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

M. D. C. Gelowitz , J. J. McArthur *

[a]*Department of Architectural Science, Ryerson University, 350 Victoria St, Toronto, ON, M5B 2K3, Canada*

Abstract

Industry adoption of environmental product declarations (EPDs, an internationally standardized document providing quantified environmental impacts over the life cycle of a product) 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 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 the success of this project, avoiding long lead-times and allowing for close review of specifications.

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Keywords: life cycle assessment (LCA); environmental product declaration (EPD); product category rules (PCR); ISO 14025; LEED; case study

1. Introduction

As building operating energy intensity decreases, the initial and recurring embodied energy in buildings requires increased attention [1]. Version 4 (v4) of the Leadership in Energy and Environmental Design (LEED) rating system

* Corresponding author. Tel.: +1-416-979-5000 x 4082.
E-mail address: jjmcarthur@ryerson.ca

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[2], responds to this by placing greater emphasis on the environmental impact of materials during construction and throughout the life-cycle of the building and includes a credit designed to encourage adoption of environmental product declarations (EPDs), which has thus far been successful in increasing global use [3].

This paper presents a case study showcasing the benefits and challenges of using materials with EPDs from the viewpoints of three stakeholders on a Canadian LEED® v4 project: the Owner/Client (Canada Green Building Council, CaGBC), the Designer (DIALOG), and the Contractor (Ledcor). The study includes the motivations for using EPDs, potential concerns with the methodology and creation of EPDs and the reliance on the information within EPDs, and evaluates the appropriateness of this reliance in design and construction.

Nomenclature

CaGBC	Canada 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

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 and are independently verified over the life cycle of a specific product. The impact categories and their values stated on EPDs are determined through a process of life cycle analysis (LCA), a methodology to determine the environmental impact of processes and ingredients through the cradle-to-grave product life cycle [7]. In order to enable comparison between products, EPDs must adhere to product category rules (PCRs), which define the criteria for a specific product category and establish the requirements that must be achieved when creating an EPD for a product [8], including criteria to be used in the LCA of any product in the category. However, PCRs may be developed by anyone who calls themselves a program operator, with no limit on who may do so [9], causing significant variation between these rules. Ideally, EPDs enable fair comparison between similar products adhering to comparable PCRs and summarize third-party verified LCA results.

2.2. Historical Drivers for EPD use in construction

Increased awareness and concern about environmental impacts, the increasing importance of embodied energy, and the increased awareness of the importance of evaluating product impacts over their lifecycle have resulted from increased influence of sustainability and rating systems such as LEED® in the built environment. The use of LCA data in environmental labelling schemes has been in use since the early 1990s [10]. The first registered EPD was published for water taps and electrical appliances through the International EPD System in Sweden in 1999. In 2000, the Institute for Environmental Research and Education founded *Earthsure* in the United States, becoming the first EPD program in North America. As more EPD programs were established, a need arose for harmonization between these differing schemes, leading to the creation of ISO standards for EPDs, which included ISO 14025 – Environmental labels and declarations [6], created by a Technical Committee for the European Committee for Standardization [10], who published EN 15804 in 2012 as a “core PCR” 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].

With the *Building Material Disclosure and Optimization – Environmental Product Declarations* credit in LEED® v4, these concerns are addressed by creating incentives for the use of EPDs in green buildings. In the credit there are two points available. One point ("Option 1") requires the use of 20 or more different products from 5 or more different manufacturers which have EPDs, while a second point is available for 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 [2]. The credit's intent is to transform the market and push manufacturers to create EPDs for products to be used on LEED® projects, 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 is permitted to develop PCRs, the number of overlapping PCRs has increased, resulting in inconsistencies between very similar products using dissimilar PCRs for their EPDs such as differences in LCA methodology or reporting [13]. The extent and validity of comparison between such products are limited to the extent that the PCR parameters are comparable. The solution, harmonization, requires the development of EN 15804, mutual recognition of PCRs [14], and/or alignment of PCRs by program operators [15]. Use of generic rather than specific data can have unfavorable effects on the EPD document [8], as can poor data quality [16]. ISO 14025 states that some data quality requirements should be "equivalent", but not necessarily identical. Since 'equivalency' is not defined within the standard, generic data could act in place of specific data, even if not recommended [17]. The use of generic datasets has been found to lead to up to 500% variation in results across environmental impact categories compared with EPDs developed with specific datasets, with this variation directly proportional to the distinctiveness of the process or material [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 their 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 make it more challenging for project teams interested in this information at this time, while the volume of products with EPDs in North America is in the process of catching up to the more mature European market.

3. Case Study Methodology

A case study was undertaken to investigate how these declarations are used through the design and construction process. The CaGBC office relocation to the newly constructed MNP Tower in downtown Vancouver 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 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. Key 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 total project area, rendered with the materials used in the office.

This 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 and the three key project participants – the Owner/Client

(CaGBC), the Designer (DIALOG), and the Contractor (Ledcor) – agreed to participate in semi-structured interviews. One employee from CaGBC, two employees from DIALOG, and two employees from Ledcor, each of whom were significantly involved with the project were recruited to complete the interviews. For confidentiality reasons, their names and specific job titles have been omitted from this paper.

These interviews focused on key topics related to the use of EPDs in a construction project, including experience with EPDs and material sourcing before the CaGBC National Office project, driving forces behind pursuing the LEED® credit, the impacts of EPDs on the project, benefits of using EPDs on the project, drawbacks of using EPDs on the project, concerns with certain aspects of EPDs, and willingness to work with EPDs in the future.

Fig. 1. Axonometric drawing of the CaGBC National Office to provide visual context for the scope of the renovation [21]

Responses were summarized and compared by creating a matrix to align interview responses by organization and topic. These responses are presented and evaluated in the following sections.

4. Case Study Results

4.1. 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 project.

4.2. 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 decrease environmental impact of the structure or envelope, so the tenant must focus on reducing environmental impact in the interior finishes and furnishings used on the project.

The Owner had three additional objectives for pursuing this credit, aimed at demonstrating the implementation of EPDs on an exemplar project to the green building community. First, they wished to reward manufacturers who had been pioneers in creating EPDs for building products, noting that such manufacturers would have been thinking about lessening their environmental impact and tracking the resource extraction and manufacturing process data to generate the LCA for 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

challenges of meeting this credit were 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 necessary to achieve the LEED® Platinum "stretch goal" for the project, and this was part of the team's strategy to maximize the number of credits wherever possible, paying close attention to the Materials and Resources credits new to LEED® v4 and yet to be widely adopted.

4.3. Impacts of using EPDs on a project

For DIALOG, one impact of using EPDs was conducting much more material research than they would have on a comparable project that did not rely on EPDs. 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 with other labeling schemes.

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. The Designers stated that products that have EPDs come from manufacturers who have an environmental story they want to tell, which the team found helpful. However, they believed that as EPDs increase in both use and availability, 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 was required to source compliant products where none were listed.

EPDs affected discussions related to materials within the project team. DIALOG did not verify whether the PCRs of the declarations and the LCA of the products lined up but used the information and data from EPDs towards analysis at a whole-building perspective, where EPDs were referred to as one source of information about a product's overall performance which was taken into consideration along with other sources of product information, rather than using EPDs to directly compare two similar products. Many EPDs state that comparability of their product to others is reliant upon EPDs having the same PCRs, because different PCRs will have varying requirements for the LCA data reported in the EPDs.

The Designer stressed the importance of the Integrative Design Process, 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 (about EPDs) first, as it has a trickle-down effect to the rest of (the) project." In addition to this, the team found products needed to achieve two or more objectives. It was not enough for the product to only have an EPD to be useful to the project. The best products would have documentation that would help achieve all of the Building Product Disclosure and Optimization credits, including manufacturer inventories, health product declarations, Cradle to Cradle certifications, or corporate sustainability reports.

The overall project team found that overall the EPD credit was a difficult credit to qualify for. As an ID+C project with a 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. DIALOG had to make use of this buffer during the construction project, and found this worked to their advantage to achieve the credit.

5. Results

5.1. Benefits of using EPDs on a project

Key benefits from the Designer's 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.

5.2. Drawbacks of using EPDs on a project

Both the Designer and Contractor noted drawbacks with the use of 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 other projects, which lead to increased 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.

Some products, such as carpet or tile, have their warranties dependent on the use of certain adhesives or sealants which created problems for the Contractor. These adhesives and sealants did not carry EPDs with them. Further, some did not meet testing requirements for other LEED® credits, such as 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 be LEED-compliant, and have EPDs for all the required components of that same product. This would also help project teams, since a carpet and an adhesive would count as two separate products towards the credit total.

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 were preferable in terms of availability, cost (shipping and lead-times), and environmental impact (related to transport distances).

DIALOG also indicated there were fewer EPDs available from small- to medium-sized manufacturers. 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. Small- to medium-sized manufacturers are restricted in this regard [8,17] and this has an 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 and scored exceptionally well in the environmental impact criteria, but may have a process or material 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 particular area under scrutination 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. However, the team saw the implementation of transparency into LEED® as a good introduction into the rating system, and predict rewarding environmental performance within EPDs as the next step.

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, especially in regards to the quality of the materials with EPDs. However, Ledcor noted there would need to be 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.

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 project, products with EPDs will help inform whole-building LCA and make material selection easier. The Designer also 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.

However, both companies felt there would be hesitation with 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 would not necessarily 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 EPDs and other product documentation only makes professionals better.

6. Case Study Conclusions and Recommendations

The following preliminary conclusions were drawn from this case study:

1. EPDs are helpful for designers as the independently-verified data is useful to justify specific material selections based on environmental performance; similarly, this transparency is of value to contractors.
2. By using EPDs to make whole building decisions rather directly compare materials and thus inform selections, issues of comparability and level of harmonization between EPDs may be avoided.
3. The number of EPDs in the North American market is limited, further restricting both comparison and material choice, adding a level of complexity to interior renovation projects seeking to use a large number of EPD-labelled products.
4. The lack of EPD harmonization between some products and warranty requirements (e.g. specified sealants) can result in an otherwise well-performing product being excluded from consideration.

5. The LEED® v4 credit provides incentives both for manufacturers to create EPDs and practitioners to implement it in construction projects.

The authors acknowledge that a single case study does not allow wide conclusions to be drawn, however the completion of additional case studies as EPD use increases will validate or correct the above conclusions. Future research should revisit this project once LEED® certification has been achieved to identify any additional issues arising and consolidate lessons learned.

There is a strong need for harmonization in PCRs which would lead to increased comparability in EPDs, an advancement that would strengthen the role of EPDs as a design tool. In this stage before harmonization, pratitioners should be cautioned with total reliance on EPDs for direct comparison, unless the underlying LCA and PCRs have been thoroughly reviewed. Instead, data within individual EPDs should be analyzed at a whole-building level. Future research on developing a formal methodology to compare EPDs without harmonization, including a template for the comparison of underlying PCRs and LCAs is currently underway.

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