

# Digital Product Passport for Circular Construction: a framework based on life cycle perspective

Maneesha Dias  
*Information and Knowledge  
Management Unit  
Tampere University  
Tampere, Finland*  
[maneesha.dias@tuni.fi](mailto:maneesha.dias@tuni.fi)

Hongxiu Li  
*Information and Knowledge  
Management Unit  
Tampere University  
Tampere, Finland*  
[hongxiu.li@tuni.fi](mailto:hongxiu.li@tuni.fi)

Ulla A. Saari  
*Industrial Engineering & Management  
Unit  
Tampere University  
Tampere, Finland*  
[ulla.saari@tuni.fi](mailto:ulla.saari@tuni.fi)

Joshua Karlsson  
*Faculty of Engineering and Natural  
Sciences  
Tampere University  
Tampere, Finland*  
[joshua.karlsson@tuni.fi](mailto:joshua.karlsson@tuni.fi)

Joaquín Ordieres-Meré  
*Industrial Management Department  
Universidad Politécnica de Madrid  
Madrid, Spain*  
[j.ordieres@upm.es](mailto:j.ordieres@upm.es)

Muhammad Shafique  
*Department of Civil and Environmental  
Engineering  
Brunel University of London  
United Kingdom*  
[Muhammad.shafique@brunel.ac.uk](mailto:Muhammad.shafique@brunel.ac.uk)

Xiangming Zhou  
*Department of Civil and  
Environmental Engineering  
Brunel University of London  
United Kingdom*  
[xiangming.zhou@brunel.ac.uk](mailto:xiangming.zhou@brunel.ac.uk)

**Abstract**— The construction industry is one of the largest industrial sectors, characterized by resource intensity, carbon emissions, and waste generation. The increasing demand for new housing and renovations for older buildings, alongside the imperative for energy-efficient buildings, place significant pressure on nations to address housing issues while concurrently preserving the environment. The building life cycle typically spans 50 to 100 years. The dissociation among stakeholders and the scarcity of data concerning building construction over its lifetime highlights the necessity for a digital product passport (DPP) that synchronizes data and fosters collaboration among stakeholders. Though previous literature has examined DPP implementation in the construction sector for circular economy practices, the findings are fragmented and there is a lack of research which could provide a comprehensive understanding of how DPP from a data point of view could facilitate circular economy practices in the construction sector. Drawing on a literature review of 25 articles from SCOPUS, the paper presents a framework that illustrates the role of data in a DPP in creating value to the stakeholders of the construction sector throughout the life cycle of a building. Further, future research directions are suggested on exploring data strategies for DPP implementation, based on the data requirements and their role in building DPPs, as well as the challenges that may arise, to ensure effective collaboration among stakeholders towards circularity.

**Keywords**— *Circular economy, Construction, Digital Product Passport, Data driven value creation, Life cycle*

## I. INTRODUCTION

The construction sector, characterized by its resource-intensive practices, generated 807 million metric tons of waste in the European Union in 2020 [1]. It is a significant user of non-renewable natural resources, such as river sand, and accounts for approximately 20% of worldwide greenhouse gas emissions [2]. With new buildings consistently being erected and older ones being torn down, there is a valuable

opportunity to incorporate circularity strategies within the building sector.

While the concept of circular economy (CE) has garnered increasing attention in discussions concerning waste management, its practical application within the construction industry remains in a developmental phase. In the Nordic countries, research focused on CE-oriented construction practices is actively being conducted [3]. Highlighting the necessity of integrating CE principles not only at the end-of-life phase of a construction project but throughout the entire lifecycle emphasizes the essential role of collaboration among all stakeholders involved [4]. These stakeholders include architects, engineers, contractors, material suppliers, building owners, tenants, demolition firms, recycling and waste management agencies, as well as public authorities and policymakers [4]. While there are advancements in the processes for proper production, processing, recycling, and reuse of building materials, the perspectives of stakeholders involved in the building lifecycle remain quite varied [5].

Digital Product Passport (DPP) is set to emerge as the next digital platform facilitating a CE by serving as inter-organizational data repositories that include lifecycle product information [6]. This initiative is set to be implemented by 2026, in accordance with European Union regulatory requirements [7]. A variety of derivatives of DPPs can be observed in published literature on the construction sector, each reflecting different stages of a building's life cycle such as building passport, building renovation passport, material passport and digital building logbook [8]. Despite the absence of a clear explanation in published literature regarding the lack of a unified system, empirical studies indicate that these terms are reflective of the specific life cycle stage addressed in each study [4], [9]. In this paper, we identify DPP as the umbrella term representing all the passport varieties. DPP is a digital record that aggregates data on a product's lifecycle, enabling stakeholders to access information pertinent to

sustainability, compliance, and circularity. They have the potential to bridge existing data gaps by requiring organizations to collect, maintain, and share product data as a condition for market entry [10]. Building DPPs are digital platforms that encompass data pertinent to a building, including material specifications, operational and financial requirements, as well as information relevant to CE practices such as the building's age and remaining lifespan [5], reuse and recycle potential of building materials [11].

Research has been conducted to understand the awareness among construction professionals on the concept of DPP and its implementation in building projects [12]. Various frameworks have been suggested to outline the criteria that should be incorporated into a building DPP [2], [13], [14]. Additionally, feasibility studies are conducted to explore the technology integration into the concept of DPP [15]. Though the literature has examined DPP implementation in the construction sector for CE practices, the findings are fragmented and there is a lack of research which could provide a comprehensive understanding of how data in a DPP could facilitate CE practices in the construction sector. To address the research gap, this paper investigates the following research question: *What is the role of data in a DPP for circular economy initiatives within the construction sector?*

To answer the research question, a literature review was conducted based on 25 articles selected from the literature in SCOPUS database. In the literature analysis, we focused on the application of DPP throughout the entire life cycle of a building, considering the diverse stakeholders engaged at various stages, as well as the critical role DPP plays in connecting these stakeholders across different phases of the construction life cycle from the data perspective. This study aims to enhance the understanding of how data contributes to sustainable value generation when applying DPP in the construction sector for CE initiatives.

## II. RESEARCH BACKGROUND

### A. Circular Economy in Construction Sector

The construction industry is a major consumer of natural resources and generates a significant amount of waste, traditionally operating under a linear take, make, dispose model [16]. The adoption of CE principles in construction aims to keep materials in use for as long as possible, reducing waste and resource extraction while promoting sustainability [4].

Circular practices can be integrated into construction by limiting the loop, slowing the loop or closing the loop. Limiting the loop focuses on using fewer resources whereas slowing the loop focuses extending the life of the product while reuse and recycle at post consumption stage reflects on the closing the loop strategy [17]. Building CE practices can be conducted by the reuse of materials at the element or component level, recycling through closed-loop systems, mechanical recycling (both with and without processing efforts), and recovery efforts related to material recovery, energy recovery, and backfilling [5].

### B. Digital Product Passport

DPP is an umbrella concept defined under Ecodesign for Sustainable Products Regulation to enhance transparency across value chains by sharing information related to factors such as origin, material composition, environmental impact,

and disposal [5], [7]. These passports are intended for any physical good placed on the market or put into service and therefore they do not exclude the construction sector. Since DPP became a popular concept and a regulatory requirement in Europe, many sector-specific and cross-sector passport types have emerged such as material passport [18], battery passport [10] and textile passport [19].

DPP terminologies specific to the construction sector are building passport (BP) [4], building renovation passport (BRP) [9], material passport (MP) [4], [5], [20], and digital building logbook (DBL) [8]. Studies indicate that these terms are reflective of the specific life cycle stage addressed in each study [4], [9]. Additionally, some of the terminology draws inspiration from other sectors, such as food industry, as evidenced by cited studies [21].

Prior studies have defined MP as collections of data that detail specific attributes of materials applied in production, which can enhance their value for material recovery and reuse [13]. DBL is defined as an interactive tool that facilitates the recording, access, enhancement, and organization of various building related data, information, and documents into specific categories [21]. It serves as a comprehensive record of significant events and changes throughout a building's lifecycle [13]. While DPP, MP and DBL take a broader life cycle perspective regarding building data, BP and BRP have a more limited focus, concentrating on specific stages of the construction life cycle. BP is described as a tool that maintains "records of state" for building products, including maintenance logs with the objective of providing information to building users such as tenants, potential purchaser and investors [4], [22], [23]. BRP focus on building and energy renovation at the renovation phase of construction life cycle and it incorporates stakeholders in creating a renovation plan with data based on appropriate timing and order of renovation requirements [23].

## III. METHODOLOGY

The literature review was conducted following the guidelines set by [24], screening and selecting the literature, extracting the literature based on predefined criteria and execution of literature review study. Considering SCOPUS as the database, journal and conference articles published in English between January 2015 and April 2025 in the fields of DPP, CE and the construction industry were identified for the literature search. SCOPUS was used as the database for literature searching considering the availability of satisfactory amount of peer reviewed content from a wide coverage of journals relevant to the topic of interest. According to [19], the most frequently used passport terminologies in the construction sector include material passport, building passport, building renovation passport, and digital building logbook. Consequently, we incorporated these synonyms into our search strategy, employing the following Boolean logic: *Digital Product Passport OR Material Passport OR Building Passport OR Building Renovation Passport OR Digital Building Logbook*. This search yielded 132 papers, which we subsequently screened in two stages: first by title and abstract, and then by full paper, following the exclusion criteria outlined in Figure 1.

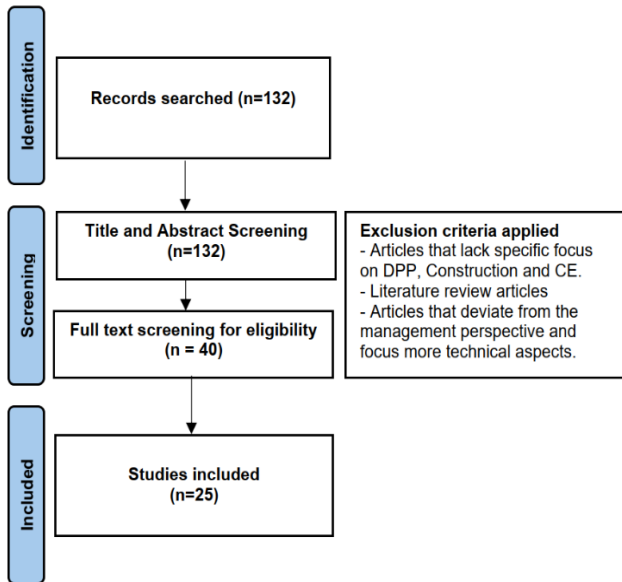


Fig. 1. Literature search and selection process

First, we conducted title and abstract screening to exclude articles that did not position the concepts of DPP and construction sector as a key focus based on the exclusion criteria outlined in Figure 1. This step reduced the literature pool to 40 articles. Next, we reviewed the full text of the remaining articles to assess their relevance for further analysis. After a thorough review of titles, abstracts, and full texts, a dataset of 25 articles was finally included for further analysis.

Two authors did the coding for the literature analysis together and came to an agreement on criteria to be considered for data extraction from the selected articles under the areas of: research objectives, applied research methods, applied theories, research context, passport type, stage of the construction life cycle, CE approach, role of data and research findings. A data extraction form was generated by incorporating the above criteria to synthesize detailed information from the identified studies, with the aim of addressing the research objective of the current literature review.

#### IV. RESULTS AND DISCUSSION

##### A. DPP along the construction life cycle

DPP-related publications were mapped across the construction life cycle to determine which phases the articles pertain to (See Figure 2). Our findings revealed that a significant portion of the articles (19 papers) focus on the end-of-life phase, while only 9 papers adopt a comprehensive whole life cycle perspective starting from the design phase until end of life.

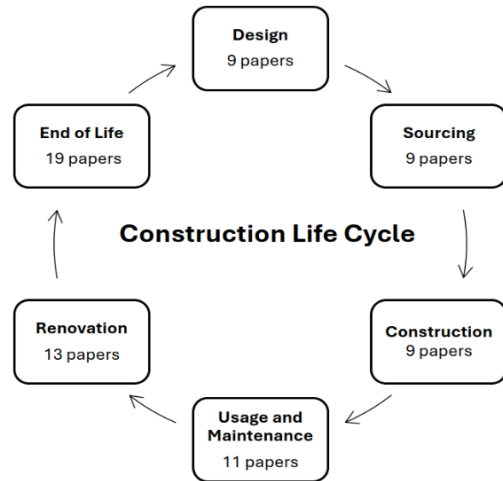


Fig. 2. Contribution of DPP along the construction life cycle

From a design standpoint, the concept of design for deconstruction has been proposed, emphasizing a data-driven approach during the building's design phase to facilitate easier dismantling later on [13]. This method employs a DPP integrated into a Building Information Management System (BIM) to organize, oversee, and produce data and metadata for disassembly models of buildings at the component level. Additionally DPP can significantly improve the tracking of materials throughout the entire lifecycle of a building, which supports more informed decision-making regarding material choices during the design phase with a focus on reuse and recycling [11].

During the sourcing phase, integrating data with DPPs enhance the visibility and accessibility of materials. It serves as a collaborative tool for sustainable and circular building design, enabling users to identify new opportunities for reintegrating materials into value chains [14]. It facilitates searching for materials based on specific criteria and user preferences, automatically aligning these requirements with the material information stored within the DPP [25]. This approach fosters improved collaboration between buyers and material owners in the sourcing process.

In the construction phase, DPP functions as an inventory of embedded materials [26]. It provides both information on the material composition and distribution within a building's structure. This allows the assessment of recyclability of the embedded materials and the respective environmental impacts, enabling informed choices regarding the selection of construction materials with a focus on environmental impacts in mind [27].

When evaluating the usage and maintenance phase, DPP facilitates vertical integration and fosters long term relationships with stakeholders throughout the construction life cycle. It enhances transparency and collaboration in the flow of information and facilitates a communication of maintenance-related data and establish take-back strategies [4]. Furthermore, following the progress of materials and components through building life cycle, DPP facilitates the tracking of their maintenance and replacement. It allows the real time data sharing of these elements as to whether they remain unused and can potentially re-enter the supply chain, or turn into waste and enter a recycling process where they can be reused or reprocessed [26].

During the renovation phase, as empirically identified by [21], DPPs facilitate material selection for building upgrades by enabling data transfer in a smooth and interoperable manner across systems and platforms. Moreover, they help monitor key energy, environmental, and financial performance indicators, allowing building managers and auditors to make informed decisions to reach deep renovation targets [23].

At the end of a building's life, DPP serves as a valuable tool for evaluating embedded materials and their recycling potential, aiding decisions related to waste and material circularity [27]. These decisions might involve assessing whether a material can re-enter the supply chain or, conversely, if it should be treated as waste and enter a recycling loop for reuse or reprocessing, or, in the least favorable scenario, be disposed of [26].

The full potential of CE orientation in a building can be explored by considering the entire lifecycle of buildings. DPPs enable buildings to be viewed as dynamic data rich structures rather than static ones that will ultimately be demolished. It can serve as a valuable database of material reservoirs, decisions regarding design for reconfiguration, upgrades, and eventual recovery following strategies of dematerializing, rematerializing, remanufacturing [4], reuse or recycling [20].

#### *B. Role of Data in the Construction Sector*

The data requirements in building construction correspond to various phases of the project lifecycle, which include building design, material sourcing, construction, usage and maintenance, renovation, and end-of-life considerations [8], [9]. At a functional level, data can be utilized to analyze a building in a hierarchical manner from the overall structure down to specific elements like apartments, individual components such as windows, doors, and walls, and the various materials associated with each component, such as wood and glass for window frames [4], [18]. Stakeholders involved throughout the building's lifecycle such as architects, engineers, contractors, material suppliers, building owners, tenants, demolition firms, recycling and waste management agencies, public authorities, and policymakers can contribute to data as well as utilize data for decision making [4] while acting as a regulatory platform that can establish industry standards across stakeholder levels.

At an organizational level, transitioning to a CE-focused business model necessitates a fundamental transformation [28]. Achieving circularity in construction presents significant challenges due to inadequate data about the materials used within buildings—such as their quality, quantity, properties and composition, origin, end-of-life potential, deconstruction strategy and the potential for reuse [11]. This lack of knowledge stems from insufficient data and documentation of materials [21]. To enable CE in construction, data related to materials and buildings, and sharing data generated through processes with relevant actors are important considerations [29]. This underscores the necessity for a unified platform such as DPP that consolidates all relevant data throughout a building's life cycle for creating sustainable value to its stakeholders [11], [28].

#### *C. Data driven value creation*

DPP is a collaborative platform where inter-organizational and intra-organizational data are shared with different levels

of stakeholders of the product [30]. It enables accurate real-time data collection at every stage of the product life cycle [31] and supports the effective management of a product [30], to which the construction sector is not an exception [32]. By adopting DPPs, organizations can foster a data-driven circular economy that offers numerous advantages, including increased transparency [20], [33], improved integrity [4], enhanced collaboration among stakeholders [8], better interoperability between systems [13], and informed decision-making [2].

DPPs streamline data management and improve information transparency [20] to facilitate its role as a trade and regulatory document to trace and track the products journey from its origin to end of life [33]. As a result, the efficiency of reintegrating materials into the value chains is significantly enhanced [9]. By adhering to best practices in database design and management, DPPs assign unique identifiers to each key data point, ensuring the integrity of the stored information and preventing problems such as the duplicate issuance of passports [4]. DPPs contain digital and standardized data, serving as a reliable source of crucial information, including calculated and measured indicators of financial, environmental and energy performance [23].

Vertical integration facilitated by DPP supports the establishment of long-term relationships with stakeholders enhancing collaboration and streamlining information exchange throughout the value chain [4]. For example, DPPs can be integrated with platforms for material exchange to develop a marketplace for material recycle and reuse [17]. The engagement of stakeholders within the construction value chain is essential for fostering partnerships and promoting industrial symbiosis, ultimately contributing to closing the materials loop [8]. DPPs play a vital role in enhancing data exchange and promoting collaboration [13], [20]. It establishes standardized protocols for data sharing, which guarantee the consistency and compatibility of data across different platforms. This standardization encourages interoperability and enables the seamless integration of tools, leading to a collaborative and efficient implementation of CE practices [13]. Additionally, DPPs improve interoperability among data sources and facilitate data integration, allowing for smooth exchange and interaction between various systems and platforms [21].

The data contained within DPPs supports informed decision-making; for instance, it can estimate the quantities of specific components available for reuse and recycle at certain time points [2]. Additionally, DPPs serve as data carriers for stakeholders, providing essential information that aids in making well-informed choices grounded in lifecycle thinking [25], promoting CE practices and innovation [11].

#### *D. Framework to understand the role of DPP for CE initiatives in construction sector –*

One of the significant obstacles in transitioning to a CE within the construction sector is the absence of comprehensive data and a systematic approach for data management [16]. Numerous studies suggest the implementation of DPP to facilitate circular information exchanges in conventional construction practices [9], [13], [20], [34]. However, challenges, such as the fragmented nature of information sharing among construction stakeholders [32], hinder their widespread adoption. To tackle this issue, this framework (Figure 3) considers data flows throughout the lifecycle of a

construction project. DPP serves as a platform that supports continuous data updates, and the integration of stakeholders both vertically and horizontally.

The proposed framework suggests that the DPP organizes building-related data in a hierarchical structure, beginning at the building level and refining it down to the element, component, and material levels [4], [27]. Possible data fields stored within the DPP may include but not limited to material specifications, supplier and manufacturing details, operational and financial information, as well as data related to CE [21], [25], [34]. This framework highlights the flow of data into and out of the DPP from all the phases of the construction life cycle, which encompasses building design, sourcing, construction, usage, maintenance, renovation, and end-of-life [8], [9].

Stakeholders involved in the building's life cycle—such as architects, engineers, contractors, material suppliers, building owners, tenants, demolition firms, recycling and waste management agencies, public authorities, and policymakers—extract this data for informed decision-making at different stages of the building's existence [4].

The framework illustrates how DPP-related data is generated, stored, and disseminated throughout the

construction lifecycle resulting in value creation. DPPs improve the integrity and transparency of data for stakeholders involved in this lifecycle [4], [20]. Additionally, it facilitates the seamless integration of data from different systems and parties into a unified platform, ensuring efficient interoperability among systems and stakeholders [21]. DPPs promote vertical collaboration along the value chain, enabling data-driven decision-making through the collective efforts of stakeholders throughout the construction process [13]. Information within DPPs fosters value creation at various stages of the construction lifecycle, supporting the transition to a CE.

DPP designed and developed incorporating a lifecycle perspective can promote circularity in the construction industry in two aspects. Firstly, DPP as a technical and process platform provides a valuable opportunity to produce digital and standardized information that can be reused by stakeholders throughout the value chain. Additionally, it promotes vertical integration and develops long-term relationships with stakeholders across the construction lifecycle enabling transparency, collaboration and effective circular decision-making.

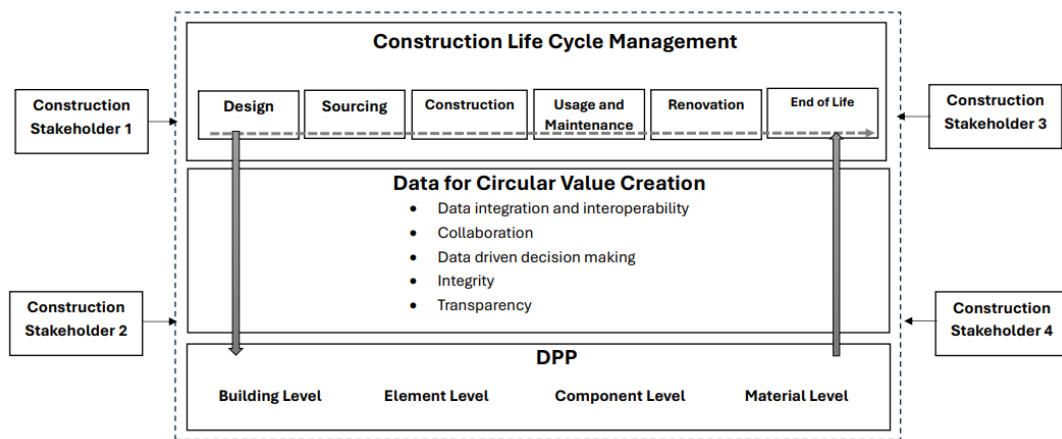


Fig. 3. Proposed Framework to understand the role of DPP for CE initiatives in construction sector

## V. FUTURE RESEARCH DIRECTION

DPPs are not yet widely adopted in the construction industry [34], revealing a notable gap in our understanding of their effective implementation to achieve CE objectives. To make progress toward a CE, it is vital to comprehend the role data plays in DPPs and develop a data strategy for DPP design and implementation, particularly concerning product performance, environmental impact, and the circularity potential of construction and demolition materials [32]. Existing studies that explore DPPs from a data perspective are insufficient. While numerous studies attempt to outline the key data criteria that a DPP or MP should include [4], [5], [28], there is still a lack of clarity regarding the types and formats of data needed at each phase of the DPP implementation [35] and how this data can contribute to value creation and enhance CE in the construction sector. Implementing DPPs should start with establishing research to identify the appropriate data types and their respective importance and availability [36],

structures and templates for data storage and management [37], followed by gathering relevant data from case studies.

Given the crucial role of stakeholders in the adoption and promotion of DPPs, they can be seen as central to the development of DPP value chain. DPPs facilitate a common language among stakeholders by standardizing data syntax and semantics, ensuring that all parties involved have a clear and shared understanding of the data being exchanged [10]. However, further in-depth studies are needed to examine the role of stakeholders and how they contribute to value creation at various levels of the construction life cycle. Additionally, incorporating diverse stakeholders into the DPP framework may result in a range of socioeconomic and technical challenges [38], [39]. Understanding these challenges will be advantageous for practitioners to implement DPP effectively.

Regenerating the loop highlights the importance of improving both the environment and society for future generations. In the context of the construction industry, regenerative design represents the highest level of circularity, fostering ongoing resource flows in a self-sustaining way,

beginning with the building's design [17]. Research focused on building design can investigate the potential for integrating data into the DPP from design stage itself into architectural plans and its impact on the value creation process.

Additionally, we encourage future researchers to explore how data related technologies will support value creation from DPP and what sort of a role they will play in data integration within the construction sector. The application of digital tools like BIM in construction-related DPPs warrants further exploration, as BIM encompasses crucial information related to the design, fabrication, and construction processes[4], [13].

## VI. CONCLUSION

The paper examines and discusses the scholarly literature that intersects with DPP, CE, and the construction sector. We introduce a framework that views DPP from data point of view, considering the construction life cycle, from a hierarchical perspective from the building level down to the level of materials. This framework underscores the importance of stakeholder integration throughout the life cycle and highlights the role data plays in value creation. Our analysis leads to the identification of future research directions centered on data strategies for DPP implementation, focusing on understanding data requirements and its role in construction DPP, as well as the challenges that may arise to ensure effective collaboration towards circularity. We encourage further research into the integration of data-driven technologies and their potential to enhance circular value creation through DPPs across various phases of the construction life cycle.

This study has its limitations which should be acknowledged. We believe that the self-chosen timeframe and considering SCOPUS as the only database may limit the review as there is a wide variety of other research that was not considered in this work. We have developed a framework considering the role of data in DPP. However, this framework could be further expanded with more dimensions and details in future research.

*Disclosure – AI was used for editing and grammar check of the paper.*

## REFERENCES

- [1] Eurostat, "Generation of waste by the construction industry in the European Union (EU-27) in 2020, by country (in million metric tons)." [Online]. Available: <https://www-statista-com.libproxy.tuni.fi/statistics/1399088/waste-generation-by-the-construction-industry-in-the-eu-by-country/>
- [2] N. Francart, S. R. B. Gummididi, E. Hoxha, and H. Birgisdottir, "A Danish model of building macro-components to promote circularity," *Journal of Physics: Conference Series*, vol. 2600, no. 19, p. 192001, Nov. 2023, doi: 10.1088/1742-6596/2600/19/192001.
- [3] S. Huuhka, M. Moiso, E. Salmio, A. Köliö, and J. Lahdensivu, "Renovate or replace? Consequential replacement LCA framework for buildings," *Build. Cities*, vol. 4, no. 1, pp. 212–228, May 2023, doi: 10.5334/bc.309.
- [4] F. Kedir, D. M. Hall, S. Brantvall, J. Lessing, A. Hollberg, and R. K. Soman, "Circular information flows in industrialized housing construction: the case of a multi-family housing product platform in Sweden," *Construction Innovation*, vol. 24, no. 5, pp. 1354–1379, Aug. 2024, doi: 10.1108/CI-08-2022-0199.
- [5] I. Nemeth, P. Schneider-Marin, H. Figl, M. Fellner, and C. Asam, "Circularity evaluation as guidance for building design," *IOP Conference Series: Earth and Environmental Science*, vol. 1078, no. 1, p. 012082, Sep. 2022, doi: 10.1088/1755-1315/1078/1/012082.
- [6] R. Kebede, A. Moscati, H. Tan, and P. Johansson, "A modular ontology modeling approach to developing digital product passports to promote circular economy in the built environment," *Sustainable Production and Consumption*, vol. 48, pp. 248–268, 2024, doi: 10.1016/j.spc.2024.05.007.
- [7] "CIRPASS\_Cross-sector and sector-specific DPP roadmaps\_1.1."
- [8] A. Gieß and F. Möller, "Exploring the value ecosystem of digital product passports," *Journal of Industrial Ecology*, p. jiec.13621, Feb. 2025, doi: 10.1111/jiec.13621.
- [9] A. Y. Topraklı, "Enabling circularity in Turkish construction: a case of BIM-based material management utilizing material passports," *Smart and Sustainable Built Environment*, Nov. 2024, doi: 10.1108/SASBE-05-2024-0199.
- [10] L. Wu, W. Lu, Z. Peng, and C. Webster, "A blockchain non-fungible token-enabled 'passport' for construction waste material cross-jurisdictional trading," *Automation in Construction*, vol. 149, p. 104783, May 2023, doi: 10.1016/j.autcon.2023.104783.
- [11] B. Sanchez, M. Honic, F. Leite, P. Herthogs, and R. Stouffs, "Augmenting materials passports to support disassembly planning based on building information modelling standards," *Journal of Building Engineering*, vol. 90, p. 109083, Aug. 2024, doi: 10.1016/j.jobe.2024.109083.
- [12] L. Panza, G. Bruno, and F. Lombardi, "A Collaborative Architecture to support Circular Economy through Digital Material Passports and Internet of Materials," *IFAC-Pap.*, vol. 55, no. 10, pp. 1491–1496, 2022, doi: 10.1016/j.ifacol.2022.09.601.
- [13] A. Vahidi, A. T. Gebremariam, F. Di Maio, K. Meister, T. Koulaeian, and P. Rem, "RFID-based material passport system in a recycled concrete circular chain," *Journal of Cleaner Production*, vol. 442, p. 140973, Feb. 2024, doi: 10.1016/j.jclepro.2024.140973.
- [14] M. Honic et al., "Framework for the assessment of the existing building stock through BIM and GIS," *Developments in the Built Environment*, vol. 13, 2023, doi: 10.1016/j.dibe.2022.100110.
- [15] G. Van Capelleveen, D. Vegter, M. Olthaar, and J. Van Hillegerberg, "The anatomy of a passport for the circular economy: a conceptual definition, vision and structured literature review," *Resources, Conservation & Recycling Advances*, vol. 17, p. 200131, May 2023, doi: 10.1016/j.rcradv.2023.200131.
- [16] L. Panza, G. Bruno, and F. Lombardi, "Integrating Absolute Sustainability and Social Sustainability in the Digital Product Passport to Promote Industry 5.0," *Sustainability*, vol. 15, no. 16, 2023, doi: 10.3390/su151612552.
- [17] K.-J. Wu, M. Fu, M. H. Ali, M. K. Lim, and M.-L. Tseng, "Bridging the sustainable circular economy in cosmetic cross-supply chain practices under uncertainties: A data-driven influential model," *Journal of Cleaner Production*, vol. 436, 2024, doi: 10.1016/j.jclepro.2023.140438.
- [18] M. R. Munaro, A. C. Fischer, N. C. Azevedo, and S. F. Tavares, "Proposal of a building material passport and its application feasibility to the wood frame constructive system in Brazil," *IOP Conference Series: Earth and Environmental Science*, vol. 225, p. 012018, Feb. 2019, doi: 10.1088/1755-1315/225/1/012018.
- [19] S. Çetin, D. Raghu, M. Honic, A. Straub, and V. Gruis, "Data requirements and availabilities for material passports: A digitally enabled framework for improving the circularity of existing buildings," *Sustainable Production and Consumption*, vol. 40, pp. 422–437, Sep. 2023, doi: 10.1016/j.spc.2023.07.011.
- [20] M. Buchholz and T. Lützkendorf, "Building passports and material inventories – concepts, trends, job sharing," *IOP Conference Series: Earth and Environmental Science*, vol. 1122, no. 1, p. 012038, Dec. 2022, doi: 10.1088/1755-1315/1122/1/012038.
- [21] M. M. Sesana, G. Salvalai, O. Greslou, M. Rivallain, and J. Zirngibl, "Long - Term Renovation Strategies, Energy Voluntary Certification Scheme and Building Renovation Passport: an overview on Energy Performance Certification tools for the European Building stock," *IOP Conference Series: Earth and Environmental Science*, vol. 296, no. 1, p. 012029, Jul. 2019, doi: 10.1088/1755-1315/296/1/012029.
- [22] R. Gasue, S. Aklashie, A. M. A. Dompey, K. Agyekum, and D. Opoku, "Implementing materials passports in the construction industry: empirical evidence from Ghana," *International Journal of Building Pathology and Adaptation*, Jun. 2024, doi: 10.1108/IJBPA-01-2024-0007.
- [23] L. M. Ottosen et al., "Implementation stage for circular economy in the danish building and construction sector," *Detritus*, vol. 16, pp. 26–30, 2021, doi: 10.31025/2611-4135/2021.15110.

- [24] W. Bandara, E. Furtmueller, E. Gorbacheva, S. Miskon, and J. Beekhuyzen, "Achieving Rigor in Literature Reviews: Insights from Qualitative Data Analysis and Tool-Support," *Communications of the Association for Information Systems*, vol. 37, 2015, doi: 10.17705/1CAIS.03708.
- [25] W. Lu, Z. Peng, C. Webster, and L. Wu, "Developing a construction waste material 'passport' for cross-jurisdictional trading," *Journal of Cleaner Production*, vol. 414, p. 137509, Aug. 2023, doi: 10.1016/j.jclepro.2023.137509.
- [26] A. Talla and S. McIlwaine, "Industry 4.0 and the circular economy: using design-stage digital technology to reduce construction waste," *Smart and Sustainable Built Environment*, vol. 13, no. 1, pp. 179–198, Jan. 2024, doi: 10.1108/SASBE-03-2022-0050.
- [27] M. Honic, I. Kovacic, and H. Rechberger, "Improving the recycling potential of buildings through Material Passports (MP): An Austrian case study," *Journal of Cleaner Production*, vol. 217, pp. 787–797, Apr. 2019, doi: 10.1016/j.jclepro.2019.01.212.
- [28] S. F. Jensen, J. H. Kristensen, S. Adamsen, A. Christensen, and B. V. Waehrens, "Digital product passports for a circular economy: Data needs for product life cycle decision-making," *Sustainable Production and Consumption*, vol. 37, pp. 242–255, 2023, doi: 10.1016/j.spc.2023.02.021.
- [29] R. Kebede, A. Moscati, H. Tan, and P. Johansson, "A modular ontology modeling approach to developing digital product passports to promote circular economy in the built environment," *Sustainable Production and Consumption*, vol. 48, pp. 248–268, 2024, doi: 10.1016/j.spc.2024.05.007.
- [30] P. Méda, D. Calvetti, and H. Sousa, "Exploring the Potential of iPad-LiDAR Technology for Building Renovation Diagnosis: A Case Study," *Buildings*, vol. 13, no. 2, 2023, doi: 10.3390/buildings13020456.
- [31] A. Vahidi, A. T. Gebremariam, F. Di Maio, K. Meister, T. Koulaeian, and P. Rem, "RFID-based material passport system in a recycled concrete circular chain," *Journal of Cleaner Production*, vol. 442, 2024, doi: 10.1016/j.jclepro.2024.140973.
- [32] A. Talla and S. McIlwaine, "Industry 4.0 and the circular economy: using design-stage digital technology to reduce construction waste," *Smart and Sustainable Built Environment*, vol. 13, no. 1, pp. 179–198, 2024, doi: 10.1108/SASBE-03-2022-0050.
- [33] P. Méda, E. Hjelseth, D. Calvetti, and H. Sousa, "Exploring the significance and priority of digital product passports implementation in building renovation projects targeting circular economy," *Smart and Sustainable Built Environment*, Sep. 2024, doi: 10.1108/SASBE-05-2024-0193.
- [34] M. Gómez-Gil, A. Espinosa-Fernández, and B. López-Mesa, "Contribution of New Digital Technologies to the Digital Building Logbook," *Buildings*, vol. 12, no. 12, 2022, doi: 10.3390/buildings12122129.
- [35] D. J. Langley, "Digital Product-Service Systems: The Role of Data in the Transition to Servitization Business Models," *Sustainability*, vol. 14, no. 3, 2022, doi: 10.3390/su14031303.
- [36] A. Pohlmann, M. Popowicz, J.-P. Schöggel, and R. J. Baumgartner, "Digital product passports for electric vehicle batteries: Stakeholder requirements for sustainability and circularity," *Cleaner Production Letters*, vol. 8, 2025, doi: 10.1016/j.clpl.2024.100090.
- [37] M. R. N. King, P. D. Timms, and S. Mountney, "A proposed universal definition of a Digital Product Passport Ecosystem (DPPE): Worldviews, discrete capabilities, stakeholder requirements and concerns," *Journal of Cleaner Production*, vol. 384, 2023, doi: 10.1016/j.jclepro.2022.135538.
- [38] S. Alt, V. Schorr, A. Vocke, and D. Werth, "Status and Future of Real-Life Application of the Digital Process Passport in Germany," *Circular Economy and Sustainability*, vol. 3, no. 4, pp. 2255–2266, 2023, doi: 10.1007/s43615-023-00275-0.
- [39] C. Hoppe, S. Winkelmann, D. Petrik, T. Schoormann, and F. Möller, "Data Tensions in the Circular Economy: Empirical Insights from the Automotive Industry".