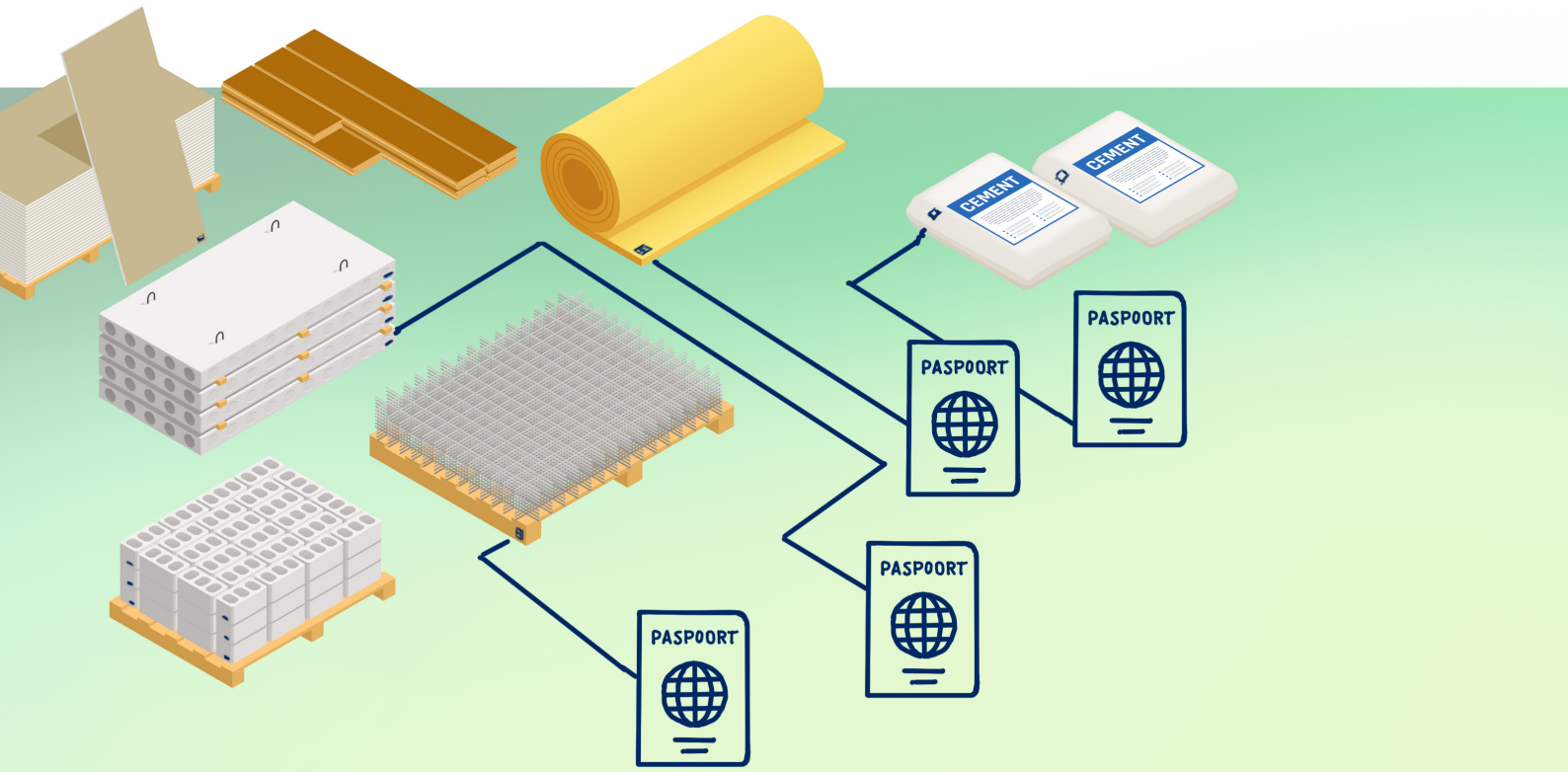
The business value of Digital Product Passports

Exploring value-driven DPP implementation for the Dutch construction industry



Master thesis - Strategic Product Design

The business value of Digital Product Passports

Exploring value-driven DPP implementation for the Dutch construction industry

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Summary

In the coming years, Digital Product Passports (DPPs) will be mandated in the Dutch construction industry through the ESPR, requiring manufacturers to provide detailed information of their products. However, if DPPs remain merely a compliance requirement, the industry may not invest sufficiently to fulfill its circular economy ambitions.

To address this challenge, this thesis aims to unpack the business value that DPP implementation brings to manufacturers in the Dutch construction industry, thereby motivating their investment in DPPs. The research employs various qualitative methods to address four research questions: understanding how DPPs are defined and perceived (RQ1), gaining insights on DPP implementation from early adopter experiences (RQ2), co-creating value-driven implementation goals and steps with manufacturers (RQ3), and determining how to support value-driven DPP implementation (RQ4). These questions are answered through literature exploration, interviews with construction industry stakeholders, non-construction early adopters, and DPP experts, alongside three co-creation workshops with manufacturers and various design activities.

The findings reveal that early adopter experiences follow four distinct phases: Awareness, Evaluation, Action, and Reflection, with the Evaluation phase proving most crucial for success. Notably, construction manufacturers currently perceive DPPs as presenting significant challenges while seeing relatively little potential—a stark contrast to the opportunities described in existing literature.

When exploring value-driven implementation, manufacturers identified varied goals and steps that must be tailored to their specific contexts, highlighting the need for customized approaches rather than one-size-fits-all solutions.

Given the current undeveloped landscape, this research proposes that manufacturers cannot be coerced into DPP implementation. Instead, a “gentle encouraging” approach is needed that validates manufacturers’ experiences, addresses their challenges, and builds confidence for implementation. To support this approach, this thesis developed future adoption scenarios as a practical resource for navigating implementation uncertainty.

Acknowledgements

I am grateful to conclude my time as an industrial design engineering student with this project. The complex topic of digital product passports and the surrounding perspectives have challenged me deeply. I am thankful for the support I have received to work through professional and personal challenges that allowed me to complete this project.

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Abbreviations

B2B	Business to business
C2C	Cradle to cradle
CE	Circular economy
CEAP	Circular economy action plan
CPR	Construction Products Regulation
DPP	Digital product passport
DPPE	Digital product passport ecosystem
DPPSP	Digital product passport service provider
ESPR	Ecodesign for Sustainable Products Regulation
EU	European union
ISO	International standard organisation
LCA	Life cycle assesment
PCDS	Product circularity data sheet
rEO	Responsible economic operator

Glossary

These are the main descriptions and definitions used in this thesis.
Secondary definitions are described within the corresponding chapters.

Circular economy (CE)	An economic system that operates on continuous cycles of defined materials
Beyond compliance	An attitude that regards the DPP not as a product of regulation requirements, but as a vehicle of value
Business value**	The net quantifiable benefit derived from DPP implementation that may be tangible, intangible, or both. The manufacturer is the main receiver of business value
Digital product passport (DPP)*	a set of data specific to a product that is accessible via electronic means
DPP Adoption**	Degree to which an industry has completed DPP implementation. Full adoption means all products have DPPs.
DPP Implementation**	The process of putting the DPP concept into practice by an individual manufacturer/rEO, with the intent to make an operational DPP
Evaluation process**	The process of translating opportunities for business value into implementation goals and steps, to execute value driven DPP implementation.
Responsible economic operator (rEO)*	the entity responsible for making a DPP available on the product that they place on the market. This is usually the manufacturer of the product.
Value-driven DPP implementation**	DPP implementation, but with the additional purpose of providing business value

** Definitions are in accordance with ESPR*

*** definitions created or adapted for this thesis*

1. Introduction

1.1 Introduction to the problem

Within the built environment, one of the biggest challenges with reclaiming materials is the lack of shared knowledge on what those materials are. (Hansen et al., 2018). Closing material loops, one of the primary actions of the circular economy (CE), requires defined materials at a global scale.

This problem translates to major environmental costs: the construction sector in Europe is responsible for 50% of total resource mining, more than 35% of resource waste, and 5-12% of national greenhouse gas emissions (European Commission - Buildings and construction, n.d.).

Digital product passports (DPPs) are introduced through the Ecodesign for Sustainable Products Regulation (ESPR) to resolve this issue of undefined materials (European Commission, 2022). With a DPP, manufacturers share what goes into their products by accompanying them with a digital data structure containing product and circularity information. The ambitions of the digital product passport are high: improved transparency and global traceability of materials (Circular Economy Action Plan, 2019), with the possibility to support activities such as urban mining, resource value retention, and buildings as materials banks.

Though the European legislation sets a good start, it has its limitation when it comes to enforcing the full ambition of the digital product passport. For example, it requires outside development of information communication technology. This means, to properly embed the DPP into practice, it relies on the industry to allocate additional resources. This is where the difficulty lies, because the way the DPP is presented, it does not inspire business action: there is a lack of information on how the DPP aligns with goals, risks, and value within businesses.

The risk is that the industry does not cultivate the interest to take the necessary implementation actions, and the digital product passport measure does not take off the way it is intended. For society, this has consequences for climate mitigation efforts and respecting planetary boundaries. For nations and cities, it limits the ability to fulfill their own circular (or socio-economic) ambitions. For manufacturers, it represents wasted resources and missed opportunities (Reich et al., 2025). For researchers, designers and other change agents, this problem mirrors a broader challenge of translating social or sustainable ambitions into action.

Therefore, given the importance of this issue and the misalignment between legislation and industry, it is useful to explore what potential a DPP can offer.

Research gap

Research on digital product passports has historically focused on technical feasibility rather than business value. Though academia increasingly recognizes the importance of a business perspective on DPPs (see chapter 2.3 Value-driven DPP framing), research in this area remains limited. Recent studies include a DPP business case for product longevity (Haasse et al., 2025), business value perspectives from textile manufacturers (Hansson & Maass, 2024), and a method for value-driven DPP design (Reich et al., 2025). This thesis contributes to this emerging field by focusing on the construction industry, where DPP adoption has high impact and priority within the European context.

1.2 Research outline and scope

The purpose of this thesis is to *uncover the business value of DPP implementation for construction manufacturers*, in order to motivate investment in DPPs. Business value refers to concrete benefits that result from executing a plan, such as increased revenue or reduced risk. This value is uncovered to make it tangible for manufacturers to understand. DPP implementation refers to manufacturers putting the DPP concept into practice.

To fulfil this purpose, this thesis introduces a new framing, in which the DPP is regarded as innovation that brings value for businesses, instead of a compliance requirement. Figure 1 shows the research questions that guide this study.

This thesis answers these research questions through the following chapters:

Chapter 2 (Understanding digital product passports) explores digital product passports, the current landscape, and business value framing
Chapter 3 (Understanding challenges and opportunities of DPP implementation) examines how challenges and opportunities are defined in literature and perceived by the construction industry, and explores how early adopters from other indusctries decide and act to implement DPPs
Chapter 4 (Developing opportunity cards) develops opportunity cards to communicate about business opportunities from DPPs
Chapter 5 (co- creation value driven DPP implementation) Co-creates value driven DPP implementation goals and steps with construction manufacturers, to examine ideas and decision-making processes for value-driven implementation
Chapter 6 (Supporting DPP implementation in practice) Develops findings into a support approach, including an adoption scenario support resource.

Figure below presents the research questions that are adressed in this thesis, and how they inform each other to build toward the research aim.

Figure 1 Research questions

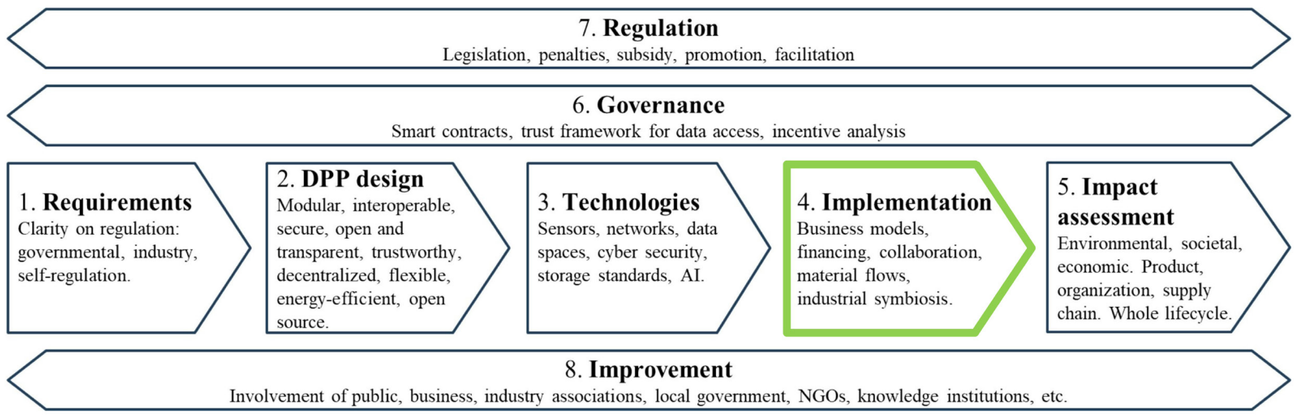


Figure 2 Summary of all DPP orchestration domains and focus area of the thesis (marked in green), adapted from Langley et al. (2023)

Langley et al. (2023) propose a framework for the orchestration of digital product Passports, that breaks it down into domains (Figure 2). This thesis addresses on part 4: Implementation.Within implementation, this thesis focuses on the perspective of the individual manufacturer, and only the moment around DPP creation.

This thesis focuses on the construction industry for several reasons. First, construction is responsible for the largest share of global resource mining (50%) and material waste (35%) (European Commission - Buildings and construction, n.d.), making DPP implementation particularly impactful. Second, construction is among the first industries required to use DPPs under European regulation (ESPR).
The research takes place in the Netherlands, which interviewed experts consider well-prepared for circular economy transitions due to existing initiatives and established ICT infrastructure.

The adoption of technology follows a path across different adoption groups: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1962). This thesis focuses on the early majority rather than current DPP

adopters (innovators and early adopters) because they represent the tipping point for widespread acceptance.

1.3 Introduction to the client

EPEA is a sustainability consultancy founded by Prof. Dr. Michael Braungart in 1987. The company applies cradle-to-cradle thinking to improve products, buildings, and urban districts. EPEA has since become the world's largest assessment body for Cradle to Cradle certification and works with manufacturers through research projects, events, and innovation consulting to help them adopt sustainable practices.

Cradle-to-cradle (C2C) is a design philosophy that eliminates waste by creating products that can be continuously cycled through either biological or technical systems. Unlike traditional "cradle-to-grave" approaches, C2C treats materials as nutrients that feed back into production cycles, with the goal of creating regenerative systems (McDonough & Braungart, 2002).

EPEA's expertise in C2C naturally extends to early involvement in digital product passports. For example: In 2018, they published a paper introducing the role of material passports in resource depletion (Hansen et al., 2018). They participated in a large-scale Horizon 2020 research project on best practices for materials passports within construction projects (Heinrich & Lang, 2019). In 2025, they helped develop these efforts into an ISO standard, which sets industry-wide international requirements to streamline DPP implementation (ISO 59040:2025 — Product Circularity Data Sheet, 2025).

EPEA's history, brand, and networks position them well to facilitate the implementation of DPPs.

Research ethics and transparency

This research was approved by TU Delft's Human Research Ethics Committee (HREC). All participants signed consent forms prior to participation. Transcripts and research documents were stored anonymously in a secure digital environment.

AI tools were used to assist with writing clarification and image creation for this report. All data collection, analysis, interpretation, and conclusions, and design results remain the author's own work.

2. Understanding Digital Product Passports (DPPs)

This chapter provides background context for the research problem by defining the digital product passport, examining the landscape that influences it, and identifying a way to approach it "beyond compliance".

The background was developed through an exploration of academic and grey literature, interviews with experts (chapter 3 - Understanding challenges and opportunities of DPP implementation), and discussions with EPEA consultants.

2.1 DPP definition and explanation

In academic literature, digital product passports are defined in various ways. Some view it as a centralized system that consolidates lifecycle data in one location (Psarommatis & May, 2024), while others adopt a broader perspective, envisioning a Digital Product Passport Ecosystem (DPPE) that is accessed, utilized, and updated by stakeholders across the product's lifecycle (King et al., 2023) or even across multiple lifecycles (Langley et al., 2023).

Recent practice-oriented literature (Barwasser et al., 2024; Hansson & Maass, 2024; D'Adamo et al., 2025; Colucciello et al., 2025) refers primarily to definitions provided by the European Commission in the ESPR and Construction Products Regulation (CPR) (European Commission, 2022). The Ecodesign for Sustainable Products Regulation (ESPR) describes the DPP as:

"a **set of data specific to a product** (that includes the information specified in the applicable delegated act), and that is **accessible via electronic** means through a data carrier" (Art. 2(28), ESPR)

This thesis adopts this definition because it most closely aligns with what industry will implement.

In literature, the DPP is often broken up into two parts: the DPP system, which describes how the DPP is structured, and the DPP data, which constitutes the information that goes into a DPP (Çetin et al., 2022). This thesis examines only the core components mandatory under ESPR regulations, termed as 'DPP core system' and 'DPP core data' by (Huib et al.,2024).

DPP system

Figure 3 shows the system components and how the ESPR defines them. Figure 4 presents how they should function together in the other DPP infrastructure. To make this easier to understand, examples of system

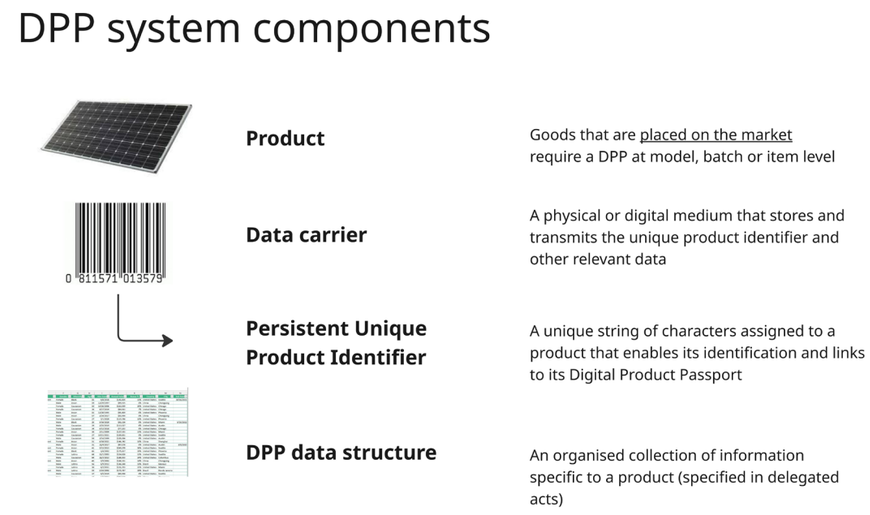


Figure 3 Definitions of system components in ESPR regulations

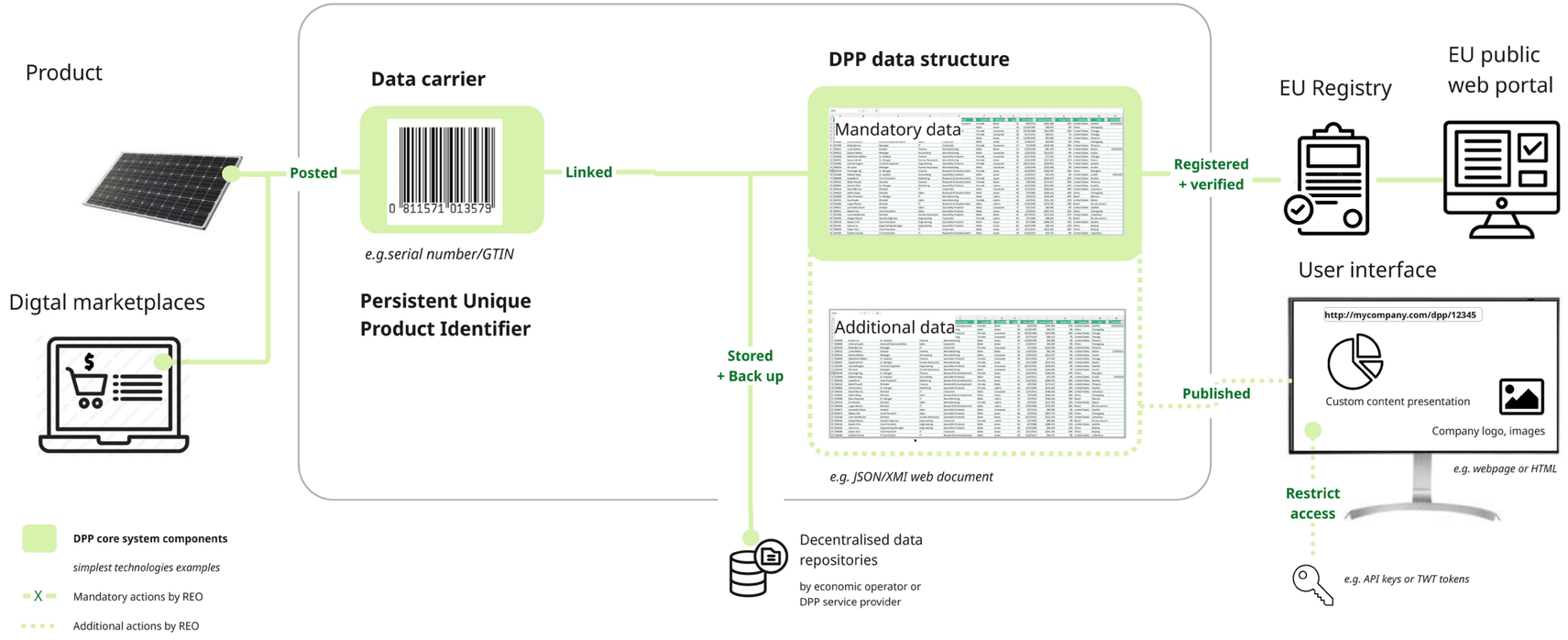


Figure 4 DPP system (outlined in green) in the intended infrastructure

technologies are added from Tammet et al. (2025).

For this DPP system to work, it relies on a few critical elements. These elements are related to **data authentication**, (e.g. verification and validation by an external party or EU registry), **system reliability** (e.g. via mandatory hosting infrastructure requirements), **data integrity** (e.g. via time stamped backups) (Huib et al., 2025).

There are also elements related to technical challenges: **interoperability** (how data systems work together to exchange information) and **automation** (e.g., machine readability). The CPR and ESPR address these elements by requiring DPP data in the construction industry to be available to various stakeholders (CPR art. 75; ESPR Art. 10(b)), be interoperable and machine readable (CPR art. 78; ESPR Art. 10(1a)), and remain accessible after the last products have been sold (CPR art. 76; ESPR Art. 9(1d)) through decentralized storage (ESPR Art. 10(c) & (d)).

These critical elements are expected to be addressed in upcoming norms and Delegated Acts. This thesis proceeds under the assumption that technical solutions will be available.

DPP data

A basis for the data requirements is provided in the ESPR under its 'ANNEX I: Product parameters'. A full overview can be found in appendix B. The DPP data describes product attributes (e.g., weight, performance), material circularity (e.g., amount of recycled content, substances of concern), circular potential (e.g., ease of repair or recycling), and environmental impact (e.g., water use, carbon footprint).

These parameters will be further defined through norms to formulate definitive data requirements. This process is conducted separately per EU member state and industry. Ultimately, these definitive requirements will determine what information manufacturers must provide in their digital product passport.

The DPP data is a key discussion point in literature, as the function of the

DPP relies on it. For example, Langley et al. (2023) explain that for DPPs to be applied properly, the data should support high-value and high-quality material and energy cycles, which requires sufficient data quantity. The type of data also matters: Hansen et al. (2018) emphasize the need to focus on qualitative data, such as providing recycling grade in addition to recycled content, as this would allow value retention of materials and avoid downcycling.

Lastly, there is a concern about the trade-off between making data requirements specific to industries to ease implementation, or keeping them sector- and border-overarching to enable cross-referencing and fulfill circular economy practices. In the latter approach, broader requirements would allow data to travel between countries and product applications, just as materials do. In 2025, a cross-sectoral data norm (ISO 59040 - Product circularity data sheet) has been developed to support this.

Ambition and purpose

The EU intends to use the introduction of the DPP to fulfill its circularity ambitions: achieving climate neutrality by 2050 (The European Green Deal, 2019) and doubling the share of recycled and reused materials in its economy, from around 11.7% in 2021 to about 23% by 2030 (Circular Economy Action Plan, 2020). In these ambitions, the use of DPPs would facilitate the slowing and closing of material loops, while also reducing waste production, carbon emissions, and energy use.

In addition, the DPP has ambitions in facilitating compliance and traceability across the EU market for construction products (Proposal for a Regulation on construction products, 2022). Lastly, it is said to support a competitive economy (EU Compass to Regain Competitiveness, 2025). These latter ambitions might be particularly relevant to the construction industry, as it is heavily influenced by macroeconomic factors such as supply chain issues, trade barriers, raw material prices, and trends in the European economy (IBISWorld, 2025).

To achieve these outcomes and ambitions, the DPP is expected to fulfill

multiple purposes. Figure 5 shows some examples: it helps identify products and materials during recycling, measure collective progress toward circularity, and compare sustainability aspects between products.

Some academic literature stretches potential of the DPP further, suggesting it could play a crucial role in transitioning into the circular economy. (Walden et al., 2021; Langley et al., 2023) For example, the DPP can enhance traceability, catalyse services such as remanufacturing, repurposing, repair and recycling and enhance transparency for market surveillance (Psarommatis & May, 2024).

In the long term, these changes have an enormous potential to radically transform relationships within industry. For example, forming opportunities for industrial symbiosis (Langley et al., 2023), and changing the way value is managed and perceived (Haase et al., 2025).

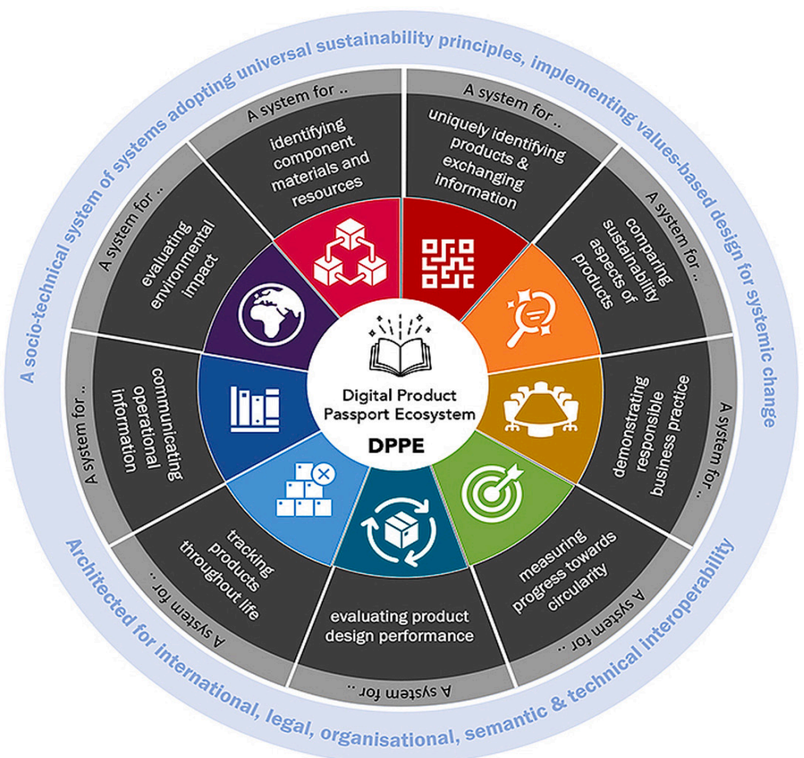


Figure 5 Intended use of the DPP ecosystem from King et. al, (2023)

DPP implementation

This thesis defines DPP implementation as:
"The process of putting the DPP concept into practice by an individual manufacturer, with the intent to make an operational DPP."
This thesis uses "implementation" rather than "DPP creation" (Huib et al., 2024) to encompass the full spectrum of activities required, including knowledge building, development, and integration.

Value-driven DPP implementation refers to DPP implementation with the additional purpose of providing business value. Organizations may pursue value-driven implementation to capture benefits from the DPP, such as improved supply chain transparency, enhanced brand reputation, operational efficiencies, or new revenue streams. This approach may involve additional implementation steps, development of supplementary features, or integration with other business systems.

DPP implementation is carried out by a responsible economic operator (rEO), the entity responsible for creating and maintaining the DPP (ESPR, 2024). In most cases, the rEO is the manufacturer of the product.
The rEO can outsource part or all of DPP creation and management to a DPP service provider. A DPP service provider (DPPSP) is an entity authorized by the rEO to provide DPP services (ESPR, 2024). This could include, for example, providing the necessary IT infrastructure.

DPP implementation
*The process of putting the DPP concept into practice by an individual manufacturer/rEO, with the intent to make an operational DPP**

**according to the definition in this thesis* → *See glossary*

Value-driven DPP implementation
DPP implementation, but with the additional purpose of providing business value**

**according to the definition in this thesis* → *See glossary*

Once operational, the DPP travels with the product throughout its lifecycle, collecting and sharing information at each stage. Different stakeholders—manufacturers, suppliers, installers, users, and recyclers—can add relevant information as the product moves through the value chain. The DPP acts as a dynamic document that grows over time (king et al, 2023), often combining data from multiple sources and related products. Figure 6 illustrates how this information accumulates across the product lifecycle.

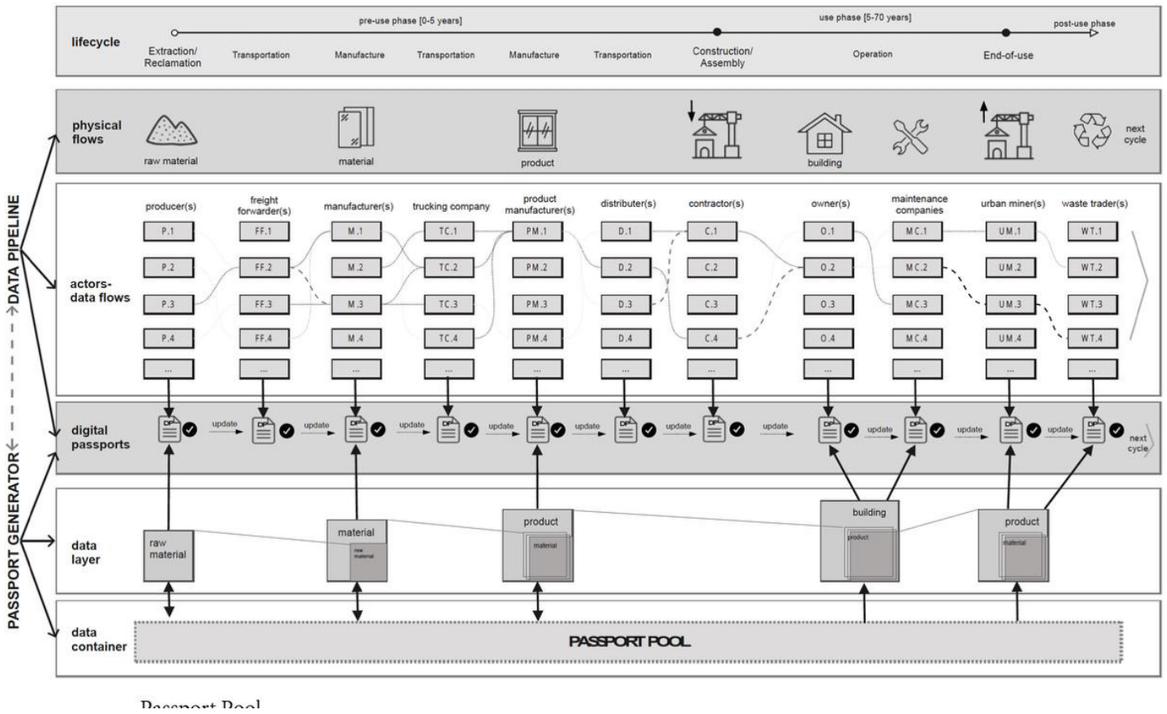


Figure 6 DPP life cycle from Çetin et al,. (2022)

2.2 DPP landscape

This section maps the DPP landscape to show which actors influence how DPPs are perceived and developed. Understanding this landscape helps manufacturers identify who they need to work with during DPP implementation. The landscape includes stakeholders, regulations, technologies, and initiatives that shape DPP development at an industry level.

Delegated acts

The ESPR establishes guiding principles, but individual EU member states and sectors determine their specific requirements through Delegated acts. These will determine how strictly the principles are enforced. Delegated acts will be implemented over the coming years, starting with textiles and batteries and then moving to the construction industry in 2027(CPR)
To inform this process, the EU established the Ecodesign Forum, the main arena for consulting stakeholders on the development of rules under the ESPR. Additionally, EU-funded research projects like Cirpass and Cirpass 2 help define DPP possibilities.

Norms

Standards development has begun for DPP systems and surrounding infrastructure. The CEN/CENELEC Joint Technical Committee (JTC24) develops standards for product identification, registry, writing, and access of DPPs. The CEN TC442 WG12 creates standards for specific economic sectors, including Building and Construction. The JTC 24 is expected to release a DPP system framework in 2025. In the Netherlands, the national standardisation body NEN established a DPP normcomittee to inform stakeholders at a national level.

Industry standards and data frameworks

The construction manufacturing industry already employs various standards and data structures for organising and sharing product information. Some frameworks that came up in interviews include:

ISO 59040: Cross-sectoral standard for exchanging circular economy information through Product Circularity Data Sheets without disclosing confidential data.

LCA standards: Environmental performance standards (ISO 14025, ISO 14040, ISO 14044, EN 15804) commonly used in construction, though focused on environmental impact rather than circularity.

MPGs: Environmental performance requirements mandatory for new residential and office buildings in the Netherlands since 2018.

Ketenstandaard Bouw en Techniek: Dutch foundation (2019) developing construction sector standards for information exchange among contractors, architects, suppliers, and software partners.

Some frameworks appear better suited for DPP requirements than others. While these standards are mentioned in industry discussions, it remains unclear which will form the basis for DPP implementation.

Data sharing systems

Interviewees also mentioned various data sharing systems and platforms:

BIM (Building Information Modeling): Widely used shared data environment for building design, construction, and operation.

DigiGO: Digital collaboration platform for the built environment that has explored DPP applications within the Dutch Digital System for the Built Environment (DSGO).

Madaster: Dutch digital platform assigning digital identities to materials for traceability and reuse throughout their lifecycle.

Nationale Milieu Database (NMD): Independent organization managing environmental performance data for products and product categories.

DPP Service Providers (DPPSPs)

Many entities offer DPP-related services. This thesis defines DPPSPs as providers whose primary service is offering complete DPP solutions (DPP data or DPP system).

Current DPPSP services are primarily startup-led, likely because startups pursue new market opportunities while larger firms wait for established demand (Palaz, 2025). DPPSP startups identified in interviews include Circularise and Tappr.

Existing IT providers are expanding their offerings to include DPP capabilities or implementation support. For example, GS1 introduces their existing solutions as part of DPP system by presenting their barcode as a possible persistent identifier.

The current DPP landscape is in early development. Available DPP services are mostly run by startups, showing the market is still immature (Palaz, 2025). The ways to implement DPPs remain unclear due to vague legislation (Petrik et al., 2025).

This is illustrated by several observations from this thesis: most DPP development occurs in research settings rather than practical applications. Few manufacturers have implemented DPPs, resulting in limited real-world examples. Available consultancy services focus on helping companies explore DPPs rather than actually implement them.

Because the field is so new, the landscape evolves continuously. Experts, practitioners, and the researcher all noted this during the study. Therefore, this chapter aims to provide a general image of the key actor types rather than comprehensive documentation of all DPP-related activities.

2.3 Value-driven DPP framing

Current compliance-driven framing

The DPP landscape shapes how DPPs are perceived and discussed.

Currently, this landscape frames the DPP primarily as a compliance obligation. This is evident in several ways: academic research often assumes manufacturers will implement DPPs to meet regulatory requirements; the ESPR regulation itself focuses on circular economy benefits without explaining additional business value; and other landscape actors (e.g., consultants, knowledge sharers, and service providers) emphasize upcoming regulatory obligations to demonstrate DPP relevance.

These combined messages reinforce the perception of DPPs as compliance-driven requirements. In this framing, manufacturers perceive the DPP as an obligation with limited business value, which incentivizes them to pursue 'minimum' DPP implementation (figure 7).

This framing poses a few challenges. First, it has limitations: regulation can only set requirements, not dictate direction, making it less effective at driving industry change than innovation. This limits proper industry steering (expert interview) and may provoke significant pushback without providing viable solutions. It relies on strong regulatory enforcement and guidance to ensure compliance (expert interview)

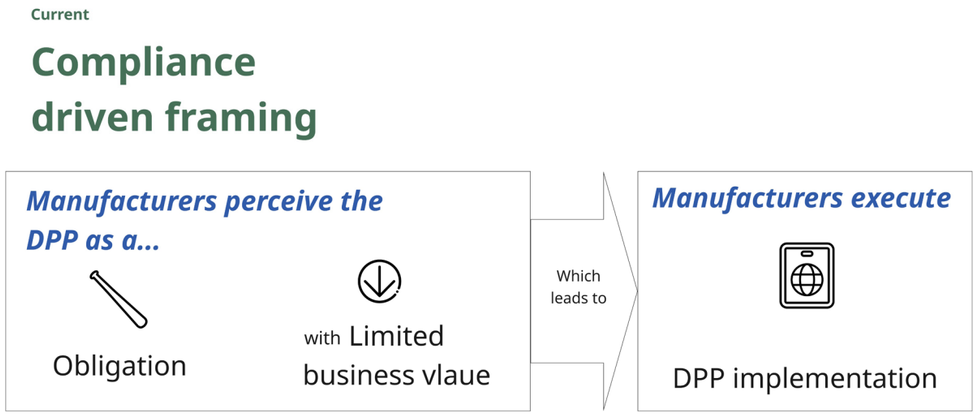


Figure 7 Compliance driven framing

Second, 'proper' DPP adoption requires actions from manufacturers beyond what regulation describes. For example, exploring novel business practices, sharing data with competitors (King et al., 2023), or ensuring the right quality of data is available (Hansen et al., 2018). These actions also represent the potential business value that DPPs can offer. Compliance-driven DPP implementation offers little to motivate these actions.

In DPP research, financial incentives are often presented as a solution to this. Financial incentives are a policy mechanism that stimulates desired behavior by providing financial rewards (Domenech & Bahn-Walkowiak, 2017). However, relying on financial incentives is not always ideal, because they can work counterproductively by reducing perceived financial value or weakening intrinsic motivation over time (Gneezy et al., 2011).
Overall, compliance-driven framing carries risks and limitations that may prevent full realization of DPP ambitions outlined by the EU and literature.

New value-driven framing

The limitation of compliance-driven framing is why newer research calls for the exploration of DPP framing "beyond compliance" (Reich et, al. 2024). The term "beyond compliance" is used to regard the DPP not as a product of regulation requirements, but as a vehicle of value. With this, the research emphasizes the need for researching strategic advantages for businesses (Haase et al., 2025) and incentivise investment by looking into business practices (King et al. 2023). A quote from a researcher in an academic meetup summarises the notion nicely:

"DPPs are only useful if businesses take them seriously enough to meaningfully integrate them." – Academic DPP expert in DiCE academic meetup

This view is shared by manufacturers themselves. In the EU's public consultation on the ESPR (European Commission - 31 January 2023), some manufacturers requested that the framework support ongoing innovation and collaboration rather than merely forcing data collection for reporting.

This thesis aligns with these views by assuming a new framing for the DPP (figure 8). With this “business value” framing, manufacturers perceive the DPP as an innovation opportunity that provides promising business value. The thesis assumes this would incentivize manufacturers to pursue DPP implementation.

This framing also addresses the potential for business value that was foundational to the origin of digital product passports. This is one of the strengths of C2C thinking, which believes that value is created when ecology, equity, and economy work together (see C2C background in appendix C). For instance, DPPs can help maintain or increase the financial value of materials, assess future material flows, and improve the quality and security of material supply (Heinrich & Lang, 2019).

New

Value-driven framing

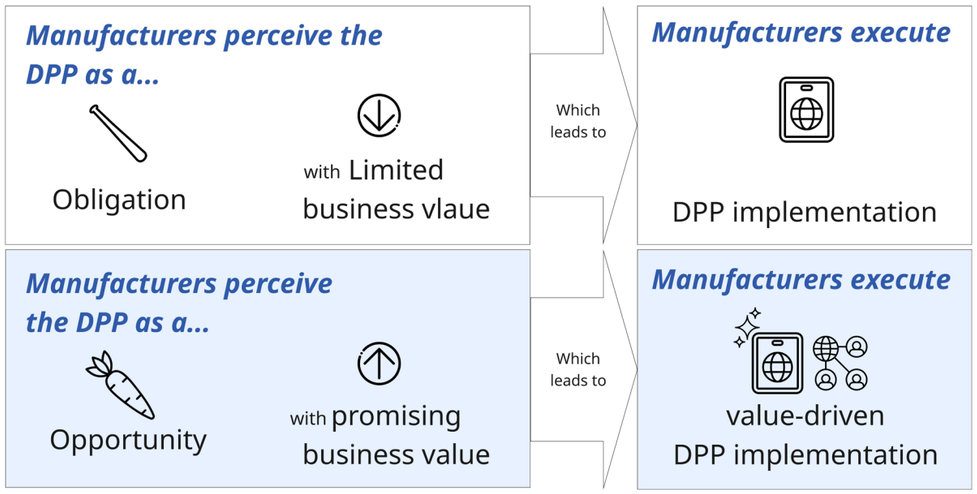


Figure 8 Compliance driven framing (white), compared to value-driven framing (blue)

As a research contribution, this view approaches value from the manufacturer’s perspective, which is often overlooked in favor of the circular economy (Walden et al., 2021; Langley et al., 2023), the value chain (Zhang & Seuring, 2024), or the passport itself (Gieß & Möller, 2025). In these sources, the attributes of the DPP seem to benefit DPP receivers (recyclers, consumers) instead of DPP creators (manufacturers, suppliers). This imbalance may limit successful DPP adoption.

3. Understanding challenges and opportunities of DPP implementation

To understand DPP implementation and its potential for the construction industry, an analysis is needed. This chapter achieves this through three parts. First, a literature review examines the potential challenges and opportunities of DPP implementation from academic research. Second, interviews with construction industry stakeholders reveal how these are perceived in practice. Finally, experiences from early adopters provide insight into the journey of DPP implementation.

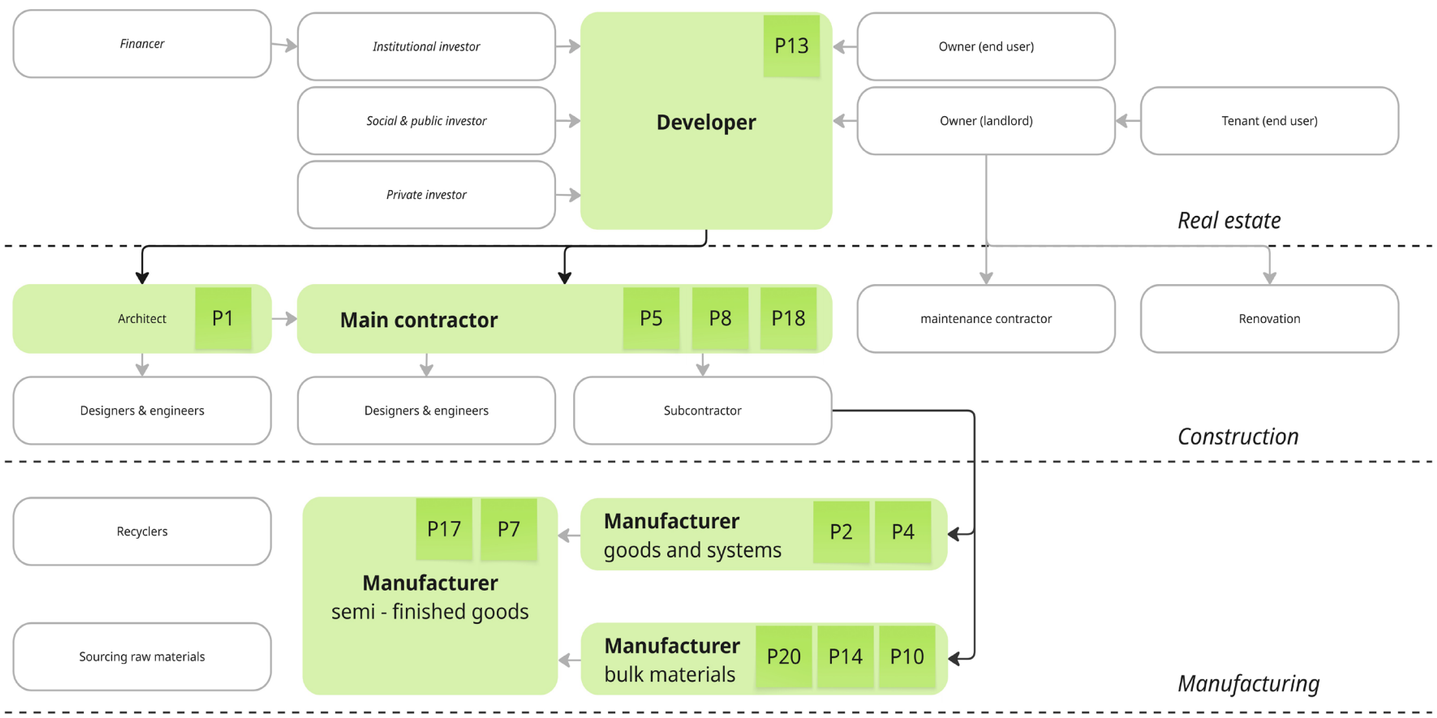


Figure 9 participant selection - construction industry stakeholders (group 1)

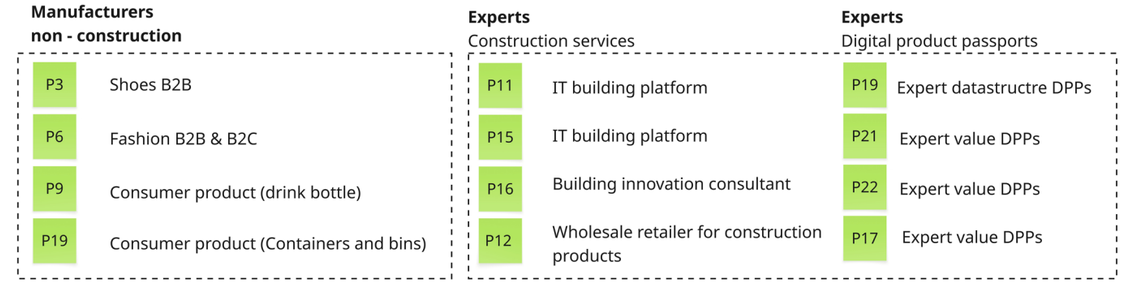


Figure 10 participant selection - early adopters (group 2) and experts (group 3)

Method

This research used a flexible research design following Robson's real world research handbook (Robson, 2011), which supports the exploratory and practical nature of the thesis. The research for this chapter involved two main activities: exploring literature and conducting qualitative interviews.

The participants were approached by the researcher. Some were part of EPEAs network and some were approached separately.

In total, 3 different participant groups were interviewed:

Group 1: Construction industry stakeholders (figure 9)
Group 2: Product manufacturers (non- construction) with DPP experience (figure 10)
Group 3: DPP experts, both academic experts and practitioners. (figure 10)

This approach was needed because construction manufacturers had no DPP experience, so insights from other industries were required. Since neither manufacturers nor early adopters understood the full potential of DPPs, expert views were added to complete the picture.

3.1 DPP implementation: Lessons from Early adopters

Some early adopters have already implemented and published DPP concepts. These early adopters are product and textile manufacturers (interview group 2). Despite being in a different industry, these manufacturers can provide insights on the experience of DPP implementation for construction manufacturers. Their experiences are quoted in figure 12 on the next page.

From these experiences, it was found that DPP implementation followed a multi-stage process: awareness, evaluation, action and reflection. The evaluation stage is the most crucial, because this is where the early adopter would decide to proceed with the DPP. As Figure 11 illustrates, every stage of the process required separate decision-making and process steps, which early adopters invented themselves. Examples include making cost/benefit proposals, mapping out the supply chain, and creating original DPP data templates. This requires early adopters to have a good understanding of the DPP system, regulation, and opportunities.

To facilitate this multi-stage implementation process, early adopters developed strategies to address the challenges around DPPs. For example, to combat high costs, some early adopters combined the DPP with other sustainability initiatives or created “quick and dirty” DPP concepts instead of complete DPPs. To address limited funding, some early adopters allocated deliberate innovation budgets, which they believed was supported by their “pioneering” company culture. To overcome implementation difficulties, the DPP-responsible often possessed extensive knowledge of the supply chain or product data.

Figure 11 Phases of value driven DPP implementation

These findings offer several lessons for the construction industry. First, they provide the basis for an outline of the key phases of value-driven DPP implementation Figure 11. Second, they demonstrate in detail the complexity of the implementation process. Compared to early-stage innovators, early majority manufacturers have fewer capabilities to handle this complexity. This highlights the necessity of creating methods and tools to support implementation. Third, the findings show examples of measures that can be taken to reduce DPP challenges and maximize DPP opportunities (e.g., aligning with existing initiatives). Finally, they demonstrate that value-driven DPP implementation can be attainable.

3. Understanding challenges

DPP implementation journey of early stage innovators

Awareness

Resources

"We find sustainability important, so we have the resources to experiment"

Basic knowledge about DPP regulations

"We had Back in head knowledge that regulation is coming (provided by branch organisation)"

Subscription to newsletter on **upcoming regulations**

ESPR legislation information provided by branche organisation

Basic knowledge about supply chain

“The advantage of having worked in this industry for so long is that I know the entire supply chain well and how many links are in it.”

Curiosity

Look on websites such as circularise and european commission give theoretical understanding on DPPs

Trade off

"I tried to find answers on how to implement, what kind of effort it would take, and what benefit it would offer"

"We made projected steps: Map supply chain, find a partner that can create IT infrastructure in line with current infrastructure"

Alignment with opportunities DPP solution providers (SP)

The DPP solution provider put **emphasis** of DPP **on opportunity** on consumer engagement after sales, with examples from other companies with similar identities

"many things came together": Extended producer responsibility, opportunity with GS1 (digital link)

Evaluation

Decision

Action

DPP data collection

"To determine what should be included in the passport, I literally went through the process of a piece of clothing: Where does it start? Who is involved? What information do we have?"

"our starting point was: “what would I want to know as a consumer? What would I want to know as a producer?” what would I want to share as a producer?"

"Create an Excel sheet with the information that could be included (as a starting point), by going through our supply chain.

We left out some data to avoid confusion on different sustainability footprint (CO2) and circularity numbers

"We created a data template by putting ESPR regulations in excel, and filling in as much as possible."

DPP data selection

“DPP as a marketing tool leaves out information to keep it manageable for the user.”

DPP development

"In a projectgroup, we **built the first concept of the DPP together** in Figma (visual tool), to **review** it **critically** in multiple sessions, thoroughly covering both the technical and design aspects."

DPP follows product design: "There is **no detailed information** in our DPP on how to **maintain** or dispose of shoes, because **you cannot** take the product apart to throw it away."

Think about what we as a brand want to communicate and pocus on those data points

"We selected data necessary for a minimum viable product"

"**Marketing & brand design** also contributed to the visual appearance (colors, fonts, photography)."

"We **sat together with the IT solution provider** and our own IT department: "Where should the data come from, and how can we link it to the [DPP solution provider]'s system?"

"**We started with a small batch** (workwear), and simple technical solutions, such as a woven QR code."

Convincing stakeholders

"The deeper you go into the supply chain, the less the idea of sustainabilty is alive."

Convincing stakeholders: "You really need to take people [suppliers] along in your story to convince them."

Reflection

Benefits

"we have the passports on our website, and can see how often they are being downloaded."

“you actually enter your materials very easily.” and you can **very easily compare** durability based on those product component options (steel v/s fiberglass nose cap)

Being recognised as sector pioneer by peers and media

“we are reaping the benefits in the sense that we are seen as a frontrunner by industry partners: we are asked for interviews and speaking at events.”

"As a positive side effect, we had a lot of traction with companies and media, who want to know about our DPP story.”

Losing urgency

“now we sit back and watch: what will the tools be and how does the standards/law crystallize? ”

Further iteration

"The current DPP version is mainly focused on transparency. **Extend life & maintenance** (further up R ladder) are not included. We **still need to make strides** on this."

“we now have at the item level a QR code, where you can **register the product** to you personally.” We'll be happy to use that soon as a **communication tool** after your point of sale.” For example, with the integration of a **loyalty programme.**

Technically we are not that far yet, but we see **opportunities to communicate with the customer**, for example that they can get to our **second-hand platform** at the touch of a button.”

Start considering DPP

Start creating DPP

Trigger

Approached by a DPP provider

"we had been approached by solution provider (TAPPR), with whom we had previously been in contact"

"we were approached by the DPP producer and we thought it was interesting."

Hit frustration limit

"We **get many customer requests** on supply chain information and on how the product is made."

"We get **requests from potential investors**: overview of supply chain, content products, carbon emissions"

Trigger

Fit with identity

"Our final trigger was a combination of a commercial USP and taking on a **personal pioneering role**."

Proactive culture: "We have a saying "No guts, no glory.": We could wait until everything is clear, but that’s not our approach."
We **value** our **learning** philosophy: "we just have to get started and learn from it."

Short term opportunities

"We are already being innovative in other areas: many products are already mapped, and we have a transparent supply chain, so **we would like to share** that."

"we combined the use of DPPs with the start of a sustainabilty initiative to reclaim the products."

"**We saw an opportunity** for creating a connection with the consumer and enabling the sharing of our information."

"**Our B2B customers** (wholesalers) value being able to offer a product passport to their customers (end users)."

"We saw the offering of a **DPP as a USP** for our product"

Quotes are translated (DeepL), anonymised and paraphrased for clarity purposes

Figure 12 Early Adopter Experiences in DPP Implementation

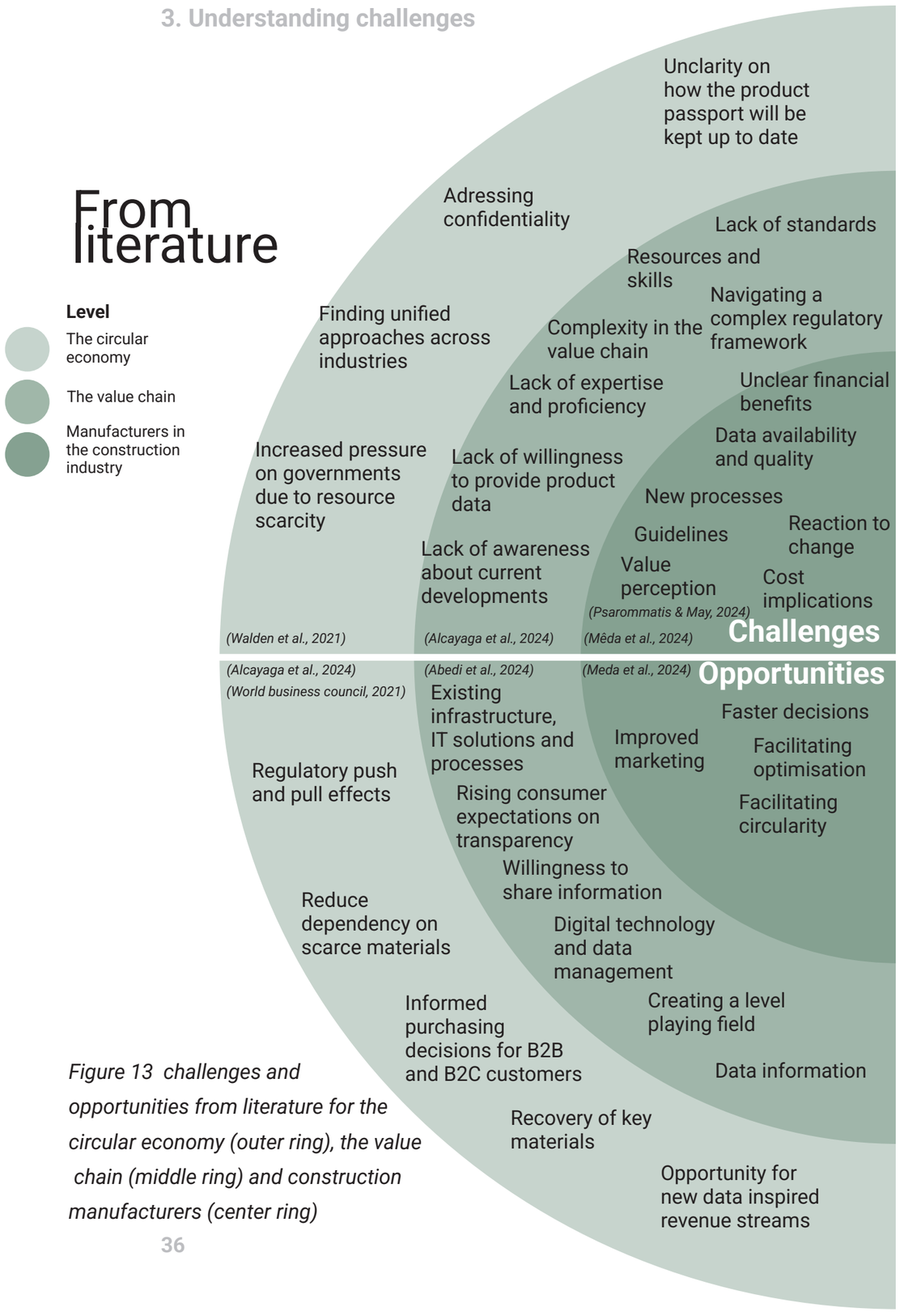


Figure 13 challenges and opportunities from literature for the circular economy (outer ring), the value chain (middle ring) and construction manufacturers (center ring)

3.2 Challenges and opportunities for the construction industry

The challenges and opportunities of DPP implementation have been extensively researched in previous literature. Figure 12 presents an overview to show the variety. Because they address DPPs at different levels, it is useful to divide them into three categories: challenges and opportunities for the circular economy (macro), the value chain (meso), and construction manufacturers (micro). For this study, the third level is most relevant, while the other levels provide context.

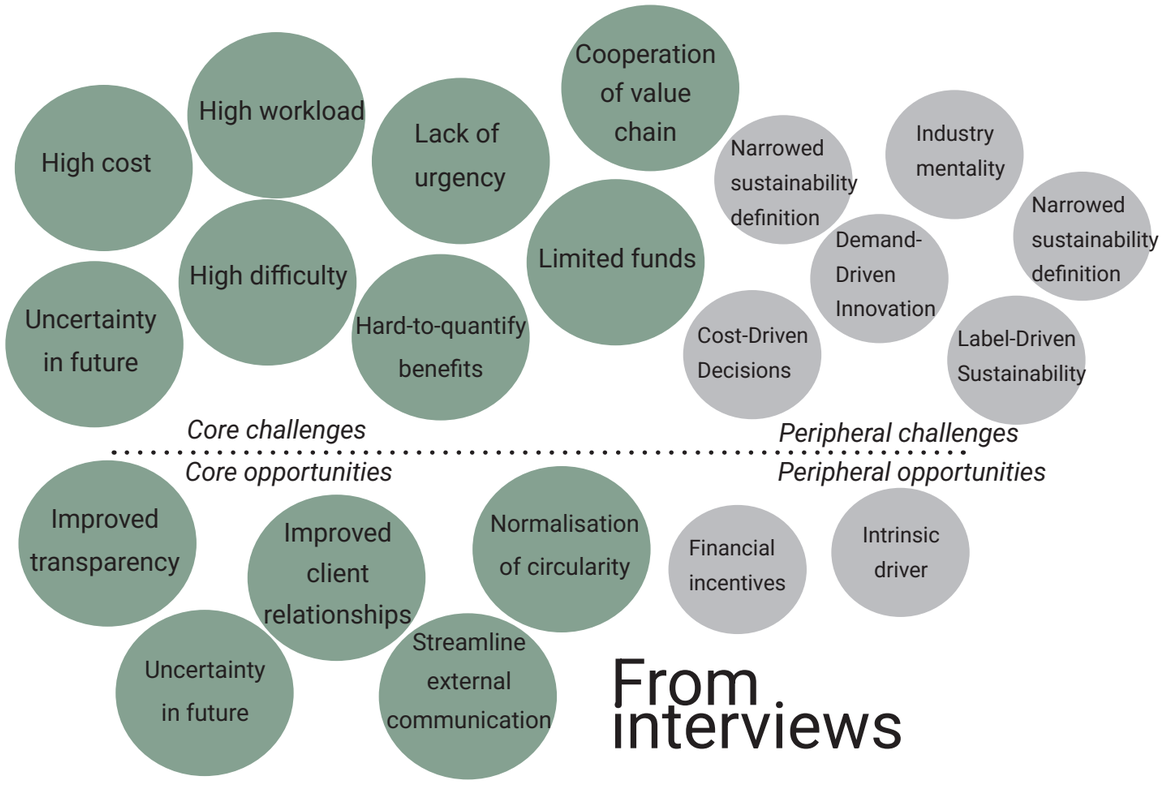


Figure 14 overview of all challenges and opportunities from interviews

The opportunities and challenges from interviews are further explained in figure 15,16,17 and 18 on the next page. Comparing the literature and interview results, it was found that manufacturers see very little opportunities for business value, compared to the potential that the literature describes. This signals that the manufacturers lack knowledge on the business opportunities of DPP implementation.

The interview results provided two tiers of challenges and opportunities: core challenges and opportunities, which are tied directly tied to DPP implementation, and peripheral challenges and opportunities, that influence DPP implementation, but are caused by other reasons. They are described in order of relevancy in figure 15, 16,17 and 18, and are explained by individual insights from participants, which are referenced in brackets.

	Core challenge	
CC1	High cost	Implementation is perceived to require significant investment in: (digital) infrastructure [P2], DPP development, building and upkeep [P5], consultancy hours [4], and buying pre-existing DPP solutions [P9].
CC2	High workload	Implementation is perceived to require lots of time and manual data gathering and filling labor [P9] [P4], a high number of DPPs [P1], especially for companies with a large product catalog [P9].
CC3	High difficulty	Implementation is perceived as a difficult task because of: limited availability of information [P2], lack of adequate DPP solutions [P9], existing infrastructure [P2], large portfolios [P6] and supply chains [P2], and logistical considerations [P1][P6].
CC4	Uncertainty in future	Manufacturers report finding it difficult to determine what future direction the regulation will bring [P3], and the accompanying risks. For example, there are questions around IP coverage [P2], reinventing the wheel [P11], whether consumers will see the added benefit [P5], and verification of data [P5].
CC5	Lack of urgency	Implementation is currently not seen as urgent. There is a lack of knowledge [P4], skepticism about the regulatory forces [P10], and a lack of movement or mention among other stakeholders [P12].

CC6	Cooperation of value chain	Manufacturers report finding difficulty convincing suppliers to share information [P6][P9]. Additionally, suppliers can lack this information themselves [P6], or manufacturers lack bargaining power with much bigger suppliers [P9]. Often, they themselves are restrained to comply with client demands [P11] and are uncertain about client acceptance of DPPs [P5].
CC7	Limited funds	Limited budgets compete with other national and international reporting requirements (energy, MPG, databases) [P5], and PV reporting [P6]. Product declarations [P12] or other sustainability or innovation projects [P5].
CC8	Hard-to-quantify benefits	Manufacturers struggle to quantify the opportunities, viewing DPPs as a ‘nice to have’ [P6] and unsure how to use them to advance sustainability [P17].

Figure 15 Core challenges to DPP implementation

	Peripheral challenges	
PC1	Narrowed sustainability definition	Sustainability within construction is focused on reducing carbon emissions [P1], viewed as an “add-on” [P4], not clearly defined [P4], and highly influenced by calculation requirements (MPG, LCA) and customer questions.
PC2	Industry mentality	The construction industry is observed to be practice-oriented, quick-acting, and risk-conscious. They often employ longstanding partnerships [P10].
PC3	Demand-Driven Innovation	Innovation within the construction industry is often demand-driven, practical, and incremental [P5]. “Smarter, faster, better, more efficient, and cheaper” [P5][P7], and it needs to meet rigid requirements from clients [P7][P12].

PC4	Label-Driven Sustainability	For sustainability, innovation is prioritised to fit into labels [P14] and BCI or MPG calculations [8], with corresponding sustainable building subsidy requirements [P8], BRIAM certifications, or fitting into NMD database categories. This often means CO_2 reduction and the use of secondary materials [P7].
PC5	Cost-Driven Decisions	Manufacturers expressed that the financial component was most important in decision-making [1][7], with low cost being more rewarding than sustainable options [4], or pricing preventing sustainable choices [5].

Figure 17 Peripheral *challenges to DPP implementation*

	Core opportunities	
CO1	Improved transparency	Improve communication on sustainabilty apsects to increase credibility [P2], differentiate on transparency, or increase acceptance of sustainable products [P2], or respond to the increased demand for information [P11]
CO2	Improved client relationships	Manufacturers report the ability to improve customer intimacy [P9], feedback down value chain [P3], supporting independent judegement [P3] informed client decision-making [P9], educate on sustianability and build new relationships [P1]
CO3	Streamline external communication	Streamline supply chain information across internal departments [P2], streamline information requests from investors and clients [P2], create shared definitions and format to discuss circularity [P5], or communicate sustainability goals [P3]
CO4	Normalisation of circularity	Manufacturers expect a normalisation of circularity [P6], using compliance as a door opener to motivate stakeholders [P1], and a increased level playing field [P4]

Figure 16 Core opportunities *to DPP implementation*

	Periphial opportunities	
PO1	Financial incentives	External financial motivation for offering DPPs on products are described as: extra revenue by offering a quality surplus [P4] or better tender offers in public procurement [P4][P5]
PO2	Intrinsic driver	Some manufacturers describe engaging with sustainability on the basis of intrinsic motivation, alignmentn with vision [P12][P6], learning culture [P11], company ethics [P2] the DPP has the opportunity to strengthen these drivers.

Figure 18 Peripheral *opportunities to DPP implementation*

During analysis, it was found that some opportunities and challenges have a cascading effect on each other. For example, limited cooperation from the value chain increases implementation difficulty, which increases the costs. This effect is also pointed out by Colucciello et al. (2025). It demonstrates that challenges and opportunities should not be viewed in isolation, but collectively to understand the broader dynamics of DPP implementation.

Key takeaways:

Lessons from early adopters (outside of the construction industry) showed the complexity of the implementation process and the necessity for methods and resources to support it.

They also provide insight into the value-driven DPP implementation process, which is outlined in four phases: awareness, evaluation, action and reflection.

Academic literature provided an extensive overview of opportunities and challenges associated with implementing digital product passports, while interviews offered a practice-oriented construction perspective.

A critical finding emerged: manufacturers perceive minimal business value opportunities compared to the potential described in literature. This reveals a knowledge gap among manufacturers.

4. Developing opportunity cards

In the previous chapter, it was found that construction manufacturers had difficulty envisioning the opportunities for DPPs to bring value to their businesses. This would hamper the exploration activities in subsequent steps, since they rely on manufacturers having this knowledge. Therefore, opportunity cards were developed to address this knowledge gap and enable the co-creation activities in the following chapters.

Method

The opportunities were selected from academic literature and interviews from chapter 3. They were chosen based on their relevance for individual construction manufacturers. Overlapping opportunities were combined and plotted in an overview (figure 19; appendix G). This overview was then used as a basis for discussion with DPP experts (from interview group 3) and redrafted with their comments. To make the cards accessible for manufacturers, the academic language was translated into practical language through two peer feedback iterations.

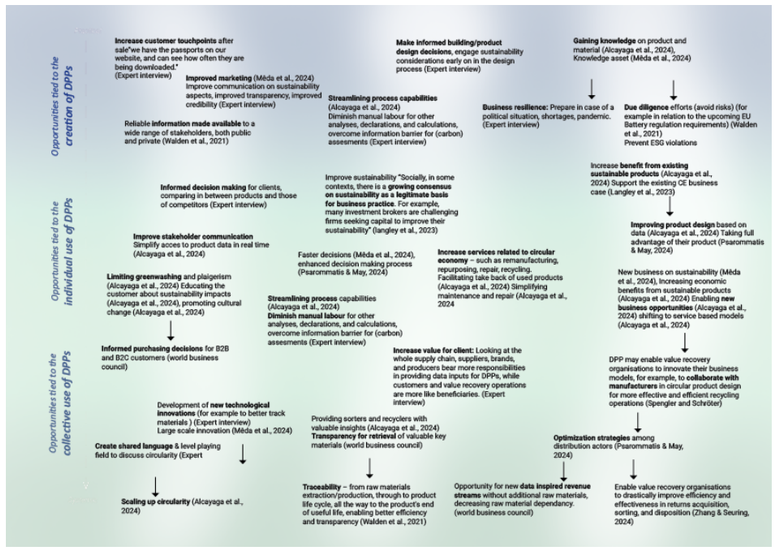


Figure 19 Overview of selected opportunities - full version in appendix G

Participant nr.	Expert type	Field of expertise	Discussion topic
17	Practitioner	information systems in the build environment	DPP system, business value
19	Academic researcher	Data Management, computer science	DPP system
21	Academic researcher	Digital Circular Economy	DPP business value
22	Academic researcher	Human computer interactions	DPP data and system, business value

Figure 20 DPP Experts (Interview Group 3, Chapter 3). Those who provided insight or feedback on opportunities are marked in green.

Opportunity selection

The developed opportunities can be found on the cards in figure 23. The opportunities were intentionally designed to vary in scope (broad vs. specific) and timeframe (immediate vs. future) to show different perspectives. In this way, broader and future-oriented opportunities could support exploration of the full range of possibilities. Short-term, specific opportunities could inspire practical examples. This allows manufacturers to make their own interpretations.

Cards design choices

The opportunity cards are designed to quickly and clearly communicate DPP opportunities to manufacturers. Cards are an effective tool for supporting discussion and decision-making because they allow information to be passed around, selected, and arranged by priority (see use in figure 22). The front and back of the cards contain different levels of information detail, allowing participants to zoom in and out during conversations. The specific design choices of the cards (illustrated in Figure 21) further enhance this functionality.

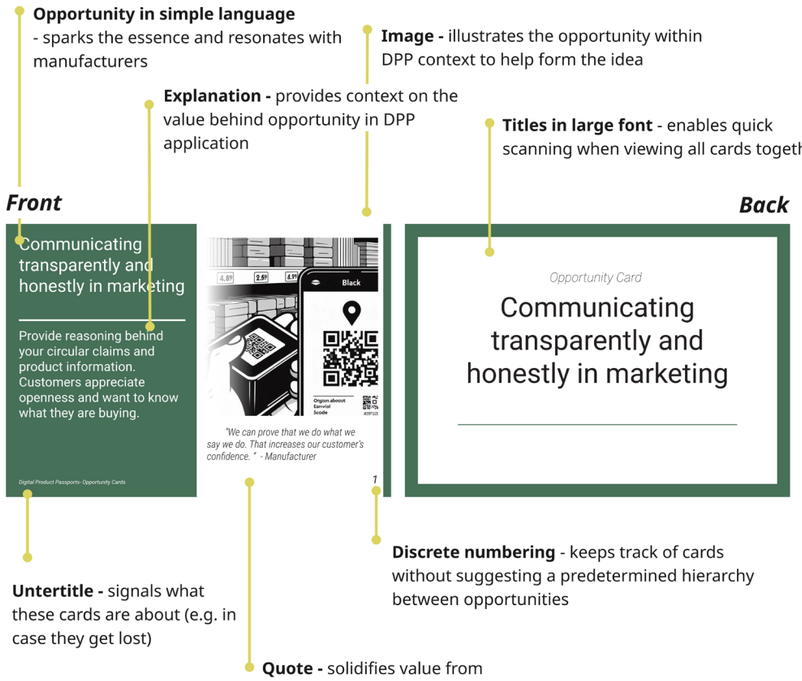


Figure 21 Design choices of opportunity cards

Figure 22 Opportunity cards in use: individual view and collective view

Figure 23 Opportunity cards (see appendix D)

A key insight emerged during the development of these cards.
In literature, the opportunities are presented as a direct result of DPP implementation. However, this idea is not entirely accurate: In many cases, additional actions or conditions are required:

Some opportunities require **adjustments to internal processes**. For example, if a manufacturer wants to use the DPP to improve product design, they must take additional steps to integrate DPP data into their product design process. This includes analyzing the data, comparing it to current metrics, and integrating the conclusions into design decisions.

Some opportunities are conditional to the **actions of other actors**. For example, to achieve supply chain transparency, other value chain actors must collaborate. To improve comparison between two products, other manufacturers must provide data with the same metrics.

Some opportunities require **additions to the DPP data and system**, such as extra features in the ICT infrastructure (e.g., a platform to compare data) or additional DPP data (e.g., location of the product).

In this way, the realization of opportunities depends on conditions or actions beyond direct DPP implementation. This may explain why manufacturers find the opportunities difficult to envision. Going forward, it would be more helpful to frame the DPP as a tool that contributes toward business value, together with other actions and conditions, rather than something that provides benefits on its own.

Key takeaways:

To address the lack of knowledge on opportunities among construction manufacturers, this chapter developed 16 opportunity cards. These cards support effective discussion and decision-making in the next research activities.

Additionally, the analysis revealed that these opportunities require more than just DPP implementation to be realized into business value. For example, they require manufacturers to adjust other internal processes, rely on cooperation of other stakeholders, or require added features to the DPP data or system.

As a result, rather than presenting the DPP as a standalone solution, it is more accurate to view it as a tool that contributes to other business objectives.

5. Co-creating value driven DPP implementation

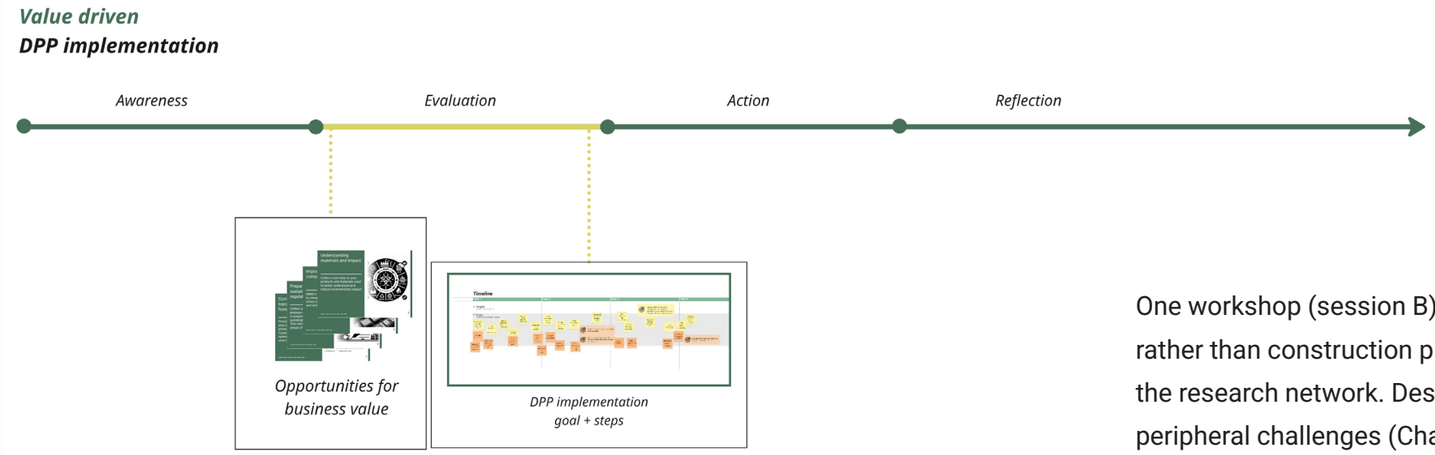


Figure 24 Mirroring the evaluation process: from Opportunity Cards to DPP Implementation goal + steps

In the previous chapter, the researcher developed opportunity cards to communicate how DPP implementation could bring value to manufacturing businesses. In this chapter, the researcher uses these cards in co-creation activities with construction manufacturers to uncover what goals and steps they would envision for themselves if they attempted value-driven DPP implementation.

The co-creation activities also simulate the kinds of activities and discussions that manufacturers would conduct independently during the evaluation phase (figure 24), if they attempted value driven DPP implementation in reality. This allows the researcher to also understand the thoughts and underlying evaluations that manufacturers would experience during this phase: what motivates their decisions, what problems they perceive, and what additional factors they consider. This important, because these evaluations ultimately determine whether they would invest in DPPs.

To summarise, the aim of the workshops is twofold: (1) to co-create goals and steps for value driven DPP implementation and (2) to understand how to support the evaluation process, in favour of DPP implementation.

Participant selection

Three separate workshops were conducted with three different manufacturers (Figure 25). Each workshop included 2 to 4 participants, consisting of employees from the manufacturing company and occasionally an external consultant from EPEA.

One workshop (session B) was conducted with a manufacturer of homeware rather than construction products due to availability constraints within the research network. Despite having different clients, supply chains, and peripheral challenges (Chapter 3.2 - Challenges and opportunities for the construction industry), their findings remain relevant for the construction industry, as both sectors face similar challenges in DPP implementation and value assessment.

Co-creation workshop	Product	Company characteristics	Participant job functions
A	Solar panel	Scale-up, innovative, SME, cirpular product	Quality & sustainability, engineering, External consultant (EPEA)
B	Homeware	International, design-led, legacy brand, quality products	Quality & Sustainability, H&S and environmental care, quality, lead engineer, External consultant (EPEA)
C	Pre-fab concrete	Family-owned, down-to-earth, Integrated, Connected	Business manager, quality & compliance, Sustainability

Figure 25 Participants co creation workshops

Workshop outline

All workshops followed a similar program, which lasted approximately 2.5 hours. These co-creation activities were informed by the experiences from early adopters from chapter 3 (Figure 12), particularly the steps they took during the evaluation phase.

The structure of each workshop (figure 28) followed four core activities:

(1) Choosing, detailing and discussing opportunities
(2) formulating a main goal
(3) plotting this goal on a timeline
(4) brainstorming accompanying implementation steps

Data collection and analysis

During the discussions, the researcher kept close notes. Directly after the workshop, additional observations and reflections were added. The discussion notes and reflections from the sessions were formed into findings, peer-discussed for interpretation with an EPEA consultant and then combined into key takeaways (see appendix H). (Figure 27)

The completed workshop materials were photographed and later annotated by the researcher (see example in figure 26) (see all completed materials in appendix H)

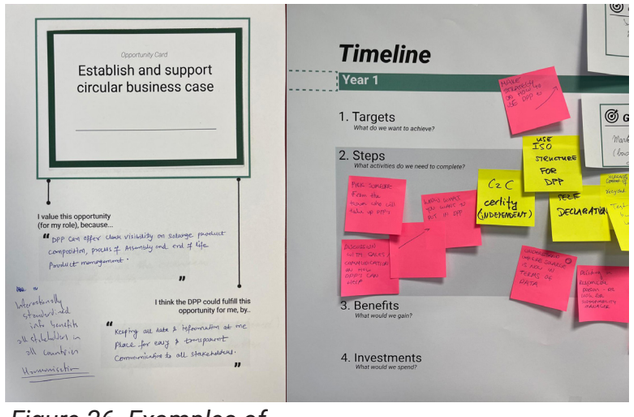


Figure 26 Examples of completed workshop material

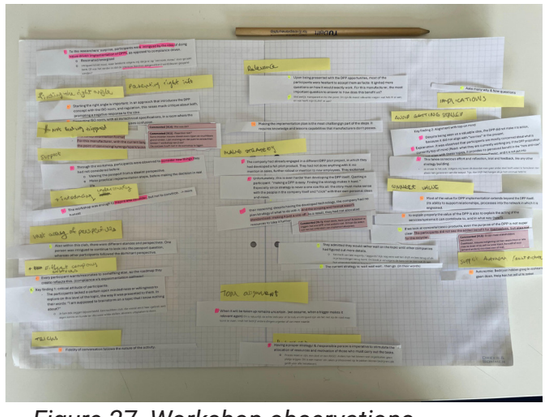


Figure 27 Workshop observations, grouped into key takeaways

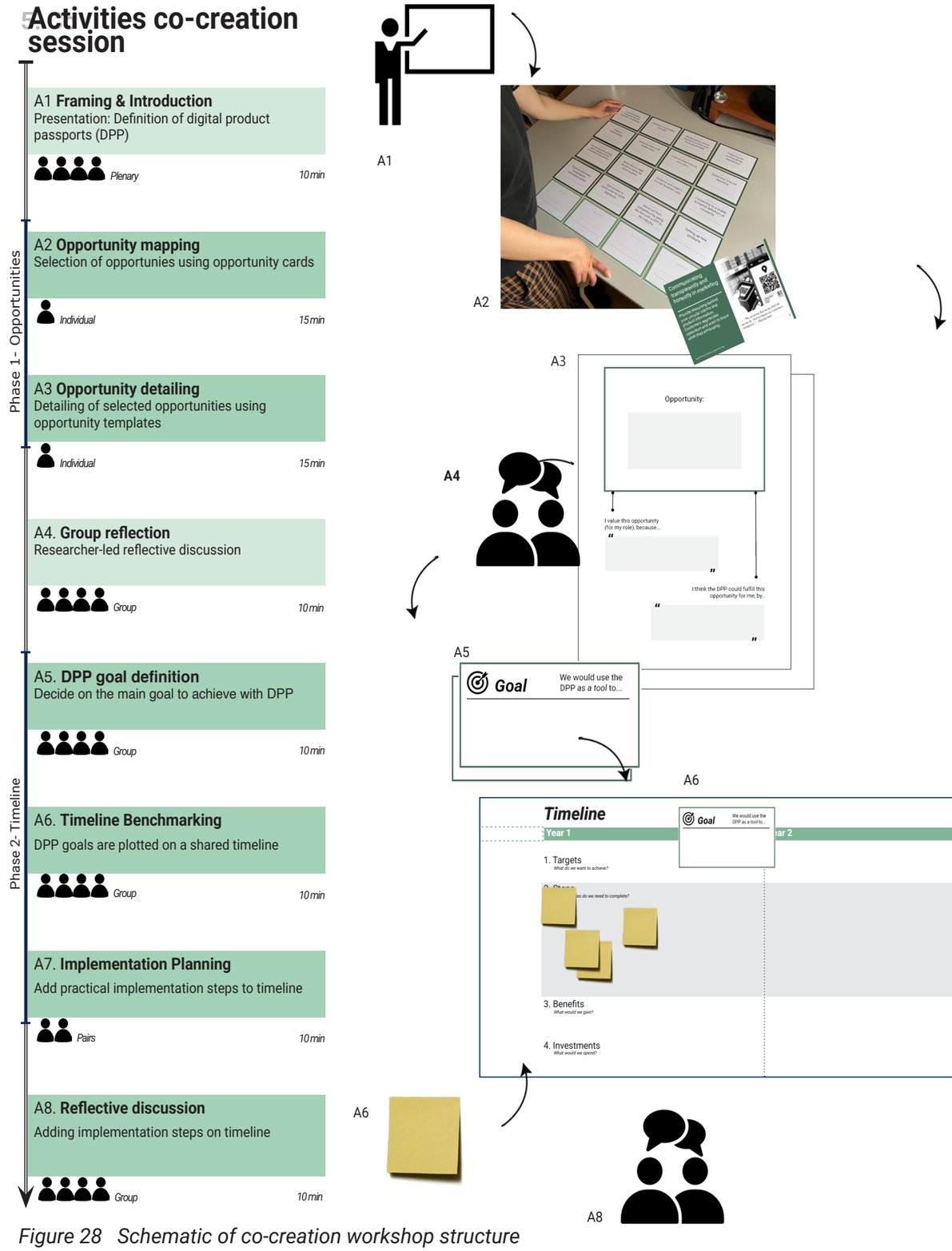


Figure 28 Schematic of co-creation workshop structure

The workshops yielded two types of results: various goals and steps for value-driven DPP implementation, and key findings about the evaluation process.

5.1 DPP implementation goals and steps

The following pages present the workshops results per manufacturer. Each manufacturer discussed a main implementation goal, and brainstormed implementation steps that contribute toward those goals. The full overview of these steps is presented in appedix x. To illustrate, the pages present key implementation steps that were most relevant to the main goal.

Group A - Solar panel manufacturer

Main DPP implementation goal

The solar panel manufacturer (group a) saw the most potential in **strengthening their marketing story**. By using the DPP to make background product data openly available to customers, they would **increase transparency regarding their product circularity** and integrate this into their marketing narratives. Furthermore, they saw a benefit in influencing policies by using DPP data templates or norms to set circularity standards.

Key implementation steps:

The key implementation steps that aligned with their goal were:

- Identify key circularity data points to present
- Create marketing integration strategy for DPP data
- Understand current data gaps

Group A - Homeware manufacturer

Main DPP implementation goal

The homeware manufacturer (group B) saw potential to **combat greenwashing** by competitors, as the regulation would push for collective DPP implementation, which would **normalize transparency**. They would strengthen their own circularity claims by strictly adhering to data norms and having their DPP data verified by an independent assessor.

Key implementation steps:

The key implementation steps that aligned with their goal were:

- Research industry data norms
- Select independent assessor for DPP and products

Group C - pre fab concrete manufacturer

Main DPP implementation goal

The prefab concrete manufacturer (group C) anticipated that using structured data templates to collect DPP data would help them **organize data** and possibly **streamline other reporting tasks**. However, they remained skeptical about how this would work in practice. As a result, their approach to DPP implementation would be more reactive (e.g. monitoring the market for ready-made solutions) rather than developing solutions by themselves.

Key implementation steps:

- Monitor available ICT services and platforms
- Monitor and analyze DPP use cases in similar products
- Monitor actions within the industry

Findings on collective goals and steps

Figure 29 presents how participants across all workshops positioned their goals and steps in a timeline. The analysis revealed that participants envisioned value-driven DPP implementation to take 2 to 4 years, significantly longer than the 18-month window that the delegated acts would provide. To address this, manufacturers should either begin DPP implementation well before regulatory deadlines, or plan to continue value-adding steps after compliance requirements have been met.

Furthermore, the steps demonstrate that manufacturers undertake both DPP implementation steps and seperate value-creation steps to realise the goal. This confirms the observation from Chapter 4 that DPP implementation alone does not automatically deliver business value.

Finally, many steps involve preparation, exploration, or development (e.g., understanding norms, conducting pilots, creating plans) rather than actual DPP creation. This reflects the early stage of DPP development, where companies must build their own processes from the ground up. As DPP services and tools mature, implementation may become more straightforward.

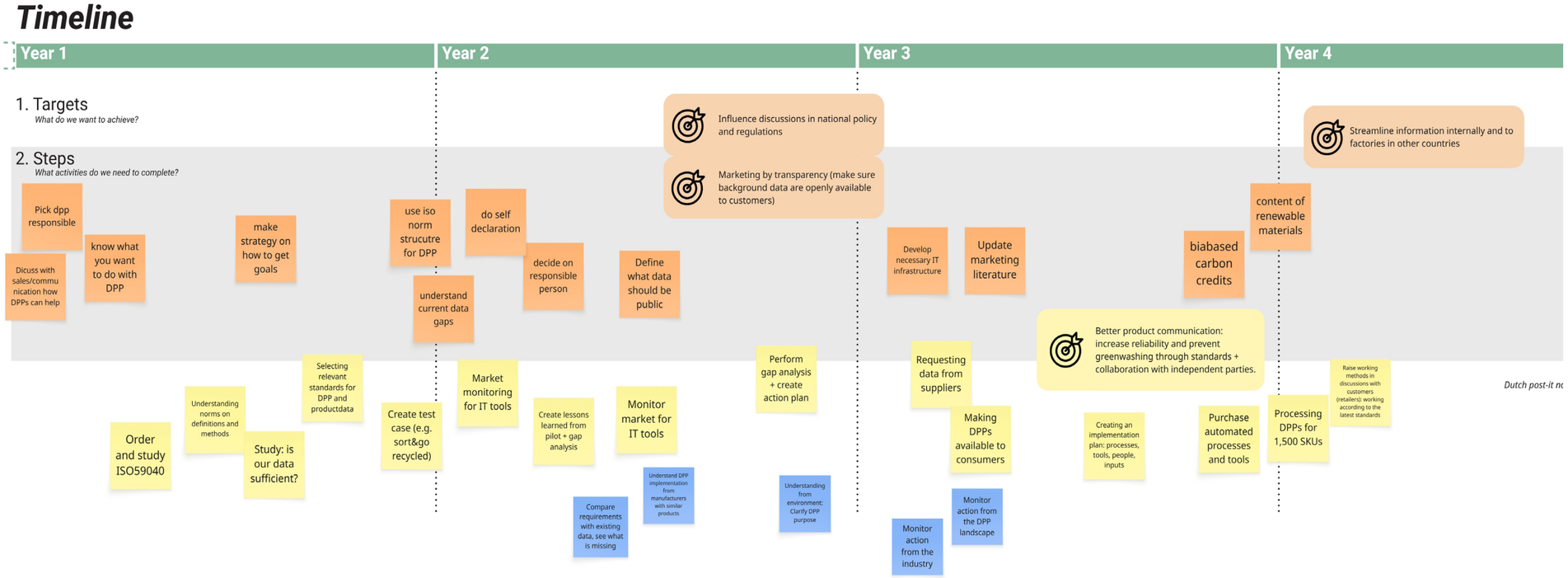


Figure 29 Timeline with implementation steps and goals from group A (yellow), B (orange) and C (blue) (full version in appendix H)

5.1 Evaluation process considerations

The discussions and observations from the workshops resulted in key findings about the evaluation process (Figure 30). These “considerations“ describe some underlying concerns and predispositions that make up the evaluation process.

Ref. nr	Evaluation process considerations	Relevant observations
EPC1	Determining the **implementation plan** and strategy is the most **important** and difficult step	Group A stalled on a previous DPP pilot project due to a lack of strategy on what to do with it. They expressed the importance of a plan. Group B said making the implementation plan is the most challenging, as it requires knowledge, capabilities and lessons (e.g. from pilots) that they don’t possess (yet). Group C: No observation made
EPC2	It is crucial to understand the **relevancy** of the DPP to the individual manufacturer	Group A recognised the DPP as a valuable idea, but expressed that it did not address current business concerns, As a result, it would not get pursued. Group B found the approach from a regulatory angle confusing. Group C had difficulty accepting the DPP concept without answering the question: How could the DPP concept benefit us?
EPC3	It is important to clarify the (relevant) **implications** of DPP implementation	Group A: No observation made Group B said they would wait with implementation until they would understand the implications better. During the workshop, going too much into irrelevant (technical) considerations prompted a feeling of demotivation. Group C asked many why & how questions during the workshop.

EPC4	DPP **value is relative** to existing solutions	The researcher observed that manufacturers [A,B,C] consistently evaluated DPP opportunities against their existing measures and alternative solutions. In doing this, they searched for what additional value the DPP would provide.
EPC5	There is a **diversity of attitudes** on DPPs	Attitudes differed widely between manufacturers: more sceptical and to the point [C], more visionary [A], and in between [B}. It also differed between employees in the same manufacturer: in group B, the different roadmap routes mirrored different opinions in how implementation should be approached.
EPC6	It is important to allow **autonomous decision making**	The researcher observed that manufacturers liked to have agency over their own ideas and innovation processes. It is important to support and respect their autonomy. For example, group C asked for more information on the DPP (signalling interest) but admitted they preferred to wait to act until others did.
EPC7	Workshops are useful as an exploration tool	The workshops helped participants explore these considerations, by considering the DPP from a new (Value driven) perspective [A], exploring practicalities [C] being inspired [A], and systematically discuss different opinions on the digital product passport [B]

Figure 30 Evaluation process considerations

The answers to these concerns vary by manufacturer, as do the predispositions that influence how they view DPP implementation. This variation explains why there is no “one size fits all” proposition for value-driven DPPs. Instead, these considerations must be carefully addressed through dialogue. An exploratory workshop can serve as a useful first step in this process.

Discussion and conclusions

This chapter (1) co-created goals and steps for value-driven DPP implementation in the construction industry and (2) probed the underlying considerations to anticipate how to support and motivate DPP implementation.

The opportunity cards from Chapter 4 successfully addressed manufacturer knowledge gaps, allowing discussions to move past ‘whether DPPs provide value’ to ‘how DPPs can provide value’.

The co-creation activities effectively triggered evaluation-style discussions, enabling the researcher to observe manufacturers’ concerns and predispositions, and extrapolate them into conclusions on the evaluation process.

The chapter results offers several contributions to practitioners. First, the implementation goals and steps from the three individual manufacturers can be used as examples or case studies, to inspire similar value driven DPP implementation plans for other manufacturers. Second, the three manufacturers vary on the spectrum of “types” of businesses, with different attitudes toward DPP implementation. Therefore, these examples can be used by researchers, consultants and DPPSPs to inspire different approaches toward these different attitudes.

In addition, the findings from this chapter present several limitations. Because the workshop findings reflect only three manufacturers’ perspectives, they cannot be generalized to the entire construction industry. Therefore, the results do not represent the full extent of possibilities for value-driven DPP implementation, nor can they quantify industry-wide levels of interest, readiness, or capabilities.

Furthermore, these workshops operate under an explicit bias toward value-driven DPP implementation. As a result, the findings represent only the potential benefits of value-driven implementation without addressing practical constraints or real-world challenges.

5. Co-creating value

Key takeaways:

Manufacturers pursue fundamentally different DPP implementation goals based on their business interests: marketing advantage (Group A), credibility protection (Group B), or operational efficiency (Group C).

Currently, value-driven DPP implementation requires three types of steps: (1) technical DPP implementation steps, (2) value-creation steps to generate business value, and (3) developmental steps to work around the limitations of the early-stage DPP landscape.

Value-driven DPP implementation could take significantly longer than regulatory timeframes allow. As a result, manufacturers should adjuist their implementation strategy to incorporate compliance deadlines

There exists no “one size fits all” value proposition for DPPs. Instead, individual maufacturers have to find alignment between DPP implementation and their business. This is done by adressing several considerations: strategic fit, relevancy, implications and added value, which are influenced by their business attitude and desire for autonomy over the implementation process.

To support and motivate DPP implementation, these considerations should be addressed by researchers, consultants, or DPP service providers during the evaluation stage of DPP implementation. As a first step, it can be useful to conduct explorative workshops.

6. Supporting DPP implementation in practice

The previous chapter presented a list of “considerations” that consultants, service providers, and researchers could address to motivate value-driven DPP implementation among construction manufacturers. However, these considerations assume that manufacturers are already considering value-driven implementation and are open to evaluating its potential. In reality, it seems this assumption does not hold.

This chapter presents critical reflections on the research outcomes that formulate and propose useful approach to support for DPP implementation. Furthermore, this chapter creates a support tool by developing future adoption scenarios.

6.1 Critical reflection on outcomes

I started this project with the intent of understanding how to persuade the manufacturing industry to engage with DPPs. I thought I would end the project with a coherent story on business value and opportunities. Instead, the project revealed something much more complex - and honestly, more frustrating.

In the process of exploring the research question, immersing myself into the context through interviewing, co-creation, and discussing ideas with the project client, I started to feel frustrated. Despite my efforts in probing, setting up interventions and finding the right words to “trigger” the participants, I found hardly any positive response.

Instead, I was met with doubts, dismissal, and a general sense of fatigue and low energy. Rather than embracing possibilities, interviewees focused on constraints. Instead of generating ideas, participants raised considerations. I thought I presented something hopeful, but I seemingly brought something that represented more burden. My narrative about business value and

opportunities fell flat in these interactions.

This felt demotivating, but it also teaches some valuable lessons about the context. It reveals how the complexity, uncertainty, technical challenges and the not-so-clear benefits could create a burdensome atmosphere around DPPs, that might feel too heavy to take on. It shows how previous negative experiences with sustainability regulations can create a pessimistic outlook on the DPP future, that clouds the possibilities of the DDP ambition. Lastly, it shows how existing daily pressures and socio-economic instability might leave individuals and businesses reluctant to embrace more uncertainty, especially if it falls outside of their field of expertise.

Lastly, it might show how the DPP lacks the novelty, promise, and general wow factor that usually provokes excitement around new technology. As a result, participants may cling to rigid attitudes and defensive thinking. They may place additional constraints on the innovation that demand proof of value, instead of allowing the space for potential to emerge.

Ultimately, no DPP design or clever positioning can provide an answer to these constraints. At least, not well enough to motivate DPP implementation among manufacturers. I felt the project unfold into an extremely challenging task, where I would have to fight off too many variables. I felt a different approach was required.

Acknowledging the Gap: Why Value-Driven Approaches Fall Short

From a strategic perspective, this negative response from industry is partly justified, because the perceived challenges are significant: high workload, costs, complexity and uncertainty (chapter 3.2 - Challenges and opportunities for the construction industry). On top of this, the challenges can be felt in the present, because they are relatively concrete and immediate. In contrast, the opportunities appear to be more abstract and long term.

The “value-driven” approach is presented to help resolve these challenges; however, these challenges still remain in value driven DPP implementation. In fact, pursuing value-driven DPPs can add more complexity by introducing additional steps and considerations (Chapter 4.2 - Evaluation process

considerations). As a result, the value driven approach cannot counterweigh the perceived effort, costs, difficulty and uncertainty that manufacturers feel in current situation.

A Different Way Forward: The “Careful Encouraging” Approach

Here is a thought to consider: these perceived challenges represent not a resistance to novelty, but a fundamental problem or need among construction manufacturers - a lack of knowledge, abilities, and time to work on DPPs. A problem which increases discomfort and uncertainty. As the upcoming regulations increase these feelings of discomfort and uncerainty with regulatoy pressure, these problems will be worth solving.

Some DPP service providers and consultants work around the challenges of DPP implementation by dismissing them. Though there is nothing wrong with these initiatives, they miss the mark on what makes DPPs so challenging: not the implementation steps themselves, but all the questions around them - what is the relevancy, implications and relative value for my business? These questions cannot be resolved by coercing manufacturers to “just try” DPP implementation. In fact, it might even provoke the opposite: a feeling of disconnect, disdain, or misunderstanding.

Instead, I invite researchers, consultants and DPPSPs to recognize and validate manufacturers’ experiences. To approach the DPP from their point of view: as a difficult, time consuming and expensive endeavour. To exercise empathy and understand needs, instead of pushing for certain outcomes. This enables them to reach a position of understanding and respect, upon which symbiotic solutions can be built.

From there, the consultant can carefully help unpack the challenges that companies face. I say “carefully”, because these challenges are often not quick to solve. For example: how would a manufacturer with 1500 product types create DPPs for all of them? To tackle these types of challenges, it is necessary to not only provide answers, but also increase the manufacturers’ confidence in their own knowledge and abilities. I recommend positioning the consultant on the same level as the client: working as partners and co-

creating solutions that incorporate knowledge from both sides. Here, the consultant might adopt an encouraging attitude by showing belief in the ability of the client, and pointing to their unique set of strengths.

What This Means Going Forward

This approach might feel unnatural to sustainability consultants who are used to highlighting undervalued concerns, or are hired to prove clear answers on sustainability problems. Opting for the “careful encouraging” approach might feel counterintuitive, but in reality, consultants could show their extensive knowledge on the DPP landscape by acknowledging that it cannot be answered in a simple manner.

The problem is that one clear direction cannot be made, because the DPP landscape that influences it is complex and constantly in motion (chapter 2- background). As a result, existing future predictions vary among sources: some predict future possible gains to be extremely promising, while others see many risks. This uncertainty about the future is one of the main challenges to DPP implementation.

I realize that no proposition can motivate DPP implementation among early majority manufacturers in the current atmosphere. To support business value-driven DPP implementation, it is necessary to support strategy activities that acknowledge and work with this complexity, rather than against it.

Conclusion

Given the current underdeveloped DPP landscape, companies perceive implementation challenges as far outweighing potential benefits, making it unrealistic to expect easy motivation for adoption at this time. Rather than pushing for immediate action, consultants can add value by addressing pre-implementation challenges such as navigating uncertainty, reducing costs, and managing complexity. This requires a “gentle encouraging” approach that validates manufacturers’ challenges, helps address them, and builds their confidence for eventual implementation.

6. Developing future adoption scenarios

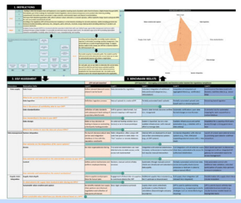
The previous part presented a ‘gentle encouraging’ approach that acknowledges manufacturers’ challenges and aims to increase their confidence in pursuing DPP implementation.

1.Introducting the DPP definition, use, and relevancy

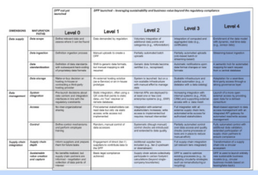
DPP explanation and use (World business council for sustainable development, 2024)

Preparing your business for Digital Product Passports - executive's guide (Constantinovici, 2024)

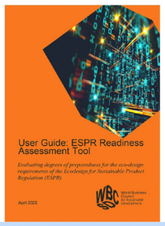
2.Assessing preparedness level and goal



DPP maturity model (Pretrik et. al, 2025)



Maturity model for DPPs (Hernandez, 2024)



ESPR readiness assessment tool
(The World Business Council for Sustainable Development, 2025)

3.Understanding the DPP data, system and technology

The simplest DPP system proposal (Huib et al., 2025)

DPP user stories (Huib et al., 2024)

4.Outlining implementation on a step-by-step basis

Roadmap to implement material passports into business offering (Hernandez, 2024)

Implementing the digital product passport - A guidebook for businesses (Keränen et al., 2025)

Figure 31 Exsiting support resources

This approach requires developing and adopting various support tools. Figure 31 presents several existing resources from literature that help understand DPP definitions, assess business preparedness levels, provide step-by-step implementation guidance, and outline DPP data, systems, and possible technologies.

Adding to these existing resources, this part develops a complementary tool to address uncertainty about the future, one of the core DPP implementation challenges (Chapter 3 - Challenges and opportunities for the construction industry). This is achieved by creating and testing future adoption scenarios.

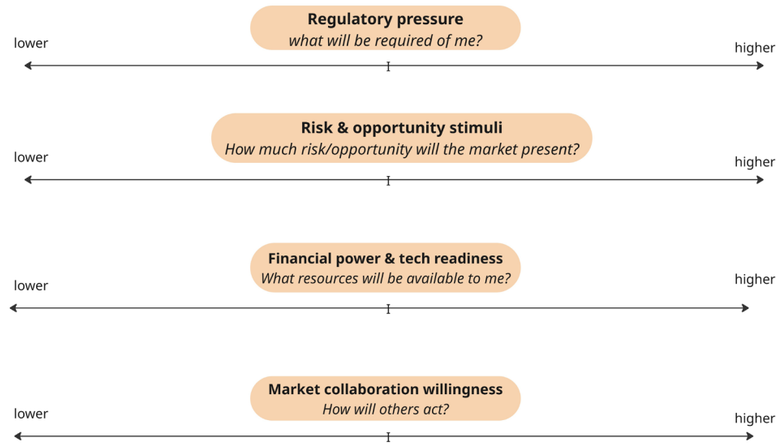


Figure 32 Four key uncertainties/scenario variables

Method

Interview insights from sustainability experts and construction manufacturers from chapter 3 revealed four key uncertainties about the future of DPPs, which serve as variables for the adoption scenarios (Figure 32).

The variables are separated into low, medium, and high categories to create a futures matrix (figure 33). From this, six key scenarios are chosen based on relevance to existing concerns and diversity of outcomes. The intention is to cover a wide range of possibilities and address existing questions.

6. Supporting DPP

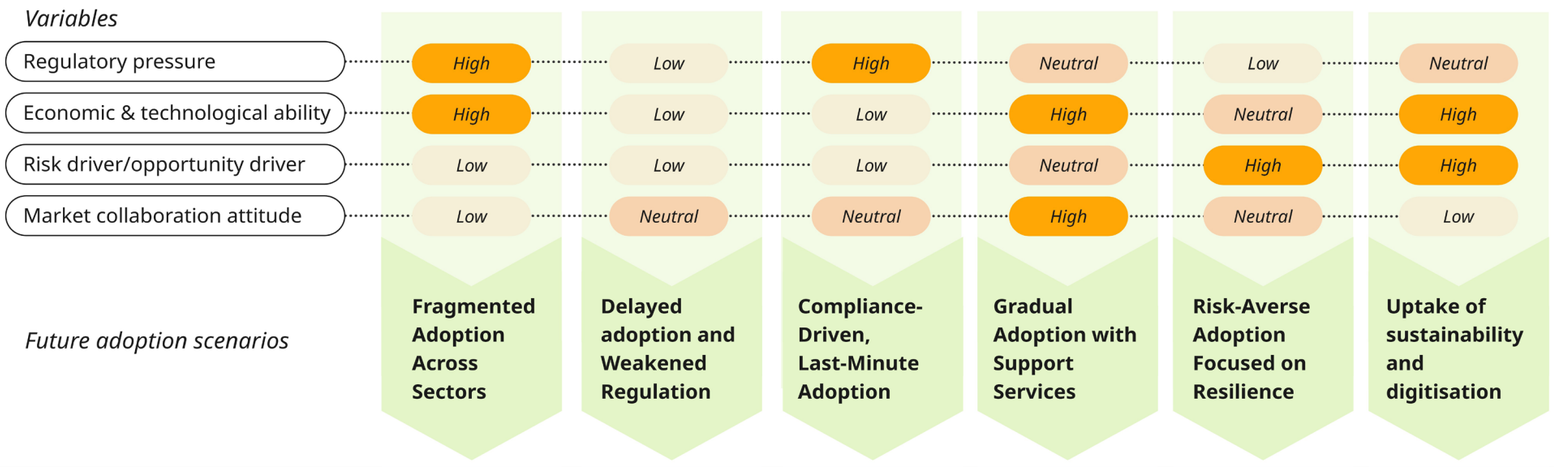


Figure 33 Futures matrix with selected scenarios

To provide reccomendations for each scenario, the researcher selected reccomendations from relevant literature, which provide strategic business approaches for the DPP implementation (Colucciello et al., 2025), guidelines for construction manufacturers for implementing DPP's (Psarommatis & May, 2024) and scenario driven action recommendations for construction industry (Barwasser et al, 2024).

feedback from a construciton industry manufacturer
The scenarios were discussed with a sustainability manager and data manager from a construction manufacturer. They were relatively knowledgeable on DPPs and the current landscape.

The following feedback was provided:

Pro: The scenarios were a good representation of the concerns that exist in the current landscape. Splitting up these concerns into possible futures can make them easier to address.

Pro: The scenarios are useful for different types of manufacturers. Larger, more proactive manufacturers can use them to steer conversations. Smaller, more reserved manufacturers can use them to prepare.

Pro: The scenarios are also useful to apply to other contexts, for example in the rollout of other regulations, services and initiatives.

Con: The scenarios do not directly address the DPP landscape actors and actions that make the future so uncertain. To improve this, the scenarios could provide insight in higher fidelity, for example by giving more examples in what they would mean for individual actors.

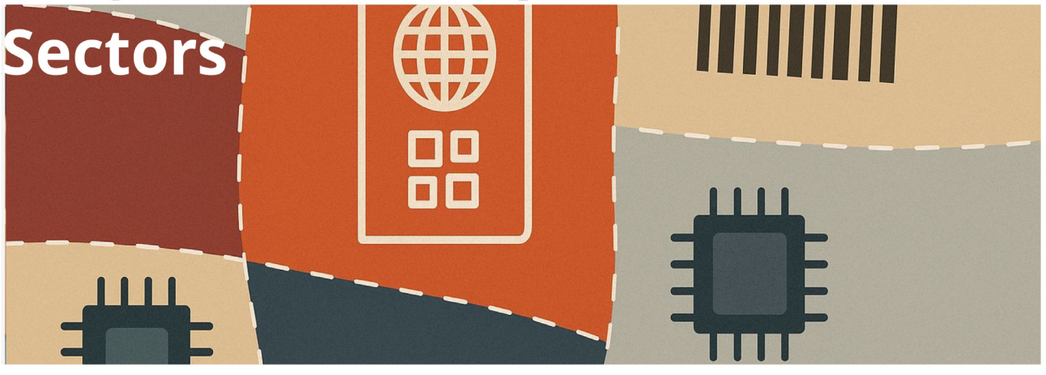
Con: The scenarios are neutral, which limits their effectiveness as persuasion tools. To improve this, they should include arguments and counterarguments for use in discussions.

Con: The scenarios are subject to change. To address this, they could be adjusted over time, or be digitised into a dynamic format.

Due to time constraints, this feedback was not implemented into the scenarios presented in this thesis. However, they form useful insights for stakeholders that want to develop them further.

Future adoption scenario's

Fragmented Adoption Across Sectors



Description

Digital Product Passports are implemented inconsistently across sectors and regions, with no unified standard guiding their development. IT providers and individual initiatives introduce varying formats, tools, and levels of complexity, tailored to specific needs or interpretations. This results in a patchwork of DPP solutions that lack interoperability and coherence, reflecting a fragmented and decentralized approach.

Factors

See introduction for explanation

Regulatory pressure	*High*
Economic & technological ability	*High*
Risk & Opportunity driver	*Low*
Market collaboration attitude	*Low*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Emergence of uncoordinated, individual DPP initiatives create friction in the DPP landscape
- IT & DPP service providers create and promote separate technologies and DPP concepts (e.g. plugins to platforms)
- Freedom for private IT providers to develop their own formats and tools
- Standards used in delegated acts vary widely across sectors, borders and industries.
- Technical interoperability (linking data between different DPPs) is not achieved

Effect

☺ Wide range of available DPP options tailoring to different needs

⚠ Inconsistencies in data quality and accessibility between different DPPs

⚠ Difficulty achieving comparing and tracing purpose of the DPP

⚠ Competitive differences between nations depending on strict/relaxed enforcement

Recommended steps for the present

To reduce risks and maximise opportunity

- *Advocate for public funding or tax incentives to support DPP adoption and infrastructure development**
- *Advocate for the creation and use of industry and region overarching standards*
- *When developing a DPP concept, make sure it follows current industry standards for data management, security, and privacy**
- *Consider conforming to global standardized practices, as hey can assist in attaining certifications or qualifications in other industries or regions**

**Recommended also by (Psarommatis & May, 2024) or (Colucciello et al., 2025)*

Future adoption scenario's

Delayed adoption and Weakened Regulation

Description

The implementation of the Digital Product Passport is delayed and diluted due to political pressure, lobbying, and regulatory complexities. Industry influence during the development of delegated acts reduces the regulation's original ambition. Meanwhile, essential foundations (e.g. IT infrastructure and standardization) remain unresolved. As a result, momentum slows and confidence in the regulation weakens.

Factors

See introduction

Regulatory pressure	*Low*
Economic & technological ability	*Low*
Risk & Opportunity driver	*Low*
Market collaboration attitude	*Neutral*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Lack of clear EU targets or mechanisms for achieving the goals set out in legislation
- Friction in the delegated acts process, unresolved parts or delays.
- Delays in establishing regulatory infrastructure (e.g. enforcement bodies and standards)
- Strong lobbying efforts or market pushback.

Effect

⚠ DPP gets adopted with limited depth and effect

⚠ DDP fails to gain traction

⚠ Reduced confidence in EU regulations and policies, and ESG requirements

⚠ Reduced hope in achieving circularity

Recommended steps for the present

To reduce risks and maximise opportunity

- *When developing DPPs, focus on achieving internal goals (e.g. reducing environmental impact or traceability of products, making informed choices)**
- *Focus on small pilot projects to develop best practices and processes*
- *Use pilot projects to demonstrate tangible benefits of the DPP to stakeholders, reducing resistance to change**
- *When implementing the DPP, focus on quick wins, while using preparatory phase to anticipate the broader context further*

**Recommended also by (Barwasser et al., 2024) or (Colucciello et al., 2025)*

Future adoption scenario's

Compliance-Driven, Last-Minute Adoption

Description

Regulatory momentum from initiatives like the ESPR and CPR begins to build, especially as delegated acts push requirements toward mandatory compliance. However, many manufacturers delay action until the last moment, leading to a rushed adoption process. This reactive approach results in operational strain on manufacturers and their support systems.

Factors

See introduction

Regulatory pressure	*High*
Economic & technological ability	*Low*
Risk & Opportunity driver	*Low*
Market collaboration attitude	*Neutral*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Growing regulatory pressure from ESPR and CPR directives. Industry remaining uninformed
- Delegated acts that bring requirements closer to mandatory compliance
- Manufacturers postponing action until compliance is unavoidable
- Manufacturers face significant challenges adapting to new requirements (e.g. unaccounted increased costs and operational adjustments)

Effect

☺ Increased importance of support mechanisms (e.g. incentives, IT solutions)

☺ Increased interest in understanding and adhering to compliance requirements

⚠ Stress, additional costs and unpreparedness during the adoption process

⚠ Competitive differences between nations depending on strict/relaxed enforcement

Recommended steps for the present

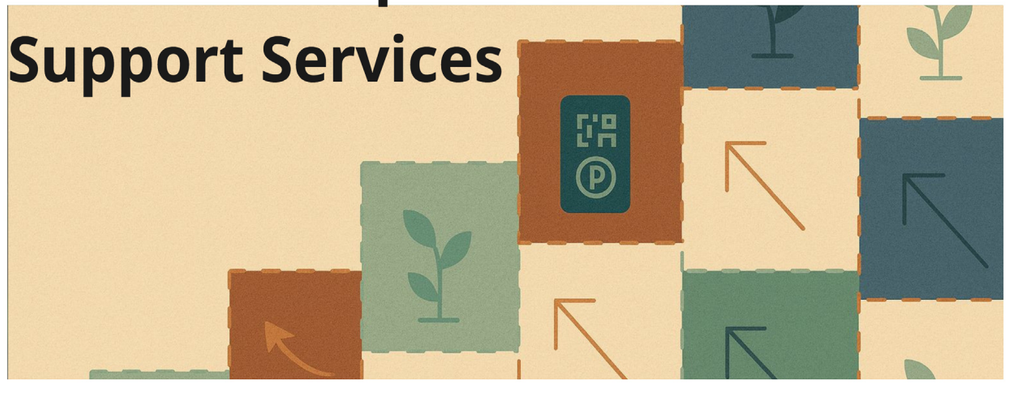
To reduce risks and maximise opportunity

- *Invest in development of digestible, cheap and fast pre-made DPP solutions that don't compromise the purpose of the DPP.*
- *Provide training on how to gather information for DPP and how to accurately input information into the DPP**
- *Prepare manufacturers: Share success stories and data-driven results to illustrate the DPP's impact**
- *Engage stakeholders early in the process, addressing concerns and incorporating their feedback into implementation plans**

**Recommended also by (Barwasser et al., 2024)*

Future adoption scenario's

Gradual Adoption with Support Services



Description

Adoption of Digital Product Passports unfolds gradually, as companies face a learning curve in understanding requirements and organizing internally. A soft rollout of compliance obligations allows businesses to adapt at their own pace and find a business case. Supportive services emerge that combine regulatory compliance with added business value. These solutions help ease the transition.

Factors

See introduction

Regulatory pressure	*Neutral*
Economic & technological ability	*High*
Risk & Opportunity driver	*Neutral*
Market collaboration attitude	*High*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Manufacturers facing the learning curve in understanding and organizing around DPPs.
- Finding opportunities for DPP implementation to increase relevance for clients, reduce risks or decrease costs
- Easing compliance burden over time (e.g. a "soft launch" of requirements in data, so manufacturers can start gathering)
- Investment in development of DPP services to combine compliance with added value

Effect

☺ Possibility to maximise value of DDP implementation

☺ Increased interest in business value of circular economy measures

☺ Avoidance of overwhelming adoption or disruptions to daily operations

⚠ increased importance to navigate compliance and practical considerations to stay relevant

Recommended steps for the present

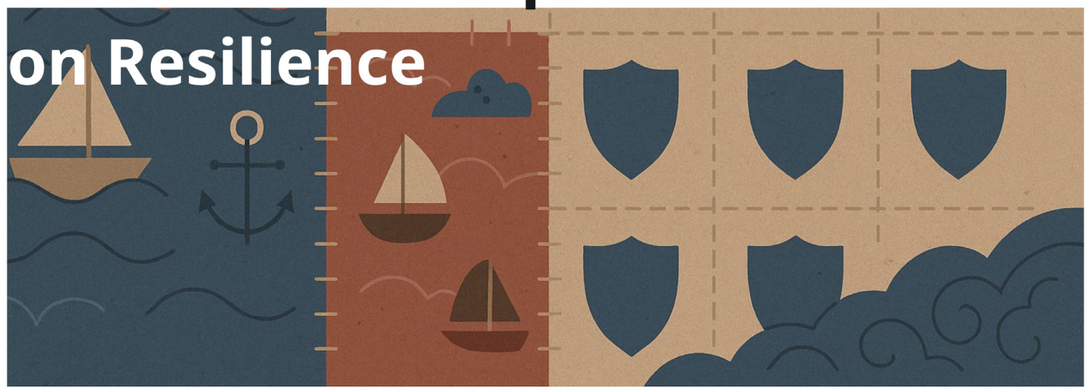
To reduce risks and maximise opportunity

- *When considering DPP development, look for actions that add value by exceeding minimum compliance requirements, for example in integrating marketing strategy or collaboration with certification bodies to enhance credibility**
- *Phase in DPP implementation, starting on a single product line.*
- *Continuously evaluate and improve the system based on performance metrics**
- *Alternatively, envision planning the DPP implementation as a seamless extension of manufacturing and operational processes**

**Recommended also by (Barwasser et al., 2024) or (Colucciello et al., 2025) or (Psarommatis & May, 2024)*

Future adoption scenario's

Risk-Averse Adoption Focused on Resilience



Description

Companies adopt DPPs in a context of geopolitical and economic instability. Concerns over data security and intellectual property slow down information sharing, especially across global supply chains. However, this risk-averse mindset also drives a shift toward regional collaboration and greater control over value chains. As a result, the DPP gains relevance as a means to strengthen business resilience and supply chain integrity.

Factors

See introduction

Regulatory pressure	*Low*
Economic & technological ability	*Neutral*
Risk & Opportunity driver	*High*
Market collaboration attitude	*Neutral*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Global instability (e.g., geopolitical conflict, trade barriers) increases uncertainty
- Manufacturers face consequences of sudden global disruptions.
- EU and nations prioritize supply chain security and economic resilience
- Shift toward regional production and control over value chains

Effect

☺ Prioritization of European manufacturing and mining

☺ Possibility of DPPs to de-risk value chain operations and support collaboration

⚠ Increased importance on collaboration within value chains

⚠ Reluctance to share sensitive information, such as IP or supplier data, via DPPs.

Recommended steps for the present

To reduce risks and maximise opportunity

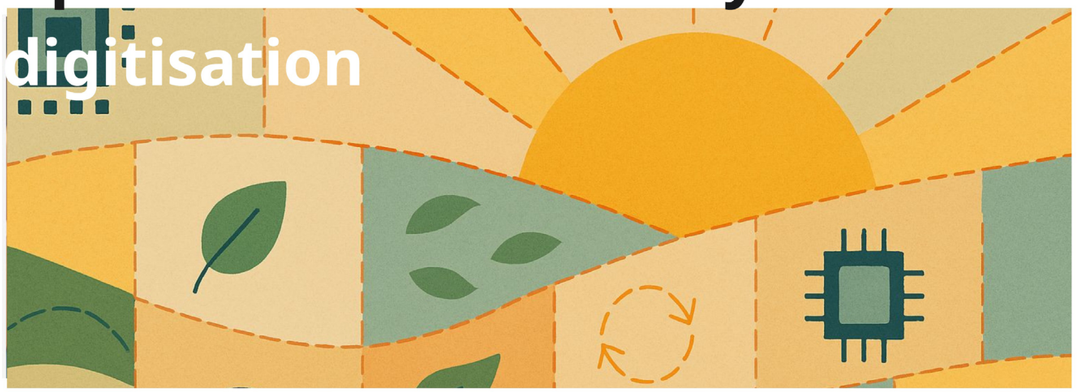
- *Invest in advanced digital technologies, such as IoT sensors, blockchain, and AI-driven tools, to enhance data collection, interoperability and supply chain transparency**

*Embrace transparency. Provide accurate and comprehensive data.**

**Recommended also by (Barwasser et al., 2024) or (Colucciello et al., 2025)*

Future adoption scenario's

Uptake of sustainability and digitisation



Description

As policies like the EU Taxonomy and CSRD take full effect, sustainability becomes embedded in the regulatory and market landscape. Momentum continues toward 2050 goals, with circularity gaining prominence. More informed consumers and advancing technologies push companies to innovate further. In this environment, DPPs are seen as part of a broader digital and sustainability transformation.

Factors

See introduction

Regulatory pressure	*Neutral*
Economic & technological ability	*High*
Risk & Opportunity driver	*High*
Market collaboration attitude	*Low*

Catalysts

Events that contribute toward the future scenario, ranked by degree of influence (low to high)

Possibility of scenario becoming reality

- Trends in industrialisation and digitisation in the construction industry
- 2030 sustainability policies (e.g., EU Taxonomy, CSRD) driving sustainability action
- Increased consumer awareness and demand for sustainable products
- Ongoing development of 2050 targets, with a focus on circularity
- Advancing digital technologies enabling new capabilities and transparency

Effect

☺ Manufacturers find incentive to improve sustainability through policies, consumer expectations, and digitization

☺ Increasing differentiation and client relevance through circularity improvements

⚠ New challenges emerge as technological adoption enables new practices

Recommended steps for the present

To reduce risks and maximise opportunity

- *Keep track of emerging resources, incentives and new technologies to capitalise on**
- *Collaborate with clients and research projects to increase chances in gaining competitive advantage**

- *Communicate to employees the importance of the DPP for the company's sustainability goals, market competitiveness and mission*

**Recommended also by (Psarommatis & May, 2024) or (Barwasser et al., 2024)*

Use of future adoption scenarios

These scenarios are designed to help stakeholders prepare in the present by gaining strategic foresight: they allow stakeholders to prepare for multiple potential futures rather than betting on one outcome, and in the process, determine where their risks and opportunities lie.

To gain this strategic insight, stakeholders can ask:

As a manufacturers/policy maker/service provider/consultant:
- *What would your own ideal adoption scenario look like?*
- *What scenario would be most detrimental to you?*
- *If one of these scenarios were to occur, how would you prepare?*

Furthermore, the scenarios are meant to be used in discussion with other stakeholders. Here, the scenarios provide a nuanced exploration of possible futures. This can be useful to accommodate, consider and discuss diverse perspectives on the future of DPPs.
Lastly, the scenarios conceptualise the four key uncertainties into concrete futures with catalysts, results and reccomendations. This decreases the vagueness around the uncertainties and allow them to be systematically adressed.

7. Discussion

This section situates the findings from the previous chapters within a broader context, examining their significance, limitations, and directions for interpretation.

7.1 Reflection on research questions

This section describes where in the thesis the research questions have been addressed, and whether the questions were useful in guiding the study.

RQ1: *Within the context of this thesis, how is a digital product passport defined and perceived?*

To answer how the DPP is defined, chapter 2 presents the DPP definition, explanation, and landscape relevant to Dutch construction manufacturers. To answer how the DPP is perceived, chapter 3 presents the construction industry's current perspective on DPPs through identified challenges and opportunities. Additional context that influences this perspective is presented as peripheral challenges and opportunities. Furthermore, chapter 3 compares this industry perspective to academic literature.

Distinguishing the definition and context of the DPP was important because DPPs are a complex and technical topic that requires a clear shared understanding to discuss with participants. Understanding how DPPs are percieved by manufacturers proved important in formulating the right support approach in the final chapters.

RQ2: *What can be learned about DPP implementation from early adopters in other industries?*

This research question has been answered in chapter 3, which presents the experience of early DPP adopters throughout their implementation journey. These findings inform the different phases of DPP implementation: awareness, inspiration, action, and reflection. The chapter also shows how early adopters maximize the trade-off between challenges and opportunities

to motivate DPP implementation.

This research question was useful for informing the activities and processes of value-driven DPP implementation, which was necessary to replicate similar activities in co-creation workshops with construction manufacturers. Furthermore, it provided insight into what to expect from DPP implementation in practice under current conditions, which was useful for later reflections. However, because the Early Adopters differed significantly from construction manufacturers, direct parallels for DPP goals and steps could not be drawn.

RQ3 *What goals and steps do construction manufacturers identify when exploring value-driven DPP implementation?*

Value-driven DPP implementation was explored through co-creation workshop activities created in chapter 5, using opportunity cards that were developed in chapter 4. Chapter 5 presents the goals and steps from 3 individual manufactures.

This question was useful for creating a workshop that would build on the previous findings to probe into the main research purpose.

RQ4: *How could value-driven DPP implementation be encouraged and supported?*

This question was addressed in several ways. First, chapter 5 presented considerations that could be used to motivate individual manufacturers during their evaluation process. Second, chapter 6 provided a general support approach based on the current DPP situation. Lastly, chapter 7 provided adoption scenarios to use as a resource.

7.2 Reflection beyond research questions

Some broader insights emerged during the process that aren't strictly bound to the research questions or purpose.

7.2.1 Reflection on value-driven framing

A new value-driven framing was proposed in chapter 2, to respond to the need of exploring DPPs "beyond compliance". Applying this frame as an assumption allowed for better exploratative research into value-driven DPPs, without being constrained by the limitations of the current compliance-driven thinking. The framing also provided a clearer explanation on what "value-driven" or "beyond compliance" means, as this was lacking in literature.

Despite this research's attempt to unpack this framing, it remains unclear whether value-driven DPP implementation and value-driven framing possess sufficient potential for success, or if they are worth pursuing on their own. Answering this question requires demonstrating that these approaches are sufficiently feasible, viable, and desirable for manufacturers.

Even if value-driven DPP implementation is deemed worthwhile, another challenge may emerge: manufacturers might act in ways that undermine DPPs' circular economy ambitions in favor of pursuing their own interests. For instance, businesses could omit crucial material data to make their products appear more favorable than they actually are.

To address these limitations, compliance-driven framing remains useful. It introduces stricter guidelines and creates urgency to ensure that DPP objectives are fulfilled by all stakeholders

7.2.2 Reflection on sustainability in business practice

This thesis is an exercise in translating the ideal a sustainability measure to fit it into practice: This exercise - a noble pursuit - is proven to be eternally challenging: I have spoken to sustainability managers with a PHD in circular economy struggling to implement carbon footprint measures. I have seen researchers presenting theory driven concepts, that touch none of pains of the industry. I have been amazed at the quantity of literature on the exploration of circular economy and its definitions, ideals, conceptual actions and recommendations, but the lack of real-world conceptualisation. This project has convinced me that cracking this part of the problem lies at the heart of making sustainability reality.

At the same time, my empathy for businesses has increased. I recognize how burdensome regulations can be when they offer no clear short or long term benefits. Businesses operate in a complex environment where fulfilling their basic role is often challenging enough. I understand the difficulty of taking risks and pioneering new approaches. Ultimately, businesses are like people—most of whom are well-intentioned and open to consider and discuss. Just like people, they simply act on what they think is best.

7.3 Recommendations

Future research

To properly embed the business perspective on DPPs into academic theory, it is necessary to further develop insights from individual cases into models that can represent broader industries. For example, Wicaksono et al. (2025) present such a framework, that describes the influence of stakeholders on DPP adoption. To create more frameworks, insights from individual businesses can be used from Haasse et al. (2025), Hansson & Maass (2024), and Colucciello et al. (2025).

Furthermore, DPP implementation depends on the development of knowledge and technologies. Because DPP researchers might be best equipped to understand the full extent of the DPP, they can have a role in filling industry knowledge gaps: further unpacking and documenting the landscape, possibilities, technologies, and future developments.

Practice

The EU and public authorities should consider their role in DPP implementation not just from a regulatory standpoint, but also as enablers of industry. For example, they could consider funding accessible IT infrastructure, knowledge support, or develop guidelines for businesses.

CE experts, IT specialists, and DPP providers can play a key role in achieving the DPP ambition for the CE, by translating it and breaking it down into achievable steps, and providing the right DPP infrastructure.

The results from this thesis and other research demonstrate how influential manufacturers' decisions can be in making the DPP a meaningful innovation. Construction manufacturers should recognize their unique position and ability to make DPPs a reality, as well as their power to influence those around them: competitors, clients, and suppliers.

Client

To address knowledge gaps and establish themselves as DPP experts, EPEA should provide accessible knowledge resources such as whitepapers, case

studies, and explanations in plain language.

EPEA could apply the “careful encouraging” approach in ongoing discussions, using C2C’s positive storytelling to highlight DPPs’ collective value for business, people, and planet, and focus on what maniufacturers can achieve. This leverages C2C’s core strength: inspiring hope in sustainability.

As DPPs become more relevant, EPEA can add value by addressing implementation questions through DPP strategy consultancy services. Depending on manufacturers’ needs, these could range from simple packages (straightforward, ESPR-compliant implementation plans) to complex solutions (comprehensive DPP strategies aligned with broader business goals). As a further step, EPEA could also support the development of new circular business models that DPP implementation enables.

For existing clients, EPEA can already offer individual DPP services (data gap analysis, preparedness assessment) and help them stay informed and prepared for upcoming regulations.

To fulfill all of these reccomendations, the various tools, explanations, methods and conclusions in this thesis can be used as a starting point.

8. Conclusion

The purpose of this research was to uncover the value that DPP implementation brings to business practice. Within the context of the construction manufacturing industry, the DPP is defined as a set of data specific to a product that is accessible via electronic means. Construction manufacturers currently perceive the DPP as a measure with many challenges, mainly related to high costs, high difficulty, and uncertainty. While the literature presents the DPP as highly promising, manufacturers see little of this promise.

Early adopters’ experiences indicate four phases in DPP implementation: Awareness, Evaluation, Action, and Reflection. The Evaluation phase is crucial, as it is where manufacturers assess the DPP’s usefulness and decide whether to implement it.

When exploring value-driven DPP implementation, construction manufacturers identify various goals and steps. The goals determine the value of the DPP to the business. There is no one size fits all, so this value proposition needs to be tailored, by considering relevance, implications, attitude.

This thesis suggests that manufacturers cannot be coerced into DPP implementation, given the current underdeveloped DPP and landscape. Proposing a value driven approach is not a solution: it does not make up for the challenges that manufacturers perceive. Instead, manufacturers should be met with a “gentle encouraging” approach, that validates and addresses their experiences and gives them the confidence to undertake value driven DPP implementation. In line with this approach, this thesis develops future scenarios, a resource to address future uncertainty.

8.1 Contributions

Research
This thesis provides a way to define and describe DPP implementation “beyond compliance”, by introducing definitions (DPP business value, value driven DPP implementation, value driven framing) and explaining the relationship in between with frames, processes.

The co-creation results provide practice-oriented examples of what value-driven DPP implementation could look like, together with methods and tools to develop them. They can be used or adapted for inspiration and further exploration in researching DPP implementation beyond compliance.

The critical reflection of the researcher contributes to ongoing discussions on the role of research in catalysing DPPs. It further emphasizes the necessity of including the manufacturers perspective in the DPP discussion and finding interests to translate the DPP ambitions into practice.

Practice
This thesis provides a collection of examples, practical experiences, methods, approaches, and tools for stakeholders interested in DPP implementation.
The introduction offers relevant DPP definitions and explanations tailored for Dutch construction manufacturers, along with an overview of ESPR regulation. The opportunity cards provide a comprehensive examination of DPP opportunities for business value, designed for use in exploration and evaluation activities. Similarly, the scenarios can be used to explore or anticipate future DPP adoption patterns. These resources are valuable for manufacturers, consultants, DPP service providers, and other stakeholders in the DPP ecosystem.

Personal reflection

I chose to work on a sustainability topic for my graduation thesis, not because I feel necessarily morally drawn to it, but because I enjoy the complexity of the topic. This project, however, definitely pushed the boundaries of how much complexity I could absorb.

I purposefully chose to do a project with a client, because I liked the idea of researching and designing in an outside context. I believe that this has deepened my findings. I learned, however, that this also brings many challenges, on top of design work, getting flooded with feedback, having to be creative in an unfamiliar office environment, and generally managing the extra admin that office life imposes.

Throughout my research, I became heavily invested in the technical and regulatory details of the digital product passport. I felt I had to understand the topic before addressing it. In the end, it feels really gratifying to have built so much knowledge about one topic in such a short time. Adjacent to my project, I also enjoyed immersing myself in the endless theory on cradle to cradle, business motivation literature, and strategic perspectives.

I am grateful for these pleasures, because I can safely say that this project is among the most difficult projects I have ever taken on.

I hope you enjoyed reading it.

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