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Investigating the effect of environmental product declaration adoption in LEED® on the construction industry: A case study

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Abstract

Industry adoption of environmental product declarations (EPDs) is increasing as LEED® v4 material credits allow reliance on their content. This raises the question as to whether this reliance is appropriate, as well as larger questions about how it is affecting the wider construction industry. A case study is presented to investigate the use of EPDs in construction projects through the experience and perspective of members of three major stakeholder groups: Owner/Client, Designer, and Contractor. This includes the motivations for using EPDs, potential concerns with the methodology and creation of EPDs, the reliance of the information within EPDs and determining appropriateness of this reliance is through the various stages of project delivery. Findings indicate that EPD impacts on the timeline is a key concern from the contractors while limited transparency of EPD development processes was a key concern for designers. Stakeholders noted that the integrative design process was critical to success of this project, avoiding long lead-times and allowing for close review of specifications.

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Keywords: LCA; EPD; life cycle assessment; environmental product declaration; ISO 14025; LEED; environmental communication; environmental management

1. Introduction

As building operating energy intensity continues to decrease, the initial and recurring embodied energy in buildings require increased attention [1]. Version 4 of the Leadership in Energy and Environmental Design (LEED) rating system [2], responds to this by placing greater emphasis on the environmental impact of materials during

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construction and throughout the life-cycle of the building. Among the new material credits in LEED version 4 (LEED v4) is a credit designed to encourage adoption of Environmental Product Declarations (EPDs) and has thus far been successful in increasing global use [3].

In this case study, the benefits and challenges of using materials with EPDs will be discussed from the viewpoints of three stakeholders on a Canadian LEED v4 project: the Owner/Client (Canadian Green Building Council, CaGBC), the Designer (DIALOG), and the Contractor (Ledcor). The experiences and perspectives of the present and future use of EPDs from all points of view are described and discussed, which include the motivations for using EPDs, potential concerns with the methodology and creation of EPDs, and the reliance of the information within EPDs and evaluates the appropriateness of this reliance in design and construction.

Nomenclature

CaGBC	Canadian Green Building Council
EPD	Environmental product declaration
IDP	Integrated Design Process
ID+C	Interior Design + Construction (LEED rating system type)
ISO	International Organization for Standardization
LCA	Life cycle analysis
LEED	Leadership in Energy and Environmental Design
PCR	Product category rules
SMM	Small- to medium-sized manufacturer

2. Context

2.1. Definition of EPDs

There are three types of environmental product labels: category labels (Type I [4]), self-declared environmental claims (Type II [5]) and Environmental Product Declarations (Type III [6]). The latter are documents which provide quantified environmental information which are independently verified over the life cycle of a specific product. The impact categories and their values on EPDs are determined through a process of life cycle analysis (LCA). LCA is a methodology for determining the environmental impact processes and products have during the total life cycle of the product, from cradle-to-grave [7]. In order to enable the comparison between products, arguably the most important aspect of EPDs, they must adhere to product category rules (PCRs). PCRs define the criteria for a specific product category and establishes the requirements that must be achieved when creating an EPD for a product [8]. The PCR must identify the product's functional performance characteristics, establish the criteria to be used in the LCA study of any product in the category, and specify the information which is required in the EPD. PCRs can be developed by a program operator, which could be anyone [9]. Thus, EPDs are the summarization of the work done through LCA in order to enable fair comparison between similar products, adhering to the PCRs, following third-party verification.

2.1.1. History of EPDs

The use of LCA data in environmental labelling schemes has been in use since the early 1990s [10]. Since then, a number of European and North American countries have been leading EPD creation and adoption. In 1999, the first registered EPD was published for water taps and electrical appliances, published through the International EPD System in Sweden. Later, the Institute for Environmental Research and Education (IERE), founded *Earthsure* in the United States in 2000, becoming the first EPD program in North America. As more EPD programs were established, there became a need for harmonization between the differing schemes. This led to the creation of ISO standards for EPDs, which included ISO 14025 – Environmental labels and declarations [6], created by a Technical Committee initiated by the European Committee for Standardization (CEN) [10]. In 2012, published EN 15804 as a "core PCR" in order to establish a higher level of harmonization in the European building and construction product market. EN

15804 is a suite of standards for the sustainability of construction works, part of which includes the processes of developing EPDs [11].

2.2. Drivers for EPD use in construction

With the *Building Material Disclosure – Environmental Product Declarations* credit category in LEED v4, the use of EPDs on building construction projects has now been incentivized for the North American market. In the credit there are two options for points: one, requiring the use of 20 or more different products from 5 or more different manufacturers which have declarations, and/or two, the use of products which fall below industry average in three of six impact categories: global warming potential, ozone depletion, acidification, eutrophication, ozone formation, and non-renewable energy depletion. The credit's intent is to transform the market and push manufacturers to create EPDs for products to be used on LEED project, and "support(ing) a transition from a single-attribute approach to one that relies on more comprehensive reporting and rewards manufacturers whose products are less harmful to the environment" [2]. EPDs can also be used as a tool during the design process to allow for comparisons between products of the same product category [8, 12].

2.3. Hindrances for EPD adoption

Given the lack of restrictions on who may develop PCRs, the number of overlapping PCRs has increased in recent years, resulting in inconsistencies between very similar products using dissimilar PCRs for their EPDs. This leads to differences in LCA methodology or reporting [13] and affects the depth and correctness of comparison between these products to the extent that the PCR parameters are not comparable. Europe's core PCR, EN 15804, was developed to achieve harmonization in the EPD marketplace. Solutions which also facilitate this harmonization include mutual recognition [14] or alignment of PCRs along all program operators [15].

Data quality issues are also inherent in the LCA stage of EPD development. The use of generic rather than specific data can have adverse effects on the EPD document [8], as can a lack of quality data [16]. ISO 14025 states that data quality requirements should be "equivalent", not necessarily identical, but equivalency is not defined within the standard. This means that generic data could act in place of specific data, even if not recommended [17]. It was found that generic datasets gave results of up to a magnitude of 500% of difference in the environmental impact categories than that of an EPD developed with specific datasets. The differences were found to be directly proportional to how distinctive the process or material was [16].

Financial constraints impose another barrier, particularly for smaller manufacturers. Zackrisson [18] and Fet & Skaar [12] identified the lack of EPDs from small and medium sized manufacturers and developed tools for the creation of EPDs for companies and manufacturers who lack the expertise, finances, and personnel to create EPDs for the products.

Finally, there is an under-representation of PCRs of North American origin given the size of the construction Industry (28% of PCRs and 20% of global construction spending) when compared with Europe (55% of PCRs and 30% of construction spending) [3, 19]. The resulting proportional lack of products with EPDs available in North America can have an adverse effect on EPD adoption for construction projects.

3. Research Methodology

As the use of EPDs in the construction industry by design professionals for the purposes of material sourcing is a relatively new concept, there must be an understanding of how the declarations are used in the design and construction process. To investigate this type of scenario, a building which used the EPDs as a key component of their overall process was required. The CaGBC National Office renovation was selected for this case study as it is set to be the first Canadian project to achieve the building disclosure and optimization credit focused on EPDs.

To achieve an all-encompassing overview of the use of EPDs, contact was made with companies which constituted the main roles on the project: the Owner/Client, the Designer, and the Contractor. Each company was asked to identify employees who would be best suited to be interviewed about the use of EPDs on the project, based

on their experience and role on the project team. A series of semi-structured interviews were conducted with these employees using questions customized based on the employee's project role (Owner/Designer/Contractor). The interviews centered around seven key topics related to the use of EPDs in a construction project:

1. Experiences with EPDs and material sourcing before the CaGBC National Office project
2. Driving forces behind pursuing the LEED credit
3. Impacts of EPDs on the project
4. Benefits of using EPDs on a construction project
5. Drawbacks of using EPDs on a construction project
6. Concerns with certain aspects of EPDs
7. Willingness to work with EPDs in the future

The development of the findings was completed by creating a matrix to align interview responses from the three separate project roles with the topics outlined above. These responses are presented and evaluated in the following sections.

4. The case: Canadian Green Building Council National Office, Vancouver, BC

The CaGBC has just recently located their Vancouver office to the newly constructed MNP Tower, designed by architects Kohn Pedersen Fox at 1021 West Hastings Street. The CaGBC office relocation is slated to be the first LEED v4 Interior Design and Construction (ID+C) Gold project in Canada, with Platinum as a stretch target. At the time of writing, the certification process is still ongoing. The project was completed by September 2nd, and obtained occupancy on September 8th, 2015.

Located on the south side of the tower on the fifth floor, the project has a total area of 3,100 ft^2 (288 m^2). As this space is acting as the office for the CaGBC, it is intended to serve as a showcase for other LEED projects in Canada, CaGBC members, visitors, and others who are interested in sustainability in the built environment. The building achieved this by considering transparency in the office, and flexibility in static and dynamic exhibit areas.

Some main goals of this ID+C project involved strengthening the link with the CaGBC Ottawa office, providing a space for meeting and collaboration which CaGBC staff could be proud of, showcasing LEED strategies in a professional setting, providing a healthy space which promotes the well-being of the staff, and showing regional nature through materiality. Figure 1 below shows an axonometric drawing of the office.

4.1. Interviewees

Interviewees included one employee from CaGBC, two employees from DIALOG, and two employees from Ledcor, each of whom was significantly involved with the project. For confidentiality reasons, their names and specific job titles are omitted.

4.2. Experience with EPDs

All interviewees noted they were familiar with EPDs, but had no experience working with them on a previous project. DIALOG indicated material sourcing was a day-to-day task, but EPDs did not enter the conversation of material sourcing and selection until the CaGBC National Office TI.

Fig. 1. Axonometric drawing of the CaGBC National Office [21]

4.3. Driving forces behind LEED credit

The CaGBC wanted the designer to understand and minimize the environmental impact of their material selections and identified EPDs as the preferred tool to do so. In an ID+C project such as this one, there is minimal ability to minimize environmental impact of the structure or envelope, so it becomes much more important to reduce environmental impact in the interior finishes and furnishings used on the project.

The Owner had three additional objectives for pursuing this credit in the form of sustainable outreach. First, they wished to reward manufacturers who had been the pioneers in creating EPDs for construction projects, noting that such manufacturers would have been thinking about lessening their environmental impact and tracking the resource extraction and manufacturing process data to create the LCA in the EPDs for a substantial period of time. Second, they wanted to demonstrate the feasibility of pursuing and achieving the credit to the green building industry. Third, CaGBC wanted to understand what the challenge of this meeting this credit was from first-hand experience and better understand how the credit affected the overall process including design and material sourcing.

DIALOG saw the EPD credit as a necessary credit to achieve the LEED Platinum “stretch goal” for the project, and this was part of the team’s strategy to maximize the credit output wherever possible, paying close attention to the Materials and Resources credits new to LEED v4 and yet to be widely adopted.

4.4. Impacts of using EPDs on a project

For DIALOG, one of the impacts of using EPDs was conducting much more material research than they would have on a comparable project that did not rely on these declarations. Not only did this change the material choices for the project, but it changed the conversation for all of the Designer’s current and future projects. Using EPDs forces designers to look at LCA and strategies within the EPD much more in-depth than previously possible, informing material choices in other projects.

DIALOG noted a necessary increase in interaction with manufacturers, due to the documentation requirements for the EPD credit. The team found that manufacturers interested in having their product used on the project were helpful, providing all the required documentation promptly. Additionally, products that have EPDs come from manufacturers who have an environmental story they want to tell, which the team found helpful. Most products are from progressive manufacturers who have been tracking their resource extraction, monitoring their manufacturing impact, and thinking about creating the EPDs for a long period of time. The Designer felt that the team tended to

link up fairly well with these manufacturers. However, they believed that as EPDs are widely adopted, these early adopter characteristics are unlikely to hold and thus practitioners will need to be more cautious regarding who they are working with. In addition to the manufacturer interaction, the Designer found that EPD inclusion required specifications to be written differently than in other projects. Usually, the team would write an open-ended specification where contractors could choose any manufacturer alternate from a generic term, as long as the product met or exceeded performance criteria. However, when EPDs were used, the specification had to be written very tightly. Instead of using the standard specification language seen in most projects, the product(s) named in the specification had to be the product the contractors used. The contractor would not be allowed to submit an alternate in this case.

EPDs affected discussions related to materials within the project team. DIALOG did not verify whether the PCRs of the declaration and the LCA of the product lined up. Rather, the team used the information and impact data within the EPDs for comparisons and whole-building LCA, rather than using the declarations for comparison between products. This is because many declarations state that comparability of their product to others is reliant upon both (or multiple) products having the same PCRs; because different PCRs will have different requirements for the LCA data reported in the EPDs.

The Designer stressed the importance of the Integrative Design Process (IDP), a holistic approach to the design and construction of a building, by learning about EPDs and the nuances of the credit at the beginning of the project timeline. This was not only helpful for the overall design goals, but for the goals specific to material sourcing and use. The team reiterated if a project had Platinum as a goal or target, the project team would "need to learn this (about EPDs) first, as it has a trickle-down effect to the rest of (the) project." In addition to this, the team found materials needed achieve two or more objectives. It was not enough for the material to only have an EPD to be useful to the project. The best materials would have documentation that would help achieve all of the building product disclosure and optimization credits, which along with EPDs would require manufacturer inventories, health product declarations, Cradle to Cradle certifications, or corporate sustainability reports. When products have this expanded documentation, the product can help achieve not only the EPD credit, but the Sourcing of Raw Materials and Material Ingredients credits.

The overall project team found that overall the EPD credit was a difficult credit to qualify for. As an ID+C project along with its small floor area, 20 materials is a relatively large number of products. DIALOG noted on whole-building projects (such as BD+C) where the structure and envelope could be included, the EPD credit would be easier to achieve. As a precautionary measure, the Designer included a buffer of approximately 5 products in the material selections, in case one of the materials which was submitted for approval did not qualify for the credit. The team lost a few products during the construction project, and found this buffer worked to their advantage to achieve the credit.

5. Results

5.1. Benefits of using EPDs on a project

Key benefits from the Designers' perspective were (1) the fact that EPDs were verified documents about environmental impacts, (2) EPDs helped the team make informed decisions, adding depth to selection discussions by providing the necessary information, and (3) the use of EPDs also raised the awareness and education level in the office, as it increased the availability of transparent material information and data. DIALOG thus concluded that EPDs gave them the opportunity to speak to the sustainability of the project much more comprehensively, providing quantifiable data to reinforce their claims where no policy or advocacy already existed to do so.

The key benefits to the contractor were (1) improved transparency on material performance claims, and (2) consistency through the use of a standard protocol (ISO 14025:2006). In addition, one interviewee noted that those materials with EPDs met or exceeded the expectations for overall quality and sustainability.

In addition to this, the Designer found EPDs helped the team make informed decisions, and added depth in discussion. The use of EPDs also raised the awareness and education level in the office, as they found the more transparent information and data is available, the better. DIALOG concluded that EPDs gave them the opportunity to say more about the project, and speak to the sustainability of the project much more fully.

5.2. Drawbacks of using EPDs on a project

Both the Designer and Contractor noted deficiencies within EPDs, the Contractor focusing on logistics-type responses and the Designer on sourcing and design issues.

While many of the products were donated to CaGBC and thus it would be hard to determine a total cost increase, the Contractor noticed a definite upcharge with some of the products with EPDs on their end and when speaking with their subcontractors. In addition to this, there were some products which had to come from longer distances than on normal projects, so there were shipping costs and longer lead-times incurred on the project. Products were also difficult to source, and this process took longer at the beginning of the project. The subtrades first submitted documentation which was LEED 2009 - but not v4 – compliant. As the project went on, the team was better prepared to find compliant products to get the EPD credit.

The Contractor also noticed some drawbacks in the products they used which had EPDs. Some products, such as carpet or tile, have their warranties dependent on the use of certain adhesives or sealants. These adhesives and sealants did not carry EPDs with them. Further, some did not meet the California Department of Public Health testing requirements for some of the other LEED credits, such as in the Low Emitting Materials credit. This makes the entire process more difficult, since aligning multiple products with these various requirements becomes a time-intensive task. An employee from Ledcor noted that ideally a product with an EPD should have EPDs for all the required components of that same product. This would also help project teams, since a carpet and adhesive would count as two separate products towards the credit total.

Most of the products specified on the project were from North America. During the design process, DIALOG started to look at products from Europe, but found balancing the different rating and reporting systems to be cost-prohibitive and challenging. Other products were considered based on the assumption of availability in North America, only to learn they were manufactured or only available in Europe. Additionally, some manufacturers positioned themselves to focus on the European market rather than the North American market. The products from North America had a more straightforward approach in regards to alignment with LEED, and is why they picked these manufacturers over European manufacturers.

DIALOG also indicated there were definitely fewer EPDs available from small- to medium-sized manufacturers (SMM). Larger manufacturers sometimes have someone on staff who is knowledgeable and can take on the process for creating EPDs, or at least have the financial capabilities to do so externally. SMMs are restricted in this regard [8, 17] and this has some effect on the total availability of EPDs in the building product market.

5.3. Concerns with aspects of EPDs

The effect PCRs and LCA have on the use of EPDs has been extensively studied in the literature, concerning PCR variability [3, 20] and LCA methodology [14, 16]. DIALOG staff held a neutral opinion on the variability of PCRs, as they believe they need to see more products with differing PCRs to get a stronger sense of the variability. Regarding LCA methodology, they believed there needed to be some flexibility in order for products to get EPDs. However, they mentioned there was some concern with trusting manufacturers to make EPDs with consistent, comparable, or true LCA data, noting that as soon as more manufacturers start the process and learn the rules of creating EPDs, they will find shortcuts or work-arounds which may affect their quality.

The Designers also had some concerns with transparency and how EPDs are analyzed. While acknowledging EPDs are great for the building industry and a good source of information, they stressed the importance of reading them with some level of knowledge. One example the interviewees gave was a hypothetical product which had an independently verified Type III EPD which scored exceptionally well in the environmental impact criteria, but there may be something which is socially unethical in the manufacturing chain. This would be hard to ascertain for someone who is not extremely knowledgeable on the topic.

One final concern noted by DIALOG is that one LEED credit is available for the use of 20+ different products from 5 different manufacturers, regardless of the environmental excellence (or lack thereof) of the product. This option within the LEED EPD credit is focused on market transformation and is intended simply to incentivize

manufacturers to create EPDs for building products. The result is that a product could have very poor environmental performance, but still qualify for the LEED credit, provided the EPD exists.

The Contractor's main concerns dealt with the shipping distances, costs, and lengthy lead-time products with EPDs had. One interviewee noted that it was hard to see the real benefit of EPDs, as materials were shipped long distances (thus increasing embodied energy due to transportation) simply because they carried an EPD.

5.4. Willingness to work with EPDs in the future

Both the Designer and Contractor indicated they would work with EPDs in the future on LEED projects. The Contactor believed it is a credit they should be targeting, and the products met or exceeded the expectations of quality and sustainability. DIALOG felt they spent a lot of time learning and becoming familiar with the concept, and were in favor of a big push in the use of EPDs in future work. They added to this by saying in the next whole-building product, products with EPDs will help inform the LCA and make material selection easier.

However, both companies felt there would be hesitation on using EPDs on non-LEED projects. Ledcor mentioned the scheduling and budget impacts associated with their use, while DIALOG noted a lot of clients would want the background knowledge that comes with EPDs, but wouldn't want to implement it in a non-LEED project. Even though this is true, the Designer stated that as they work on more LEED projects, the non-LEED projects benefit from this over time, since knowing which products are environmentally friendly because of their EPD and HPD only makes professionals better.

6. Case Study Conclusions

The project team did not seem concerned with the comparability and level of harmonization between EPDs, putting more importance on the information within the EPDs to make LCA decisions rather than as a means to compare and select materials. Given the current lack of EPDs in the North American market, this is a more suitable way to use EPDs than to compare them without this harmonization. Both the Designer and Contractor stressed the importance of initiating the material selection process early, preferably during the IDP stage of the project for two reasons: (1) products need to be qualifying for multiple credits, and significant research is involved in finding products that can do so. (2), there are long lead-times associated with the products due to the relative scarcity of declared projects and thus beginning the ordering process early ensures everything arrives on schedule.

DIALOG indicated a key impact of the case study project was to trigger an overhaul of their material specification process to incorporate EPDs, including how they both specify materials and categorize specifications. Ledcor similarly noted a process change, requiring an early thorough specification review to identify specific products with longer lead-times and potential incompatibility between associated products (like adhesives and sealants) and LEED requirements.

In general, all parties saw LEED as a good method of providing incentives both for manufacturers to create EPDs and practitioners to implement it in construction projects, and would use the knowledge gained from working with EPDs on future LEED and non-LEED projects.

7. Recommendations and Conclusions

Using EPDs on construction projects contributes to a positive end-goal. The products used met or exceeded the standards for environmental performance established by DIALOG and Ledcor. Practitioners should aim to learn more about the origins of EPDs (which may come with project experience), and abstain from total reliance on the EPD documentation for comparison between individual products and use EPDs from a whole-building standpoint.

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