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Characterization of the Cradle to Cradle Certified™ Products Program in the Context of Eco-labels and Environmental Declarations

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Abstract: (1) Background: The Cradle to Cradle Certified™ Products Program (C2C Certified for short) is a scheme for the certification of products that meet the criteria and principles of the Cradle to Cradle® design approach. The objective of this paper is to characterize C2C Certified as an instrument for external communication in the context of environmental labeling and declarations. (2) Method: An eco-label characterization scheme consisting of 22 attributes was used to analyze C2C Certified. In addition, it was compared with the established standardization labeling typologies, namely Type I and Type III. This was further illustrated in an example within the building and construction sector. (3) Results: C2C Certified can be classified neither as a Type I, nor a Type III label. The main weaknesses of C2C Certified from a labeling perspective are: the generic, but not product-specific focus of the awarding criteria, the lack of a life cycle perspective, and the incompletely transparent stakeholder involvement procedure. Nevertheless, for certain attributes (e.g., the awarding format), C2C Certified provides practical solutions and goes beyond a Type I eco-label. Substantial similarities between Type III declarations and C2C Certified cannot be identified. (4) Conclusions: The main advantages and shortcomings of C2C Certified from a labeling perspective are pointed out. The approach shows similarities to a Type I eco-label, and efforts toward conformance with the International Organization for Standardization (ISO) labelling standards would result in improving its comparability, recognition, and robustness.

Keywords: cradle to cradle; environmental labeling; eco-label; EPD; characterization; criteria; ISO

1. Introduction

The environmental performance of products (including goods or services) is a credence attribute that cannot be determined by the user, even after purchase and consumption [1]. In this sense, environmental labels and declarations (referred to further in this paper as labels or eco-labels) are considered a useful tool for conveying such environmental product information from the producer to the final user [2].

Nowadays, there are many different types and varieties of environmental labels and certification approaches that deliver information on the environmental performance of products [3]. Among these, the Cradle to Cradle Certified™ Products Program certification system (C2C Certified for short) has gained a certain relevance. However, this system is not officially assigned to any of the three typologies that were established by the International Organization for Standardization (ISO), and it is therefore challenging to evaluate its performance characteristics as a tool for external communication.

A review of the scientific literature shows that there are only a few publications that analyze C2C Certified as a certification system. In 2011, a position paper by the Dutch Ministry of Economic Affairs, Agriculture, and Innovation [4] described C2C Certified from a communication perspective,

focusing on how users approach certification and on how and whether life cycle assessment (LCA) can be incorporated. Similarly, Bakker et al. [5] focused more on the C2C concept from a business perspective in product development, and additionally on how LCA can complement C2C. Bjørn and Hauschild [6] compared the C2C approach with eco-efficiency and LCA. They briefly addressed C2C Certified by using certified products as examples, and they compared their performance from an LCA perspective. De Pauw et al. [7] briefly juxtaposed C2C Certified with LCA to show two fundamentally different approaches in assessing the effects of products on the environment, i.e., the benefits versus the burdens. Niero et al. [8] compared the environmental impact associated with different levels of two C2C certification requirements by using LCA. Nevertheless, a comprehensive analysis of C2C Certified from a labeling perspective was missing. Recently in a book chapter, Bjørn and Hauschild [9] explored C2C Certified, and briefly compared it with ISO Type I labeling, concluding that the program in focus has many similarities to classic Type I eco-labels, such as the Nordic Swan. Nevertheless, a systematic attributes-based comparison of C2C Certified and (common) environmental labeling schemes (based on ISO) is still missing.

To address this gap, the objective of this paper is to characterize the C2C Certified program as an instrument for external communication in the context of environmental labels and declarations, by applying a comprehensive set of attributes.

The present work is structured as follows: Section 2 provides introductory information on environmental labeling and ISO, followed with an explanation of C2C Certified. Section 3 describes the materials and methods needed to achieve the given objective. Section 4 provides the results, while the discussion and conclusions are given in Sections 5 and 6, respectively.

2. Background

In this section, background information on environmental labeling and the ISO standards for environmental communication is provided. Further, details regarding C2C Certified and the certification process are explained afterwards.

2.1. Environmental Labelling and ISO

ISO defines three types of environmental labels and declarations, which will be described later. An overarching standard that is common for the three is ISO 14020 [10]. It provides nine common guiding principles for the development and use of environmental labels and declarations.

Type I environmental labels are defined by ISO 14024 [11] as voluntary, multi-criteria based third-party programs (managed by a respective eco-labeling body) that award licenses for the use of environmental labels on products. Type I eco-labels are based on the concept of eco-efficiency [9], which proclaims that the development of new products or the improvement of existing products should be done with an intention to reduce their damage on the ecological systems (i.e., doing more with less). To achieve the certification, a product should fulfill certain product environmental criteria that are also based on life cycle considerations. "Product environmental criteria" is the official term as per ISO 14024. However, in this paper, the terms "awarding criteria" and "certification criteria" (as per C2C Certified) are also used and accounted as synonyms. Type I eco-labels usually facilitate business-to-consumer (B2C) communication, and the awarded label indicates overall environmental preferences within a certain product category. Typical examples include the German Blue Angel (BA) [12], the European Eco-label [13], and the Scandinavian Nordic Swan [14].

Type II labels are self-declared environmental claims that are either issued in the form of a claim, a stamp, a label, a declaration, or a more complex rating system. It is not mandatory for such claims to undergo third-party certification. Although ISO 14021 [15] seeks to harmonize the basic principles and requirements of such self-declared claims, nowadays, their availability and variability on the market is large, making it almost impossible to categorize average properties and characteristics. Thus, Type II claims are not further considered in this work (a further explanation for this is given in Section 3).

Type III environmental declarations (known also as environmental product declarations, or EPDs) present third-party verified and quantified environmental information on the life cycle of a product. They are governed by ISO 14025 [16], and are based on an LCA study that was conducted according to specific product category rules (PCR). EPDs are intended for business-to-business (B2B) communication, although B2C application is not precluded [16]. Typical Type III programs (managed by a legal body called a program operator) include the Swedish International EPD® System [17] and the German Institut Bauen und Umwelt e.V. (IBU) [18].

2.2. C2C Certified

This subsection introduces C2C Certified. Firstly, the Cradle to Cradle® design approach that is the underlying method focused on during certification is described. Secondly, the certification program and its functioning are introduced.

2.2.1. Cradle to Cradle® Design

Cradle to Cradle® (C2C) is defined as a continuous improvement design approach that was developed by William McDonough and Michael Braungart, and detailed in their 2002 book *Cradle to Cradle: Remaking the Way We Make Things* [19]. Cradle to Cradle® is a registered trademark that is owned and licensed by McDonough Braungart Design Chemistry, LLC (MBDC). The approach integrates multiple attributes such as safe materials, the continuous reclamation and reuse of materials, clean water, renewable energy, and social fairness. Instead of aiming at reducing the negative environmental impacts of products (e.g., by optimizing already existing systems, such as the concept of eco-efficiency), C2C aims at leaving "a beneficial footprint for human society and the environment" through product design [20] (p. 2). C2C proponents believe that this design approach can be achieved by fulfilling three principles [9,20]:

- Waste equals food, i.e., eliminate the concept of waste: all materials are seen as potential nutrients in either the technical or the biological cycles; products should be designed with materials that are safe for human health and the environment, and they can be reused everlastingly;
- Use current solar income, i.e., use renewable energy: renewable energy sources are paramount to effective design, and their use should be maximized;
- Celebrate diversity: it is believed that technological diversity is key for innovation, and local specifics should be considered, i.e., avoiding "one-size-fits-all designs"; operations should be done with social fairness and stakeholder considerations.

2.2.2. Introduction to and Functioning of the Certification Program

C2C Certified was launched in 2005 by MBDC. A license to manage the program was granted to the Cradle to Cradle Products Innovation Institute (C2CPII), a not-for-profit organization, in 2010 [20]. The certification program strives for full integrity of the three C2C principles mentioned above [21]; its rules and certification standard are therefore directed toward achieving these principles [20].

Products seeking certification under C2C Certified are evaluated against criteria and divided into five "quality categories", namely: Material and Health, Material Reutilization, Renewable Energy and Carbon Management, Water Stewardship, and Social Fairness [21].

According to the C2C Certified Products Standard v3.1 [20] (i.e., the guiding document that determines the program's operation), the certification applies to materials, subassemblies, and finished products. The scope is generic, and is neither specific to a product group or industry sector, nor geographically limited. Nevertheless, it specifically excludes e.g., food, beverages, pharmaceuticals, or fuels, as well as buildings (but not building and construction-related materials). Products with ethical issues or safety concerns from rare or endangered species, etc., are excluded.

C2C Certified incorporates a rating system of five levels (Basic, Bronze, Silver, Gold, and Platinum). An achievement level is assigned to each of the five quality categories. The product's overall mark is

determined by the lowest achieved level assigned to one of the five quality categories. As of September 2017, there were 499 products certified (0.2% Platinum, 18% Gold, 37% Silver, 43% Bronze, and 2% Basic), most of which were in the categories Building Supply & Materials and Interior Design & Furniture (183 and 170 certificates, respectively) [22]. A trend for the program's growth since its establishment cannot be depicted, due to unsuccessful attempts to obtain historical data. Nevertheless, according to unofficial information, it is estimated to be around 10–20% per year since 2014.

The process for certification of a product first begins with the determination of whether the product is appropriate for certification, i.e., whether it falls within the scope of the program and conforms with the Banned Chemicals List developed by C2C Certified. Further, the product should be evaluated for whether it conforms to the program standard. As a next step, the applicant selects an assessment body from a list of accredited assessment bodies that work with C2C Certified. It is common practice that the applicant works with the assessor during the process of supply chain data collection or data evaluation, and during the process of optimization strategy development. Usually the assessor supports the applicant until the end of the certification process. Further, the applicant pays an associated certification fee, and the C2CPII performs a review that is based on the Assessment Summary Report. The review concludes whether the information is complete and accurate, and a certification decision by C2CPII follows [21].

3. Materials and Methods

The following section describes the method and steps applied to reach the objective of this paper. This study is based on desk research, i.e., a review of scientific publications and an examination of published documents related to the programs in focus. Expert interviews have not been carried out.

3.1. Characterization of C2C Certified Regarding ISO Typology

As a first step, this paper characterizes C2C Certified and compares it with the established Type I and Type III rules given by the respective ISO standards. Type I and Type III are two very different approaches in regard to providing environmental product information, serving different purposes, and operating in different manners. The comparison enables an understanding of how C2C Certified is characterized, and how it is positioned on the market compared with other established approaches. Type II were excluded from this analysis, because (as explained in Section 2.1), self-declared claims can vary enormously in their awarding type, purpose, and other characteristics; they are therefore difficult to characterize under a common denominator.

For the characterization of the three approaches, this work adapts Minkov et al.'s characterization scheme for environmental labels and declarations [3]. The scheme originally provided a list of 18 characterization attributes, with their respective features divided into four categories. Additionally, four new attributes were identified, namely: "Awarding criteria scope", "Materiality principle", "Awarding criteria revision", and "Stakeholders involvement". The attribute "Transparency" was moved under the category "Conclusive". A new category, "Governance characteristics", was established, maintaining four of the attributes that were originally under the category "Standard characteristics". These modifications assured a more complete and better structured characterization scheme, which in turn led to a better delimitation between the three compared approaches. The final characterization scheme applied in this work is presented in Table 1. A description of each attribute and its respective features is provided in the Supplementary Materials to this article.

Table 1. Adapted eco-label characterization scheme applied in the present study, based on Minkov et al. [3].

Attributes and Features		
Communication Characteristics		
1 ISO Typology Type I Type II Type III Undefined	2 Awarding format Seal Rating (non-sealed) Rating (sealed) Declaration (non-sealed) Declaration (sealed)	3 Multiplicity of covered aspects Single-aspect Multi-aspect
4 Aspects diversity Environmental Social Health	5 End-user focus Business-to-consumer (B2C) Business-to-business (B2B) Both	
Scope		
6 Sector scope Sector-specific Multi-sectorial	7 Operation scope Product Production process/method Organization	8 Geographic scope National Regional International
9 Awarding criteria scope Product-specific Generic	10 Materiality principle Yes Neutral No	11 Life cycle (LC) perspective Non-LC based LC based LCA based
Standard Characteristics		
12 Compulsoriness Voluntary Mandatory	13 Financing [1] Fees and/or member dues Governmental subsidies Industry funding Donations Other	14 Purpose Ideals-centric Adversity-centric Neutral
15 Longevity Single-issued Renewable Improvement-based		
Governance Characteristics		
16 Governance Governmental Quasi-governmental Private (PFP, NPO, NGO)	17 Verification First party Second party Third party	18 Awarding criteria revision Yes, regularly Yes, randomly No
19 Stakeholder involvement Low Medium High		
Conclusive Characteristics		
20 Transparency [2] Label-setting process Awardees Funding Verification report	21 Comparability Low Medium High	22 Environmental excellence Intended Not intended Possible

[1] The evaluation of this attribute could result from the sum of two or more features. [2] The features of this attribute are evaluated individually. ISO: International Organization for Standardization, NGO: or non-governmental organizations, NPO: private for non-profits, PFP: private for profits.

3.2. Sector-Specific Example

A comparison of a particular approach as C2C Certified with the generic ISO requirements on Type I and Type III labels must unavoidably remain on a generic level. To make the analysis more explicit and concrete, a second step involved the assessment of C2C Certified against concrete examples of Type I and Tape III labels within a specific sector.

The C2C Certified categories of certified products were reviewed in order to define a relevant industry sector for the example. The ones that dominated with the most certified products were Building Supply & Materials, and Interior Design & Furniture (183 and 170 certificates respectively, as of September 2017) [22]. Consequently, these products were hereafter assigned to one common sector, "Construction and construction services" (as classified by the Central Product Classification v2.1 of the United Nations Statistics Division [23]), which was selected as the subject of the example.

The selected exemplary sector is also relevant for the other labeling approaches that were observed. In the last few years, there has been a high interest in the assessment and certification of construction-related materials through EPDs [24–26]. Moreover, green-building certification schemes (GBCS) such as the ones of the German Sustainable Building Council (DGNB) [27], the British Sustainability Assessment Method for Buildings (BREEAM) [28] or the United States (US) Leadership in Energy and Environmental Design (LEED®) v4 [29], recognize the use of EPDs for the disclosing of the environmental information of construction products. Type I eco-labels do not necessarily find application in GBCS; nevertheless, many programs certify end-consumer products applicable in the "Construction and construction services" sector for both B2C or B2B relations and are used in Green Public Procurement (GPP).

Further, two exemplary approaches (in that they are typical representatives for Type I and Type III labels) were selected and compared with each other, and with C2C Certified. They were chosen based on literature research and a predefined criteria set that is described in Table 2.

Table 2. Criteria for shortlisting programs to be compared with Cradle to Cradle Certified™ Products Program certification system (C2C Certified).

Criterion	Description
ISO typology	The selected program shall be a typical representative of the respective ISO typology (i.e., Type I or Type III);
Operation within the selected product sector	The selected program shall certify products applicable in the selected industry sector;
Market recognition	The selected program shall be well established and recognized on the market with proven traditions along the years.
Geographic coverage	The selected program shall operate in the same countries where C2C Certified operates.

As a typical Type I eco-label, BA was selected. Established in 1978, the eco-label is the first and oldest eco-label worldwide [30], and the one that has the highest number of certified products and the largest market share [31]. From over 100 product categories covered by BA, 16 are classified under "Construction" products [12]. The eco-label was established in Germany, but BA certified products can be found beyond it, in almost all of the European countries, as well as worldwide. BA is a member of the Global Eco-label Network (GEN), an organization that is leading Type I eco-labels worldwide [32].

Founded in 2004, IBU is one of the most prominent Type III program operators nowadays, and was therefore selected as an example in this work. IBU is the biggest Type III operator in Germany, and only operates within the scope of construction products and components [18]. EPDs issued by IBU can be found on products all over Europe and beyond. The program operator is a founding member of the ECO Platform, a cooperation of program operators and LCA practitioners working on the

development of a coherent framework for the EPDs of construction products [33]. IBU also works in close cooperation with other single operators beyond Europe on the basis of mutual recognitions and agreements [25].

Figure 1 displays the steps undertaken to achieve the objectives of the paper.

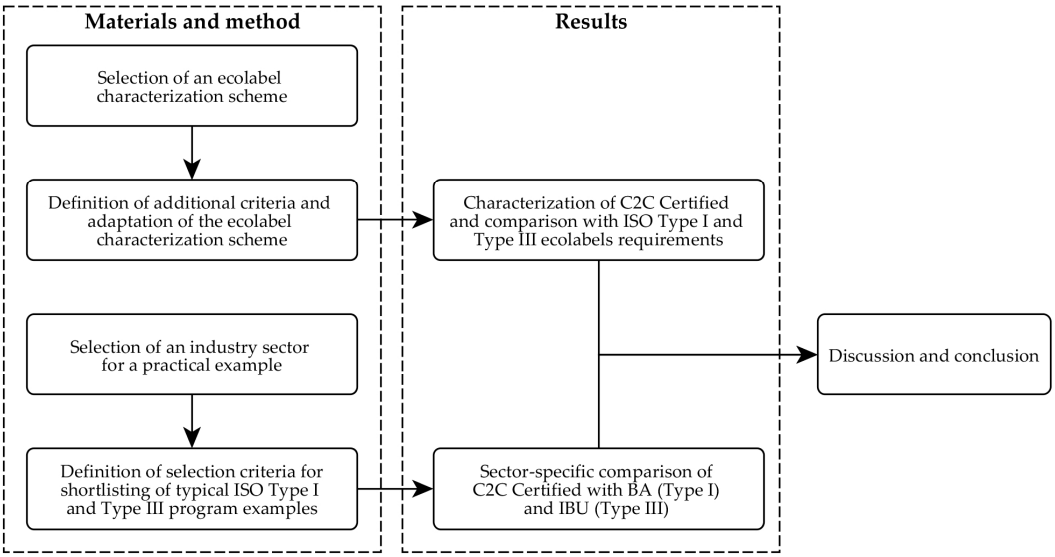

Figure 1. Description of the method flow of the paper at hand.

4. Results

This section provides the results of the study, initially by presenting the general characterization of C2C Certified (Section 4.1), and further by providing a sector-specific example and comparison (Section 4.2).

4.1. Characterization of C2C Certified Regarding ISO Typology

This section presents the analysis of the C2C Certified approach by comparing it with Type I and Type III, as postulated by ISO 14024 and ISO 14025, respectively. The results of the attribute-based assessment are given in Table 3. Following this, the section gives an overview of the results, and highlights several of the most critical and relevant characterization attributes for C2C Certified.

In the following section, some key aspects of the above-listed attributes assessment are described in more detail, with a focus on the C2C Certified performance in comparison with Type I and Type III environmental labels. The section follows the structure of the characterization scheme (Table 3), based on the five main categories.

Table 3. Characterization of C2C Certified and comparison with Type I and Type III environmental labels, based on a characterization scheme adapted from Minkov et al. [3]. EPD: Environmental product declarations, LCA: life cycle assessment, PCR: product category rules.

Attribute	Type I Eco-Label	Type III EPD	C2C Certified
Communication Characteristics			
ISO typology	Type I (ISO 14024)	Type III (ISO 14025)	Does not fully conform with Type I or Type III label requirements of ISO
Awarding format	Seal (binary pass–fail information; products either conform or not)	Declaration (non-sealed; quantified environmental data using predetermined parameters)	Rating (sealed; ranked on a predefined scale after complying with minimum performance criteria)

Table 3. *Cont.*

Attribute	Type I Eco-Label	Type III EPD	C2C Certified
Multiplicity of covered aspects	Multi-aspect	Multi-aspect	Multi-aspect
Aspects diversity	Environmental only (few programs cover also social/health aspects)	Environmental only	Both environmental and social/health
End-user focus	B2C (mostly)	B2B (mostly)	B2B (mostly)
Scope			
Sector scope	Multi-sectorial	Multi-sectorial	Multi-sectorial
Operation scope	Product (social criteria often related to the organization)	Product	Product (certain criteria in three of five quality categories relate to the organization)
Geographic scope	National (mostly), regional, or international	National (mostly) and international	International
Awarding criteria scope	Product-specific (product-specific awarding criteria)	Product-specific (product-specific LCA category rules)	Generic (equal criteria for all products)
Materiality principle	Yes (key environmental performance characteristics of the products are identified for the definition of awarding criteria)	Neutral (the EPD intends to declare a comprehensive set of impacts without prioritizing them)	No (all products are assessed against the same set of criteria, independent from their individual materiality)
Life cycle (LC) perspective	LC based	LCA based	Non-LC based
Standard Characteristics			
Compulsoriness	Voluntary	Voluntary	Voluntary
Financing	Fees and/or member dues (mostly); governmental subsidies (seldom)	Fees and/or member dues	Fees and/or member dues; donations
Purpose	Ideals-centric (a benchmark of achieving excellence within the respective product group)	Neutral (declarations cannot be categorized under this category)	Ideals-centric (a benchmark of achieving conformance with the C2C principles)
Longevity	Renewable (the license can be renewed after expiration or when the awarding criteria are revised)	Renewable (the EPD can be renewed after expiration or if significant changes in the system elements occur)	Improvement-based (in case of re-certification, intentions for improvement must be reported)
Governance Characteristics			
Governance	Governmental (mostly, but not an ISO 14024 requirement)	Private (mostly)	Private
Verification	Third party (mandatory by independent, external body)	Third party (independent body, not mandatory to be external, if not explicitly for B2C application)	Third party (mandatory by independent, internal certification body; however, independence of the conformance assessment body not assured)
Awarding criteria revision	Yes, regularly (revised based on a predefined period that is usually dependent on the product group specifics and market conditions)	Yes, regularly (PCR usually expire in 3–5 years, when it is further revised or, if not used, when it is discarded)	Yes, regularly (revision of the Product Standard to be done every three years)
Stakeholders involvement [1]	High (product category selection and awarding criteria development should be the result of a consultation process with stakeholders)	High (mandatory open consultation during development or update of EPD program instructions and PCRs)	Medium (during the product standard revision process, two public comment periods are at disposal for comments by stakeholders; not yet carried out in practice)

Table 3. *Cont.*

Attribute	Type I Eco-Label	Type III EPD	C2C Certified
Conclusive Characteristics			
Transparency	Program-specific; usually information on the program-setting process, awardees, funding, and pricing is accessible; verification report shall be available for the eco-labeling program, but not mandatory for the public	Program-specific; usually information on the program rules and PCRs is accessible, but information on funding and pricing is more seldom accessible; verification report shall be available to any person upon request	Information on the certification process, awardees, funding, and pricing is accessible; verification report exists, but it is not publicly available
Comparability	Medium (comparison and comparative assertions are not possible between products awarded the same label; awarded products can claim superiority to non-awarded products)	High (the EPD allows for objective comparison between products if the same PCR is used; comparative assertions not allowed)	Low (comparison between products is difficult due to the five quality categories; comparative assertions are not possible; comparability is not strived for by the program)
Environmental excellence	Intended (frontrunner principle applied)	Not intended (all products can get a declaration)	Intended (however, frontrunner principle not applied)

[1] In this category, interested parties (e.g., industry or trade unions, consumers, media, science, environmental groups, etc.) are envisaged as stakeholders external to the program.

4.1.1. Communication Characteristics

The "Communication" category consists of criteria related to the awarding format of an eco-label, the type and multiplicity of covered aspects (environmental and other), as well as the end-user focus. Ultimately, an eco-label affiliation to any of the three ISO typologies is evaluated. In the case of C2C Certified, the program does not fully conform to Type I (ISO 14024) or Type III (ISO 14025), although many similarities to Type I are pointed out hereafter when presenting the results of the characterization analysis.

C2C Certified applies a rating awarding approach consisting of five levels, from Basic to Platinum. This is considered advantageous in comparison to a binary pass–fail approach, since the label allows for the differentiation and ranking of the performance of the different certified products (the aspects of comparability in this relation are further described in Section 4.1.5). However, it is important to highlight that although a ban of the use of certain toxic substances and materials is ensured, only a rudimental material and energy inventory of the product is made at the first level of certification (i.e., Basic). This level is intended to show that the company has started out "on the path to certification" [20] (p. 11). The Basic certification is provisional, and the product must undergo further higher certification no later than two years after the Basic achievement, as it would otherwise be delisted from the program. Basic-level certification cannot be used as a mark on the product, but only in marketing materials [22]. This change in the latest version of the Product Standard v3.1 [20] reduces the risk of accusations of greenwashing.

In contrast, Type I eco-labels are usually awarded for real product performance. This is assured by ISO 14024's requirement for market analysis, as part of the feasibility study on the development of criteria for a new product group (discussed further in Section 4.1.2). Type III declarations, on the other hand, assure the robust communication of products' LCA profiles. Nevertheless, these products can be completely imaginary, and are either still in the research and development (R&D) phase or configured to answer certain application needs, without having been put into application.

C2C Certified is a multi-attribute system that covers both environmental and social performance aspects in their certification criteria. The intended end-user focus of C2C Certified is not explicitly stated. According to Bjørn and Hauschild [9], certification applies to both B2B and B2C, depending on the nature of the certified products. In practice, mostly B2B applications have lately been observed;

such as for example, the application of C2C Certified into the green-building rating and certification systems, which is discussed further in Section 4.2.

To conform with the respective ISO standards on Type I eco-labels and Type III declarations, programs shall cover and communicate multiple environmental aspects. Aspects beyond those that are environmental are not prohibited, but are also not explicitly defined and governed by the observed ISO standards.

Due to their binary awarding format and the ease with which final consumers can understand them, Type I eco-labels are mostly used for B2C, although this is not a requirement of ISO 14024. Type I eco-labels are also used in B2B in e.g., public procurement procedures (described further in Section 4.2).

According to ISO 14025, Type III EPDs are intended for B2B communication. Nevertheless, B2C applications are not prohibited by the standard. Additionally, additional rules for verification apply in the case of B2C (see Section 4.1.3).

4.1.2. Scope

The scope of an eco-label has several dimensions. It consists of the type of sector and geographical coverage, the operational scope of the label, what the awarding criteria cover, and whether materiality and product life cycle perspectives are considered behind the criteria.

C2C Certified is a multi-sectorial approach that is practically not limited by geographic boundaries. Although it is intended for the certification of products, some criteria are company-focused instead of product-focused; thus, they also focus on gate-to-gate processes only (discussed further in this section). Renewable Energy & Carbon Management, Water Stewardship, and Social Fairness are three of the five quality categories that require information on certain criteria that are related to the organization, without being related to the product that is the focus of the certification.

C2C Certified is a certification system whose certification criteria are not product-specific, but rather general for all products. The program does not require any product-specific feasibility and materiality assessment study for the establishment of new product categories or product-specific certification criteria, while Type I eco-labels do, as requested by e.g., ISO 14024. The advantage of having common rules for all products is that these are easy to understand by the consumer. However, two disadvantages occur: on the one hand, the criteria become too generic; thus, in theory, all sorts of product categories could qualify for the certificate. On the other hand, in the specific case of C2C Certified, it is easier to certify products from product groups that are homogenous or simpler from a material perspective (while it is difficult to do this for products from other product groups that are not so homogenous or that consist of more complex materials) [9]. This limits those product categories that, in practice, can undergo certification.

Applying identical criteria to all of the products also implies that the certification focus would not always necessarily be on those aspects and parameters that are the most relevant in completely determining the (environmental) performance characteristics of the product. This determination of products' relevant characteristics is known as the 'materiality principle', i.e., "focusing where it really matters" [34] (p. 113). If the materiality principle is not observed, certain certification criteria could be found to be irrelevant for a certain product, though they would still need to be covered and reported in order for the product to obtain the certificate.

Furthermore, the application of common awarding criteria, but not product-specific ones, implies that a specific evaluation of a product's life cycle is not performed, but rather considered as common for all products. In addition (and partly because of the lack of product specificity), many criteria in C2C Certified focus only on a particular life cycle stage, e.g., mostly on the final manufacturing (gate-to-gate), without conducting a specific evaluation of the life cycle of the given product under certification, and without providing a proper argumentation for the exclusion of any life cycle stage.

Conversely, when setting the awarding criteria, ISO 14024 requires Type I eco-labels to conduct feasibility and materiality assessment studies on the potential product categories, including on the specifics of the market (e.g., under 30% of the products from a given product category could obtain

the label). The standard here demands that product-specific environmental criteria be elaborated, respecting the materiality principle. This helps to differentiate environmentally sound products from others, based on "a measurable difference in environmental impact" [11] (p. 5). Furthermore, ISO 14024 postulates that the criteria for awarding Type I eco-labels shall not lead to the transfer of impacts from one life cycle stage to another, or "from one medium to another without a net gain of environmental benefit" [11] (p. 9). Thus, the product's life cycle shall be taken into account when awarding criteria are developed. This should ensure that, although final awarding criteria do not necessarily cover all of the life cycle stages of a product, the risk of burden shifting is minimized.

For the development of ISO 14025-conformant Type III EPDs, the LCA rules are based on PCR, which are considered to be a particular set of awarding criteria. PCR assure that the rules are specific to the product group in focus, and that future LCA studies based on the PCR focus on the most relevant aspects and parameters. All of the life cycle stages from cradle to grave are usually covered. In the case of the omission of a certain stage, this shall be justified properly. Nevertheless, from an impact assessment perspective, the materiality principle is not always observed in practice, because Type III operators often do not allow for the selection of impact categories that are specific to the product group, but rather keep them general for all PCR.

4.1.3. Standard Characteristics

The standard characteristics of an eco-label are defined by the type of compulsoriness of the label, its financing, the definition of the purpose, and longevity. C2C Certified is a voluntary program that is funded by certification fees and donations. Its purpose is to certify the level of products' conformance with the five C2C quality categories.

C2C certificates expire after two years. In case of re-certification, intentions for improvement must be reported in the form of optimization strategies (e.g., an intention for the eventual phase-out of a problematic substance) and a progress report against the original action plan [20]. This characteristic of C2C Certified can be considered as a step beyond the classic Type I eco-labels and Type III declarations, where, after expiration, an eco-label license or an EPD can also be renewed, but a binding requirement for improvement in the case of re-certification does not exist. Technically, in the case of Type I eco-labels, an improvement of the environmental performance of the product can be aimed at if the updated awarding criteria demand it. Nevertheless, ISO 14024 does not demand for a continuous improvement strategy to be set as part of the label or the criteria update.

4.1.4. Governance Characteristics

The governance characteristics relate to the type of governance, the verification process (including the conformance assessment and final certification), the regulations regarding the awarding criteria revision, and the process of stakeholders' involvement.

C2C Certified is managed by the non-for-profit organization C2CPII (see Section 2.2.2). Regarding the verification process, an assessment body that is trained and accredited by C2CPII performs the testing, analysis, and evaluation of the applicant. When an evaluation is finalized, the assessment body provides an Assessment Summary Report to C2CPII, and the latter takes the final certification decision [21]. However, the assessment body, i.e., the body that "conducts [the] conformance assessment" of the applicant [35] (p. 7) and "makes a certification recommendation" [35] (p. 15), can also act as a consultant. According to C2CPII, this double role of the assessment body is in the "best interest of the client by providing guidance to achieve certification" [35] (p. 7). This is in conflict with the verification requirements of ISO 14024 and ISO 14025; thus, the conformity assessment does not qualify as independent. As the Assessment Summary Report is the main information for a certification decision, this is a significant issue.

In comparison, Type I eco-labeling programs shall conform to ISO 14024 by undergoing mandatory, independent, external third-party verification, performed by a body that is independent to the program holder and the applicant [11]. In the case of Type III EPDs, the process is similar, but verifications can

be either internal or external. According to ISO 14025, independent external third-party verification is mandatory only when the declaration is intended for B2C communication [16]. Nevertheless, in practice, it is performed by most of the operators.

The C2C Certified Product Standard shall be revised no later than three years from the date of the current version [36]. As of November 2017, v3.1 of the standard is under its first revision, which started in June 2014 and is expected to finish by the end of 2018 [37]. A revision of the certification criteria is not explicitly set as part of the process, and this is considered as a flaw in the program's documentation. However, an improved version of the standard is sought in practice, assuming that certification criteria would be revised and eventually improved. In contrast, ISO 14024 clearly states that the awarding criteria for Type I eco-labels shall be reviewed within a predefined period. Similarly, PCR for the elaboration of Type III declarations have a predefined expiration period that is set by the respective program operator, after which the PCR shall be revised or discarded.

According to the program's policy for the revision of the standard [38], the revision process should consist of two public comment periods (60 days each), during which external stakeholders may provide inputs. Five advisory groups (one for each quality category) consisting of over 70 experts are responsible for providing expert guidance on the new standard. All of these activities give the impression of substantial stakeholder involvement. Nevertheless, according to personal communication with the C2C Certified support personnel, by the time the present article was submitted, no public comment period had been held, though this is expected to happen in 2018 [39]. The authors do not know of any additional publicly accessible information on any stakeholder involvement process (e.g., protocols of collected and processed comments).

Regarding Type I and Type III labels, the respective standards governing their development are both established on Principle 8 of ISO 14020, stating that an open consultation with interested parties should be included in the process of developing eco-labels and declarations. For Type I eco-labels, the product category selection and awarding criteria are a result of a consultation process between the program and the interested parties. Similarly, Type III EPDs are issued based on PCR developed after stakeholder consultations. Furthermore, for the update of the instructions for the operation of the Type III program, the program operator seeks stakeholders' opinions via an open period for comments.

4.1.5. Conclusive Characteristics

Transparency, comparability, and the intention to achieve environmental excellence are the three attributes that form the last category of the characterization scheme.

Concerning transparency, information on the certification process, awardees, funding sources, and pricing is accessible for C2C Certified. The Assessment Summary Report is submitted by the assessment body to C2CPII, but this document is usually not publicly available.

This is considered to be in line with ISO 14024, according to which information on the program-setting process and rules of the specific program shall be accessible; a verification report on the certified product shall be available to the eco-labeling body, but it is not mandatory that it be open to the public [11]. Similarly, ISO 14025 allows open access to the program-setting process; a verification report of the EPD shall be available upon request [16]. Further evaluation cannot be made here, since the level of transparency of the operation of a given Type I eco-label or of a given Type III EPD program is program-specific.

Comparability is not a topic in C2C Certified. The Product Standard v3.1 [20] does not mention comparability or comparative assertions regarding the superiority between certified products. Nevertheless, stakeholders tend to use C2C certificates in order to compare products in reality [40]. At first glance, this seems possible, because the rating format of awarding gives the user a notion of superiority between products, and the idea that a comparison is possible. However, in practice, obtaining an objective conclusion by comparing two C2C certified products is challenging and scientifically unjustified. The reason for this is that a product obtains a respective level of certification as the minimal performance level achieved in one of the five quality categories, regardless of which

one. Thus, a product is awarded e.g., an overall rating of Silver, because it may obtain a minimum score for Silver in e.g., the Material Health category. However, this does not imply that it has the same performance characteristics as another product that also has achieved an overall rating of Silver, but achieved its minimum score in e.g., Social Fairness. As a result, if the user does not get introduced with the background documentation (e.g., the certification scorecard) along with the certificate, misleading conclusions are conceivable.

A careful comparison of the scorecards of two products could give the user a perspective on which product scores better in each category. Nevertheless, C2C Certified does not oblige, but rather only encourages, certification holders to publish the scorecards on their marketing materials [20]. Furthermore, the awarding criteria setting procedure does not consider the so-called 'frontrunner' principle, i.e., a certification awarded only to the best performing products of a product category for a certain market. Thus, overall comparative assertions should not be allowed.

With regard to Type I eco-labels, comparative assertions between two products that have the same label are not possible, and neither are statements regarding the level of environmental superiority between the same. This is due to the binary awarding format, through which both products have covered the same criteria, but nothing more. However, Type I eco-labels in their essence are used to indicate an overall environmental superiority over products that do not hold the label. Environmental excellence is aimed for, and only the best performing products within a product category on the market can obtain the label.

By their nature, Type III declarations allow the user to compare products under the condition that the EPDs are based on the same PCR (e.g., identical product category definition, system boundaries, and functional unit). EPDs are designed to present transparent and quantitative information, thus allowing the user to fully understand eventual limitations while making a comparison. Depending on the granularity of the product group definition, rules for the execution of the LCA could vary to different extremes, going from being very specific to very generic; this could be an impediment for EPD comparisons, despite being based on the same PCR. The product performance improvements can be measured based on the disclosed LCA profile that lists potential environmental impacts in the form of impact categories. However, Type III EPDs are not intended to suggest the environmental excellence of the declared product, given that theoretically, all products can obtain a declaration. Comparative assertions are not allowed.

The eco-efficiency approach (used as a basis by Type I eco-labels) and the C2C approach differ in their fundamental principles aimed toward sustainable production, as do the respective labeling and certification schemes that are derived from them. C2C Certified can be considered neither a Type I nor a Type III label, although similarities to Type I can be identified. However, the main discrepancies relate to the generic (but not product-specific) awarding criteria focus, the lack of product life cycle perspective, and the non-explicit requirement for criteria revision, despite the requirement for regular revision of the standard. Type III conformance is not achievable. An obvious reason, among others, is that for example, C2C Certified does not apply LCA.

4.2. Sector-Specific Example

In the following section, a sector-specific example is provided: C2C Certified is compared against the performance characteristics of two existing labels, namely the Type I BA and the Type III IBU. The same set of characterization attributes as in Section 4.1 is used, but in Table 4, the results are presented only for those that show specifics of the analyzed approaches and are important for the comparison. Few of them are discussed hereafter. Following this, the performance of the three approaches from the perspective of overall acceptance within the "Construction and construction services" sector and GBCS is presented.

Table 4. Characterization of C2C Certified and comparison with Blue Angel (BA) and Institut Bauen und Umwelt e.V. (IBU) in the context of construction products.

Attribute	BA	IBU	C2C Certified
Communication Characteristics			
ISO typology	Fully conformant Type I eco-label program according to ISO 14024	Fully conformant Type III program operator according to ISO 14025	Does not fully conform with Type I or Type III label requirements of ISO
Awarding format	Seal	Declaration	Rating (sealed) Five ratings: Basic, Bronze, Silver, Gold, Platinum
Multiplicity of covered aspects	Multi-attribute: Four general protection objectives: Climate, Resources, Environment and Health, and Water (type and number of specific aspects are dependent on the product category)	**Multi-attribute:** **Six environmental impact** categories: Global warming Ozone depletion Acidification for soil and water Eutrophication Photochemical ozone creation Depletion of abiotic resources (elements and fossil fuels) And 10 resource use parameters	Multi-attribute: Five quality categories: Material and Health Material Reutilization Renewable Energy and Carbon Management Water Stewardship Social Fairness
Aspects diversity	Mostly environmental and occupational health and safety, but also social (for certain product categories)	Environmental (optional health)	Both environmental and social/health
Scope			
Sector scope	Multi-sectorial 16 product categories with many subcategories related to the "Construction and construction services" sector	Sector-specific 109 PCRs in three main groups (Basic materials and precursors, Building products, and Building service engineering)	Multi-sectorial two product categories with many subcategories related to the "Construction and construction services" sector
Standard Characteristics			
Longevity	Renewable Label validity: three to five years	Renewable EPD validity: five years	Improvement-based certificate validity: two years
Governance Characteristics			
Verification	Third party (mandatory by independent, external body)	Third party (mandatory by independent, external body; verifiers are approved by the advisory board)	Third party (mandatory by independent, internal certification body; however, independence of the conformance assessment body not assured)
Awarding criteria revision	Yes, regularly; criteria revised after three to five years	Yes, regularly PCR validity: three years	Yes, regularly (revision of the Product Standard is to be done every three years)
Stakeholders involvement	High (open consultations during the development of new or updating existing awarding criteria)	Medium (no procedure for the involvement of external parties in program rules' development or update; internet forum available for public comments during the development of new or updating expired PCR)	Medium (during the Product Standard revision process, two public comment periods are at disposal for comments by stakeholders; not yet carried out in practice)
Conclusive Characteristics			
Transparency	Program rules—yes Awarding criteria—yes Awardees—yes Pricing—yes Verification report—not public	Program rules—yes PCR—yes Awardees—yes Pricing—yes Verification report—available on request	Program rules—yes Certification criteria—yes Awardees—yes Pricing—yes Verification report—not public

BA applies a binary seal type of awarding format. In addition, the label is divided into four different protection objectives: Climate, Resources, Environment and Health, and Water. When a

product is awarded the BA label, a protection objective is assigned and displayed on the seal. The idea is that the consumer is shown the focus of the awarding criteria. The assignment of more than one protection objective to a product group is inadmissible [41].

EN 15804+A1 [42] is a European norm, providing core rules for the product category of construction products in development for EPDs. Together with ISO 14025, EN 15804+A1 is also the core standard behind the ECO Platform initiative (explained in Section 3.2.). The standard is widely accepted, and is a symbol of harmonization work between a large group of stakeholders working in the sector. In this sense, IBU's involvement in this process is a guarantee for a coherent and aligned communication flow in the sector between stakeholders along the supply chain. As an example, IBU's EPDs follow the EN 15804+A1 requirements on impact assessment by declaring the results based on six environmental impact categories and 10 resource use parameters, as set in the standards (listed in Table 4).

Whereas IBU's EPDs cover environmental (and optionally health) aspects, both BA and C2C Certified also include social elements. BA recognizes products that are environmentally friendly in a holistic way, but that also meet high standards for occupational health and safety. "Socially controversial" products are excluded [41] (p. 1). Furthermore, the fundamental principles and rights relating to working conditions, as reflected in the applicable core labor standards of the International Labor Organization (ILO), shall be met both by the licensees and the value chain producers [41].

On the other hand, C2C Certified also account, with their Social Fairness category, for progress made toward sustainable business practices, respecting human rights and labor practices, and assuring worker health and safety. The different certification levels require different levels of commitment, starting from a self-audit and assessing the protection of human rights at the Basic level, to aiming for a third-party audit of the facility that conforms with an internationally recognized social responsibility program (e.g., SA8000) at the Platinum level [20].

C2C Certified is recognized by LEED® v4 for credit "Building product disclosure and optimization—material ingredients", where C2C Certified's rigorous requirement for a complete bill of material is used to achieve one point. An additional point is given if the material ingredient optimization is documented (a requirement for C2C Certified levels above Silver). It is not known whether C2C Certified is recognized in other GBCS or schemes for other sectors. Nevertheless, in 2017, the US Environmental Protection Agency (EPA) recommended C2C Certified in their "Recommendations of standards and eco-labels for federal sustainable purchasing" in seven building and construction product categories [43].

EPDs by IBU and other program operators are also promoted by LEED® v4 to achieve material credits [44]. The scheme awards materials with one point in the category "Building product disclosure and optimization—environmental product declarations". EPDs also find application in GPP, since the declared information is verified, and allows for a comparison of the environmental impact at the level, on the one hand, of technically equivalent construction materials and products, and on the other hand at the level of building elements or even a whole building. An example of the application of EPDs in GPP are the recently developed GPP criteria for office building design, construction, and management by the European Joint Research Centre [45], where the performance of the main building elements can be evaluated based on EN 15804-conformant EPDs. IBU is also recognized by the main GBCS in Europe—DGNB and BREEAM.

Despite BA not being recognized in any GBCS (i.e., it does not bring any credits in any of the described schemes), the label has a strong focus on construction-related materials (a total of 16 product categories), and the label's requirements are often used in GPP practices. Figure 2 shows the application areas and the respective overlaps between the three approaches.

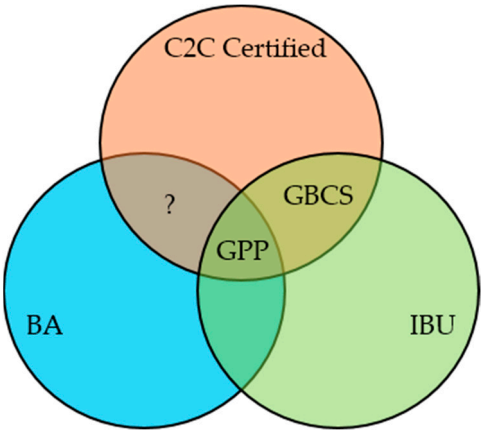

Figure 2. Application areas and overlap between C2C Certified, BA, and IBU.

5. Discussion

C2C is a useful approach in concept development and in designing new products. It is assumed to be effective for a deeper understanding of material composition and design for recycling [5]. Nevertheless, it is also important for designers to understand and track the environmental impacts and benefits of their design actions [7,46]. In this sense, as a tool for providing quantifiable environmental effects and as an instrument for external communication in the context of environmental labels and declarations, C2C Certified still bears certain shortcomings.

On the one hand, a flaw in the relation between the certification holder and the user (e.g., a consumer or designer) could arise when the latter does not completely understand that C2C Certified is a benchmark for achieving the C2C principles, rather than a tool for the quantifiable estimation of environmental impacts. Furthermore, when the C2C certificate is taken as a given without attention into the details (i.e., examining the scorecard), users may use it for direct comparability between certified products or to plead for overall environmental preferability over non-certified products, which, as shown in this paper, is not that straightforward.

On the other hand, C2C Certified is often perceived by the public as a Type I eco-label [47]. As discussed by Bjørn and Hauschild [9], and as also confirmed in the paper at hand, the program shows many similarities to Type I. Nevertheless, when going through the program's documentation, it is significant that ISO 14024 (the standard that defines Type I eco-labels) is never cited under the list of normative references, whereas a reference to ISO 14025 (Type III) occurs many times (see e.g., C2CPII 2015, C2CPII 2016a and C2CPII 2016b [35,48,49]). Therefore, in order to provide clarity for an interested public, this paper answered the question of whether C2C Certified is a Type I or Type III (as defined by the respective ISO norms), and parallel to this, it pointed out the benefits and drawbacks of such (non)conformity.

C2C Certified is a voluntary, multi-aspect program with a multi-sectorial scope. These typical Type I characteristics are backed by assured access to information about the program setting regarding funding and operation, as well as regarding product certification. In certain respects, the program even goes beyond a typical Type I eco-label, e.g., the binary pass–fail awarding format is upgraded by a rating scheme that ranks the products' performances. However, some of its characteristics show clear non-conformance with the requirements of ISO 14024. First and most importantly, the certification criteria of the program are generic without being product-specific. Thus, a specific evaluation of a product's life cycle is not performed. The standard further requires the elaboration of feasibility studies for the establishment of new product categories or product-specific awarding criteria, which is missing in C2C Certified, as it has a generic, but not product-specific, scope. The missing product-specific life cycle perspective in the certification criteria development ensures that the evaluation of a product focuses only on certain life cycle stages without any product specificity. This bears the risk of misbalance

between the different certification criteria [8] by shifting burdens between life cycle stages, which is a situation that shall be avoided, as ISO 14024 explicitly states.

Similarities between C2C Certified and Type III declarations can barely be found. However, together they can be recognized as complementing tools. As shown in the sector-specific example in this paper, both approaches are applicable in LEED® v4, where they complement each other without competing. Thanks to their different application purposes (i.e., a certification of conformance and comprehensive content declaration versus a quantitative list of impacts), they are used to obtain different credits through different conformance paths. Furthermore, when it comes to the evaluation of alternatives and backing up strategic decisions, a quantifiable approach to the estimation of potential environmental impacts is needed; this is not supported by C2C Certified, but rather by EPDs.

On a higher level, this paper raises a discussion of whether C2C Certified is an eco-label or not. Eco-labeling is a voluntary method of environmental performance certification and labeling. An eco-label identifies products that overall are environmentally preferable within a specific product category. In this sense, C2C Certified is awarded to products that have achieved a certain level of conformance to the C2C principles. Thus, the question that has to be answered is whether the adoption of the C2C principles actually leads to the creation of overall environmentally preferable products. This has not been the focus of this article, and it deserves to be unraveled in future research; yet, according to Bjørn and Hauschild [9], C2C certification cannot guarantee better environmental performance for products compared with other products from the same product category.

Moreover, as an additional point for future examination, few articles (e.g., Paul et al. Niero et al, and Bjørn and Hauschild [7–9]) discuss that C2C Certified does not guarantee that a certified product really meets the C2C principles philosophy. De Pauw et al. [7] argue that the certification levels of the program cannot represent the beneficial impact of a design. According to Bjørn and Hauschild [9] (p. 615), "C2C certified products are by no means ideal C2C products". Not even a Platinum level assures a "true" C2C product, i.e., one that fulfills all three principles for all aspects. According to Bühner [47], the full circularity of a product is not assured until one reaches the Silver level.

6. Conclusions

This article provides a characterization and analysis of C2C Certified as an external communication tool in the frame of environmental labels and declarations, and does so by applying an existing, upgraded eco-labels characterization scheme to that developed by Minkov et al. [3]. To the authors' knowledge, such a comprehensive analysis from this perspective has not yet been published, and the results are considered to be of interest to a variety of the programs' stakeholders, e.g., the C2C Certified management, existing and future C2C Certified certification holders, and the general public as potential users of C2C Certified products.

By comparing the approach with the requirements of ISO on environmental labeling, and by additionally comparing it with two existing typical representatives of Type I and Type III labels, the advantages and weaknesses of C2C Certified are exposed. An analogy with Type II self-claims is not conducted, due to the very wide scope of the standard, and the difficulty in characterizing it with any typical example.

As a communication approach, C2C Certified is considered operational; the program's management seems robust; the program's guiding documents are detailed and transparent. Still, its undefined affiliation in the realm of environmental labels gives the user heterogeneous perceptions of the program's objectives. For example, C2C Certified is often perceived by the public as a Type I label, although the program itself never states this. In this context, this work shows that despite the differences, C2C Certified has many similarities to a typical Type I eco-label (and very few to Type III). It is believed that the eventual efforts put toward fulfilling ISO 14024's conformance requirements for eco-labels would help improve C2C Certified's image and its robustness as an eco-label, and would also allow for a more objective comparison with other eco-labels.

Given the achieved objectives and obtained results of this paper, it can be concluded that the established methodological approach can be applied to any other environmental labeling scheme or standard by comparing it with any other scheme, or, as done here, by juxtaposing it with ISO standards for environmental labels in order define conformity to a certain ISO typology. Amongst others, potential users could be program holders and eco-label developers testing and comparing their approaches, as well as companies looking for an appropriate environmental label for their products, or consumer organizations guiding their members through the current variety of existing eco-labels.

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