector, the EU Strategy for Textiles, introduced as part of the Circular Economy Action Plan (CEAP), mandates compliance with the Ecodesign for Sustainable Products Regulation (ESPR). This regulation includes a requirement for DPPs for each textile product, aimed at achieving the following objectives[1]:

- enhance sustainable production
- extend product lifetimes, optimizing product use, and providing new business opportunities to economic actors through circular value retention and extraction
- support consumers in making sustainable choices
- enable the transition to the circular economy by boosting materials and energy efficiency
- support authorities to verify compliance.

[1] European Union, 2024. "Proposal for a Regulation Establishing a Framework for Eco-design Requirements for Sustainable Products." Official Journal of the European Union, 2024. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL
. Accessed [2024-07-04].

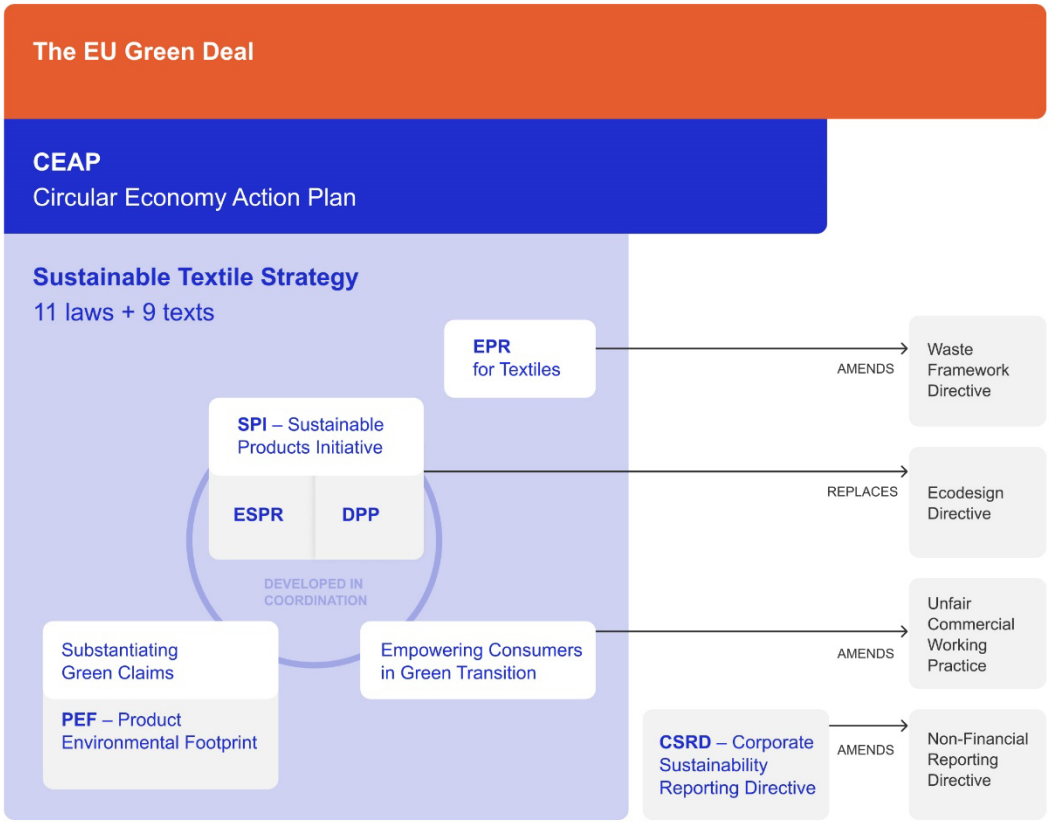

Figure 1. Infographic on the European legislative framework.

In summary, the project aligns with EU directives prioritizing sustainability and climate action by implementing DPPs in textiles by 2028. This initiative supports circular economy principles and aims to achieve stringent environmental goals outlined in the EU Green Deal and Circular Economy Action Plan (CEAP). However, at the project's inception, the relevant EU regulations were still evolving. As of now, the EU has not yet released delegated acts that specify requirements for specific industries, including textiles (expected in 2026). This uncertainty includes, for example, information requirements and the design of the DPP system.

Consequently, the scope, implementation plan, and project structure were developed dynamically. Continuous adaptation was necessary as updates and new findings emerged from the EU and the EU's CIRPASS project. CIRPASS aimed to prepare the ground for the gradual piloting and deployment of the Digital Product Passports[2]. This pilot was designed to be agile and flexible, facilitating the efficient incorporation of new information and requirements. This approach ensured responsiveness to the evolving regulatory landscape while effectively meeting project objectives.

The following sections provide a detailed account of the project's comprehensive activities, encompassing requirement analysis, development of a data protocol, creation of a consumer

[2] CIRPASS Digital Product Passport, 2024. “Welcome to CIRPASS” Available at: https://cirpassproject.eu/ Accessed: [2024-07-04].

interface, design of technical architecture, implementation of unique product IDs, data gathering, and piloting of a technical framework for managing live data accessible to end consumers.

3. PROJECT ACTIVITIES

The project comprised several key activities to achieve its objectives effectively:

1. **Gathering knowledge of the DPP and the DPP system:** Conducted extensive research on the DPP system to establish the scope and strategic direction
2. **Analyzing information requirements and developing the DPP Data Protocol:** Conducted a comprehensive analysis to determine the necessary information requirements for a DPP in the textile sector, considering evolving EU regulations and findings from the CIRPASS project, and formulated a detailed data protocol ensuring data viability, accessibility, machine-readability, and interoperability while protecting personal and corporate information.
3. **Designing a consumer interface and choosing what data to share:** Designed and developed a user-friendly consumer interface to provide access to DPP information through QR code scanning, ensuring ease of use, configurability, and scalability.
4. **Designing the technical architecture:** Designed and piloted a robust, scalable, and resilient technical architecture following ESPR regulation recommendations, incorporating API infrastructure and decentralized data storage.
5. **Creating unique product IDs:** Implemented unique QR codes linked to DPP data on over 3,000 garments, involving the creation, mapping, and printing of labels in manufacturing facilities, and attachment of these labels to the correct, unique garments.
6. **Gathering data:** Identified sources and gathered data according to the established protocol, with selected attributes defined by EU requirements. Data was dispersed across various systems within the brand's system landscape.
7. **Piloting the technical framework:** Developed and deployed an IT solution to manage live data, allowing consumers to access DPP information by scanning QR codes and evaluating user interactions through analytics.
8. **Writing a master thesis:** Documented the research on the opportunities and challenges of introducing DPPs for the textile and fashion industry, incorporating project insights and external interviews.

These activities were executed to ensure the project remained responsive to regulatory changes, aligned with industry needs and demonstrated operational implementation in practice, ultimately contributing to the successful implementation and evaluation of DPPs in the textile sector.

4. STRUCTURE AND IMPLEMENTATION

This section outlines the execution strategy of the project, detailing the roles, responsibilities, and methodologies employed to achieve the project's objectives. It encompasses the project's overall structure, specific phases, and critical activities that contributed to the successful implementation of the DPP system in the textile industry.

4.1 PROJECT ORGANISATION:

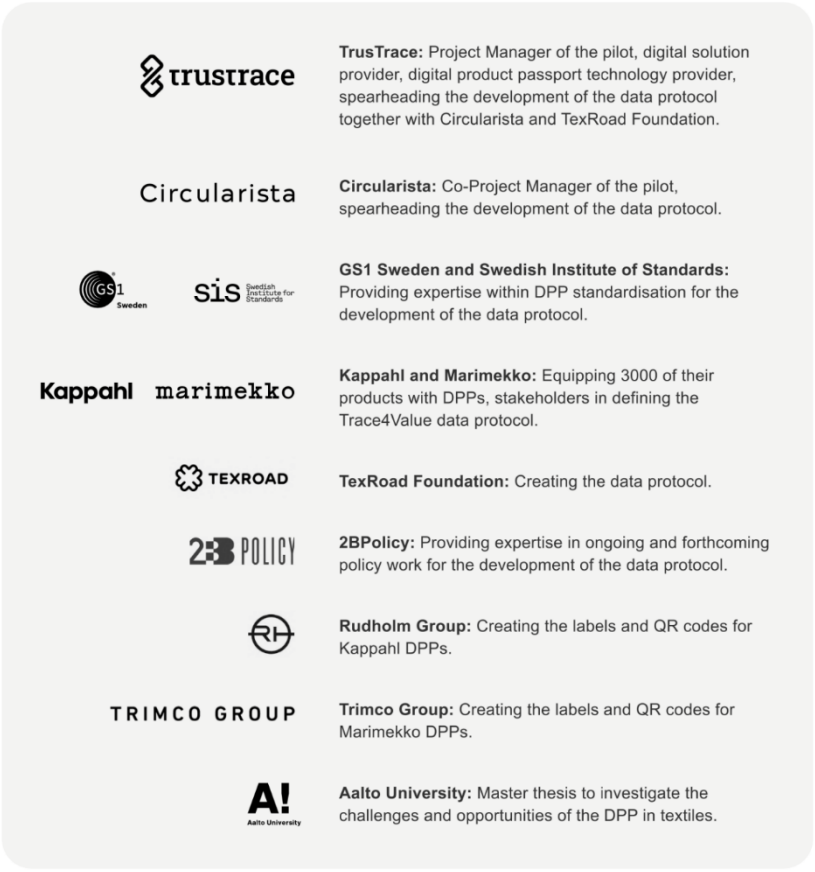

Figure 2. The figure describes the project partners and their respective roles

Marimekko and Kappahl engaged their entire organizations, from IT, Sales, Supply Chain and Product Development/Innovation departments to the Sustainability team, as well as their manufacturers and label suppliers. For Marimekko, the focus was on their key production location in Portugal. Kappahl involved two production locations: Bulgaria and India. Both brands played crucial roles in co-creating the data protocol, implementing digital data carriers, providing DPP product data, and launching the DPP products onto the market.

4.2 PROJECT ACTIVITIES AND RESULTS

This section delves into the specific activities undertaken during the project and the resulting outcomes. Each activity is described in detail to highlight the processes involved and the achievements realized. The focus is on the practical steps taken to implement the DPP system, from initial research to tangible results.

4.2.1 GATHERING KNOWLEDGE OF ESPR, THE DPP AND THE DPP SYSTEM

A pivotal phase in the project involved conducting comprehensive research on the DPP and its system to establish scope and strategic direction. This endeavour was crucial for laying a solid foundation and guiding subsequent project activities effectively.

Initially, efforts focused on understanding the fundamental concept of the DPP, including its objectives in promoting sustainability and supporting circular economy principles. This included analysing existing DPP implementations across industries, studying case studies, and reviewing reports to identify best practices and challenges.

Additionally, research delved into the regulatory landscape governing DPPs, particularly EU directives such as the Eco-design for Sustainable Products Regulation (ESPR). This exploration ensured alignment of project objectives with regulatory requirements and strategic goals.

Identifying key stakeholders and their roles within the DPP ecosystem was critical. This involved mapping out the responsibilities of manufacturers, brands, consumers, regulatory bodies, and technology providers to facilitate collaborative efforts towards successful DPP implementation. This phase also defined the initial scope of the pilot project.

Furthermore, research extended to evaluating technical infrastructure and data requirements essential for supporting DPPs in the textile industry. Various technologies and data management systems were assessed for their suitability in collecting, storing, validating, and accessing DPP-related information, emphasizing interoperability and compliance with industry standards.

By undertaking this rigorous knowledge-gathering process on the DPP and its system, the project was well-positioned to advance its goal of implementing a scalable and interoperable DPP system in the textile industry. This foundational work ensured that project activities were grounded in thorough research, strategic foresight, and alignment with industry best practices and regulatory mandates.

Findings

The European Commission defines a DPP as a tool “...to electronically register, process and share product-related information amongst supply chain businesses, authorities, and consumers[3]”. The DPP is defined by CIRPASS as "...a structured collection of product related data with pre- defined scope and agreed data management and access rights

[3] European Union, 2024. "Proposal for a Regulation Establishing a Framework for Eco-design Requirements for Sustainable Products." Official Journal of the European Union, 2024. Item (26) to (39) (page 25-27 of the Proposal) Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL Accessed [2024-07-04].

conveyed through a unique identifier and that is accessible via electronic means through a data carrier[4]."

Based on the research, the project established that the DPP consists of three primary components:

- **DPP Data:** Comprehensive information about the product meticulously aligned with the defined scope, definitions, and standards set for DPPs, encompassing data on materials, supply chain, compliance, circularity, and environmental impact.
- **IT Systems and Architecture:** Robust IT systems designed to facilitate seamless data interoperability across various platforms and stakeholders.
- **Unique Product Identifier:** A distinct digital identifier assigned to each product, serving as its digital fingerprint, enabling efficient access to product-specific information via a designated data carrier.

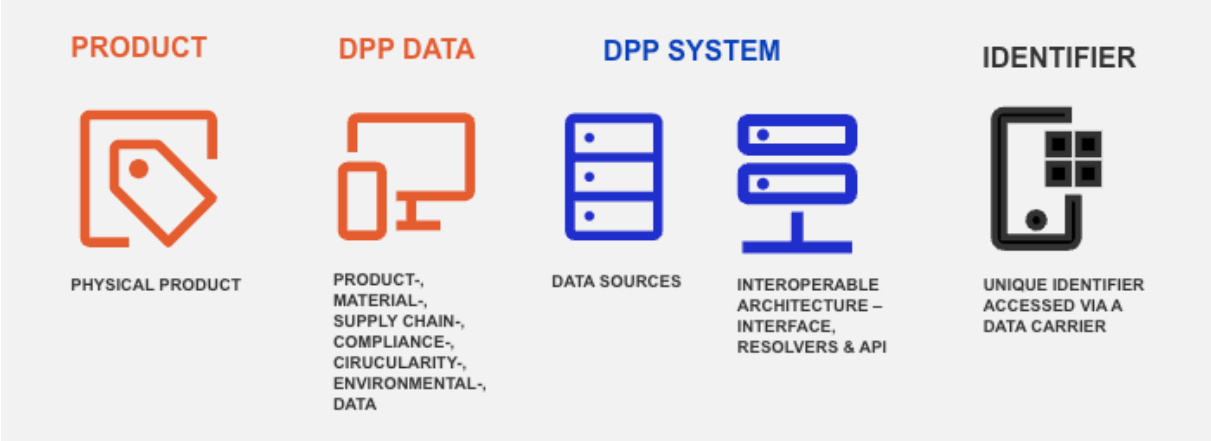

Figure 3. Infographic of the Digital Product Passport (DPP) and its components.

The DPP system is designed to encompass data sharing and enrichment across the entire circular lifecycle—from sale through repair, reuse, to recycling—and engage all stakeholders in the circular value chain. Key actors include[5]:

- **DPP Creator - Responsible Economic Operator (REO):** Brands and retailers responsible for placing products on the market and implementing the DPP.
- **DPP User - Consumers/Customers:** Product purchasers who scan the data carrier to access product information.
- **DPP User - Public Authorities:** Regulators, customs, and market surveillance authorities requiring access to aggregated DPP data.
- **Circular Economy Operators (CEOPs):** Encompassing both product life extension actors (e.g., repairers, remanufacturers) and end-of-life managers (e.g., recyclers, waste handlers) who utilize and contribute to the DPP:

[4] CIRPASS, 2024. "DPP in a nutshell". Available at: https://cirpassproject.eu/dpp-in-a-nutshell/ Accessed [2024-07-04]
[5] CIRPASS, 2024. *D2.2 DPP Use Cases Report* ,"Primary role related to DPP for each stakeholder category" page 81, table 11. Available at: https://cirpassproject.eu/wp-content/uploads/2024/04/CIRPASS_D2.2_DPP_UseCases_Report_v2.0.pdf Accessed [2024-07-04].

- **DPP User and Contributor - Product Life Extension Actors:** Responsible for adding data throughout the product lifecycle, such as information on repaired materials, ensuring DPP information accuracy.
- **DPP User - End-of-Life Managers:** Require access to aggregated DPP data for efficient management of end-of-life products.

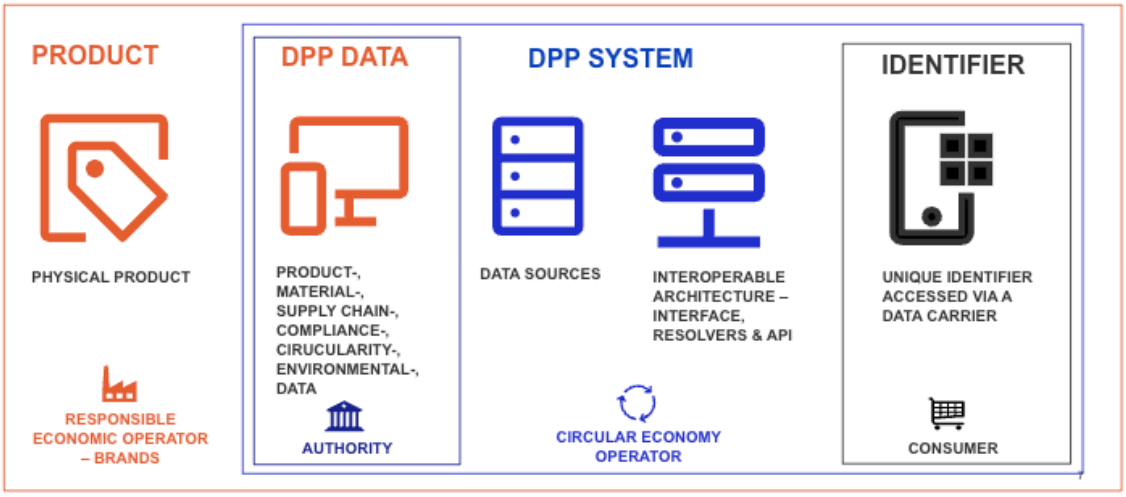

Figure 4. Infographic of the Digital Product Passport (DPP), its components and the stakeholders using, and/or contributing to the DPP.

Initial scope and strategic approach

The project initially focused on the garment's early lifecycle stages, from production to sale, and the initial creation of DPP data shared with consumers. Primary actors involved were the brands Kappahl and Marimekko as the Responsible Economic Operators and consumers as DPP users.

The intentional limitation of the initial scope was driven by pilot constraints and a strategic decision to start with a small-scale implementation. This phased approach allowed for validating DPP creation and data sharing within a specific actor in the value chain before expanding to include additional actors and lifecycle stages.

Before the Trace4Value pilot, Trustrace and Circularista had conducted another pilot with the brand Filippa K and Product Life Extension actor Unitex, founded by Re:Source. This previous pilot focused on implementing a form of DPP in the take-back, sorting, and repair phase, exploring how a DPP could be used in that part of the product life cycle. The insights gained from this earlier project reinforced the decision to initially concentrate on the not-yet piloted production-to-consumer segment in the Trace4Value pilot. You can access the C-PLM project report here[6].

Crucially, the system was designed with scalability in mind, ensuring flexibility to seamlessly integrate with future circular economy operators and regulatory authorities.

[6] Trustrace, Circularista, Filippa K, Unitex, C-PLM 2023. Circular Product Lifecycle Management System. Available at: https://resource-sip.se/app/uploads/2021/09/Report-C-PLM-ReSource-201123.pdf Accessed [2024-07-04]

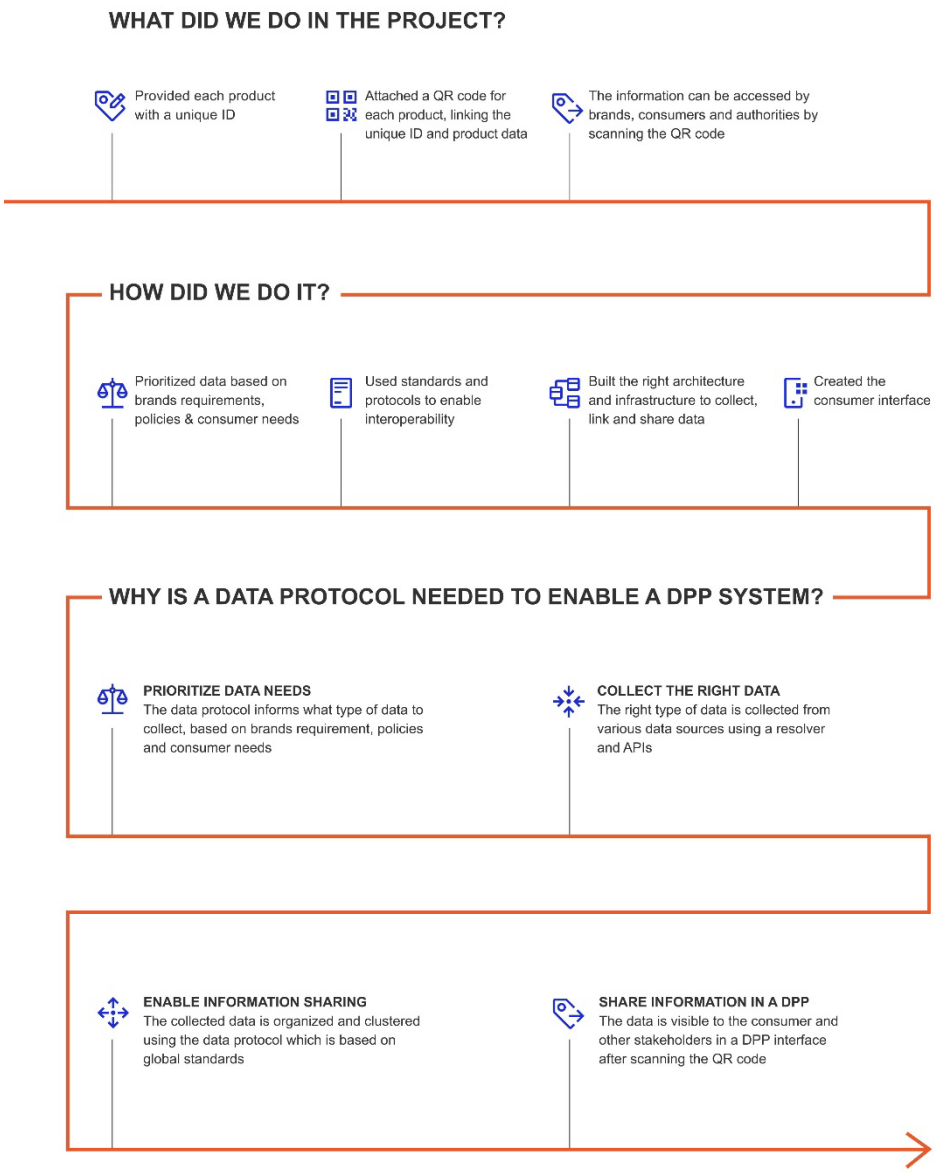

Figure 5. Infographic illustrating the project's activities, methodologies, and the rationale behind creating a data protocol.

The parties involved in this phase included TrusTrace, Circularista, Kappahl and Marimekko.

4.2.2. ANALYSING INFORMATION REQUIREMENTS AND DEVELOPING THE DATA PROTOCOL

To establish the relevant information requirements for the DPP the project conducted a thorough requirements analysis. This phase included monitoring updates on European communications related to the ESPR (Eco-design for Sustainable Products Regulation) and DPP directives, as well as reviewing insights from the CIRPASS project and other global DPP initiatives. The primary objective was to investigate the information requirements for implementing a DPP in the textile sector, considering both mandatory and optional parameters.

The information requirements were derived from several sources:

- The ESPR regulation[7] and the findings from the CIRPASS project[8]
- Additional regulations such as AGEC[9] (Anti-Waste Law for a Circular Economy)
- Brand-specific requirements
- Existing textile data protocols, including the Circular Product Data Protocol[10], Circularity.ID Open Data Standard[11], and Product Circularity Data Sheet[12].

Based on the established information requirements, a detailed DPP data protocol was developed. This protocol was formulated by clustering and defining data according to agreed-upon rules, ensuring alignment with current developments in the field. The protocol was designed to ensure that the data is viable, accessible, machine-readable, and interoperable, while maintaining the protection of personal and corporate information in compliance with global standards. GS1 Sweden and SIS (Swedish Institute for Standards) played a crucial role in mapping out potential standards applicable to different data attributes.

The protocol consists of 125 data fields linked to an item number. The data fields are categorized in nine different information groups. Each of the data fields has a specified format and definition. A snapshot of the data protocol is seen in Table 1. The full data protocol can be downloaded here[13].

[7] European Union, 2024. "Proposal for a Regulation Establishing a Framework for Eco-design Requirements for Sustainable Products." *Official Journal of the European Union, 2024*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL Accessed [2024-07-04].
[8] CIRPASS, 2024. “Project Results”. Available at: https://cirpassproject.eu/project-results/ Accessed [2024-07-04]
[9] Republique Francaise, 2020. “LAW No. 2020-105 of February 10, 2020 relating to the fight against waste and the circular economy (1)” Available at: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000041553759 Accessed [2024-07-04]
[10] EON, 2021. ”Circular Product Data Protocol”. Available at: https://www.circulardataprotocol.org/ Accessed [2024-07-04]
[11] Circularity ID, 2024. ”Circularity ID Open Data Standard Schema V4.0”. Available at: https://circularity.id/open-data-standard.html Accessed [2024-07-04]
[12] PCDS Product Circularity Data Sheet Luxembourg, 2024. ”PCDS System”. Available at: https://pcds.lu/pcds-system/#data-template Accessed [2024-07-04].
[13] Trustrace, 2024. ”DPP Data Protocol”. Available at: https://trustrace.com/downloads/digital-product-passport-data-protocol Accessed [2024-07-04].

INFO GROUP	ITEM NUMBER	DATA FIELD NAME	EXAMPLES	DATA FORMAT	DEFINITION
Brand Information	100,00	Brand	*Kappahl*	Open text (brief)	The primary brand of the product, and typically the brand on the label.
Supply Chain Information	200,00	Supplier Name	*COTTON DIVISION*	Open text (brief)	The name of the company operating the specific manufacturing facility where production took place.
Product Information	300,00	Product Identification Systems	*GTIN*	Text (fixed format)	The Product ID system a brand uses to uniquely identify a product that will be digitized. Today, companies use different systems for identifying their products, such as GTIN, SKU or Style Numbers.
Material Information	350,00	Component	*Body, trim, lining fabric, etc*	Text (from standard list)	Part of the product that is being described with info about material type, fiber composition, recycled content, etc.
Digital Identifier	370,00	Data Carrier / Identifier Type	*RFID thread, NFC chip, QR code, etc*	Text (from standard list)	The type of physical data carrier attached to the product.
Care Information	400,00	Care Image	*Care icons image*	Image (format?)	Image of care icons.
Compliance Information	500,00	Harmful Substances	Yes / No	Open text (brief)	The presence of harmful substances must be disclosed with the mention "contains a harmful substance" if said substance is present at a concentration higher than 0.1% (in weight) in the product. The statement is followed by the name of all the harmful substances present in the product. French Decree No. 2022-748; Art. R 541-221.IX.
Circularity information	600,00	Performance	TBC	TBC	TBC
Sustainability information	650,00	Circular, Sustainable, Social Brand Statement	*The [Company Name] Foundation uses philanthropic resources to find, fund and facilitate disruptive innovations, initiatives and research that enable a socially inclusive and planet positive textile industry.*	Open text (multi-line)	Information provided about circular, sustainable and social practices in place, as written by the brand. Excludes certifications on product. This information is guided by the Green Claims Directive.

Table 1. A snapshot of the DPP Data Protocol displaying the nine information groups and some examples of the data fields and their corresponding formats and definitions.

To date, the European Commission has not yet provided clear definitions for all information requirements. Therefore, some of the data fields lack examples, formats, and definitions (these are named TBC - to be concluded - in the protocol). For example, the ESPR legislative text requires a method for measuring product performance or durability to evaluate its circularity potential, but specific guidance on measurement methods is currently lacking. Similarly, there is uncertainty about how to measure carbon dioxide emissions in the textile industry, particularly in relation to the Product Environmental Footprint (PEF) tool. For example, there are legal restrictions in Norway on using generic data for product-specific claims in consumer communications[14]. This legal uncertainty suggests potential non-compliance if the PEF tool were to be used within the DPP framework.

The potential definitions on some specific data fields are discussed in the draft technical report from the ESPR in a preliminary study on potential eco-design measures[15]. In terms of ”Durability“ it could include metrics such as resistance to stress, minimum durability of function, repairability scoring index/label, availability of repair information and maintenance

[14] Norwegian Consumer Authority, 2022. *GUIDANCE TO THE SUSTAINABLE APPAREL COALITION,* ”ENVIRONMENTAL CLAIMS IN MARKETING TOWARDS CONSUMERS BASED ON THE HIGG MSI” Available at: https://www.forbrukertilsynet.no/wp-content/uploads/2022/10/nca-and-acm-joint-guidance-environmental-claims-based-on-higg-msi.pdf Accessed [2024-07-04]

[15] European Commission, 2023. ”Eco-design for Sustainable Products Regulation - preliminary study on new product priorities. Technical Draft.“ Available at: https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2023-01/Preliminary%20ESPR%20WP%20Report_MERGED_CLEAN_.pdf Accessed [2024-07-04]

instructions, spare part availability and delivery time, disassembly, number of materials/components used, modularity; transformability; detachable/adjustable elements.

The study also considers how to verify a product's recyclability and proposes the following metrics; identifying ability to easily separate the product into different materials, choice of materials and restrictions on substances, condition for the access to product data relevant for the recycling and introducing a recyclability scoring index/label. As the study explains these are suggestions that would need to be further investigated but it is likely that some of these metrics will be included in the DPP information requirements.

In addition, as of the pilot phase, it was not yet clear which information requirements would become mandatory for specific industries under the delegated acts (expected for textiles in 2026). While the data protocol developed in this pilot primarily focuses on the textile industry, it also provides insights into necessary data collection for other industries. The protocol, while not fully comprehensive due to ongoing guidance updates, is expected to cover at least 80% of the forthcoming EU information requirements. Clarifying which of these requirements will be mandatory and which will be optional remains crucial moving forward.

With the latest updates to ESPR, there remains uncertainty regarding the mandatory information that must be disclosed to specific stakeholders. This guidance will be pivotal for future compliance. Below, a detailed section outlines some of the data fields within the protocol, emphasizing their potential relevance to various stakeholders and illustrating how access to this data can foster more sustainable circular value chains, based on the pilot findings but also other relevant guidance such as findings from the CIRPASS project[16].

4.2.2.1 DESCRIPTION OF INFORMATION GROUPS AND VALUE TO STAKEHOLDERS

Brand Information

Information related to the brand, sub-brand, parent company, trader and reseller such as location, logo and contact details. This information is mandatory in the ESPR so that the authorities can locate and contact the Responsible Economic Operator of the product and DPP. Information about the brand could also be useful for the consumer to make more informed decisions and to the Reseller to authenticate the product's origin.

Supply chain information

This info group includes traceability data such as country of origin, operator registry and supplier information. Knowing where, and in what factory the product has been produced increases transparency towards the consumer. Traceability data is also a prerequisite to calculate environmental footprint.

Product information

This info group includes data about the product size, colour, weight, type and group. This information will probably not provide much additional value to the consumer in their purchasing decision of a new garment since data such as size, colour and type are already

[16] CIRPASS, 2023. "D2.1 Mapping of legal and voluntary requirements and screening of emerging DPP-related pilots." Available at: 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 Accessed [2024-07-04].

available information on either product tag or on the web if shopping online. However, without the DPP, comprehensive information about the product is historically not something that has been accessible when buying a used garment. Take for example the two data fields “Year of intended sale” and “Season of intended sale”, this information will inform the consumer of how “old” the garment is, which could be important information in order to understand for how long the garment has been in use. Although, the look and feel/the description of the current condition will probably be more informative than when it was first in store. Another important data point for the consumer considering buying the product second hand could be the initial price of the product, in comparison to the resale price, both data fields are included in this info group.

In a similar way that this information group could be important for the consumer in the resale phase, it will also be crucial for the Product Life Extension Actor sorting the garment for resale. Easy access to specific product information will streamline the sorting process and potentially increase the resale value of the product. If the reseller can authenticate the product's origin and provide comprehensive information, it will enhance the product's value. This objective was validated in a previous pilot project.

In the pilot project conducted by Trustrace and Circularista in collaboration with Filippa K and Unitex, the business case for taking back, sorting, repairing, and reselling used Filippa K garments was validated. The project developed a digital system to manage and add information about the collected garments and the repair/sorting studio could enter data on various aspects, such as material, product details, supply chain, and repair information.

Since the collected garments did not initially have a Digital Product Passport (DPP) attached, the project added some DPP data during the sorting, repair, and resale phase, linking this information to an NFC tag attached to the products at this stage. Through this digital system, data such as the cost of sorting and repair could be calculated, and data on product wear and tear provided insights into the performance of specific products. Filippa K could gather insights to improve product design, increase transparency, and aid in pricing the products for resale. However, it became evident that this process would be more efficient and cost-effective if the collected products had a DPP attached already in production.

Although the C-PLM project did not pilot the entire DPP architecture and infrastructure (the guidance on DPP had not yet been released at the time of the pilot), it could still validate the EU objectives for the DPP, such as extending product lifetimes and providing new business opportunities through circular value retention, supporting consumers in making sustainable choices and increasing transparency.

Material information

This info group describes the material/fibre composition of the garment, and the type and source of material used. It also includes prints, dyes and finishes. This info group could be of value to the consumer in understanding the sustainability of the product (e.g. recycled/renewable) and quality of the product. In the same logic as presented in the section about Product Information, this information is important for sorters for resale and repairers. It is also useful information when sorting for recycling.

Digital Identifier

This info group includes information about the type of data carrier (QR code/NFC tag/RFID tag/watermark) it’s material, location and ISO standard. It is important information for the

recycler to know how to handle the carrier at the recycling stage. The mechanical and/or chemical recycling process will destroy the digital identifier unless the identifier is integrated to fibre level (“molecular”) level.

Care Information

This info group includes information on how to take care of the garment throughout its life e.g. instructions for washing/ironing. It is valuable information for the consumer to prolong the product's life. It could also be valuable for the reseller to have this information about the product at the point of resale to provide to the consumer to increase the value of the second-hand garment.

Compliance Information

This info group describes how the product adheres to chemical compliance, if it has any certifications, presence of harmful substances (in accordance with REACH) or if it sheds microplastics to the environment. This information is useful for the consumer in making more informed buying decisions, for example validating certifications. It could also be useful for the reseller to be able to validate that the product does not contain harmful substances. The presence of chemicals and/or harmful substances could also affect the recycling process whereby this would be important information for the recycler to access.

Circularity Information

This info group describes how the product is prepared for circularity e.g. the performance or durability of the product, it’s recyclability, repairability, disassembly and sort/recycling instructions for used garments as well as the product’s circular design strategy. The consumer could benefit from accessing this information in two ways: (1) consider the product’s potential for circularity in buying decisions and (2) knowing where to return the product for repairing, resale and/or recycling. The recycler/sorter/repairer could benefit from accessing sorting-, recycling- repairing-, and disassembly instructions.

Sustainability Information

This info group describes the sustainability aspects of the product in terms of e.g. the product footprint (environmental/material/carbon), consumption of water/energy, emissions to air/water/soil and waste generated. This information could be used by the consumer for making more informed purchasing decisions.

4.2.2.2 STANDARDS

In addition to outlining and defining all the information requirements and identifying the relevant stakeholders, there is ongoing work to establish standards for the data attributes and to enable interoperability and data sharing through the use of global standards. There are numerous competing and non-harmonized dictionaries and classification systems for the textiles sector at both international and national levels [17] as well as a varying degree of clarity in global standards for interoperability and data sharing—where some standards are

[17] CIRPASS, 2024. Cross sector and Sector Specific DPP Roadmaps. Page 74. Available at: https://cirpassproject.eu/wp-content/uploads/2024/04/CIRPASS_Cross-sector_and_sector-specific_DPP_roadmaps_1.2_2024-03-27_1527.pdf [Accessed 2024-08-07]

established but lack clear application guidelines, and others are yet to be defined—we encountered the challenge of determining appropriate standards for each context.

The standardization activities underway aim to develop the DPP system. It is conducted at the European level within CEN-CLC/JTC 24 Digital product passport – Framework and system, where all European countries and affiliated organizations are welcome to provide input. The work is based on a Standardization Request set out by the EU Commission, specifying the needs to standardize in support of the DPP legislation. Standardization requests are used by the EU commission increasingly to avoid detailed legislation and provides an open, consensus-based setting for European industry to join and provide their input and experience and thus have influence on the how to fulfil the requirements in legislation. The standardization request for DPP specifies 8 topics to write harmonized standards for:

1. Unique identifiers
2. Data carriers and links between physical product and digital representation
3. Access rights management, information system security, and business confidentiality
4. Interoperability (technical, semantic, organisation)
5. Data processing, data exchange protocols and data formats
6. Data storage, archiving, and data persistence
7. Data authentication, reliability, integrity
8. APIs for the DPP lifecycle and searchability

This will require Europe to mobilize wide sets of knowledge, experience and research to standardize a DPP system applicable to all types of product groups. What information is expected to populate the different DPP's will be specified in delegated acts under development in the EU Commission.

The first product category required to use a DPP is batteries, as specified in the Battery Regulation. This will enter into force in February 2027. This is likely to serve as very useful role model for the product categories to come, where textile is a highly prioritized product group.

Using standards is crucial to enable a functional DPP system for all value chains across sectors, nations and regions. Standards provide a common approach to a range of topics, anchored in industry practices and scientific state of the art. This is especially important in building functions and systems applicable across multiple countries and regions. Standards increase interoperability between stakeholders and systems in the value chain and lessens trade barriers by harmonizing requirements for e.g. safety, compatibility, sustainability and performance. This is essential for small countries relying on export and import. Especially important aspects of using standards are predictability, trust, safety, transparency and accountability. For a functioning DPP system, international (ISO and IEC) standards and European (CEN and CENELEC) standards will be used to ensure e.g. interoperability and security.

In the pilot, Both ISO standards and GS1 standards were used. The GS1 standards provide a comprehensive set of standards to identify, capture and share information about objects throughout their lifecycle, providing the core foundation for interoperability. The GS1 standards were utilized for specific data attributes, such as country of origin, size, and product name. Additionally, serialized GTIN was used to generate the unique product IDs. This serialization allowed for each individual item, rather than just the product type, to be uniquely identified.

The parties involved in creating the DPP data protocol included Trustrace, Circularista, GS1 Sweden, SIS, TexRoad Foundation, Policy Hub, Marimekko, and Kappahl.

4.2.3 DESIGNING THE CONSUMER INTERFACE AND CHOOSING WHAT DATA TO SHARE

A consumer interface was designed and developed to provide consumers access to the DPP information through scanning a QR code. Several workshops with project group members were held to identify interface requirements, emphasizing ease of understanding, configurability, the avoidance of information overload, and highlighting the most important information for easy access. The design process followed industry-standard methodologies for design thinking, UX, and UI workshops, incorporating practices such as Google Sprints. This approach facilitated iterative testing and collaboration with both consumers and project group members to refine the user experience and interface design.

The design process involved iterative testing with consumers and project group members to assess both the user experience (UX) and user interface (UI). Additionally, efforts were made to gauge consumer preferences regarding desired data points. However, due to the pilot's limited scope, comprehensive user testing was not extensively conducted.

The interface was built with future scalability in mind, allowing other stakeholders in the value chain—such as repairers and recyclers—to access and enhance DPP data throughout the product lifecycle, in the future.

In the absence of guidance on which data to present to specific stakeholders the project independently selected data points based on insights from other initiatives and user testing during interface design. This strategy aimed to enable meaningful consumer comparisons pending formal EU guidance on standardized data points for consumer viewing.

To enhance usability and understanding for consumers, the interface displays highlighted sections that provide a quick overview of important data points. Each brand selected which information to highlight based on the product, their knowledge of their customers, and what they considered essential to display. Kappahl chose to emphasize compliance, material, and supply chain information, while Marimekko highlighted material, care, and supply chain details. While this approach aimed to cater to consumer needs and brand-specific priorities, it also underscored the challenge of inconsistent data presentation across brands. In the absence of standardized guidelines from the EU at the time of the pilot, this diversity in highlighted data points could potentially hinder consumers' ability to make direct comparisons across products, highlighting the project's urgency in advocating for EU-standardized data points for consumer information.

Key participants in this phase were TrusTrace, Circularista, Marimekko and Kappahl.

4.2.4 DESIGNING THE TECHNICAL ARCHITECTURE

A robust, scalable, and resilient technical architecture was developed to address critical gaps identified in previous DPP pilots. This architecture was meticulously designed to align with ESPR regulation recommendations, ensuring maximum interoperability and compatibility with

existing systems. Central to its design was an API infrastructure and decentralized data storage framework.

The finalized architecture incorporated a resolver framework for decentralized data storage, facilitating validation, sharing, and updates of DPP information over time. Recognizing the digital maturity disparities across the industry, a Product Data Platform (data repository) was introduced to streamline data retrieval for the DPP interface, enabling brands to upload data in a spreadsheet format. The architecture functioned as follows:

1. **Uploaded data:** The data was uploaded, validated, and stored in two separate sources: the Trustrace traceability platform and the Trustrace Product Data Platform.
2. **Assigned Unique Identifiers:** Each garment in the pilot was assigned a unique identifier using a serialized Global Trade Item Number (GTIN). This serialization allowed for each individual item, rather than just the product type, to be uniquely identified.
3. **Embedded the GS1 Digital Link in QR Codes:** The serialized GTINs were then encoded into QR codes using the GS1 Digital Link standard. This standard transforms the GTIN into a web URL, which can be scanned by any smartphone or QR code reader.
4. **Linked to Digital Product Passport:** When a consumer or stakeholder scans the QR code on a garment, the GS1 Digital Link directs them to a specific URL (DPP consumer app webpage), while at the same time sending a request to the resolver using the serialized GTIN to identify in what data sources the information related to the unique product resides. The data is then fetched from the data sources via APIs. The URL then leads to the webpage displaying the DPP data.

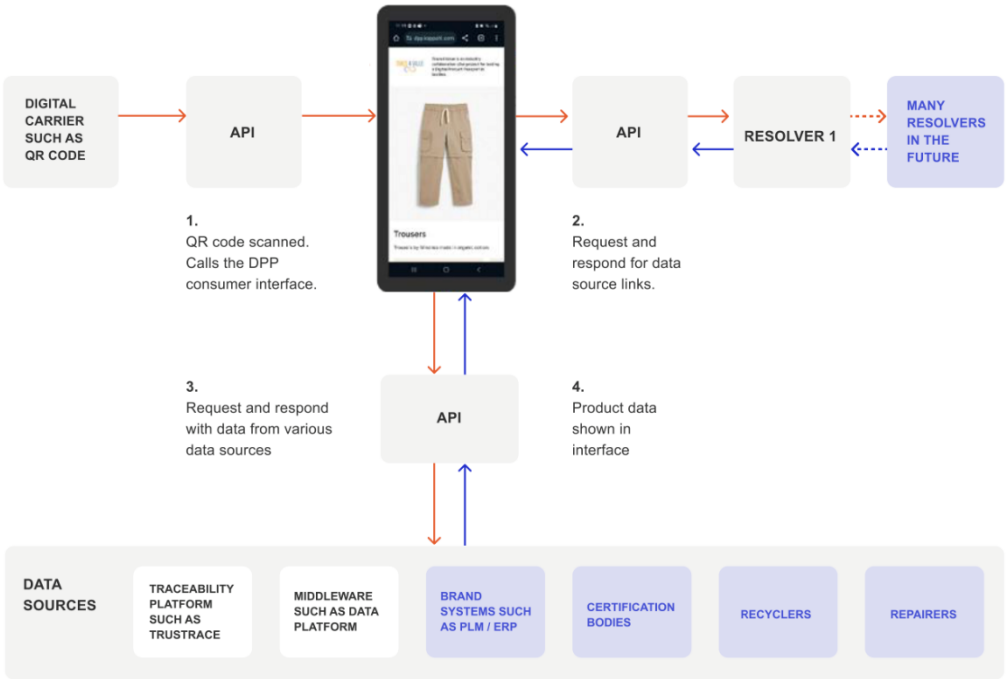

Figure 6. Infographic of the pilot technical architecture.

API development focused on enabling seamless integration with multiple systems. APIs linking the DPP consumer interface with the Product Data Platform and traceability systems were standardized to ensure robust performance and interoperability. Figure 7 illustrates the diverse data sources and sample data fields collected from each respective source.

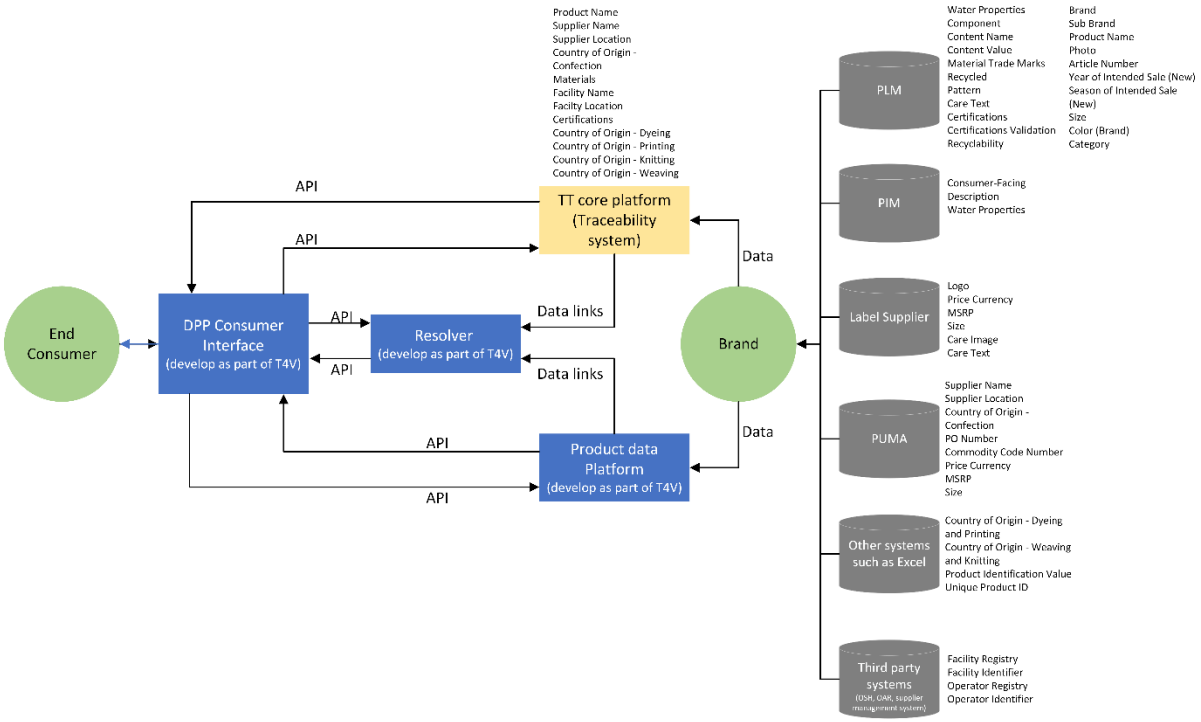

Figure 7. Infographic of the data flow of a DPP system in the pilot.

The development process followed the double diamond discovery framework and employed an agile, scrum-based approach, adhering to industry standards. Implementation progressed smoothly, with expected challenges primarily centred around data mapping among stakeholders such as brands, label providers, and solution providers. Key alignment efforts included transitioning towards a serialized GTIN as a unified identifier across all parties.

Given the utilization of browser cookies in the DPP consumer interface, GDPR compliance was upheld with provisions for user consent to accept, reject, or customize cookie preferences.

Usability and prototype testing were conducted with stakeholders before development commenced. Testing occurred across various stages and environments, encompassing both positive and negative test cases.

Testing phases included:

- **Unit, Integration, and System Testing:**
  - Verification of individual components like the product data platform, DPP consumer interface, and API responses in isolation.
  - Validation of interactions among developed systems to ensure seamless functionality.
- **Acceptance Testing:**

    - Evaluation conducted by brand users and end-users to determine adherence to acceptance criteria.
- **Compatibility Testing:**
    - Ensured proper functionality of the DPP consumer interface across diverse platforms, devices, browsers, and operating systems.

The technical architecutre was built by Trustrace. Circularista was also involved in the development process.

4.2.5 CHOOSING THE DATA CARRIER AND IMPLEMENTING IT

To pilot the complete journey of creating a DPP and assess the impact of DPP implementation, care labels with unique QR codes were created, mapped, printed, and attached to over 3000 garments. This process involved collaboration with label providers and garment manufacturers. The QR codes were linked to a unique product ID generated through serialized GTIN.

The digital data carrier, a QR code, was provided by the brand's care-label supplier. QR code is recommended by CIRPASS as the most consumer-friendly data carrier[18]. In Kappahl's case, their internal quality specialist was responsible for ensuring the accuracy of the data on these labels and compliance with the legal requirements of each market where the product would be sold. In Marimekko's case, this activity was done within a team with representatives from their sustainability-, sourcing- and quality- departments. Unique QR codes for the serialized care labels were printed and then sent to the Cut, Make, and Trim (CMT) suppliers. This process required meticulous planning because each QR code had to be unique to each product, using the serialized GTIN. It was essential to match the correct QR code with the corresponding garment, considering both size and type. Consequently, during garment production, manufacturers needed to carefully incorporate the correct label into the appropriate product type and size. This represented a significant operational shift from the usual process of using a single care label for an entire production run.

Kappahl chose to integrate the QR code into the existing garment care labels, while Marimekko had the data carrier printed separately and subsequently sewn into the garment through an additional sewing operation on the production line.

Key participants in this phase were Trustrace, Kappahl, Marimekko, Rudholm Group, and Trimco Group, along with the manufacturers of Kappahl (IR Exports Private Limited and KoushModa Ltd) and Marimekko (Pedrosa & Rodrigues, S.A).

4.2.6 GATHERING DATA

Kappahl and Marimekko were responsible for identifying sources (visualized in figure 7) and gathering data according to the established data protocol. In the protocol both mandatory and optional data fields were included and not all data attributes were yet clearly defined from the EU. Only selected data attributes clearly defined by the EU and that were tested on the customers when designing the consumer interface were collected.

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[18] CIRPASS, 2024. *D2.2* Exploring possible Digital Product Passport (DPP) use cases in battery, electronics and textile value chains. Available at: https://cirpassproject.eu/wp-content/uploads/2024/04/CIRPASS_D2.2_DPP_UseCases_Report_v2.0.pdf [Accessed 2024-08-07]

4.2.6.1 KAPPAHL'S DATA GATHERING

To meet the pilot's data protocol requirements, Kappahl leveraged their Product Lifecycle Management (PLM) system, the TrusTrace traceability platform, their eCommerce platform, and order placement system. Additionally, manual data entry was performed using an Excel spreadsheet, which served as the data import tool enabler, into the Product Data Platform established by TrusTrace.

Both of Kappahl's products involved onboarding the Tier 1 CMT supplier responsible for garment manufacturing onto the TrusTrace platform. This was run as a separate Project independent of the Trace4value initiative, but the data was leveraged in this project to pilot the decentralized architecture. This process encompassed two key steps: 'step 1' involved supply chain mapping, followed by 'step 2' which integrated the platform's purchase order trace module. Through this mapping and tracing process, the collection of product data extended to the fibre level for fabrics and supplier level for trims and zips, which were sourced from Kappahl's designated supplier list. The primary data source for Kappahl's products thus included their Tier 1 supplier, supplemented by data from the TrusTrace platform's tracing capabilities. Additionally, Kappahl requested suppliers of the piloted products to perform full traceability of the garments using the Trustrace core platform.

4.2.6.2 MARIMEKKO'S DATA GATHERING

Marimekko gathered data from their supplier relationship management system, as well as their product data systems. To ensure efficient data gathering, Marimekko collaborated in the pilot with a long-term partner supplier based in Europe, with which the brand has developed a so called "closed loop" production model. This partnership facilitated the acquisition of most of the essential data needed for the DPP pilot. The data was uploaded via the Excel spreadsheet in the Product Data Platform established by TrusTrace, as they did not use Trustrace traceability platform at the time of the pilot.

The data was fed to Kappahl and Marimekko's consumer interfaces upon scanning the QR code, using APIs and a resolver – as mentioned in section 5.2.4 Designing the Technical Architecture.

Key participants in this phase were Trustrace, Kappahl, Marimekko and Circularista.

4.2.7 PILOTING THE TECHNICAL FRAMEWORK

Developed over three months in Q4 2023, the IT solution was put into production in January 2024. By Q1 2024, over 3000 garments equipped with unique QR codes linking to DPP data were available for purchase through Kappahl's and Marimekko's digital channels and in stores. Consumers accessed this data by scanning the QR code. The products chosen by Kappahl to include the DPP were a pair of children's trousers and a children's sweater, one by each of Kappahl's production management teams in Dhaka, Bangladesh (global lead office for knitwear) and Delhi, India (global lead office for woven). These represented products manufactured in two of their three main production hubs (with China being the other main sourcing country). Marimekko selected a T-shirt manufactured under a closed-loop production model, utilizing cutting waste and leftover fabric from their jersey products as raw

materials. These T-shirts were produced by one of Marimekko's partner suppliers based in Portugal, a key production location for the brand.

Figure 8. Pictures of the piloted garments and their respective QR codes linked to their DPPs.

Analytics were implemented to evaluate user interactions with the interface. This analysis aimed to understand scanning behaviour, time spent on DPP information, subsequent actions taken by consumers, geographic data on scans, and the most interesting information for consumers. The data has been gathered in accordance with GDPR regulations.

The QR codes were used also to communicate around the Pilot in various knowledge sharing forums and presentations, where a sample QR code was scanned multiple times, by another audience than the end-consumers of the products. This introduced variability in the data as we chose not to differentiate it by unique item level, but only scanning in total, which presents a challenge in analysing consumer behaviour specifically at that point. Despite this, the gathered data provided valuable insights based on all the scans performed.

Moreover, it is important to note that during the pilot phase, most consumers were likely unaware of the DPP pilot and the presence of the QR codes. Since scanning DPP QR codes is not yet a widespread habit among consumers, many did not know to look for or scan these codes. In the future, when DPP becomes a standard practice and more mainstream, consumer awareness and interaction rates are expected to be significantly higher. This anticipated shift will likely result in different engagement patterns and more comprehensive insights into consumer behaviour.

Based on the data gathered from the total number of scans, the following data was gathered:

- Between February 15 and July 8, there were a total of 912 scans. These scans included 539 unique visitors, of which 291 were from Scandinavia. The countries where scanning occurred included Finland, Sweden, China, South Korea, the United States, Ireland, Hong Kong, Spain, Canada, France, Norway, Switzerland, Taiwan, Italy, Germany, Iceland, Belgium, the Netherlands, Bangladesh, Pakistan, Portugal, and the United Kingdom.
- The average session duration was 1 minute and 15 seconds, with an average of 1.81 sessions per user.
- Most users scanned the QR code once, while approximately 30% of users scanned the QR code between 2 and 5 times.
- The data also indicated that no specific type of information was accessed more frequently than others, as there was an equitable distribution in the number of times different sections (accordions) were clicked.

This phase involved project partners Trustrace, Kappahl, Marimekko, and Circularista.

4.2.8 INCLUDING A MASTER THESIS IN THE PILOT

At the pilot phase's onset, the decision to incorporate a master thesis arose from the recognized need to delve deeper into the implications of DPPs within the textile industry. With regulations scheduled for implementation by 2028 and limited research available since their introduction in 2023, there was a notable gap in understanding how DPPs would impact stakeholders, especially brands. The thesis aimed to address this gap by investigating the potential opportunities and challenges associated with DPP adoption, drawing insights from industry workshops, meetings, and interviews with Nordic textile and fashion enterprises. The thesis was written by Eveliina Lehtisalo for Alto University.

The thesis is called *Digital product passport for textile and fashion enterprises: Opportunities and challenges* and focused on examining the opportunities and challenges presented by DPPs for textile and fashion enterprises. The qualitative case study included observations from project activities such as workshops and interviews with industry stakeholders. The research aimed to understand stakeholder perspectives, regulatory implications, and potential impacts on business practices.

Findings emphasized improvements in traceability, transparency, and consumer engagement, while identifying challenges such as supply chain complexity and technical implementation barriers. Despite these challenges, the DPP is viewed as a positive regulatory step towards achieving sustainability goals in the industry. The findings from this thesis provided valuable insights into the strategic integration of DPPs within the textile industry, highlighting considerations for enhancing transparency, sustainability, and consumer engagement. The thesis can be accessed here.

The insights from the thesis played a crucial role in shaping several aspects of the pilot implementation. Key findings informed the development of strategies to enhance stakeholder engagement and refine data management protocols. By incorporating these research outcomes into the pilot initiatives, the project aimed to align activities with emerging best practices and regulatory expectations. This approach ensured that the pilot not only validated technical functionalities but also explored the broader implications of DPP implementation within the textile industry.

4.3 TIMELINE AND MILESTONES:

Figure 9 illustrates the timeline of the project activities and key deliverables.

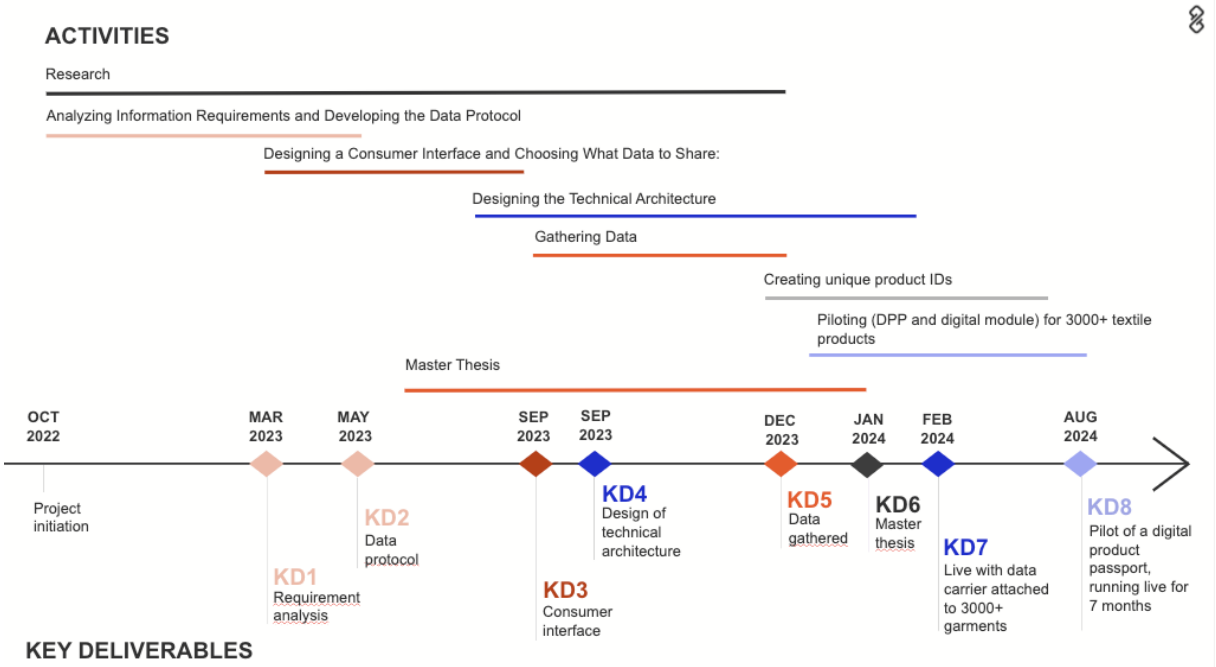

Figure 9. A timeline of the project illustrating key deliverables

4.4 CHALLENGES AND SOLUTIONS:

Implementing the DPP system in the textile industry posed several significant challenges that required innovative solutions to ensure successful integration and adoption across the supply chain.

Data Variability and Standardization

One of the primary challenges encountered was the variability in data availability and standardization across different stakeholders and supply chain stages. This variability necessitated the development of a robust data protocol that could accommodate diverse data sources while ensuring consistency and reliability. The pilot phase highlighted the need for clear guidelines and standards for data collection, especially without definitive EU regulations on certain data points.

As the DPP system is currently being standardized at European level, with the involvement of many European countries, it is essential to have representation from different industries involved. This is challenging, as the system is intended to be functional for any type of product group. Influence from Swedish stakeholders is coordinated via the Swedish standardization committee at SIS.

Integration into Existing IT Infrastructures

Another critical challenge involved the integration of DPP into existing IT infrastructures and operational workflows of brands and suppliers. The diverse digital maturity levels among stakeholders required adaptable technical solutions. To address this, a scalable and interoperable technical architecture was designed, leveraging API integration and decentralized data storage. This approach not only facilitated seamless data exchange but also supported the future scalability of the DPP system.

Stakeholder Engagement and Collaboration

Furthermore, the pilot phase underscored the importance of stakeholder engagement and collaboration. Involving stakeholders from IT, quality assurance, sustainability, and innovation departments, as well as manufacturers and label suppliers, was essential for piloting the technical framework and ensuring alignment with operational realities. This collaborative effort helped address data mapping challenges and facilitated the adoption of serialized identifiers like GTIN across all parties involved.

Regulatory Uncertainties and Future Requirements

Additionally, navigating regulatory uncertainties and anticipating future requirements posed challenges in defining the scope and content of DPP. The approach to select relevant and meaningful data points for consumers, while complying with evolving regulatory expectations, involved strategic decision-making based on insights from user testing and international standards.

Future Solutions and Strategic Directions

Looking ahead, the solution lies in further refining the data protocol based on ongoing regulatory updates and industry feedback. Establishing clearer standards for data interoperability and information requirements such as footprint calculations and circularity metrics will be pivotal in enhancing the DPP's effectiveness and acceptance across global markets. Moreover, exploring advanced traceability solutions and considering DPP-as-a-Service options will enable smoother implementation, particularly for smaller enterprises seeking compliance without extensive internal resources.

Summary

In summary, overcoming these challenges required a multi-faceted approach that combined technical innovation, stakeholder collaboration, regulatory foresight, and strategic decision-making. The insights gained from the pilot phase provide a solid foundation for optimizing the DPP system and advancing sustainable practices in the textile industry.

5. OUTCOMES AND IMPACTS

In this section, the outcomes and impacts of the pilot implementation of the Digital Product Passport (DPP) system in the textile industry are explored. The pilot aimed to test the feasibility and functionality of the DPP system and assess its broader implications for stakeholders across the circular value chain. From the initial design and stakeholder engagement to practical implementation and consumer feedback, this section emphasizes the pivotal findings during the pilot phase.

5.1 PILOT IMPLEMENTATION AND IMPACT

By Q1 2024, over 3000 garments equipped with QR codes linking to DPP data were available for sale through Kappahl's and Marimekko's channels. The implementation phase validated the technical framework and evaluated consumer interaction through analytics.

Pilot impact on brand engagement and Organizational Readiness

In general, the guidance around DPP has remained largely theoretical, leaving actors in the value chain uncertain about how the DPP would function in practice. The primary motivation for brands to join the pilot was to test the DPP system in a real-world setting and obtain a tangible example of a DPP. This hands-on experience led to increased engagement across the entire company, including senior decision-makers, sparking interest from all departments and identifying additional business opportunities, such as enhancing marketing strategies and integrating DPP data into community programs.

Furthermore, observations from the pilot suggest a strategic shift in DPP implementation beyond the sustainability department alone. Aligning and deploying DPP across various operational teams managing the product’s lifecycle is believed to enhance effectiveness and add more value. This finding underscores the importance of integrating DPP into broader operational strategies rather than confining it solely to sustainability initiatives.

The brands aimed not only to test the functionality of the DPP but also to better understand its requirements and consider the necessary IT systems. This pilot provided an opportunity to develop internal expertise and know-how regarding DPP implementation.

Overall, this pilot provided the brands with invaluable insights into the practical implications of adopting a DPP system, helping them to refine their strategies and prepare for future regulatory requirements in the textile industry. It laid the groundwork for discussing new data solutions and prioritizing initiatives based on the pilot findings.

Insights from analytics

The insights derived from the gathered data can be leveraged to refine future initiatives, improve user engagement strategies, and enhance the overall effectiveness of digital content delivery. The data collected offers valuable lessons on how to engage both local and international audiences effectively.

However, it is important to once again highlight that this data is based on all total scans. The QR codes were also used in various knowledge-sharing forums and presentations, where sample QR codes were scanned multiple times by audiences other than the end-consumers of the products. This introduced variability in the data, as we chose not to differentiate it on the unique item level, but only on total scans. This approach presents a challenge in analysing consumer behaviour specifically, as the data includes interactions from diverse settings and purposes beyond typical consumer usage.

Moving forward, distinguishing between end-consumer scans and other types of engagement could provide clearer insights into actual consumer behaviour and preferences, allowing for more targeted and effective strategies.

- **Geographical Reach and Engagement:** The data shows a broad geographical reach, with users from 21 different countries scanning the QR codes. This indicates a successful international engagement and suggests that the campaign or initiative had a global appeal.
- **Scandinavian Focus with Global Reach:** A significant portion of the scans (291 out of 539 unique visitors) came from Scandinavia. This may suggest a higher level of interest or awareness in this region, or it could be attributed to the fact that Trace4Value is a Scandinavian initiative with a strong presence of the brands (Kappahl and Marimekko) in Scandinavia. Despite this localized focus, the project achieved notable global reach, with scans occurring in various countries worldwide, including China, South Korea, the United States, Ireland, Hong Kong, Spain, Canada, France, and more. This indicates that while the core engagement was concentrated in Scandinavia, there was considerable international interest and outreach, highlighting the potential for broader global impact and awareness.
- **User Engagement:** The average session duration of 1 minute and 15 seconds suggests that users were moderately engaged with the content. This duration is sufficient for users to read and understand key pieces of information, indicating that the content was likely concise and relevant.
- **Repeat Visits:** Approximately 30% of users scanned the QR code between 2 and 5 times, indicating repeat engagement. This could suggest that users found the information valuable enough to revisit or that they were interested in tracking updates or changes to the content over time. It could also be an indication of the project's nature—a pilot project engaging people for more reasons than just wanting to purchase a product but rather learning what the DPP could look like and what information to show. The repeat visits could highlight the importance of keeping content up-to-date and relevant to encourage users to return.
- **Uniform Interest Across Content:** The equitable distribution of clicks on different information sections (accordions) indicates that all provided information was of equal interest to users. This suggests that the content was well-balanced and that no single section was disproportionately more appealing or neglected.
- **Consumer Behaviour:** Most users scanning the QR code only once might indicate that most users were looking for specific information or were satisfied with the information provided on their first visit. In a real-life scenario where consumers are aware of the DPP at the point of purchase, this data can help in understanding consumer behaviour and preferences for future improvements in content delivery.
- **Implications for Future Campaigns:** The insights regarding session duration and the number of sessions per user could inform future content strategies. For instance, ensuring that key information can be accessed quickly and easily might enhance user satisfaction and engagement.

- **Potential for Improvement:** While the equitable distribution of clicks is positive, it also suggests there is no standout feature or content that is driving higher engagement. Future efforts might explore adding more interactive or engaging elements to see if any content could further increase user interest.

Strategic Alignment and Compliance

The project's activities were aligned with EU directives such as the ESPR (Eco-design for Sustainable Products Regulation), ensuring compliance and strategic alignment with sustainability goals outlined in the EU Green Deal and Circular Economy Action Plan.

Collaboration and Stakeholder Engagement

Successful implementation relied on collaborative efforts among stakeholders, including manufacturers, brands, consumers, regulatory bodies, and technology providers. This collaborative approach facilitated knowledge-sharing and industry-wide adoption of DPPs.

Future Scalability and Industry Impact

The project's foundation in thorough research, strategic planning, and stakeholder engagement positions it to scale DPP implementation across the textile industry. Insights gained from the pilot phase and ongoing evaluations will guide future initiatives aimed at enhancing sustainability and efficiency in product lifecycle management.

6. LESSONS LEARNED AND KNOWLEDGE DISSEMINATION

This chapter delves into the lessons learned from our pilot implementation of Digital Product Passports (DPPs). It highlights key insights, challenges navigated, and strategic solutions that paved the way for enhanced sustainability and transparency within our operational context. It also includes a suggested approach for how to implement DPPs.

6.1 INSIGHTS FROM PILOT IMPLEMENTATION

- **START IN TIME! Gathering data can be an extensive activity and it impacts the overall digital strategy of your company:** Initiating data gathering early in the project lifecycle proved to have a significant impact. The extensive process of data collection is expected to influence the digital strategy of participating companies moving forward. Early engagement allows for comprehensive planning and alignment of data collection efforts with broader digital transformation goals, paving the way for seamless integration of DPPs into existing systems.
- **Close collaboration with all stakeholders in the value chain is key:** Effective collaboration with stakeholders across the value chain was foundational to project success. Engaging manufacturers, suppliers, brands, and technology providers from the outset facilitated knowledge sharing, streamlined processes, and enhanced mutual understanding of project objectives. This collaborative approach fostered innovation, addressed implementation challenges, and promoted industry-wide acceptance of DPPs.
- **Standards are important to facilitate easy integration between different systems:** Adherence to standardized data formats and protocols played a pivotal role in enabling interoperability across diverse systems. Establishing clear standards for product-related information, such as component types and attributes, simplified data integration and exchange between stakeholders. This standardization enhanced efficiency, minimized errors, and promoted consistency in data handling throughout the supply chain.
- **Stay up to date with coming clarifications and precision of requirements from EU such as for DPP data, DPP system and access for different stakeholders:** Remaining abreast of evolving EU regulations and guidelines pertaining to DPP data and systems was essential. Proactively monitoring regulatory updates enabled project teams to anticipate changes, align implementation strategies with emerging requirements, and mitigate compliance risks. This proactive approach ensured that DPP initiatives remained compliant and responsive to regulatory developments and is key to scaling DPP implementation.
- **Gather data to be compliant also with other regulations:** The data collection process for DPPs contributed to compliance with broader regulatory frameworks beyond EU directives. Integrating DPP requirements into existing compliance initiatives can ensure holistic adherence to environmental, safety, and consumer protection regulations. This approach can streamline regulatory reporting, minimize audit risks, and enhance corporate governance practices across the organization.
- **Other benefits for Brands, triggered by DPP:** Throughout the project, ongoing dialogues revealed numerous potential benefits of Digital Product Passports (DPPs)

beyond regulatory compliance. Enhanced transparency in product information is likely to foster consumer trust and loyalty, positioning brands as leaders in sustainability and responsible product stewardship. DPPs also facilitate improved supply chain visibility, which enhances operational efficiency and informed decision-making. This increased transparency and efficiency can drive a competitive advantage and market differentiation, underscoring the business opportunity presented by adopting DPPs. Recognizing transparency and DPPs as a strategic advantage could significantly benefit businesses in a competitive marketplace. In addition, the Digital Product Passport (DPP) could serve as a crucial enabler for circular business models, such as repair and resale, by providing unprecedented access to information about products in their post-consumer phase. This includes detailed records on how many times a product has been resold, whether it has undergone any repairs, and other relevant usage data. Such insights not only support the lifecycle management of products but also offer valuable feedback to product developers. By leveraging this information, future products can be designed and manufactured with enhanced durability, repairability, and sustainability in mind, thus promoting a more circular economy.

6.2 SUGGESTED APPROACH TO IMPLEMENTING DPP

Requirements Assessment and Impact Analysis

- **Legislation Requirements Assessment:** It is essential for fashion brands to review the legislative requirements to understand their impact on business operations. Conducting an impact assessment and cost-benefit analysis will ensure that the proposed requirements are balanced and contribute positively to achieving a transparent, sustainable, and circular value chain.

Data Collection and Storage from Upstream Supply Chain

- **Organizational Preparation:** Fashion brands should prepare their organizations by involving representatives from key areas such as product design, sourcing, IT, and sustainability.
- **Data Impact Identification:** Brands need to determine how data and information requirements will affect their business, considering their product materials and sourcing models. An assessment of the level of control over the supply chain and products should also be conducted.
- **Ongoing Information Update:** Fashion brands must stay informed about developments and updates related to Digital Product Passport (DPP) regulations, including standards for digital product passports and forthcoming delegated acts for textiles. Identifying suitable partners and vendors to support these efforts is crucial.

Data Requirements and Storage

- **Understanding Data Requirements:** It is important for fashion brands to familiarize themselves with the data requirements of the European Sustainability Reporting Standards (ESPR) relevant to their sector and products. Brands should identify the sources of this data within their organization or from external data providers and adhere to the Trace4Value data protocol in line with the latest ESPR requirements.

- **Addressing Data Gaps:** Brands need to identify any missing data and develop a plan to gather and source this information. Ensuring data accuracy and considering the engagement of vendors to assist in this process is recommended.
- **Data Storage and Utilization:** Incorporating the capability to store, process, and utilize data within a complex value chain is essential. Brands should select a partner for data storage and access facilities.

Information Carrier and Solution Provider Selection

- **Information Carrier Strategy:** Brands should determine their strategy for the information carrier (e.g., QR code, NFC chip, RFID). Selecting a product identification system and equipping products with IDs that link physical products to digital information is necessary. Collaboration with finished goods (tier 1) suppliers and label providers is important as this affects operational processes in the facilities.
- **Solution Provider Selection:** Fashion brands must choose a DPP solution provider (Interface and Resolver). They should determine how to source data for the Interface and assess their digital readiness to decide whether to integrate all data from their system with the Interface or to consolidate information in a data repository managed by a preferred solution provider. If integrating with other systems, developing APIs to securely fetch and provide data between systems is recommended.
- **Consumer Data Display:** Brands should decide what additional data, beyond mandatory requirements, will be displayed to the consumer via the interface.

6.3 KNOWLEDGE SHARING

Throughout the pilot phase, active engagement in disseminating insights and findings related to the DPP system has been a cornerstone. Key presentations and events have played a pivotal role in fostering dialogue, sharing insights, and promoting the adoption of DPPs across diverse industry platforms and events.

Key presentations included:

- Press Release of the Data Protocol at GS1 Sweden
- Nordic Circularity Accelerator program by Nordic Innovation / Accenture (funded by Nordic Council of Ministry)
- Transformation Conference at Helsinki Fashion Week, by ScandinavianMIND
- Transformation Conference at Copenhagen International Fashion Fair, by ScandinavianMIND
- Transformation Conference at Stockholm Fashion Week, by ScandinavianMIND
- D-congress, Svenska Mässan, Gothenburg
- Webinar MixiCenter – The Future of DPP
- Digital Management Week, Gothenburg
- DPP Prototype Program by Copenhagen School of Design and Technology (KEA)
- Scandinavian Mind podcast
- Released the playbook: "Unlocking DPP - The WHY, What and How of Digital Product Passports" where Trace4Value was presented at Global Fashion Week, Copenhagen
- Webinar and panel about "Unlocking DPP" where Trace4Value was presented
- TEKO digital seminar about digital product passports
- Presentation at Habit Impact Day 2024

6.4 FURTHER READING

In parallel to the Trace4Value pilot, TrusTrace created the playbook: Unlocking DPP- The Why, What and How of Digital Product Passports. The playbook can be downloaded here.

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