

Environment Product Declaration (EPD) in Construction Industries: Significance and Barriers

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ABSTRACT

Adopting a sustainable approach in production processes and activities in the construction industry is considered one of the best strategies that support the direction of sustainability and promote the development of the green approach in this industry and contribute effectively to providing environmentally friendly construction products that have high reliability and credibility that gives the product the ability to compete efficiently in the market and facilitate the consumers' purchase options. This paper discusses to highlights the importance of adopting an environmental product declaration for the products in the construction industries while determining the benefits of using it for manufacturers and the other stakeholders in the construction sector, in addition to identifying the obstacles that hinder its implementation in the construction industries.

Keywords: Environment Product Declaration (EPD), Product Environmental, Footprint (PEF) and Life Cycle Assessment (LCA), product categorization rules (PCR).

INTRODUCTION

Adopting environmental product declaration (EPD) for labeling the products of construction industries is one of the sustainable strategies that has become an urgent necessity as it greatly contributes to developing the green approach in manufacturing processes for construction products and achieves environmentally friendly manufacturing processes that contribute effectively to transforming the non-environmentally friendly construction industries into environmentally friendly industries through which Preserving the environment and reducing pollution in additional to enhance the environmental performance for stakeholders in the construction sector and provide them the demanding data for these products that help them to select the eco-friendly construction materials which comply with construction project design and requirements and achieving the sustainable goals. Increasing environmental awareness places demands on many producers to offer products that meet high environmental standards, as well as a responsibility to convey information about the environmental quality of their products. One of the most modern ways to achieve and demonstrate the environmental awareness of producers about the impact of products on the environment is environment product declaration (EPD). Certainly, producers who are motivated by their interests and EPD as a communication tool can improve production efficiency and expand their markets (Bajramovic et al, 2022).

LITERATURE REVIEW

Environment Product Declaration (EPD) identification

Environmental Product Declarations (EPD) describe a product and its emissions, Life Cycle Assessments (LCA), representing a complex but essential contribution to sustainable construction (Zag, 2024). The implementation of the environmental product declaration is one of the environmental classification standards that achieve the sustainability of the construction products, which gives accurate information about the environmental performance of the products and services based on the life cycle assessment of the product (LCA). According to Kumaran the primary function of a certified environment product declaration (EPD) is to provide a quantitative, objective, and reliable description of the environmental properties of products. Environment product declaration (EPD) is defined as an independently verified and recorded document that provides transparent and comparable information about the environmental effect of the product life cycle in a reliable manner (EPD, 2020).

The product environmental declaration (EPD) is a voluntary tool from a third party, it refers to realistic information about the environmental performance of services and products, achieving high environmental performance, the ability to resilience and adapt in the context of the market, it also leads to increased production and increased efficiency of the organization (Palmieri et al, 2017). Environmental product declaration is standards or labels that focus on providing adequate and systematic information on carbon dioxide emissions and ozone depletion. These standards can be used to document the impact of manufacturers of building products and materials on sustainable development goals while supporting their goals (Secher et al, 2018).

The Environmental Product Declaration Program (EPD) was developed to standardize industry-specific product life cycle assessment assumptions, allowing for transparent and credible reporting. (EPD) is the third type of environmental label as defined in ISO Standard ISO 14025:2006, Environmental Labels and Declarations – General Principles (International Organization for Standardization 2006). It communicates the environmental impacts of a service or product through the use of life-cycle assessment methods. The process of developing (EPD) includes data collection consistent with analysis and reporting requirements backed by third-party verification. This ensures the reliability of (EPD) information (Mukherjee & Dylla, 2017). An environmental product declaration is a verified and registered document that provides transparent and comparable information about the life cycle of a product. Obtaining a recent EPD is often the main purpose of performing an LCA product analysis (Bajramovic et al, 2022).

Background of Environment Product Declaration

The Product Environmental Declaration (EPD) was introduced in Sweden in 1997 and is now considered one of the most successful environmental statement systems in the international arena; it is a voluntary third-party certification tool that indicates factual information about the environmental performance of services or products. It is one of the three environmental classification labels of the International Standard ISO including type I (ISO 14024,2002); type II (ISO14021,2001) and type III (ISO 14025,2006) 14020, which are all based on a product life cycle assessment (LCA). A tool that represents this category is covered by ISO 14025 Type III (Palmieri et al, 2017). The validity of the environmental declaration for the product ranges from 1 to 5 years depending on the preferences of the company or the type of product (Ibanez-Fores et al, 2016).

The Characteristics of Environment Product Declaration (EPD)

An EPD is a standardized, third-party-certified label for communicating a product's environmental data

based on an LCA. Some green building rating systems consider it a powerful data source (Del Rosario et al, 2021). EPD refers to the environmental performance of the service or product and facilitates the comparison of products based on the same systematic platform and is based on quantitative and reliable data for the life cycle of the product. The detection of hot spots that have an environmental impact during long production chains such as building materials or buildings is one of the main advantages of using them in Complex areas such as the construction sector (Arvizu-Piña & Burgos, 2017). Product declaration provides quantitative, accurate, transparent, systematic, and reliable environmental data entry for environmental data based on the life cycle assessment method for the product or product group (Aydyn & Celebi). According to Palmieri et al, (2017), implementation of the environmental product declaration (EPD) for the product in the production process ensures:

- i. **Credibility:** Independent organization, appropriately accredited validates and ensures the disclosure of information appropriately related to the product to verify its authenticity, which enables consumers and business partners to assume responsibility for purchasing options. The company that adopts this tool implements a system of continuous improvement of the environmental quality of its services and products as well as reinforces its commitment towards sustainability which leads to improving the company's image within the framework of competition.
- ii. **Objectivity:** The information spread by the product environmental declaration tool should include verified assessments that confirm useful data related to the product life cycle to the external and internal stakeholders.
- iii. **Comparability:** The product environmental declaration (EPD) allows for the comparison of many similar products belonging to the same sector.

Life Cycle Assessment (LCA)

Life cycle assessments (LCAs) are a deep dive into a specific process in which all emissions within a certain range are accounted for. Common scopes include cradle-to-grave, where all emissions are included from the first steps of extraction and use of raw or recycled materials through end-of-life processes. Cradle to the gate, where an appropriate stopping point is determined and emissions are not accounted for beyond that point. From the gate to the grave, an appropriate starting point is determined and emissions are not calculated before that point (Rees, 2022). To meet the requirements for obtaining an EPD it is necessary to apply and conduct a life cycle assessment of products and processes. Life cycle assessment (LCA) is a structured approach to review a product and its entire life cycle. Cycle evaluation covers the entire life cycle of a product, process, or activity, and includes exploitation and processing of raw materials, production, transportation, distribution, use, recycling, and finally final disposal (Steubing & de Koning, 2021).

Originally, product life cycle assessment methodologies were developed to create decision support tools to distinguish between services, products, or product systems on environmental grounds, as several relevant applications appeared during the development of the methodology, such as using it as a basis for communicating comprehensive environmental performance to stakeholders (Del Borghi, 2013). Using LCA as an assessment tool has become a comprehensive model for assessing the energy and environmental performance of building or construction materials. It is one such method that aims to scrutinize environmentally unfriendly services and products (Pacheco-Torgal et al, 2014). (LCA) is the process of calculating the environmental effects of a process or products from cradle to grave, which includes the impacts that occur during the mining, extraction, manufacturing, and production stages of all raw materials used in the process as well as the distances traveled when transporting through the supply chain as well as the effects of the use and disposal of materials At the end of life (Mukherjee & Dylla, 2017).

Palumbo et al, (2020) discussed that the construction sector plays an important role in the move toward a low-carbon economy. Life cycle assessment (LCA) is one of the most effective methods for the analytical evaluation of environmental profiles and an effective tool for calculating environmental impacts in building

design-oriented methodologies, such as Building Information Modeling (BIM). In the early design stages, general LCA databases are used to conduct life cycle inventory (LCI), while detailed stages require more detailed data, such as Environmental Product Declarations (EPDs), documents that provide accurate results, and analyses based on LCA. Each product has a more or less negative impact on the environment, which is manifested at all stages of the product life cycle. The process of performing a product life cycle assessment analysis (LCA) is essential because environmental friendliness has become an additional quality of the product (Bajramovic et al, 2022).

To meet the requirements for obtaining an EPD it is necessary to apply and conduct a life cycle assessment of products and processes. Life cycle assessment (LCA) is a structured approach to review a product and its entire life cycle. Cycle evaluation covers the entire life cycle of a product, process, or activity, and includes exploitation and processing of raw materials, production, transportation, distribution, use, recycling, and finally final disposal (Steubing & de Koning, 2021).

Kumaran identified three stages of environmental product declaration information based on the three stages of product life cycle assessment (LCA). The first stage is the production stage which begins with obtaining raw materials and generating energy for the manufactured product at the factory door. The second stage is the product use stage which includes the distribution and use of the product from the factory gate. The third stage includes transportation to disposal facilities and recycling processes. Figure 1 shows three stages of Life Cycle Assessment (LCA) for the product.



Figure 1 Stages of (LCA)

The Process of Making Environment Product Declaration EPD

Bajramovic et al, (2022) discussed five steps for making an environmental declaration for the product. The first step included finding the product categorization rules (PCR) document by searching for it or creating it, as there are already documents on the rules for classifying ready-made products for many products, and they are constantly being developed and updated, as they are in the PCR database for the international environmental declaration system. For the product, ready-made PCR documents are available in addition to those that are under preparation. However, if there is no PCR for the product or its expiration date, it must be developed, verified, and approved. PCR documents are prepared if it does not exist through an open, transparent, and participatory process that includes many Companies and professional organizations to ensure the provision and introduction of relevant knowledge and experience about a specific product. However, if the PCR expires, the document is reactivated and updated, making it valid again for a certain period. In the second step, the analysis of LCA should be taken into account and must be carried out by standards 14040 and 14044 and by the steps and conditions determined by choosing two PCR documents. As for the third step, the information obtained in the EPD document is interpreted. The output must be formatted the environmental product declaration in the form of a PDF document, as it contains the required information stipulated in the PCR program and must contain Information, Reports, and Summary. In the fourth step, the EPD document, which was created must be verified and certified by the International EPD system, where all information must be verified separately, as the EPD evaluator must be neutral, which

means must not participate in any way in analyzing LCA. Finally, in the fifth step, registration and publication take place. After verification, EPD goes through the registration process and is stored in the EPD database. The applicant receives official confirmation that EPD has been published. Figure 2 shows the process of making EPD.

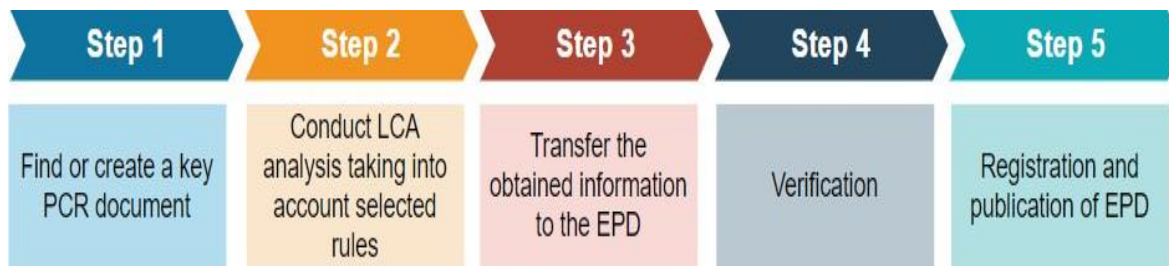


Figure. 2 The process of making EPD adapted from Bajramovic et al, (2022)

The Barriers to Implementing Environment Product Declaration (EPD)

The use of environmental product declaration (EPD) is widespread in developed countries, but in developing countries, the use of environmental product declaration did not receive the required attention due to the weakness of sustainable strategies and the lack of attention to aspects of environmental assessment. According to Arvizu-Piña & Burgos, (2017) the trend in European countries towards making the use of environmental product declaration mandatory and recognized by other countries (emerging and developed). The method of publishing (EPD) is often not applicable in developing countries, especially where regulations, legislative authority, markets, industries, and environmental sites are different. Developed and emerging countries recognize that technical and financial aspects represent an obstacle to implementing environmental product declaration (EPD) with a lack of understanding of product environmental advertising. Developing countries also face an additional obstacle is the delay in implementing environmental regulations with a life-cycle approach and construction industry capacity (Arvizu-Piña & Burgos, 2017). Andersen et al, (2019) identified several barriers to implementing a product environmental declaration. Factors included a lack of demand from authorities and construction companies, LCA/EPD expenses, a lack of knowledge about how to document sustainability in the built environment, and a lack of demand-driven incentives in the Danish construction industry. These barriers need to be addressed to enhance the competitiveness of EPDs within the Danish construction sector. While Toniolo et al, (2019) stated that the lack of knowledge among consumers is the main weakness in applying the environmental declaration of the product.

The Significance of Environment Product Declaration in the Construction Industry

The study of the literature demonstrated several benefits gained from using (EPD) in the construction sector. Many researchers have referred to the benefits that can be obtained through using (EPD) as a tool. The overall goal of eco-labeling is to protect the environment as a primary goal that seeks to direct customers towards products and services that are less polluting. Certainly, competitive advantage brings higher profits to companies on the one hand, and on the other hand, producers encourage consumers to participate in improving environmental protection and the entire ecosystem. Corporate managers must raise awareness and reliability among consumers through various educational and marketing activities for environmental development. In this way, they will increase the efficiency of eco-labels in the market and enhance their competitive advantage in existing and new markets (Bajramovic et al, 2022). Durao et al, (2020) state that the environmental performance of building products and assemblies is a determining factor in the environmental sustainability of buildings. Environmental awareness of the impacts of pollution with the depletion of resources leads to increasing demand for environmental information on services and materials. The need for objective, transparent, and independent information on the environmental performance of

building products increases with the increasing of stakeholder's readiness in the construction sector for informed decisions, green procurement, and consideration of environmental aspects.

Arvizu-Pina and Burgos, (2017) argued that Environmental labels are one of the most effective implementation tools for reducing greenhouse gas emissions in developing countries in addition to being one of the most attractive cost/benefit ratios. Implementing environmental assessment tools in the construction sector is required during the growing phase of emerging economies, as the use of environmental product declaration (EPD) in developed countries increased as one of the main tools for environmental assessment. Gelowitz & McArthur, (2016) stated that EPD offers benefits for engineers and contractors such as the benefits of EPD for designers: Helping the team in making decisions and selecting products, Verifying the documents about environmental effects, Raising education and awareness among the teamwork such by including the dialog about the sustainability of the project, Providing quantifiable data to support their claims as there is no policy or call to do so. The benefits for contractors: Improved transparency on materials performance claims, and consistency through the use of the standard protocol (ISO14025: 2006), materials containing EPD met or exceeded expectations for overall quality and sustainability.

Creating an environmental product declaration (EPD) can be considered as a solution that provides the demanding information that enables Manufacturers of construction products, users, owners of buildings, designers, and others who are active in the construction sector and buildings to make decisions that address environmental impacts of the buildings and other construction activities (Global, 2013). Rees, (2022) argued that EPDs are an important part of the solution to climate change. Both producers and buyers need clear, well-defined metrics to make decisions on, and environmental protection documents provide these metrics for a variety of products, many of which are very carbon-intensive, especially in the construction industry. EPDs will be essential for an optimal transition to a circular and sustainable economy. They provide the basis on which consumers can make informed, climate-based decisions about the products they buy and allow producers to compete to reduce their negative environmental impact effectively. many companies believe that advertising the positive environmental impact of their products will earn them a larger market share or higher revenues due to customers' willingness to pay a green premium, and EPDs are one way to do this.

The environmental performance of building products and services is based on reliable and verifiable information. It will be essential to evaluate the environmental performance of buildings shortly. The importance of EPDs based on EN 15804 and ISO 14025 may increase shortly as the European Construction Products Regulation (CPR) mentions EPDs as a potential means of assessing the sustainable use of natural resources and the impacts of construction works on the environment (Passer et al, 2015).

Meili & Jungbluth, (2019) discussed that environment product declaration (EPD) provides reliable, transparent, and comparable information about the environmental impact of the product life cycle, and the goal of (EPD) is to provide verified information and relevant information to meet different communication needs as it provides a basis for a fair comparison of services and products through their environmental performance in addition to being a reflection of the continuous environmental improvement of services and Products over time and it can communicate and add relevant environmental information across a product's supply chain. Environmental labels and declarations were developed to help users and buyers make informed comparisons between different products.

Ayдын & Celebi identified the Advantages of using environmental product declaration in the construction sector:

- i. Helps guide designers, architects, contractors, and building owners as well as clients into selecting, using, and maintaining a product.

- ii. It assists contractors in eco-friendly recovery and waste disposal during the construction demolition phase.
- iii. It helps improve existing products and facilitates the eco-design of new products in terms of economic and environmental benefits.
- iv. It provides transparent, reliable, and accurate information for data entry through the tools and methods used in the environmental assessment of buildings and construction materials.
- v. Provides ease of responding to major political pressures on the construction sector, which has major implications regarding resource use and waste generation by reporting environmental performance and providing environmental information on construction products.

According to Secher et al, (2018), manufacturers of building products and materials have a great influence on reaching a set of goals within the sustainable development goals. (EPD) and (PED) are two methods of measuring the environmental effects of building products in the building products market, and their purpose is to help the construction industry adopt a sustainable practice approach through the inspiration of United Nations goals of sustainable development and related matters. Manufacturers of building materials and products have the potential to influence seven of the United Nations' 17 Sustainable Development Goals, including good health and well-being, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, sustainable cities and communities and responsible consumption and production.

RESEARCH METHODOLOGY

This paper aims to determine the benefits that can be achieved when adopting the environmental product declaration (EPD) in construction industries while determining the impact on the stakeholders in the construction sector and its impact on the environment in addition to determining the obstacles that hinder its implementation process. A review protocol was created that includes the necessary review steps and details, the time frame and databases, key search terms, and inclusion and exclusion criteria during the 2006 to 2022 time frame. Terms such as product environmental declaration, benefits of product environmental declaration for construction products, and obstacles to product environmental declaration were used to develop search strings. As the articles were reviewed, other cited articles were added (snowball sampling). Extensive reviews were conducted to capture articles relevant to the topic of the study. The title and abstract were reviewed to ensure that the articles were relevant to the scope of the study. 21 articles were identified that contain examples of environmental declaration for the product. Duplicate articles were removed, as were articles not relevant to the subject of the study, and it was ensured that the rest of the articles met the inclusion criteria. The selected articles were then studied to determine the importance of the environmental permit in creating environmentally friendly construction products, as well as its importance to stakeholders in the construction industry, in addition to the obstacles that hinder its implementation process. Before manufacturers in the construction industry, the result of the study was to identify many benefits regarding the necessity of implementing the environmental declaration for the product by manufacturers in the construction industry and its importance in creating a construction industry that meets environmental requirements, while identifying many obstacles that hinder the process of its adoption and application by manufacturers.

ANALYSIS AND DISCUSSION

This study aimed to demonstrate the importance of applying for an environmental permit for the product in the construction industry, in addition to identifying the obstacles that hinder the application process. An extensive study of the literature related to the environmental permit was conducted, where many benefits achieved by applying the EPD were identified, including providing environmentally friendly construction products, giving the product the ability to compete efficiently in the market, facilitating the consumers'

purchase options, preserving the environment and reducing pollution, raising education and awareness among the teamwork and enhancing the environmental performance of stakeholders in the construction sector, provide the stakeholders with the demanding data for construction products, enhance sustainable construction and sustainable development goals and providing adequate and systematic information on carbon dioxide emissions and ozone depletion. Table 1 shows the summary of the EPD significance.

Table 1 Summary of the EPD Significance

Nos	The Significance of EPD	Authors
1	providing environmentally friendly construction products	Bajramovic et al, (2022); Palmieri et al, (2017); Durao et al, (2020); Meili & Jungbluth, (2019); Aydyn & Celebi
2	gives the product the ability to compete efficiently in the market	Bajramovic et al, (2022); Palmieri et al, (2017); Global, (2013) Rees, (2022)
3	facilitate the consumers' purchase options	Bajramovic et al, (2022); Arvizu-Piña & Burgos, (2017); Durao et al, (2020); Gelowitz & McArthur, (2016); Meili & Jungbluth, (2019); Azarijafari, (2020); Aydyn & Celebi
4	Preserving the environment and reducing pollution	Bajramovic et al, (2022); Durao et al, (2020); Rees, (2022); Aydyn & Celebi
5	Raising education and awareness among the teamwork and enhancing the environmental performance of stakeholders in the construction sector	Bajramovic et al, (2022); Palmieri et al, (2017); Gelowitz & McArthur, (2016); Global, (2013); Meili & Jungbluth, (2019); Aydyn & Celebi
5	provide the stakeholders with the demanding data for construction products	Bajramovic et al, (2022); Zag, (2024); EPD, (2020); Mukherjee & Dylla, (2017); Palmieri et al, (2017); Arvizu-Piña & Burgos, (2017); Del Rosario et al, (2021); Aydyn & Celebi; Gelowitz & McArthur, (2016); Global, (2013); Rees, (2022); Meili & Jungbluth, (2019)
7	Enhance sustainable construction and sustainable development goals	Zag, (2024); Palmieri et al, (2017); Bajramovic et al, (2022); Durao et al, (2020); Gelowitz & McArthur, (2016); Secher et al, (2018); Passer et al, (2015)
8	providing adequate and systematic information on carbon dioxide emissions and ozone depletion	Palumbo et al, (2020); Secher et al, (2018); Arvizu-Piña & Burgos, (2017); Rees, (2022)

Based on Table 2 many barriers were identified that hindered the application of EPD including lack of demand from authorities and construction companies, lack of knowledge about how to document sustainability in the built environment, lack of Incentives, delay in implementing environmental regulations, LCA/EPD cost, and technical aspects. Table 2 shows the summary of the EPD barriers.

Table. 2 Summary of the EPD Barriers

Nos	Barriers	Authors
1	Lack of demand from authorities and construction companies	Andersen et al, (2019)
2	Lack of knowledge about how to document sustainability in the built environment	Andersen et al, (2019); Toniolo et al, (2019)
3	Lack of Incentives	Andersen et al, (2019)
4	Delay in implementing environmental regulations	Arvizu-Piña & Burgos, (2017)

5	LCA/EPD cost	Andersen et al, (2019); Arvizu-Piña & Burgos, (2017); Passer et al, (2015)
6	Technical aspects	Arvizu-Piña & Burgos, (2017)

Several researchers mentioned some successful experiences in applying EPD as Gelowitz & McArthur, (2016) referred to the results of the case study that was achieved when the EPD was adopted to implement the interior design and construction of the Green Building Council building in Canada, the implementation achieved satisfactory results for the construction project, as it achieved many benefits from the designer’s point of view, including the establishment of a team working to make informed decisions based on the documentation provided by EPD, which added depth to the selection discussions by providing the necessary information. The EPD documents also helped raise the level of awareness and learning in the office. It also raised the program development tools and allowed the team of work to talk about the sustainability of the project. Where the main benefits to the contractor were improved transparency on material performance claims, consistency through the use of a standard protocol, and the fact that materials included in the EPD documentation met or exceeded expectations for overall quality and sustainability. Wu et al, (2014) mentioned that in March 2014, the international EPD system initiated by the Swedes Environmental Management Council included 18 categories of building products, including a variety of the most commonly used building products materials such as cement, concrete, steel, wood, and paint.

For developing the EPD application process several researchers mentioned several measures that can be taken to support the trend towards applying EPD, where Andersen et al, (2019) pointed out that countries such as Germany, Norway, and the United Kingdom had better success in creating incentives that included regulation, building certification schemes, public procurement, knowledge, and documentation requirements about environmental claims. Rees, (2022) discussed the various additional resources that should be provided including better organization of EPD. Bajramovic et al, (2022) mentioned that corporate managers must raise awareness and reliability among consumers through various educational and marketing activities for environmental development. In this way, they will increase the efficiency of eco-labels in the market and enhance their competitive advantage in existing and new markets. Information, more municipal and state EPD requirements or bidding incentives, and subsidies to companies that bear the additional cost of establishing an EPD. While Passer et al, (2015) discussed that more robust life cycle inventory data are needed to provide reliable public data and support the making of a trustworthy EPD.

CONCLUSION

The results of this study reveal the significance of adopting EPD for construction products and materials in the construction industry while identifying the barriers that hinder the application process. The sustainable goals that are achieved by applying EPD in the construction industry were highlighted, which include documenting the impact of manufacturers of building products and materials on sustainable development goals, achieving high environmental performance among manufacturers, increasing production, increasing the efficiency of the organization, increasing the competitiveness of construction products, preserving the environment, reducing pollution, and limiting resource depletion, in addition to being an important part of the solution to climate changes. Adopting EPD as a data source in the construction sector is an important approach to achieving the provision of eco-friendly construction products that meet the market need for the required products in parallel with respecting the environment and protecting it from degradation and pollution. While the study found that the EPD method is often not applicable in developing countries, especially when regulations, legislative authority, markets, industries, and environmental sites differ, technical and financial aspects in developed and emerging countries represent an obstacle to implementing the Environmental Product Declaration (EPD) with Not understanding the environmental declaration of the product. Developing countries also face an additional obstacle of delays in the implementation of

environmental regulations with a life cycle approach and the capacities of the construction industry.

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