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THE FUTURE OF ECOLABELS

Characterization of environmental labels beyond the criteria of ISO 14020 series

Nikolay Minkov[1] · Annekatrin Lehmann[1] · Lisa Winter[1] · Matthias Finkbeiner[1]

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Abstract

Purpose ISO 14020 series of standards provide guidance for establishing ecolabels and a classification based on three label types, I, II, and III. They also determine the consideration of product's life cycle and application of the life cycle assessment (LCA) in ecolabeling. Still, the large number and variety of existing ecolabels has led to consumer confusion in the recent years. The objective of this paper is to propose a characterization scheme for ecolabels and to provide recommendations for the enhancement of existing ecolabel classification, questioning the current sufficiency of ISO.

Methods To reach the objective, we first create a sample of ecolabels covering forest and paper products as an example, to narrow down the enormous number of existing ecolabels (over 460 as of August 2018). Second, we analyze their content, purpose, and awarding criteria through a desk research. In parallel, scientific publication, reports, and standards are also analyzed. Third, based on the obtained information, we define a list of ecolabel characterization attributes and their options and observe tendencies in ecolabel development. Ultimately, based on the outcomes of the proposed characterization scheme, we give recommendations for enhancement.

Results and discussion Ultimately, we compare a sample of 45 ecolabels against 18 attributes of the proposed characterization scheme, including, among others, their ISO typology, life cycle perspective, awarding format, covered environmental aspects, and scope. Regarding type I or type III label, ISO seems to be explicit and their requirements are well respected, including how LCA is to be applied. However, approximately 60% of the explored ecolabels in our sample did not declare any ISO typology, whereas none assigned a type II classification. These "undefined" ecolabels, as we call them, apply different awarding formats and criteria in combination and hybrid forms that are not recognized and described by ISO or any other observed classification approach. Misuse of the term "LCA" is also perceived in such "undefined" initiatives.

Conclusions We conclude that the current ISO standards on ecolabels belittle the consequences that the increased number of undefined ecolabels brings. We provide a list of recommendations for the enhancement of the current ISO classification in seven topics, namely, awarding format, aspects diversity, operation scope, verification, reconsideration of the usability of ISO 14021, new ISO classification, and transparency. Limitations of the study and outlook conclude the work.

Keywords Characterization · Ecolabel · Environmental labeling · Forest and paper products · ISO

1 Introduction

The labeling of products is recognized as an action of an organization to communicate product-specific information to customers and end-users (Roe et al. 2014). In this context, many consider environmental labels (or ecolabels) a suitable tool to improve production and consumer decision-making, as ecolabels provide valuable information when considering the environmental qualities of a product (Bratt et al. 2011). Environmental qualities are often credence characteristics of products, i.e., the user cannot determine them by simple inspection or experience or they are expensive to judge even

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✉ Nikolay Minkov
nikolay.minkov@tu-berlin.de

[1] Chair of Sustainable Engineering, Department of Environmental Technology, Technische Universität Berlin, Office Z1, Straße des 17. Juni 135, 10623 Berlin, Germany

after purchase (Darby and Karni 1973; Bougherara et al. 2005).

However, as shown further in this paper, nowadays, ecolabels are often developed on an individual and independent basis. They serve particular needs, markets, and credence products and have different awarding approaches and criteria. Thus, different ecolabels exist worldwide. This profusion can lead, on one hand, to consumer confusion given the multiplicity of information formats (OECD 1997; Dendler 2014; Janßen and Langen 2017; Brécard 2014), and, on the other hand, to overlap and antagonize between environmental labels and label types (Allison and Carter 2000; Banerjee and Solomon 2003; Engels et al. 2010; Goossens et al. 2017; Horne 2009).

1.1 Environmental labels and the role of ISO

As ecolabels serve different communication purposes and consist of different formats, the International Organization for Standardization (ISO) provides general definitions and principles for the establishment of voluntary ecolabels through the standard ISO 14020 (ISO 2000). Furthermore, three broad types of voluntary labels have been defined through the following standards, which are as follows:

1) ISO 14024 (ISO 2018) on type I environmental labels or ecolabels—these are multi-criteria-based, third-party-verified labels awarded to products that fulfill certain product environmental criteria based on life cycle considerations;
2) ISO 14021 (ISO 2016) on type II environmental labels, known as self-declared environmental claims, issued in the form of a claim, stamp, label, or declaration; and
3) ISO 14025 (ISO 2006a) on type III environmental declarations, known also as Environmental Product Declarations (EPD). These are third-party verified, quantitative declarations based on a Life Cycle Assessment (LCA) of the product, according to ISO 14040 (ISO 2006b) and apply Product Category Rules (PCR) that are designed specifically for the particular product group in focus.

Being internationally recognized and accepted, these three types have existed for almost 20 years now without being substantially modified (despite the updates of ISO 14021 and ISO 14024 in 2016 and 2018, respectively, when only minor revisions were undertaken). By revising the existing literature, a question has arisen whether the current ISO typology is sufficiently covering all varieties of existing ecolabels and their multiple characteristics. Galarraga Gallastegui (2002) identified weaknesses in the current type I labeling schemes, among which the lack of sufficient categories for the classification of the different types has been pointed out. The United Nations Environmental Program (UNEP) called upon an improved classification framework for ecolabels beyond the existing "superficial" ISO levels to catalyze their better understanding (UNEP 2005). Cobut et al. (2012) gave the example of the Forest Stewardship Council (FSC) label, which was considered as a type I label in their study, although they stressed that it is not a multi-aspect label (a core principle of type I labels, according to ISO 14024), but certifications undergo a third party review and cover key environmental issues. Similar to their outcomes, a publication by the Organization for Economic Co-operation and Development (OECD) concluded that the current ISO typology fails to represent the full diversity of ecolabels nowadays and that all further efforts of ISO on looking at additional standards to cover all types of environmental labels have been concluded (Gruère 2013). The study concluded that the diversity and unequal growth in the increase of ecolabels were driven by the combination of "traditional" labels (e.g., type I) and "more recent" types.

1.2 Other classification approaches

Prior to the publication of the first versions of ISO 14020 series, a study by the United States Environmental Protection Agency (US EPA) (see EPA 1998) provided a classification according to a number of attributes, e.g., operation scope, verification, and compulsoriness (we further describe these in Section 3.1.6, Section 3.1.10, and Section 3.1.11, respectively). In 2005, Rubik and Frankl (2005) proposed a classification based on the compulsoriness of ecolabels. Building on their findings, a study conducted by Horne (2009) also proposed a classification founded on the compulsoriness of the labels, but with focus on product sustainability and routes to sustainable consumption. Additionally, the OECD (Gruère 2013) provided characterization criteria in the context of an international overview of environmental labeling. The study at hand builds upon their findings. Nevertheless, none of these classification approaches have aimed at or have achieved the substitution of ISO typologies as a classification system applied in practice.

1.3 Objectives of the study

Given the extensive literature on the profusion of ecolabels and consumer confusion, there is still a sparse scientific contribution on improving the characterization and classification of ecolabels. Therefore, this work aims at proposing a characterization scheme for ecolabels and at providing recommendations for the enhancement of ecolabel classification. This is based on a list of attributes for the description of ecolabels and builds on the classification approaches listed in Section 1.2. In this paper, we use the term "attribute," defined by the Oxford Dictionaries (2018) as "a quality or feature regarded as a

characteristic or inherent part of something," i.e., of an ecolabel. An attribute in this work is considered as a synonym of a characteristic.

The two-fold objective of this paper aims to contribute to both the science and practice by developing a scientifically sound approach for ecolabel characterization and by proposing improvements in the classification used by stakeholders. We reach the objective by fulfilling the following research tasks:

1) Development of a representative ecolabel sample;
2) Content and criteria analyses of the sampled ecolabels and attribute identification;
3) Characterization scheme setting and recommendations for the enhancement of ecolabel classification.

Section 2 describes the method undertaken to achieve the research tasks. Section 3 shows the results, overviews the proposed characterization scheme, and ultimately provides recommendations for the enhancement of ecolabel classification based on the identified challenges. Section 4 provides the conclusions and outlook.

2 Methods

This paper represents an analytical study based on an online desk research. The following sub-sections describe the steps undertaken to reach the proposed research tasks.

2.1 Development of a representative ecolabel sample

As a first step, we created a list of 91 ecolabels, shortlisted out of the online Ecolabel Index database (Big Room Inc. 2018), being the largest free ecolabel directory that contains over 460 entries (as of August 2018). We narrowed down the many environmental labels by focusing only on the ones that assert to certify products under the category "Forest products/Paper." The category was predefined by the database, and we used it as a search term. We selected paper and forest products (used for paper products) as an exemplary product group that consists of a complex supply chain, several manufacturing steps, and intermediate and final products. Consequently, the stakeholder spectrum was recognized to be very broad, suggesting that many different ecolabels could be found along the supply chain.

We assumed that by limiting the excerpt to a certain product group, we would risk missing out on covering ecolabels with important qualities for completing the list of attributes for ecolabel characterization. Thus, being aware that this could be a biased choice, as a second step, we added five complementary labels in our analysis, which would normally not fit under this product category (e.g., EU Energy label). The additional labels considered were either new initiatives with the potential to become relevant for the market (e.g., The European Product Environmental Footprint, PEF[1]) or they held certain attributes that were important to be discussed herewith, but not those possessed by any of the preselected labels (e.g., WindMade).

Ultimately, due to the lack of access to information (e.g., published documentation or operational webpages), English or German translation, general inactivity of the program, or duplication, i.e., same ecolabel multiplied in different countries, the final list was reduced to 45, including the five complementary ones. The complete ecolabel sample that we worked with and the information on the data collection can be found in the Electronic Supplementary Material, sheet "Database." The sample contains initiatives introduced between 1978 and 2013, covering 27 countries and the European Union and grouped in four categories.

Three ecolabels of the sample were dedicated only to paper products, while another four were related to forest management (including chain of custody certification). The rest were categorized as multi-sectorial labels (see Section 3.1.5), also covering forest and paper products. This list included four type III programs. In addition, PEF was included with the pilot study on "Intermediate paper product". PEF and one type III program (i.e., FP Innovations) were taken from Minkov et al. (2015), since they were not listed in the Ecolabel Index database.

2.2 Content and criteria analyses of the sampled ecolabels and attribute identification

To identify the attributes for ecolabel characterization, three steps were undertaken. First, through an online desk research, we reviewed 90 documents—mostly scientific publications, but also reports and standards—to study the development of and challenges related to ecolabels and to compare existing classification and characterization approaches. This includes the ISO criteria and principles regarding environmental labels. The obtained information was used to support the motivation, formulate the research objectives, and back the final recommendations. Nevertheless, only four of the identified documents related to ecolabel characterization and classification (listed in Section 1.2).

Scientific literature was collected through the scientific citation indexing service "Web of Science[2]" by using the predefined search terms "ecolabel," "environmental label," "environmental claims," "labeling scheme," and "ecolabel

[1] According to Bach et al. (2018), the PEF initiative is currently in transition phase until 2021 and it is not yet decided what the outcome would be used for, e.g., an ecolabel or something else. However, it aims at the development of a harmonized environmental footprint methodology, including the communication of environmental performance based on relevant criteria (EC 2013; Lehmann et al. 2016)

[2] https://webofknowledge.com/

classification." Other documents like standards, guidelines, or reports were also identified by internet searches with identical keywords. Program documentation and guidelines for the overall administration and operation of the shortlisted 45 ecolabels were obtained by an online search through their webpages. No publication time restrictions were applied to the overall desk research.

Second, we analyzed the selected ecolabels by exploring the content of their program guiding rules and awarding criteria, looking for distinctive attributes and their options. Based on these outcomes and the findings of the identified studies from the past that relate to ecolabel characterization and classification, we elaborated an initial list of attributes, from which ecolabels could be characterized. For multi-sectorial labeling programs (e.g., Blue Angel), we reviewed the awarding criteria that related only to forest and paper products.

Third, once an initial list of attributes was created, we further refined them by, e.g., excluding or merging certain attributes or certain options of an attribute. This was an iterative process of additional desk research and working individually on each considered ecolabel in a greater detail. Lastly, we defined categories, based on thematic similarities to classify the attributes, thereby to improve their presentation.

All attributes and their respective options are individually discussed in Section 3.1 supported with data for the distribution of ecolabels from the sample.

2.3 Characterization scheme setting and recommendations for enhancement of ecolabel classification

Subsequently, we summarized the identified attributes and their options together in a form of a characterization scheme. The scheme was, then, applied to the ecolabel sample and juxtaposed with the existing ISO typology (see Section 3.2). A detailed description of each ecolabel according to the defined attributes and the characterization scheme is given in the Electronic Supplementary Material, sheet "Database." Based on the information gained, we, then, identified gaps and challenges and gave recommendations for the enhancement of ecolabel classification (see Section 3.3).

Figure 1 gives a schematic overview of the steps undertaken to achieve the objectives of the paper.

3 Results and discussion

The following sections describe and discuss the results of the study. First, we overview the list of attributes, and, then, we analyze the findings related to each defined attribute individually and their respective options using statistical data from the ecolabel sample. Lastly, we overview the characterization scheme and conclude the section by also identifying the potential gaps and challenges and our recommendations for enhancement.

3.1 Identified attributes for ecolabel characterization

Following the described method in Section 2.2, we established a list of 18 ecolabel characterization attributes, grouped in four categories (see Table 1). Each attribute is individually described in Section 3.1.1 to Section 3.1.18, and, where relevant, the distribution of the respective attribute options per attribute in the ecolabel sample is given. A note has to be made, however, that the distribution shares are influenced by and valid only for the product group we examined.

3.1.1 ISO typology

ISO defines three broad types to classify voluntary labels (see Section 1.1). We, first, observed how these three types were distributed among the examined ecolabels. About a third of the ecolabels were classified as type I, whereas about 10% were type III. Almost 60% did not characterize with any ISO typology. Moreover, no ecolabel was explicitly declared to be type II. This is shown in Fig. 2.

It was not a straightforward decision as to how to determine these undefined ecolabels and whether any of them were typical self-declared environmental claims (i.e., type II) or if they were any others that were different from the three ISO types. On the one hand, as the requirements of ISO 14021 are broad, ecolabels cannot automatically be assigned as type II. On the other hand, some of the ecolabels go beyond the standard's requirements. For example, approximately half of them declare undergoing an independent third-party certification, which according to the standard is not mandatory and already a step further from a regular self-declared claim.

In this regard, certain cases of undefined ecolabels have been addressed by some authors (e.g., Horne 2009; Leire and Thidell 2005; Panainte et al. 2014), by calling them "type I-like" labels, as they bear certain type I qualities, but address only a single environmental aspect or a single product group (see Section 3.1.6 and Section 3.1.8). Similarly, others can be considered as declaration type of statements, but to cover only a single phase of the product's life cycle, thus not qualifying as type III. Nevertheless, we refrained from categorizing them under a specific typology, as there could be many combinations, but we generally called them "undefined" ecolabels and describe their differentiating attributes further in this work.

3.1.2 Awarding format

The awarding format of an ecolabel has an effect on the level of information that the consumers receive and on the way they are likely to interpret this information (EPA 1998; Weinrich and

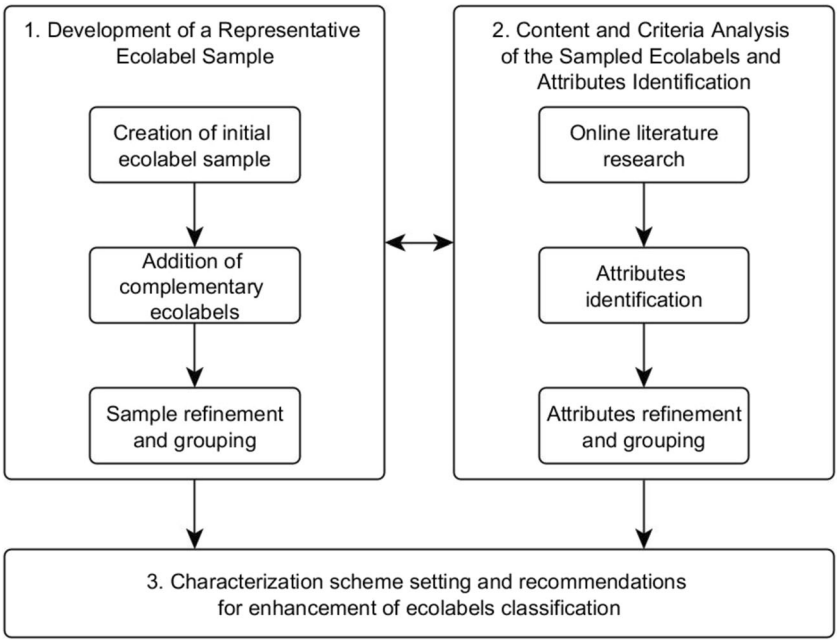

Fig. 1 Description of the method flow

Spiller 2016). Keeping the ISO classification aside, we distinguished three main awarding types and four sub-types out of our examination (described in Table 2 and quantified in Fig. 3).

According to Wu et al. (2014), seal-type ecolabels can be seen as a benchmark, awarding a product that meets the predefined performance criteria. Rating type ecolabels are considered as a newer initiative, implementing different levels of benchmarks (i.e., grades or ranks). These are seen as more comprehensible and provide the most information among other alternatives, such as seal-type ecolabels (Emberger-Klein and Menrad 2018). Weinrich and Spiller (2016) considered rating-type ecolabels as an important tool to promote product differentiation, thus, justifying the eventual increased interest in them by policymakers. Policy regulation or strong retailer commitment would also be needed if rating ecolabels are used to indicate not only the superiority but also the inferiority of products (e.g., a traffic light classification also indicating bad performance) (Thøgersen and Nielsen 2016).

When juxtaposing the ISO types with the complete range of awarding formats that we identified, the classic type I labels conform to the "seal" ones, whereas the type III ones conform to the "non-sealed" declarations. However, what is more interesting, the existent ISO typology approach seems insufficient and fails to cover the many different awarding types that exist and operate on the market nowadays.

3.1.3 Aspects diversity

This attribute examines whether ecolabels covered additional aspects aside from the environment. We counted that around 30% of the ecolabels also considered social aspects. However,

Table 1 List of identified characterization attributes divided into four categories

• Communication characteristics	• Life cycle characteristics
1. ISO typology	5. Life cycle perspective
2. Awarding format	6. Multiplicity of covered aspects
3. Aspects diversity	7. Operation scope
4. End-user focus	
• Standard characteristics	• Conclusive characteristics
8. Sector scope	16. Transparency
9. Geographic scope	17. Comparability
10. Verification	18. Environmental excellence
11. Compulsoriness	
12. Governance	
13. Financing	
14. Purpose	
15. Longevity	

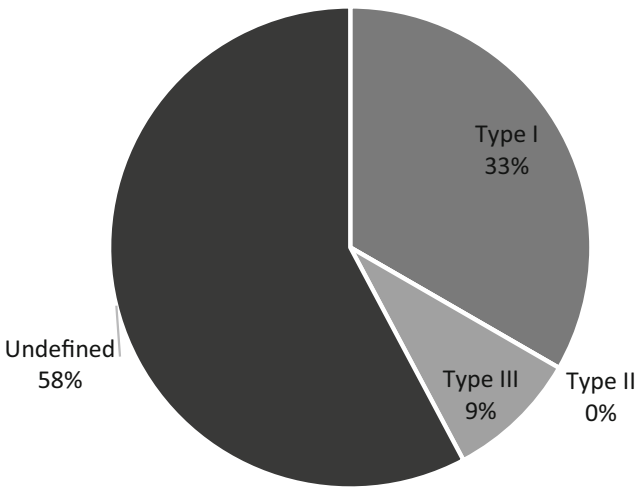

Fig. 2 Distribution by ISO typology of ecolabels from the sample

Table 2 Identification and description of the existing awarding formats

Type	Description
1. Seal[a]	• These ecolabels provide simple binary pass–fail information (UNEP 2005) • Products either comply with the criteria of the ecolabel program or fail to be awarded (Thøgersen and Nielsen 2016) (e.g., EU Ecolabel and all type I labels) • Products awarded in the same product category cannot be compared (Cobut et al. 2012) • Type II claims, such as, e.g., "compostable," are also included under this category
2. Rating	• These ecolabels demonstrate a level of superiority between products by ranking them on a predefined scale (e.g., Gold, Silver, Bronze)
2.1. Rating (non-sealed)	• Products are ranked based on their performance without minimum criteria to be covered or a seal to be awarded (e.g., EU Energy label)
2.2. Rating (sealed)	• Prior to the ranking, the ecolabel is awarded to a product with a seal after complying with certain minimum performance criteria (e.g., Cradle to Cradle Certified™ Products Program)
3. Declaration	• These ecolabels consist of declarations of quantifiable results based on pre-set list of categories
3.1. Declaration (non-sealed)[b]	• These ecolabels provide quantified environmental data using predetermined parameters • ISO type III labels (e.g., Earthsure) fall under this category, for which comparative assertions are not allowed (ISO 2006a)
3.2. Declaration (sealed)	• The product obtains a seal for covering minimum criteria in addition to the declaration of pre-defined categories of results (e.g., WindMade)

[a] Entitled also as "seals-of-approval" by EPA (1998) and Horne (2009)

[b] Several declaration-based ecolabels did not conform fully to ISO 14025 and, therefore, could not be classified as type III declarations but still served similar purposes; thus, they were accounted for in this study

our analysis showed that often the criteria were only qualitative and, in most cases, focus on social issues within local communities, health and safety issues related to employees, labor and wages, facilities and workplace, etc. Moreover, social criteria did not evidently relate to the product under evaluation, but rather to the organization (see Section 3.1.7). However, only around 20% of the organization-awarding ecolabels in our sample declared covering social aspects. Furthermore, a clear trend could not be observed where newer ecolabels considered social criteria more often than the older ones. Nevertheless, an expert survey among academic researchers and practitioners conducted by Shao et al. (2017) showed that health, safety, and labor issues ranked in the top 10 among other environmental aspects in the subject of sustainable consumption.

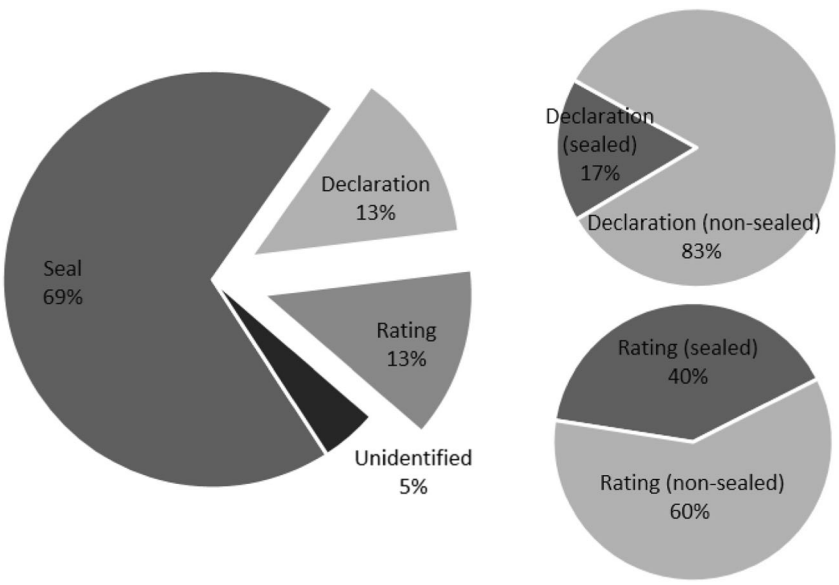

Fig. 3 Distribution by awarding format of ecolabels from the sample

3.1.4 End-user focus

The most common differentiation of the end-user communication focus of ecolabels is between the end consumer (business-to-consumer, B2C) and businesses (business-to-business, B2B). In their publication, Gruère (2013) distinguished two more types of communication channels, i.e., business-to-government (B2G) and government-to-consumer (G2C), of which we did not have examples in our sample.

Seal- and rating-type ecolabels are usually better understood by consumers than declaration-type ecolabels. The former are less demanding in terms of the technical knowledge of the users, although they sometimes may be oversimplified and judgmental (Banerjee and Solomon 2003; Horne 2009). Moreover, they are considered a useful tool for consumers, due to their benchmarking properties (see Section 3.1.2). In contrast, the declaration type of labeling (e.g., type III labels) is a common way of B2B communication where technical knowledge in processing complex sets of results is ensured on both the producer and consumer sides. In our sample, we observed almost even distribution of ecolabels that focused on B2B, B2C, and those covering both.

3.1.5 Life cycle perspective

Principle 5 of ISO 14020 postulates that the development of ecolabels shall take into consideration all relevant aspects of the product's life cycle (LC) (ISO 2000). Life cycle thinking (LCT) and the application of LC-based evaluation tools (like LCA) in product certification are important, since it assures that burdens are not shifted between the different LC stages.

Through the online desk research, it was difficult and uncertain to track how ecolabels considered an LCT perspective and how they eventually applied LCA at the stage of criteria development. However, what we could observe with higher precision was to what extent these were addressed in their awarding criteria. In our analysis, we distinguished three variations of ecolabels according to the LC perspective and the application of LCA:

- Non-LC based—these can be product-based ecolabels that only consider a single stage or attribute of the product in their awarding criteria. Accounting of the complete LC at the stage of criteria development is not necessary, neither an LCA study is performed at any point (e.g., Chlorine-Free Products Association).
- LC-based—these ecolabels require only a qualitative LC screening of a product under consideration at the point of criteria development, whereas the awarding criteria could only focus on particular LC stages. A full LCA study is not necessarily performed. The classic ISO type I ecolabels fall under this category.
- LCA-based—such ecolabels consider all relevant environmental aspects of a product throughout its entire LC (cradle-to-grave), and full conformance with ISO 14040 (2006b) is required. ISO type III labels fall under this category.

Figure 4 shows the profile of the observed ecolabels regarding their LC perspective. About a third of them declared a non-LC perspective. Another third accounted themselves as LC-based, whereas the last third declared that their criteria were based on full LCA. Regarding the latter finding, 29% of these were type III labeling programs (for which, an ISO-conformant LCA study is anyhow mandatory). Another almost a third were other ecolabels that require LCA studies to be conducted. Strikingly, for over 40%, we could not prove through our research that they required a complete LCA for a product to meet certain criteria. This finding raises the question regarding the potential misuse of the term "LCA" in the subject of ecolabeling.

Almost 70% of the undefined ecolabels did not require a full LCA. Ecolabels were mostly based on specific environmental concerns within a particular product sector and on a particular LC stage of the product, rather than on a complete LCA. No clear tendency was observed toward an increased adoption of LCA by newer ecolabels.

3.1.6 Multiplicity of covered aspects

Ecolabels can be characterized based on the types and number of environmental aspects that they consider in their assessment criteria and the results profile they disclose, respectively. Herewith, we distinguished them only as single- and multi-aspect. Single-aspect ecolabels cover and report only one environmental aspect (e.g., CO_2-eq. emissions or recycled content), whereas the multi-aspect ones cover more than one. When it comes to LCA-based ecolabels, the communication of LCA results by a single or incomplete set of impact aspects shall be considered carefully due to the risk of burden-shifting between impact categories.

The majority (over 70%) of the ecolabels examined in this study were multi-aspect labels, to which the classic type I and III labels belong. Of the rest—the single-aspect ones, which did not follow within any ISO typology—approximately 65% were carbon footprint labels (e.g., based on single-impact category LCA studies or other accounting methods), and the rest were awarded as single aspects, such as energy consumption, share of renewable energy sources, or content/lack of certain substances (e.g., chlorine-free products).

3.1.7 Operation scope

The operation scope defines whether an ecolabel characterizes a property of the product, a production process, or an

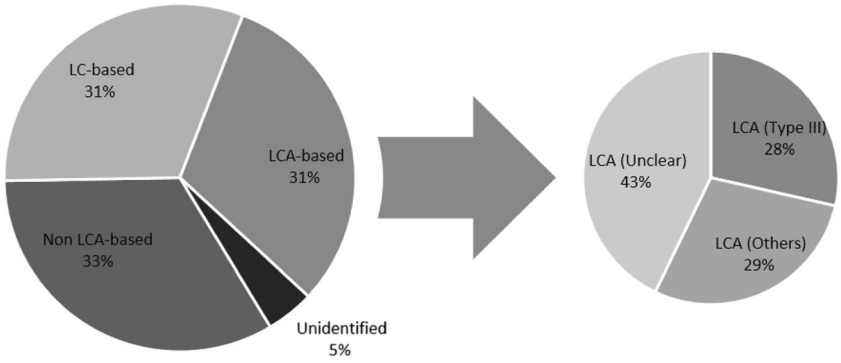

Fig. 4 Distribution of ecolabels from the sample by life cycle (LC) perspective

achievement of an organization. The former is usually what ecolabels refer to. However, as seen in our analysis, some can also address production processes or organizations (ISEAL 2015; Roe et al. 2014) (see, also, Section 3.1.3). Therefore, the operation scope can be distinguished between the following:

- The performance of a product—the ecolabel characterizes a property of the product or an ingredient of the product (e.g., the Biodegradable Products Institute Label awards a level of biodegradability) or the product use (energy efficiency);
- The performance of a production process—awarding criteria are developed regarding a step of or the whole production process or method (e.g., FSC, awarding sustainable forest management);
- The performance of an organization—in this case, an ecolabel awards certain achievement of an organization (e.g., LowCO_2 Certification, certifying the relative decrease of an organization's carbon footprint). The certification of an organization can be further related to a specific site (physical location) or to the overall performance or commitment of a company.

In the ecolabel sample, we observed all three types of operation scope; over three quarters of all characterize the performance of a product. The other two categories were equally distributed—approximately 10% each. Only undefined ecolabels certified the performance of organizations. The majority of LCA-based ecolabels certified the performance of products; nevertheless, beyond ecolabeling, LCA can be applied also to production processes and organizations (e.g., see Martínez-Blanco et al. 2015).

3.1.8 Sector scope

Regarding their production sector scope, ecolabels can be either sector-specific or multi-sectorial. In the first case, only one sector is covered and ecolabels are usually tailor-made for a specific problem at hand (de Boer 2003), e.g., Ancient Forest Friendly™. Multi-sectorial ecolabels cover products from different sectors; certification criteria are usually developed for each product group individually (e.g., Blue Angel). Such ecolabels are usually well suited to product sectors where the criteria are relatively easy to define and where "no controversial political conflicts exist" (Truffer et al. 2001).

Among the observed ecolabels, a quarter are sector-specific, and these are all undefined by ISO. All type I and type III labels are multi-sectorial, except for FP Innovations, an ISO type III operator serving the wood industry.

3.1.9 Geographic scope

Ecolabels can have a national, regional, or international perspective and scope. Regional ones are rare. Among the examined ecolabels, we considered the European-based initiatives like the EU Ecolabel, EU Energy label, and PEF (being around 7% of all) as regional. National and international ecolabels had an almost equal share of the rest (approximately 36 and 42%, respectively). Over 16% of the ecolabels could not be defined. It was noticeable that type I and type III labels were usually national-based initiatives, whereas most of the others declared an international scope (almost 60%).

3.1.10 Verification

Verification refers to the confirmation, through the provision of objective evidence, that all criteria and requirements of an ecolabel are met (ISO 2018). This confirmation is considered critical in strengthening the reliability of an ecolabel (Nikolaou and Kazantzidis 2016). We distinguished three types in our work. Since the ISO 14020 series do not use a harmonized terminology on this matter, we had to adjust the definitions, by using as a starting point the definitions by ISO 17000 on vocabulary and general principles for conformity assessment (ISO 2004):

- First-party verification—performed by the organization that applies for the ecolabel itself.

- Second-party verification—performed by an independent verification body that can be internal to the labeling program.[3]
- Third-party verification—performed by an independent third-party verification body that is external to the labeling program.

No verification is certainly an option, too. In our sample, only one ecolabel stated that verification was not required; two ecolabels performed a first-party verification. A total of 60% relied on a third-party (here, including all type III labels) and twice less used a second-party. Each of the listed verification forms could be observed in the undefined ecolabels.

3.1.11 Compulsoriness

Labels can be either voluntary or mandatory. The latter are relatively rare; examples according to the EPA (1998) and Rubik and Frankl (2005) can be, e.g., hazards or danger labels (e.g., a pesticide content label) or related to information disclosure (e.g., an energy label), i.e., they apply to only a specific set of goods and characteristics, and aim to reach standardized information disclosure (Gruère 2013). In this regard, ISO discourages any mandatory characteristic for environmental labeling programs individually, "including those developed or operated by government-sponsored agencies" (ISO 2016). Nevertheless, in practice, an ecolabel can become pseudo-mandatory in cases when major market players adopt it and further insist that their suppliers conform to it or when a producer is "forced" to use a certain label, because all its competitors do so. The only mandatory label in our sample is the EU Energy label, which is driven by EU legislation.

3.1.12 Governance

The mode of governance is critical to understand the incentives behind an ecolabel (Gruère 2013; Li and van't Veld 2015). One can divide ecolabels mainly by governmental or private ones. Furthermore, we defined an additional category for governmental initiatives that were managed by private companies, i.e., quasi-governmental. Private ecolabels can be managed by private for profits (PFP), private for non-profits (NPO), or non-governmental organizations (NGO). Usually, the market influence and penetration of programs run by governments is much higher when compared to the private ones (Banerjee and Solomon 2003).

Figure 5 represents the establishment of ecolabels from 1978 to 2015, showing a tendency of governmentally owned and operated ecolabels giving in to private initiatives. There have been no newly established governmental ecolabels since 2003, and almost all of them were established in the early 90s. An exception is PEF, counted separately here as a governmental initiative but is currently in the transition phase (Bach et al. 2018).

In our ecolabel sample, governmentally managed ecolabels had a share of approximately 25%. The rest were divided into PFPs, NPOs, and NGOs. We further observed that type I labels were typically governmentally (or quasi-governmentally) managed, whereas the rest (apart from the EU Energy label and PEF being governmental but not type I) were privately managed initiatives.

3.1.13 Financing

Ecolabel program holders apply a variety of combinations of funding sources, such as private or governmental financing, fees and/or member dues, donations, or industry funding, and hardly any rely on only one source. We obtained an average profile of the funding sources using data available for 34 ecolabels in our sample (see Fig. 6).

Apart from ecolabel fees, which is a source of financing applied by all ecolabels, the results showed that type I labels also rely on governmental subsidies. On the contrary, type III labels in the sample were financed only via license registrations and/or annual fees and member dues. Donations and industry funding were shown to be important funding sources for many of the undefined ecolabels. A small share came from conference revenues or investment incomes (indicated as "others" in Fig. 6).

Specific classification based on pricing could not be observed, as data were scarce and very heterogeneous. Financing was used as an additional sub-category under the attribute Transparency (see Section 3.1.16).

3.1.14 Purpose

Regarding their purpose, certain ecolabels can serve as a benchmark of achieving certain ideals or excellence (e.g., EU Ecolabel). We call these ideals-centric.[4] Others serve at the bottom line to show the avoidance of certain adversities, e.g., "chlorine free paper" ecolabels like the Chlorine-Free Products Association. Likewise, are the social labels or ecolabels that contain social criteria, claiming that their products have been created at least in a socially acceptable manner (e.g., Climatop). We call these adversity-centric. This categorization is applicable only for the seal and rating labels and is

[3] In contrast to this adapted definition, ISO 17000 determines a second-party as an activity that is performed by a body that has a user interest in the object (e.g., purchasers or users of an ecolabel), which cannot be the case in ecolabelling.

[4] According to de Boer (2003), ideals-centric labels are seriously criticized because they do not provide methodology to clearly distinguish individual products across an entire product category.

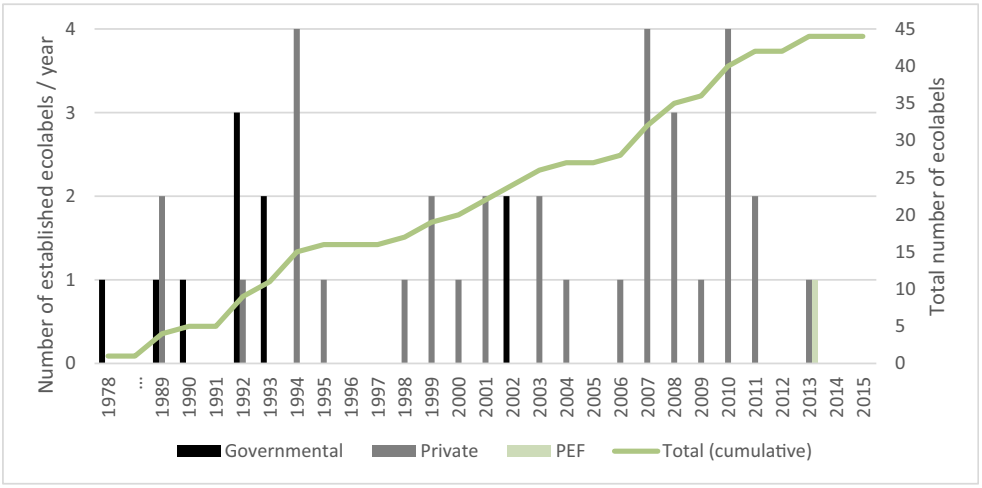

Fig. 5 Establishment of ecolabels (governmental vs. voluntary) and accumulation along the years (1987–2015)

based on the work of de Boer (2003). We categorized declaration types of ecolabels as "neutral" under this category.

In our analysis, all type I labels were logically defined as ideals-centric, whereas type III labels were neutral. For the rest, a mixture between ideals- and adversity-centric ecolabels was observed, whereas the latter were very few in number (below 10%).

3.1.15 Longevity

This attribute defines the fate of an ecolabel after expiration. An ecolabel can be either issued once and never be a subject of further verification again, or it can be updated (e.g., after expiration). The former we called "single-issued" ecolabels. In cases when an update is foreseen, an assessment and verification are required after a certain period or after the ecolabel criteria are revised (e.g., for type I labels). Significant changes in system elements (e.g., raw materials, suppliers) can be a driving force for, e.g., type III declarations to be updated. We named such ecolabels as "renewable."

Moreover, an ecolabel can also imply improvement requirements, i.e., the product must demonstrate an improved performance on a regular basis (e.g., a reduction of CO_2 emissions during the use phase by 10% every two years). We called this type "improvement-based ecolabels" or "reduction claims."

Regarding this attribute, our examination showed that all type I and type III were classified as "renewable," whereas for the rest, the information was controversial. "Single-issued" were usually the type II self-declared labels and, in our sample, many of the undefined ones, among which we also detected "improvement-based" approaches.

3.1.16 Transparency

Transparency is an indication of credibility and trust in an ecolabel, and it is undeniably worth observing. It should be assured through all stages of the ecolabel's development and operation (ISO 2018). In this relation, Principle 4 of ISO 14020 states that "information concerning the procedure,

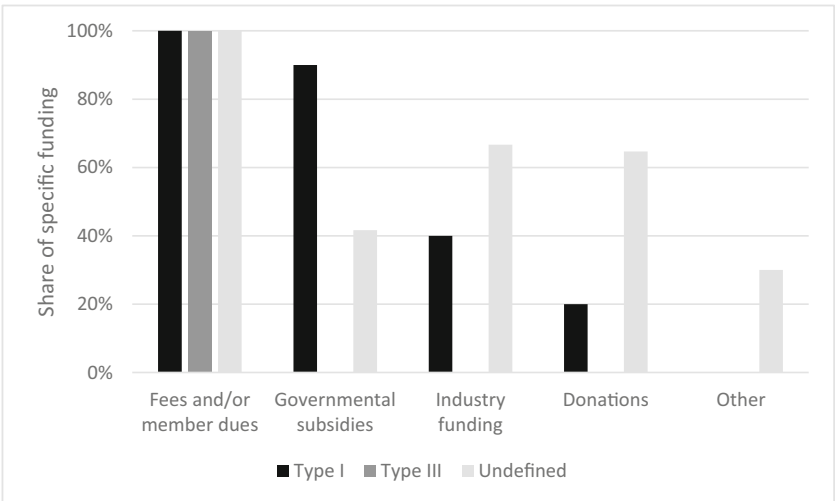

Fig. 6 Share of specific funding sources divided by ISO type

methodology, and any criteria used […] shall be available and provided upon request […]". Furthermore, Principle 9 develops on the necessity of relevant information on the environmental aspects of labeled products l to be accessible by purchasers (ISO 2000).

Gruère (2013) examined the transparency of ecolabels based on the following two factors: (1) the available information on the ecolabel setting process and (2) the available information on the publication of awardees. In addition to this, we included another sub-attribute, (3) access to information on financing.

In the final sample, we included only ecolabels for which information on the ecolabel setting process was assured; however, information on the awardees was available for two thirds of the cases. Data were mostly missing for the undefined ecolabels and type I labels. Regarding access to information on funding, information on the funding profile was obtained for 75% of the ecolabels (see Section 3.1.13), but only a third provided quantitative data on pricing.

3.1.17 Comparability

Comparability is an important attribute of an ecolabel when evaluating or promoting products (Marin and Tobler 2003). However, as the estimation of how an ecolabel ensures comparability between awarded products is subjective, we did not provide quantitative results of the observed ecolabels, but we base our estimation on the ISO requirements. As set by ISO 14025, type III should assure the user with the most objective level of comparability[5] among the three ISO types as long as the compared EPDs are based on the same PCR (Minkov et al. 2015). Type I ecolabels were counted at a level below, since a comparison is not possible between the products awarded the same ecolabel if a binary awarding is applied. Type II labels are very diverse in their criteria setting process, thus a level of comparability could not be adjudged. Nevertheless, ISO 14021 devotes a substantial part of the standard on defining rules for comparative claims.

3.1.18 Environmental excellence

This attribute determines whether an ecolabel assures conditions that allow for the demonstration of excellence by the labeled products among other products. Type I ecolabels promote environmental excellence by delivering credible information to consumers regarding the most environmentally friendly products on the market, also assuring in the criteria setting process that a certification is awarded only to the best performing products of a product category. In contrast, type III labels do not inform the end-user about environmental excellence, as they only provide the buyer with the environmental profile of the certified product and every product can theoretically obtain a declaration. Regarding type II and all the other undefined ecolabels, environmental excellence could be promoted, depending on the awarding criteria and ecolabel's objectives. Due to the subjective character of this attribute, quantitative results are not provided.

[5] "Comparability" shall not be confused with "comparative assertion" which is explicitly forbidden by ISO 14025.

3.2 Characterization scheme setting

In this sub-section, we overview the proposed attributes and their options in a characterization scheme, grouped under four topics. In addition, we provide a map of those attributes with the existing ISO and undefined types of ecolabels (see Table 3). As an outcome, recommendations for the enhancement of the current ecolabels characterization are proposed.

It is important to mention that, as no ecolabels were classified as type II in our sample, in the conclusive attributes (numbers 17 and 18 in Table 3), we evaluated the responses for type II based on the prescription of ISO 14021, but not on the results of the ecolabel sample. Moreover, the results in Table 3 are given in relative scores and are based on a mean value for the representative set (calculation formula is provided in the Electronic Supplementary material, sheet "Scheme"). Results are valid only for the examined ecolabel sample in this study.

3.3 Recommendations for the enhancement of ecolabel classification

The outcomes and findings of the analyzed ecolabels and the proposed characterization scheme in the preceding sections represent scientifically justified evidence that underline the need for improvements in the current existing classification of ecolabels.

By comparing the existing ISO typology against the proposed characterization scheme (summarized in Table 3), two main conclusions could be drawn, which are as follows: on the one hand, the standards on types I and III (ISO 14024 and 14025, respectively) are strict, clear, and demanding by their nature. Ecolabels declaring an affiliation to types I or III are well defined and much latitude is not allowed. However, these were about less than half of the ecolabels that we worked with. Furthermore, we observed a standstill in the development of new type I programs for several years, whereas type III have also seemed to have reached their peak (Arvizu-Piña and Cuchí Burgos 2017). On the other hand, about 60% of the observed ecolabels could not be assigned to any ISO type, whereas the added value to declare type II was not accounted by any ecolabel. These undefined ecolabels were characterized by each existing attribute option (see Table 3).

Given the above-mentioned findings and assuming that the ISO typology is the classification scheme used the most in

Table 3 Overview of the proposed characterization scheme and semi-qualitative comparison between the three ISO types and undefined ones; indication in the table is based on relative scores from 0 to 15: [XXX], always (15); [XX], frequently (8–14); [X], rarely (1–7); [ ], never (0)

No	Attribute	Type I	Undefined (type II)	Type III
Communication characteristics				
1	ISO typology	XXX		XXX
2	Awarding format			
	Seal	XXX	XX	
	Rating (non-sealed)		X	
	Rating (sealed)		X	
	Declaration (non-sealed)		X	XXX
	Declaration (sealed)		X	
3	Aspects diversity			
	Environmental (only)	XX	XX	XXX
	Social/health	X	X	
4	End-user focus			
	B2C	XX	X	
	B2B	X	X	XX
	Both	X	X	XX
Life cycle characteristics				
5	Life cycle perspective			
	Non-LC-based	X	XX	
	LC-based[b]	XX	X	
	LCA-based[c]	X	X	XXX
6	Multiplicity of covered aspects			
	Single aspect		X	
	Multi-aspect	XXX	XX	XXX
7	Operation scope[a]			
	Product	XX	XX	XX
	Production process/method	X	X	
	Organization		X	X
Standard characteristics				
8	Sector scope			
	Sector-specific	X	X	X
	Multi-sectorial	XX	XX	XX
9	Geographic scope			
	National	XX	X	XX
	Regional	X	X	X
	International	X	XX	X
10	Verification[d]			
	First party		X	
	Second party	X	X	
	Third party	XX	X	XXX
11	Compulsoriness			
	Voluntary	XXX	XX	XXX
	Mandatory		X	
12	Governance			
	Governmental	X	X	X
	Quasi-governmental	X		
	Private (PFP, NPO, NGO)	X	XX	XX
13	Financing[e]			
	Fees and/or member dues	XXX	XXX	XXX
	Governmental subsidies	XX	X	
	Industry funding	X	XX	
	Donations	X	XX	
	Other		X	
14	Purpose			
	Ideals-centric	XXX	XX	
	Adversity-centric		X	
	Neutral		X	XXX
15	Longevity			
	Single-issued		X	
	Renewable	XXX	X	XXX
	Reduction-based		X	
Conclusive characteristics				
16	Transparency[e]			
	Label-setting process	XX	XX	XXX
	Awardees	XX	XX	XXX
	Funding	XX	XX	XX
17	Comparability[f]			
	Low		? (undefined)	
	Medium	XXX	XXX (type II)	
	High		? (undefined)	XXX
18	Environmental excellence[f]			
	Intended	XXX	? (undefined)	
	Not intended		? (undefined)	XXX
	Possible		XXX (type II)	

[a] For undefined ecolabels, the total amount of occurrences exceeded the real amount of revised ecolabels, as several have claimed to support both, e.g., product and organization certification

[b] Optional for type I, according to ISO

[c] Requirement for type III, according to ISO

[d] Third-party verification is a mandatory requirement for types I and III, according to ISO

[e] Scoring is given to ecolabels that answer "yes." The sub-categories were evaluated independently from each other

[f] ISO perspective

practice (see Section 1.2), we call for a revision and upgrade of the currently existing ISO typologies and their respective standards. Herewith, we provide several specific recommendations for improvement.

3.3.1 Awarding format

We identified five different types of awarding formats (see Table 2), whereas currently only two have been

standardized—the seal and declaration. Emerging new types (e.g., the "rating (non-sealed)" type) may become largely adopted practice in the future. It is evident not only in practice, but also in the literature, that such new types have been tested (see, e.g., Thøgersen and Nielsen (2016) or (Weinrich and Spiller (2016)). Special attention should be given to these types of rating schemes as they could be misused by setting the reduction target or the benchmark in an accommodating way. Therefore, standardization could be especially useful. ISO should observe such developments and recognize, adopt, and classify them in an existing or new typology.

3.3.2 Aspects diversity

When ISO standards on environmental labeling were first developed, the communication of topics, such as social impacts, health and safety issues, or chain of custody certification, was still emerging and not the focus of ecolabeling. To date, none of the discussed ISO standards regulate social aspects. Nevertheless, the increasing importance of social issues is noticeable, due to the increased amount of initiatives working on this topic (Rubik 2015). We have also observed that in the last few years these aspects have appeared more often in ecolabels. Studies (e.g., Dendler 2014 and Nikolaou and Kazantzidis 2016) have suggested the use of overarching schemes that should provide more information on the social aspects together with environmental dimensions.

For future standardization activities, we recommend that ISO keep the currently existing ecolabeling standards from defining rules regarding criteria that are different from the environmental. Social and socio-economic aspects should be aggregated in (an) additional norm(s), where the specifics of such evaluations are addressed, referring also to existing guidelines for social assessment. As a result, there would be no need to define new typologies to only include social aspects. Instead, these could be counted as a sub-typology of a regular environmental type (e.g., a type I ecolabel).

In addition, given the increasing scientific literature on sustainability labeling (not being in the focus of this study), a logical next step would be the consolidation of guidelines on environmental with socio-economic aspects and the establishment of a future sustainability label typology, along with the existing types. This may require the development of a new standard. Currently, ISO 14021 explicitly prohibits self-declared claims "of achieving sustainability" (ISO 2016) and accepts the use of qualified claims of "sustainability" only by third-party verified schemes. These, however, are not in the scope of ISO 14021 and have never been discussed by ISO 14024 or by ISO 14025.

3.3.3 Operation scope

Considering the operation scope of ecolabels, the inclusion of the performance of organizations is seen as an emerging tendency, especially with regard to socio-economic aspects. The "classic" ISO types of ecolabels, however, are not intended to certify organizations, but products only, since product specificity is sought in their awarding criteria. Here, we recommend a similar approach as that for the socio-economic aspects, i.e., an eventual additional norm that defines the requirements on the scoping of organizations.

Nevertheless, further exploration is needed to determine whether there is a proven market or scientifically sound reason for the existence of such a new typology of product-specific ecolabel, covering organizational specifications. In any case, it should be noted that voluntary environmental management instruments for organizational assessment, such as the European Eco-Management and Audit Scheme (EMAS) (EC 2009) or the international ISO 14001 (ISO 2015), and guiding documents as the "Guidance on Organizational LCA" (Martínez-Blanco et al. 2015) already exist and as such should be attentively considered.

3.3.4 Verification

Independent third-party verification is necessary to avoid unfair practices by companies that use the imperfect consumer knowledge to increase economic benefits through self-claimed labels (Brécard 2014). Studies have assumed that self-declared claims cannot lead to improved environmental quality due to the lack of regulation of the ecolabel's awarding criteria and inconsistent evaluation systems (Shao et al. 2017; Brécard 2014). Nevertheless, a study by Yenipazarli (2015) suggested that ecolabels often did not apply external third-party verification due to the increased costs and the increased end price of the certified product, respectively.

Assuming the need for more information to be in a position to give a specific recommendation on this aspect, we provide only two perspectives for future consideration by ISO. One possibility is the delimitation of ISO from standardizing self-declared and non-third party-verified claims. An alternative is to allow for the standardization of non-third party-verified claims, but only when a certain level of transparency of the evaluation system behind the ecolabel is assured.

3.3.5 Reconsideration of the usability of ISO 14021

With their standard on type II labels, ISO seeks to harmonize the basic principles and requirements for self-declared claims. However, according to the current setting of the standard and its broad requirements, almost every environmental label or a claim that does not undergo third-party verification falls under the definition of a type II label. As seen in practice, an affiliation to it does not seem beneficial for ecolabel program holders. Thus, type II currently cannot be considered as a distinctive ecolabel type, but rather as a recommendation of following certain broad principles for self-declared claims. If a

description of an ecolabel is sought, we recommend that ISO reconsider the usefulness and usability of ISO 14021 and its extremely wide scope of application by being more specific in their criteria. Otherwise, we recommend the term "type II" to be made available for the description of a specific ecolabel typology as the current types I and III.

3.3.6 New ISO classification

In 2005, UNEP identified a need for the development of scientifically sound methods for the evaluation of the real environmental effects of ecolabels (UNEP 2005). Among several reasons for the absence of such methods, the lack of proper classification of ecolabels was listed. To date, improvements in this direction are not known. In this sense, the characterization scheme presented in this paper could be used by ISO as a basis for the further proposal of a new, improved, and more detailed classification. This should incorporate the interlinkages between the attributes defined in this work and classify the many more types that exist beyond the ones of today. Ultimately, the creation of a new classification should also consider the market and consumer behavior perspectives—aspects not dealt within this work and are subjects for additional research.

3.3.7 Improved transparency as an indirect outcome of a stricter ISO classification

Overall, transparency and access to information are decisive to reliability and trust. Our examination of the existing ecolabels revealed that often information was hard to obtain, thus bringing doubts about the ecolabels' aims and the plausibility of their awarding criteria. For example, an attribute influenced by the transparency of awarding criteria is the LC perspective, where we observed that vague and inaccurate information led to the misuse of terms such as "LCT" and "LCA."

Additionally, the program function, the financing mechanisms, or the governance of ecolabel schemes are important aspects for which information should be accessible. ISO set explicit requirements on transparency, but, being voluntary, these standards are not binding. If incentives for a better acceptability of the ISO classification are in place (e.g., the ones we suggest previously), the adoption of ISO among ecolabel program holders would increase, thus improving the transparency of the respective ecolabels that they manage.

4 Conclusions and outlook

This paper contributes to the scarce availability of scientific work related to the classification of environmental labels. We provide a set of scientifically derived attributes in the form of a characterization scheme for ecolabels which fills the gap in characterizing the currently existing types of ecolabels. From a practical perspective, our contribution is considered as an initial step toward a consistent methodological framework to provide clarity within the plethora of ecolabels on the market and to guide an improved classification of ecolabels.

The analysis of the elaborated representative ecolabel sample against the proposed characterization scheme revealed that nowadays, the existing typology provided by ISO does not serve properly as a classification and differentiation medium for ecolabels anymore. Although a general approach of ISO is to develop standards when there is a clear market requirement, we currently observed a great variety of ecolabels that were not covered by the current existing ISO guidance and, thus, were classified as "undefined."

In this work, we recommended that ISO refine the current classification and criteria for ecolabel development. We expect this to lead to improvement in the standards' robustness and credibility by being up-to-date with the latest developments in the ecolabeling world. An improved classification would, on one hand, incite ecolabel programs to rely more on ISO and to actually apply their guidance. This would result in the improved transparency of the ecolabeling setting processes and, thus, in better market positioning. On the other hand, this should facilitate companies that intend to certify their products in the selection of the most appropriate type of ecolabels for their products. This is expected to ultimately have an impact on the end-users by facilitating their choices when purchasing products.

On a more general level besides the recommendations to ISO, the proposed characterization scheme can be of use for a variety of stakeholders. Ecolabel program holders can apply it to juxtapose their existing or prototyped schemes with the ISO typology or to compare them with other ecolabels. Companies looking for appropriate ecolabels for their products can support their informed choices by analyzing different schemes based on the attributes they are interested in. This was successfully tested in previous study by Minkov et al. (2018), where an initial version of the scheme was applied to compare three different ecolabels.

The scope of this work was limited by covering ecolabels only for one specific sector "forest and paper products" (with the inclusion of a few others). This limitation bears the risk of missing certain attributes or an option of an attribute that is held by an ecolabel that was not covered in this study; nevertheless, we assume that no substantial additional attributes are missing for a general application of the scheme. Further expansion of the ecolabel sample to include other product groups is considered useful to improve the statistical representativeness of the results, to observe whether significant changes would occur, and maybe, also, to fine tune certain attributes.

Besides, during the course of this work, we identified issues that were not tackled within this paper but deserve

appropriate research in the future. First, LCA is a well-developed and recognized method for assessing the potential impacts of products and reducing the risk of one-sided environmental characteristics (Gruère 2013; Finkbeiner et al. 2014). Its use in ecolabeling is justified by the need to cover wider types of impacts (see Section 3.1.5). However, it still seems controversial, and some questions worth exploring include (1) whether it is the high cost, complexity, or verifiability as to the reasons why the application of LCA in ecolabeling has not increased lately, (2) whether LCA is a solution for each case and ecolabel, and (3) whether its potential has been fully realized. In this sense, forest management labels, like FSC, call upon all who apply or use LCA to recognize its limitations (FSC 2016).

Second, ecolabels are often criticized regarding their vagueness about environmental themes and "[…] their failure to assure the buyer about the product's ecological impact [...]" (van Amstel et al. 2008). Ultimately, the overall goal of ecolabels is "to encourage the demand for and supply of those products and services that cause less stress on the environment" (ISO 2000). Thus, operational and widely accepted methods for evaluating the real environmental effects of the use of ecolabels should be in the scope of further research.

Third, as indicated in Section 3.3, the development of a new and improved ecolabel classification would benefit the most from future research that incorporates the outcomes of this work together with studies orientated to consumer behavior and market analysis.

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