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123 Designing an assessment methodology and tool for Circular Economy academic projects

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Abstract

This project responds to the research question of how to evaluate circular economy projects in the academic context. For this purpose, it takes two programs, Recircula Challenge and Circular Economic Awards, of the HUB Recircula of the Polytechnic University of Catalonia (UPC) as case studies. The development of the project follows the Action-Research methodology. For its process, the Recircula HUB organisation, the participants of the competition, and the jury of the Recircula Challenge program were involved. The project methodology is divided into three cycles; the first cycle defines the problem; for that end, it analyses different circular economy evaluation methodologies currently used in organisations and companies and defines the requirements to be met by the evaluation tool of the program. The second cycle co-designs the tools and develops the circular economy evaluation methodology using templates and rubrics created ad-hoc for each program. The third cycle evaluates and reflects on the tools and the implementation process by analysing consistency and validity. Finally, the project shows the two tools developed in this project consisted of templates for the participants and evaluation rubrics for the jury members. It concludes by pointing out the importance of learning and awareness-raising resources for university students and its potential to improve circular economy in higher education. Moreover, the results of the work show that environmental impacts are the most difficult to understand and the least adequate to evaluate. Therefore, it is necessary to deepen and reinforce this aspect among students and participants of the programs through workshops, working examples, and reviewing the criteria established for its evaluation. To this end, it is very important to achieve a common understanding of the designed tool and its concepts. To conclude, at present, Circular Economy projects are at the forefront of Sustainable Development; this work seeks to generate greater awareness and appreciation in academia by introducing the concepts and methods to measure such projects' results.

Keywords: Circular Economy, Sustainability education, indicators, rubric, impact

Introduction

The current linear (extract-use-throw) production model relies on the use of the environment and natural resources to continue to have destructive effects on the planet. However, the current climate, ecological and environmental crisis highlight the need to introduce changes to alleviate production and consumption model pressures on Earth. In this line, the circular economy emerges as a potential alternative to the conventional model. In the European context, it is strongly promoted through the new Circular Economy Action Plan mechanisms; in 2015, the ambitious "Closing the Loop" action plan was adopted (European Commission [EC], 2012). It has been followed by the recent "A new Circular Action Plan" in 2020, part of the European Green Deal (EC, n.d.). Furthermore, Sustainable Development Goal (SDG) 12 aims to ensure sustainable production and consumption patterns globally.

This new paradigm, born in the 1980s from the philosophy of industrial ecology (Andersen, 2007), proposes to rethink and redefine current needs and how to satisfy them following three basic principles; extending the useful life of products, maintaining their usefulness, optimizing the resources used throughout the life of the product by minimizing their negative impacts, and closing the cycle by retaining value of the materials used. Unfortunately, not all circular models are sustainable. Therefore, it is important to assess the model's sustainability by combining two key concepts: the need for transformation to a resource-efficient model and the need for a more sustainable society.

Context of the case study

The work frames in the HUB Recircula of the Universitat Politècnica de Catalunya (UPC). It aims to educate future experts in the Circular Economy and SDG 12, aiming to do more and better with less to decouple economic growth from environmental degradation, increase resource efficiency, and promote sustainable lifestyles. Furthermore, the HUB acts as a network between students and public and private entities; the relation is established through different programs, Recircula Challenge and Circular Economy Awards. The Recircula Challenge program spotlights the problems private and public organisations face and incentivises the participants to give potential solutions upon the circular model. The Circular Economy Awards program recognises the best circular economy final study project of UPC.

Considering that there are no tools to evaluate the results of circular economy projects at the academic level, this paper aims to answer the following research question: "How to evaluate circular economy projects in a systematic, objective, and efficient way in the academic context?".

In this line, the general objective of this work is to design a tool for the evaluation of projects that assesses the circularity of them for the two programs, Recircula Challenge and Circular Economy Awards. The tool has to be flexible, meaning that it has to apply to any project results evaluation regarding the circular economy. Furthermore, it will serve as a learning resource for authors of the projects and evaluate the programs mentioned above. This last application has two objectives: on the one hand, to guide the participants to carry out their self-assessment and measure their performance. On the other hand, systemise and standardise the jury's assessment and obtain a unique ranking that compares the different projects. For this, two specific goals have been defined:

- **Versatile Assessment:** The first goal considers versatility as a key characteristic to evaluate projects since students develop projects of diverse nature. The tool has to be valid in circular economy technical nature projects.
- **Holistic assessment:** The second goal is to obtain a holistic evaluation. The tool has to systematically evaluate the critical aspects that make the project sustainable and circular, thus assessing the potential for success of long or short term projects.

To that point, the work redefines the evaluation of both programs, including cross-cutting criteria (circular economy) to evaluate the proposals in their entirety. To that end, ad-hoc evaluation has been conducted by integrating the specific rules of each competition, defined by the HUB management, thus differentiating two tools, one for each program. Both tools are based on different rubrics at three-level that have made possible to establish the evaluation criteria. The evaluations of all members generate the final ranking list from which the award-winning projects are discussed.

In this work Recircula Challenge 2021 edition has been piloted; the jury members and the authors of the works who were subsequently evaluated participated actively. As a result of their continuous feedback during the tool development process, the proposed improvements have been established.

Finally, this work contributes to meeting different SDGs; the HUB Recircula aims to create knowledge to achieve SDG 12 for Sustainable Production and Consumption. On the other hand, the HUB also acts as a connector to create new alliances between public-private actors and students from different universities since it accepts the

participation of contestants not linked to the UPC, favouring the achievement of SDG 17 (Alliances to achieve the Goals). Lastly, this work tries to develop a fair and equitable evaluation method for the named contests at the UPC responding to SDG 16 of Peace, Justice and Solid Institutions. However, it should be mentioned that these programs aim to visualise the good work of students, but mainly to raise awareness and sensitise future professionals on the need for action in changing the production and consumption model.

Method

The work has followed Action – Research (AR) methodology (Coughlan & Coghlan, 2002). It is a participatory process characterised by active and close contact between the researcher and the agents of the organisation - in the context of this work is the Recircula HUB - so that both form part of the research team and constantly interact in the process (Hussey Roger & HusseyJill, 1997). This method aims to analyse new facts and at the same time collaborate in the transformation of certain unsatisfactory conditions. Therefore, it is of the utmost importance that the researcher understands the reason for the work. Likewise, the concept of AR refers to a learning process, which involves understanding and managing the knowledge acquired from the existing theory and apply it in practice. The AR process has four basic phases: planning, action, development, and reflection (Mertler, 2008). The methodology consists of continuous cycles of reflection, whose strong point is to understand in-depth the phenomenon to be analysed and increase the level of knowledge of the problem (Alan & Emma, 2011). These phases can be broken down into nine specific measures that make up the complete cycle.

The planning phase is responsible for defining the plan before development (measures of planning phase: identification and definition of the scope of the content; a collection of information; literature review; development of the research plan). Next, the act phase implements the plan (measures of act phase: implementation of the plan and piloting; data analysis). Subsequently, the development phase is an action plan that includes the review and improvements of the phase before (measures of development phase: development of an action plan). Finally, the reflection phase reflects the entire process and shares the results obtained (measures of reflection phase: communication of results; the reflection of the process).

In this work, three research cycles have been designed. The first cycle, called the definition of the problem, aims to study current methods to evaluate the circular economy and identify the requirements of the tool. The second cycle, called the design of the tool, aims to develop an evaluation tool for academic projects. The last and final cycle called evaluation reflects on the tool development process (see Figure 1). The

research methodology has a common base, the problem definition cycle, which derives into two parallel tool development cycles: the Recircula Challenge and the Circular Economic Awards. Finally, the process ends with the evaluation cycle applied in the first case (Recircula Challenge), since it is where the developed tool has been implemented and piloted. Therefore, in the evolution of this work, three different states are differentiated:

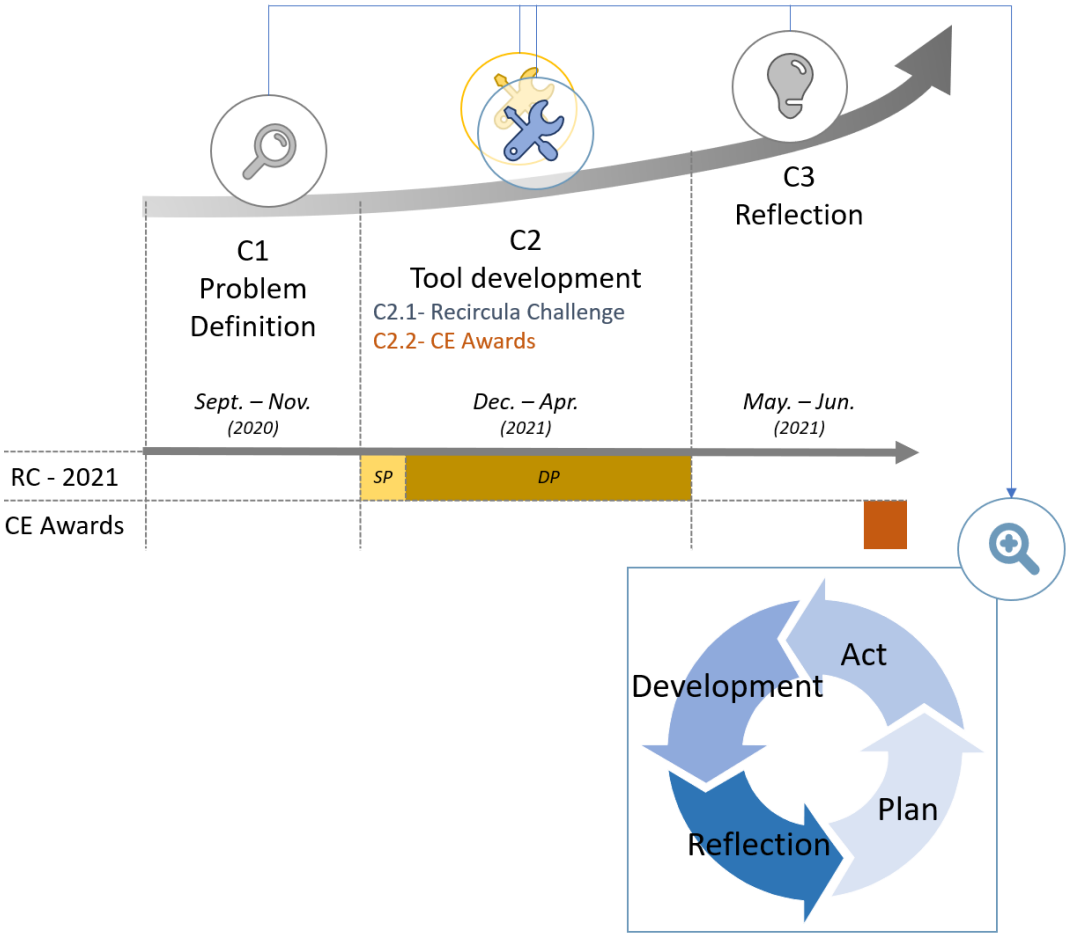

Figure 1. AR Cycles.

Note: RC: Recircular Challenge; CE Awards: Circular Economy Awards; SP: Selection Phase; DP: Development Phase.

Cycle one – Problem Definition

The problem definition cycle includes everything related to state of the art in circular economy assessment tools. Moreover, the co-definition done with the programs' organisers gathers the points to measure with the tool. Regarding the literature research, scientific and non-scientific articles dealing with indicators or circular economy assessment tools have been analysed; see Figure 2 for the applied process.

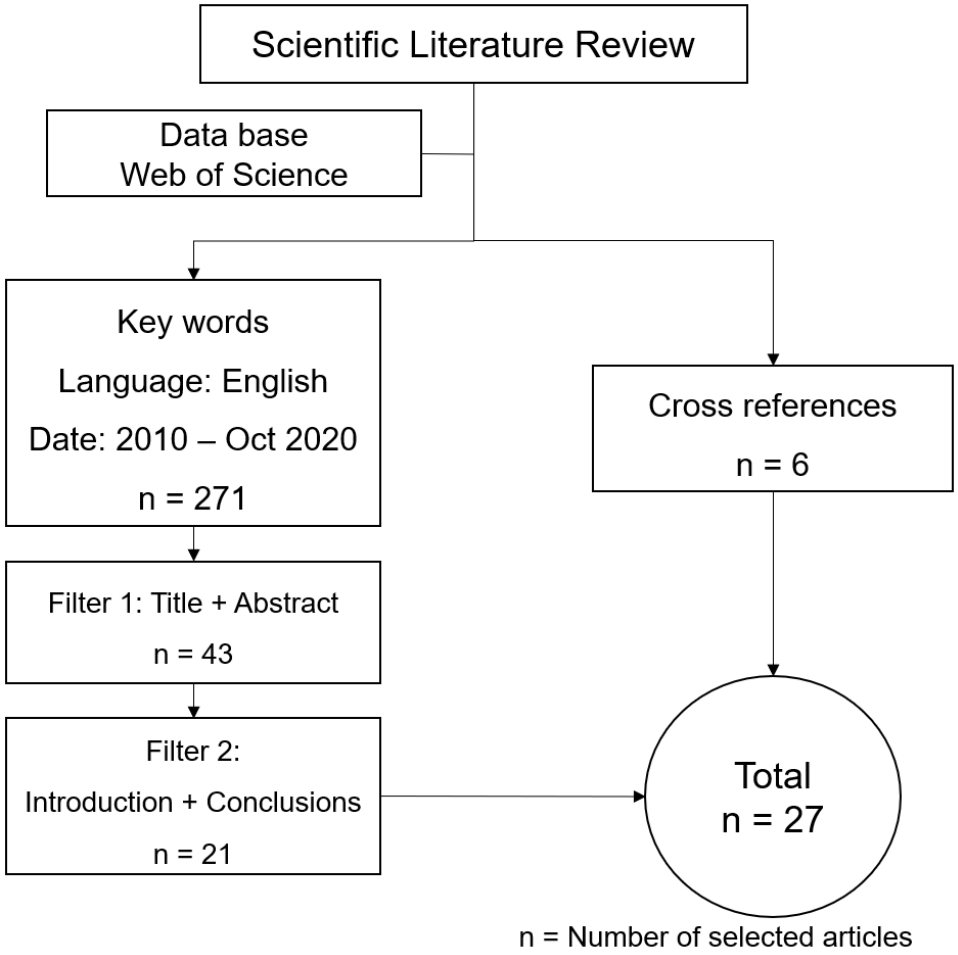

Figure 2. Process for literature review.

In addition, the programs' contents provide the established criteria and the aspects that the tool must include.

Cycle two – Tool development

The second cycle focuses on the design of the tool. This stage involves multiple actions to build the evaluation methodology. The tool has been developed starting from cycle one. Successive cycles of action and development have been necessary to validate the tool with the coordinators of the programs. The second cycle ends with a joint reflection between the participants and the members of the jury.

The first step is to design the evaluation method; to that end, rubrics and report templates have been used. The evaluation rubric is composed of levels, categories, categories definition, and criteria that define each level's requirements. The template for participants is compound by different categories and phases, explicitly describing each category's requirements. Then, the validation of rubrics criteria and templates has involved successive implementation and piloting of the tool. Finally, the utility and difficulty of the tool have been valorised by participants and members of the jury.

Cycle three - Evaluation

Finally, the final evaluation has been done in the third cycle from the observed results and the development process. For this, the repeatability of the evaluations and its limitations have been analysed.

The agreement of the evaluation is measured by Fleiss Kappa coefficient (Fleiss, 1981) that represents the level of association between the evaluations. In addition, the global score (final quantification of the project grade carried out by means of the weighted average of the dimension evaluations) of the kappa coefficient has been analysed. This coefficient measures the degree of concordance of nominal or ordinal evaluations carried out by multiple evaluators when evaluating the same samples. The statistic can vary between -1 and +1; being -1 no agreement in nothing observed, 0 the agreement not better than chance, and values greater than 0 increasing agreement; the maximum value is+1, which indicates a perfect agreement.

Results and Discussion

Recricular Challenge

This program has two phases, the selection phase, which aims to select those projects that fulfill the program requirements, and the development phase, in which participants expose the solutions and the best project is awarded.

Selection Phase

The categories of the evaluation rubric, the definition, and the weight for each category are described in Table 1. Next, the jury member has to identify the level of the evaluation scale for every project. The average of the evaluation is the final score; for the initial question, more than half of the jury has to give a positive response to the project for continuing in the program.

Table 1. Selection phase rubric.

Evaluation category	Definition	Weight	%
Circularity, systematic vision, and efficiency in the use of resources.	It is the essence of the program. The following question is answered: *" Is a technology-based solution proposed, and does it improve the life cycle of products or services following the principles of the circular economy sustainably?"*	Yes/No	-
Design and quality Technique.	The projects in this first installment are in the phase of ideation, so it requires: • Definition of the problem and objectives of the draft • Definition of the methodology to achieve the objectives	5/9	50
Social impact of the proposal.	It refers to which sector and segment of society target the proposal and which actors they want to involve in the project; it has been characterized as: • Potential market and socio-economic impact provided	2/9	22,5
Innovation and creativity.	The innovation and creativity potential of the proposal	2/9	22,5

After implementing the first evaluation rubric, an evaluation meeting was held from which the following comments about the tool were received:

- The rubric is too developed to assess a large number of projects; it requires a lot of time to assess the projects (average of 4.5 hours to evaluate 21 projects; 13 minutes / project);
- There is a necessity to simplify the categories of evaluation;
- Rubric levels and scores vary, complicating the assessment.

Five members carried out the evaluation using tool out of eleven who completed the jury. After these comments, the decision to modify and simplify the evaluation was taken. As a result, the following two categories were left:

- Circularity, systemic vision and efficient use of resources: adaptation to the challenge
- Design and technical quality

Development Phase

The development phase is structured in two sections, feasibility of the project and impacts, each of them contains three categories:

A. Project feasability - 50%

A.1 Project identification, obajectives and proposed solution - 20%

A.2 Network and key stakeholders – 15%

A.3 Design, quality and technical feasibility – 15%

B. Impacts - 50%

B.1 Social impacts – 20%

B.2 Environmental impacts – 20%

B.3 Economic impacts – 10%

Tool valorisation

The form for participants and jury members has six questions that briefly collect their perception of the usefulness of the tool, the difficulty of completing it, along their comments. A total of seventeen people responded; the results are described below.

The majority of the participants found the template useful; 58% answered that they found it useful or very useful, while 16% believed it was not useful. If we compare with the difficulty, 25 % believe that it is difficult, and 50 % think that it is easy or very easy to complete. Thus, in general, the template has been useful, while its difficulty has varied.

Regarding the template sections, the easiest ones to complete were; identifying the problem, objectives, and solution and calculating the economic impact, while calculating the environmental impact was the most difficult section. Furthermore, the difficulty of the different sections ranges from easy to complete to adequate difficulty; although the difficulty is intermediate, the sections "Design, quality and technical feasibility" and "Environmental impact" are the most difficult to complete for the participants.

On the other hand, the participants' comments highlight the issue with the template format; several participants are not satisfied with the design: font, colors, etc. On the other hand, other comments pointed to the way how the challenge organisers sent the template to the participants, the lack of different template languages diversity, and the lack of a model template that they could follow. Moreover, suggestions to define more than one template model were received.

Regarding the jury's assessment results, the answers suggest that the difficulty of completing the evaluation rubric is great although the tool was found useful. Two out of five felt that was difficult compared to one who felt it was easy, but all five felt it was a useful, quite useful, or very useful tool for evaluation. Regarding the categories, the survey asked about the adequacy of the criteria for evaluating the proposals. In general, the opinions are that the tool is adequate, except for environmental impact and economic impact. In general, positive comments were received, but suggestions for improvements aim to restructure the template and rubric.

Circular Economy Awards

Circular Economy Awards program has unified the template with the rubric, having a single product, see Table 2 for the program template and rubric scheme.

Table 2. Circular Economy Awards template and rubric scheme.

Project category	Weight (%)	Dimensions	Weight of the dimension (%)
Scope	15	Temporal scope	30
		Geographic and sectoral scope of the project	35
		Potential audience / Market	35
Circularity	25	Circularity	50
		Creativity and innovation for the EconomyCircular	50
Sustainability	10	Dimensions of Sustainable Development	60
		SDG-related indicators	40
Result	50	Project impact / Proposal effectiveness	30
		Efficiency in the use of resources	30
		Feasibility of the proposal	20
		Risks and opportunities	20

From the general comments, the main difficulty is the length of the template. Therefore, it was denied implementing the tool in the 2021 edition without prior training and dissemination. Finally, it has been decided to pilot its implementation in the Master projects of 2021 edition without being mandatory to complete all the sections. This is because the template should collect the information of the works and should not develop anything outside the scope of the already finished final work projects.

Evaluation Cycle

All the jury members agreed that all the requirements of the program phases were integrated into the evaluation as well as the project impact assessment. But, anyway, some difficulty has been observed when identifying impacts and subsequently measuring them. Due to this, the jury brainstormed to give ideas for improvements, being following three the most liked ideas:

- The necessity to train on how to measure impacts within the program's workshops
- The necessity to define a template example so that participants have a reference
- The necessity to integrate the rubric in the template

Therefore, the methodology to measure the impacts of the projects should be reviewed. The template defines a section for each impact category which can be too ambitious when no further help has been given to the participants. Modifying the template to a freer format (providing a clear definition of the objective) could facilitate the participant's task. Moreover, adding the evaluation rubric in the template would not only improve the transparency in the evaluation, but it could also improve job performance.

Finally, it should be noted that the impact of the program on participants has not been evaluated; the HUB provides a series of workshops where different useful tools are explained for the development of proposals. In addition, the problems that arise in the Recircula point out real cases of the private and public organisations that need innovative solutions. For future editions, the program impact assessment on the participants could be measured, considering the rise of environmental awareness and the acquired knowledge about tools and methodologies for evaluating circular projects.

Regarding the rubrics agreement study, which measures the concordance between the evaluators, between the different phases, the results evidence that it has been improved from a weak level (k=0.37) to a moderate level (k=0.47). It means that the rubrics have been adapted between the two phases. In the selection phase, the rubric was implemented for the first time, while the development phase rubric is the improved and adapted version of the rubric of the selective phase. On the other hand, credibility is provided by the continuous revisions and meetings held during rubrics development, which ensures that the criteria may be adjusted to the reality of the program.

However, the objective is not to have a *k* coefficient of one since it would mean that there is no variability between the evaluations of different people; therefore, a single evaluator would be sufficient to evaluate all the projects. Moreover, the program invites different profiles of experts precisely to diversity the perspectives, so the tool's objective is not to eliminate subjectivity in the evaluations.

On the other hand, from the selective phase, where the projects are not very mature and dispersed (in some cases), there is an improvement in the consistency of the evaluations to the development phase that could be due to the improvement of the rubric criteria definitions. Still, the main reason is the maturity of the projects, as they evolve from the first phase and, what is more, the template factor, as it defines the requirements of each section in detail.

Likewise, and intuiting that the template improves the reliability of the evaluations, consideration should be given to introducing the rubric in the participants' template for self-evaluation. In this way, the differences between the evaluations of the jury and the participants could be analysed.

Conclusions

This work answers the research question of how to evaluate circular economy projects in a systematic, objective and efficient way in the academic context. It does so by developing tools composed of templates and assessment rubrics that identify the characteristics to be assessed. Therefore, the objective of designing an evaluation tool for circular economy projects for the Recircula Challenge and Circular Economy Awards programs has been achieved. Furthermore, the result of the work is a new contribution for the UPC, since previously it has not worked in this type of tools oriented to the academic context.

The tools cover the most relevant categories to systematise the evaluation of the projects. Although ad-hoc tools have been developed each competition, the same development process has been followed. The following can be concluded:

A shared language and understanding by all users of the tools (participants and jury members, in addition to the whole organisation of the programs) about the concepts and factors included in the circular economy projects are necessary to achieve the objective of this work. Therefore, constant communication between program organisers has been a key aspect to agree on the tools.

On the other hand, measuring the results of the projects has been one of the difficulties identified by this project. The first limitation has been in the measurement methodology since the indicators are diverse, and their application depends on the type of action. For this reason, it was decided to develop a set of indicators adaptable to different types of proposals. Moreover, not having specified or limited the measurement of impact has made its subsequent evaluation difficult, and therefore its assessment criteria are generalised.

During the tool building, the characteristics of academic circular economy projects have been defined. Since these characteristics are subjective and ambiguous concepts, they have been discussed and reflected upon. Finally, the tool attempts to integrate the different approaches in the evaluation.

Recircula Challenge

In general, a high degree of usefulness of both the template and the rubric has been observed from the piloted tools; the surveys show that the "Environmental Impacts" section is the most difficult to understand and the least adequate to evaluate. Therefore, it is necessary to deepen and reinforce this aspect through workshops, other work examples, and reviewing the criteria established for its evaluation. To this end, it is very important to achieve the aforementioned understanding.

On the other hand, the consistency and validity of the rubrics analysis indicate a high variability among the qualifications of the jury members. However, this is not an aspect that should be evaluated negatively since each jury member responds to a different profile of expertise. Therefore the variability in the evaluations is accepted. Likewise, the tool has to be revised and adapted along the next editions since the diversity of evaluated projects gives versatility and flexibility.

Circular Economy Awards

The fact that it has not been possible to implement and pilot the tool in this program has not allowed obtaining user ratings. From the feedback of the members of the jury of the last edition and the organisers of the HUB, a need for gradual integration of the tool has been concluded. This tool is considered to support the development process as it integrates the structure of the works and the self-evaluation rubric.

In the evaluation, the results section dimensions and criteria have been the most difficult to establish. This section covers environmental, social, and economic impacts holistically. The key for its evaluation was to focus on assessing the efficiency and effectiveness of the project.

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