

Adaptación de los indicadores RRI para la evaluación socioambiental de los Centros Tecnológicos de la Comunidad Valenciana

Adaptation of the RRI indicators for the socio-environmental evaluation of Technology Centres in the Valencian Community

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Abstract

The study of the social integration of science and innovation, as well as the responsibility of the actors in the Science Technology and Innovation system with this integration, is a topic that is increasingly requiring greater prominence. The question is currently being raised as to how the structures or actors in the STI system can be modified and, therefore, how responsible practices can be designed and integrated to induce institutional change.

Technology Centres, as agents of the innovation ecosystem, are private, non-profit research organisations that have their own material and human resources necessary to carry out activities aimed at both generating technological knowledge and facilitating its exploitation, either by existing companies or by generating new business initiatives. As agents of the innovation system, their activity must contribute to the socioenvironmental advancement in their territory.

In this paper we propose a methodology based on adapted RRI indicators for evaluating the social responsibility of the activities carried out in technology centre. We apply it to the specific case of the Technology Centres in the Valencian Community. The results show different degrees of maturity level for each of the RRI dimensions analysed.

Keywords: *Responsible Innovation, Technological centres, RRI indicators, evaluation*

Resumen

El estudio de la integración social de la ciencia y la innovación, así como la responsabilidad de los actores del sistema de ciencia, tecnología e innovación con esta integración, es un tema que cada vez requiere mayor protagonismo. Actualmente se plantea la cuestión de cómo se pueden modificar las estructuras o los actores del sistema de ciencia, tecnología e innovación y, por tanto, cómo se pueden diseñar e integrar prácticas responsables para inducir el cambio institucional.

Los Centros Tecnológicos, como agentes del ecosistema de innovación, son organizaciones de investigación privadas y sin ánimo de lucro que cuentan con los recursos materiales y humanos propios necesarios para llevar a cabo actividades dirigidas tanto a la generación de conocimiento tecnológico como a facilitar su explotación, ya sea por parte de las empresas existentes o generando nuevas iniciativas empresariales. Como agentes del sistema de innovación, su actividad debe contribuir al avance socioambiental en su territorio.

En este trabajo proponemos una metodología basada en indicadores de RRI adaptados para evaluar la responsabilidad social de las actividades realizadas en los centros tecnológicos. La aplicamos al caso concreto de los Centros Tecnológicos de la Comunidad Valenciana. Los resultados muestran diferentes grados de nivel de madurez para cada una de las dimensiones de RRI analizadas.

Palabras clave: *Innovación responsable, centros tecnológicos, indicadores de RRI, evaluación*

1. Introduction

Organisations in Spain that fund and/or carry out research increasingly value the need for more dynamic governance and better social integration of research and innovation. (Revuelta, 2013). Internal drivers of change, such as the digitisation of science and the political will to better align with the needs and concerns of society, are generating policies and processes of transformation of the Research, Development and Innovation (RDI) system that include all aspects related to Responsible Research and Innovation (RRI).

The European Union, as the driving force behind this reality, is establishing what the *Europe 2030* growth strategy (*Una Europa sostenible de aquí a 2030 | Comisión Europea*) considers, as one of the three priorities of this process, the development of smart growth, based on knowledge and innovation, capable of ensuring that innovative ideas can be converted into products and services that generate growth and employment. (Geoghegan-Quinn & European Commission, 2010). However, economic growth cannot be alien to the social and environmental challenges we face and therefore the European strategy also prioritises the achievement of an economy based on sustainable growth, which makes efficient use of resources without undermining its competitiveness.

The definition of RRI is firmly anchored in European policy processes and values. The RRI concept emerged almost 10 years ago in 2013 from a rather limited academic debate, centred on the need for responsible innovation. (Hellström, 2013). Today this idea is part of EU research and innovation policy as a cross-cutting theme in the current Horizon Europe programme and in the European Union's aim to become a true Innovation Union, where research and innovation are the main drivers of competitiveness, employment, sustainable growth and social progress. Likewise, the recently approved Spanish Science, Technology and Innovation Strategy (2021-2027) includes as one of its main lines of action, Axis 14, whose aim is to promote the commitment of Spanish society to RDI, fostering scientific dissemination and culture, reflection on the role of science and technology in today's society, and promoting open and inclusive science and innovation.

All of the above leads us to conclude that the study of the social integration of science and innovation, as well as the responsibility of the actors of the RDI system with this integration, is an issue that is not only topical, but one that will increasingly require greater prominence.

However, the discourse should not only address the responsibilities of individual actors, but also the responsibilities associated with the structures to which they belong. This raises the question of how structures can be changed and thus how RRI processes can be designed and integrated to induce institutional change. (Macnaghten et al., 2014)(Wiarda et al., 2021).

RRI reflects different lines of activity that we summarise here according to their most prominent authors: anticipatory governance (Karinen & Guston, 2009), constructive real time evaluation and other forms of technology assessment (Guston, 2014) and (von Schomberg, 2012), previous consent (Wilsdon & Willis, 2004), value-sensitive design (Friedman et al., 2017) socio-technical integration (Fisher & Schuurbijs, 2013), corporate social responsibility (Glerup et al., 2014), transdisciplinarity (Wickson & Carew, 2014) and, finally, the perspectives or thematic areas (Strand, Spaapen, Bauer, Hogan, Revuelta, Stagl, Paula, & Guimaraes Pereira, 2015).

Following initial attempts to define the term and promote it as a relevant aspect of research governance, there is now growing agreement on key aspects of RRI and possible means of implementation (B. C. Stahl et al., 2017).

In this paper we will approach responsibility in science and innovation, as a complex concept from different perspectives, also called thematic areas, following the guidelines of the work of the EU expert group (Strand, Spaapen, Bauer, Hogan, Revuelta, Stagl, Paula, & Guimaraes Pereira, 2015) and the results of two prominent European projects in the field of RRI, MoRRI and SuperMORRI. (Mejlgaard et al., 2018). They approach RRI from the key areas, each of which poses its own challenges and questions about the impact of science and innovation activity on society: (i) Gender Equality, (ii) Science education, (iii) Public Engagement, (iv) Ethics and social justice, (v) Governance, (vi) Open science and innovation, (vii) Environmental sustainability

2. Technological centres as agents of the innovation system and their role in relation to responsible innovation

Technology centres (TC) represent a set of agents and institutions with a clearly identified role within the National Innovation System (NIS): they are in charge of driving digital transformation and economic growth through the improvement they produce in the innovative capabilities of industry and the development of key technologies for industry. (Hecklau et al., 2020). Their role as intermediaries between knowledge-producing centres and the industrial sector is key, as they act as institutions that connect other NIS organisations and drive innovation for the economy, society and government. Governments must adapt the way in which RDI support policies are designed and implemented, so that they incorporate mechanisms that transform the NIS to achieve more socially desirable results. (Borrás & Edler, 2020). At the same time, a continuous process of institutionalisation of RRI in the technological centres will allow to gradually shape the leading role they play and adapt it both to the new demands and to the new challenges of the new technologies. (Owen et al., 2021), thus closing the virtuous circle.

Technology centres in Spain, as agents of the NIS, are private non-profit organisations that carry out activities aimed at both generating technological knowledge and facilitating its exploitation, either by existing companies or through the generation of new business initiatives. Their success is measured in terms of the competitive improvement of companies and their contribution to the economic development of their environment. As agents of the NIS, their activity must contribute to the advancement of RRI in their territory. (Fitjar et al., 2019).

The main activity of the TC is innovation, as they are not scientific centres but innovation centres. Therefore, in this paper we are going to adapt the principles that guide RRI, and which have been mentioned in the previous section, to Responsible Innovation (RI). We would like to highlight here that, if, the implementation of RRI in science is still far from the desired level, in the specific case of innovation, its application is still at an incipient level. For this reason, we propose to work in this paper with a new IR indicators model resulting from the adaptation of the RRI indicators models found in the literature (Strand et al., 2015)(Meijer et al., 2016) to the reality of ITs.

We consider that the principles of IR are fundamental for the TC in order to: (i) legitimise the value and importance of investments in innovation in front of civil society, demonstrating that their impacts go beyond the economic return; (ii) align innovation projects with the priorities of public institutions such as the United Nations, the European Union and the European governments and thus guarantee access to their lines of funding; (iii) use public funds for innovation as a lever for territorial development, in its multiple aspects such as economic, social and environmental.

Therefore, the aim of this paper is to carry out an in-depth study of how IR is being articulated in the technological centres of the Valencian Region and in the results of their activities.

Given that the main activity of TC is to develop goods or services that generate added value, benefits and competitive advantages for companies and this, in some cases, involves aspects related to intellectual property, in the context of technology centres, an adaptation of the key RRI areas of analysis for IR has to be made. In this adaptation, two key concepts will be modified: (i) open science or innovation will not be considered since most of the results of the TC cannot be made open for reasons of confidentiality since a significant amount of research, and a large proportion of innovation activities, are conducted by privately funded organisations (ii) we will call social justice inclusive innovation in order to align with new European trends in this field. (Chataway et al., 2014; Heeks et al., 2014). In this way, we propose to carry out the analysis with five (5) the dimensions or areas, all of which are necessary for the analysis of the socio-environmental performance of innovation: Gender, Public Engagement, Innovation education, Environment, Inclusive innovation, which are presented in Figure 1.

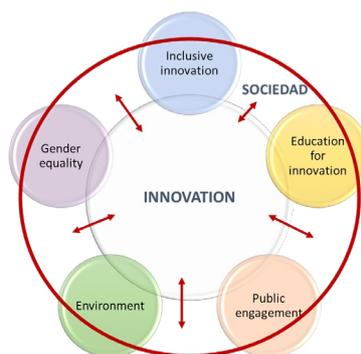


Figure 1. Areas of RI.

This paper takes, as a starting point, the assumption that RI is relevant to technology centres and can have a positive impact on their performance. For that, it presents the results of the application of a set of tailored RI indicators for the responsible evaluation of 9 technology centres in the Valencian Community.

3. Methodology of the project

To achieve that we propose the methodological approach described in Figure 2. Its steps will be thoroughly described in the following sections.

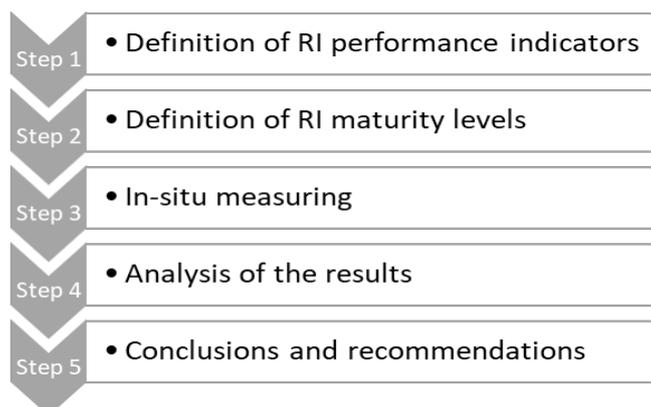


Figure 2. Methodological approach proposed for the evaluation of RI in TC.

3.1. Definition of the RI performance indicators

After the search for relevant RI literature for the definition of indicators for process and outcomes, we agreed to focus the indicators on the meso level (technological centre) and on the micro level (Project). To this end, each of the TC was asked to choose two projects, one financed with European funds from the H2020 programme and the other financed with regional funds from IVACE. That way, the projects chosen by each centre were intended to be relatively similar in terms of operational structure.

Table 1. List of indicators for TC

Area	Process Indicators	Outcome indicators
Gender	Gender Equality Plan	% women in the workforce (compared to % of trained women in the most relevant area)
		% women in management positions
Environment	Environmental management system. Environmental certification	of waste recycled

Area	Process Indicators	Outcome indicators
Public engagement	Strategy for citizens' inclusion (consultation panels, end-users only, market research, etc.)	Reduction of the centre's energy consumption
		Number of people from outside the organisation who have participated in innovation activities in 2018-2020
		Number of people from outside the organisation who have participated in each stage of innovation
Education for innovation	Calendar of education for innovation actions	Number of training actions targeting students; primary, secondary, VET and higher education
	Communication and outreach strategies	Number of training actions targeted at professionals in the relevant sector
Inclusive innovation	Strategy for the inclusion of small and micro enterprises	Number of small and micro enterprises in the Valencian Community that have interacted (clients and project partners) with the centre.
	A strategy for the inclusion of socially disadvantaged groups	Number of companies in developing countries that are related to SDG 9 and have interacted with the centre

Table 2. List of indicators for projects developed by TC.

Area	Process Indicators	Performance indicators
Gender	Did the project rules include a gender component?	% of women who have participated in the project (institution and partners)
		% of women who were leaders of work teams
Environment	Did the project rules include a specific environmental component?	Harmful emissions/solid waste/wastewater
	Have any aspects of the project changed to address environmental concerns?	Clean primary energy consumption
Public engagement	Did the project rules include citizen participation?	Number of citizens who have participated in the project
	If yes, at what stage of the innovation process?	Type of citizen participation (design of innovations, opinion polling, market analysis)
Education for innovation	Did the project include innovation education actions?	Number of innovation education activities in research centres, enterprises, schools or others
		Means of communication used for innovation education activities

3.2. Definition of maturity levels for the evaluation of each RI area

In this section, we draw upon the findings of section 3.1, e.g., the list of indicators, as well as the view of RI as a holistic framework for assessing-responsibility, in our construction of the RI maturity model.

Maturity models (MM) can be found in the literature for a wide range of application areas. Some of them close to the RRI or RI realm: corporate social responsibility (Calabrese et al., 2013) and stakeholder relationship management (Bourne, 2016).

According to (B. Stahl et al., 2017) MM can be developed either with a top-down or a bottom-up approach. In our case we will follow the top-down approach, that is, predefined set of stages of maturity which are then linked to certain aspects that can be assessed to indicate the stage of the organisation. In our case we will adapt the RRI stages of maturity for industries developed by these authors and transform them to a MM for RI evaluation of technological institutes.

The levels of maturity proposed have a twofold objective: to be empirically relevant and tailored to the context to be analysed. For that, they must be intuitively clear and convincing.

After consultation with the managers of the centres to be assessed and in order to ensure that all the proposed maturity levels would have a clear meaning for all stakeholders involved in the assessment process, the authors of this paper decided not to use the usual scale of five maturity levels, but to propose a scale of four levels, each of which could be clearly identified: *unconscious, reactive, proactive and strategic*. In other words, we used the levels proposed by Carsten, but eliminated the intermediate level: defined.

In figure 3 the four stages of the MM are presented:

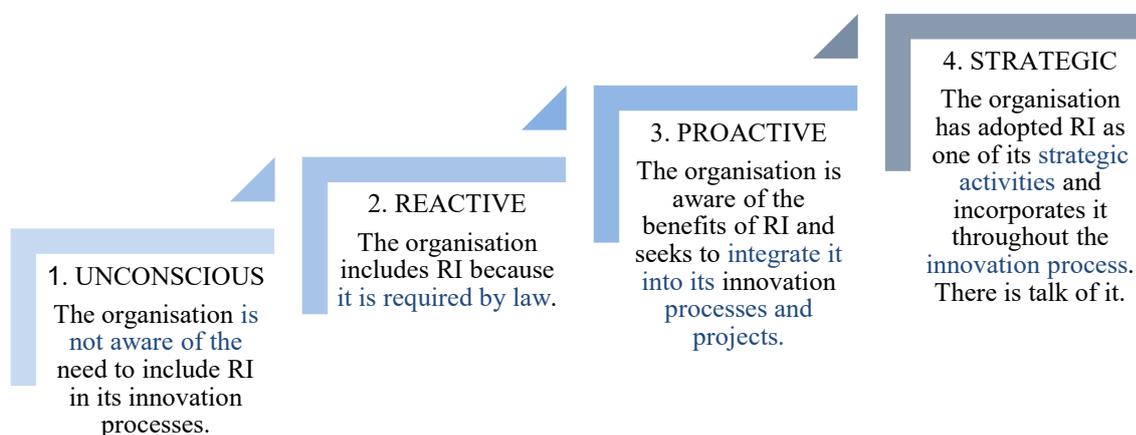


Figure 3. Maturity levels for assessing the performance of ITs in each area of IR.

3.3. In-situ measuring

In order to obtain the necessary information for each of the indicators mentioned in the first step, two meetings were planned for each of the TC. The first was an online workshop where the objectives of the study were presented, as well as the list of process and results indicators for each of the IR areas. During this meeting, the dates for the on-site personal interviews were set. In the second meeting IT managers and middle management were interviewed. In each centre, between 4 and 6 interviews were carried out. The interviews took place in person between 20/04/2021 and 28/09/2021.

The responses to the questionnaires as well as the interviews were subsequently analysed. The interviews were transcribed, which allowed for a reading and re-reading of all the information that was provided.

Once all the information had been analysed and understood, the team defined the items to be covered by each of the 4 levels of maturity specified. These items were set in such a way that there would always be at least one CT at a strategic level. In other words, the scale of measurement was defined ad hoc.

Since this is the first study on IR assessment in TC, we had no reference to what level of responsiveness the TCs could reach, so it was decided to ensure that at least one of them reached the top of the scale.

Therefore, for each of the IR areas, we defined a series of activities to be carried out in order to achieve each of the four maturity levels. In the following section, a list of the defined items is presented for each of the areas, as well as the results obtained by each institute for each of the areas assessed.

3.4. Analysis of the results

The results obtained for each área an technology centre are shown in the following figures:

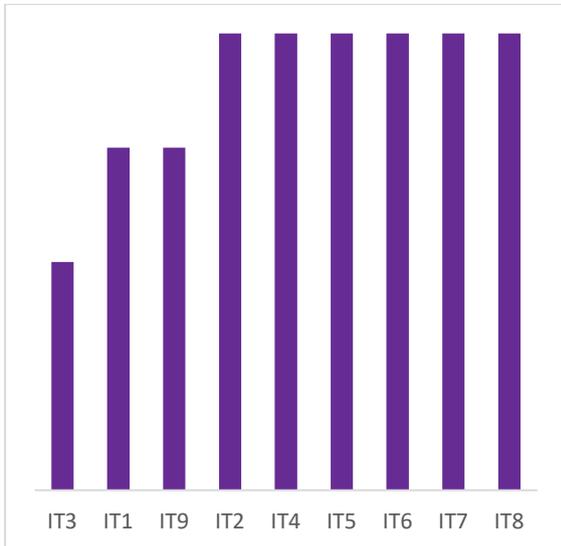


Figure 4. TC evaluation results for Gender equality.

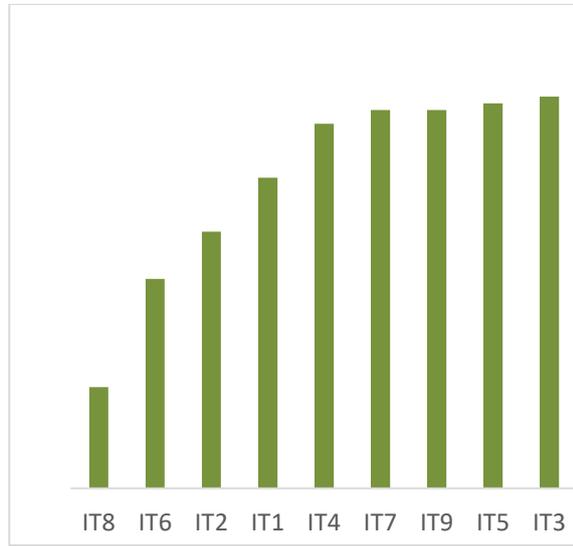


Figure 5. TC evaluation results for Environment.

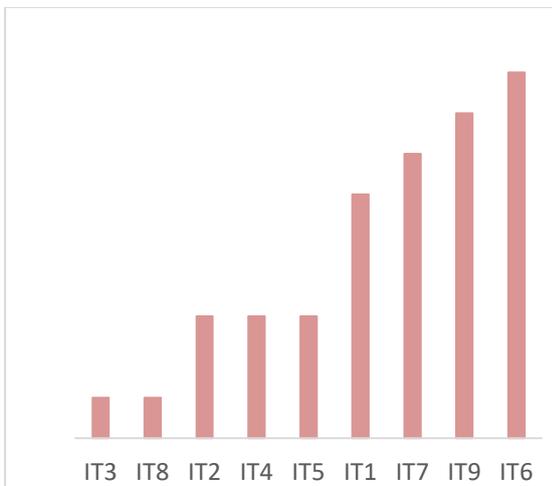


Figure 6. TC evaluation results for Public engagement.

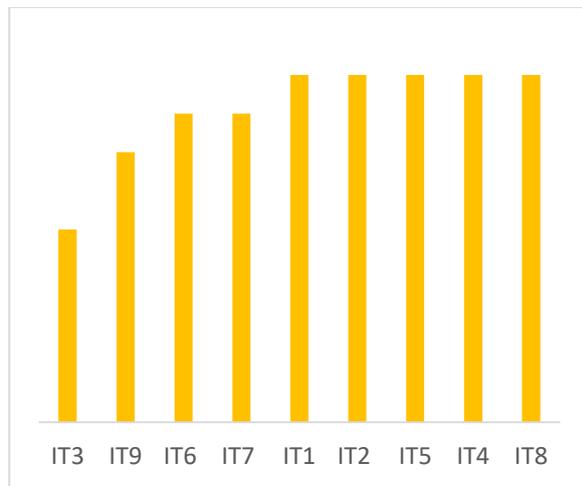


Figure 7. TC evaluation results for Science education.

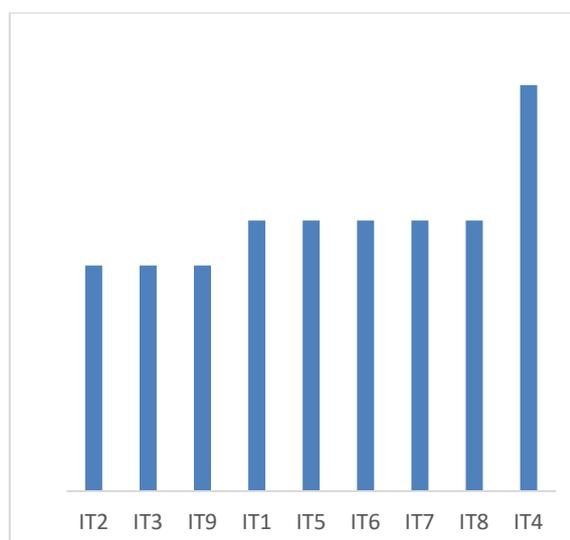


Figure 8. TC results for Inclusive Innovation.

Results in Figure 4 show that 2 out of 9 of the technology centres classify as maturity level reactive in the gender dimension. Those are TC that have an Equality Plan, the Equality Seal and certain measures for reconciliation and co-responsibility. However, gender is not embedded in the organizational culture and processes. Moreover, 3 of the centres classify as proactive which implies that they are aware of the benefits of including a gender perspective and seek to integrate it into its innovation processes and projects. The centres' activity in this area goes beyond what is requested in the call for proposals or in current legislation. Finally, results also show that that 3 centres are at the strategic maturity level. They have incorporated a gender perspective in their organizational processes, especially in recruitment and communication. With regard to recruitment, they are centres aware of the value of incorporating diverse profiles into work teams and the importance of using neutral and non-discriminatory language in order to attract as many people as possible. As far as communication is concerned, they are centres that carry out inclusive and non-sexist communication and provide their staff (especially in the area of communication) with specific training for this purpose. These TC are aware of the importance of language and of the gender image they have to offer to the outside world. Finally, at the strategic maturity level we can find 4 TC. That means that these centres assume the gender perspective as part of its organizational culture and incorporate it throughout the entire research and innovation process. Processes and activities are developed that take this dimension into account as an inherent part of its performance.

Results in Figure 5 show that 2 out of 9 centres classify as reactive level in the environmental area, which implies that environmental management is mainly driven by an external mandate, such as rules or legislation imposed in the sector around the topic or by requirements set by certain calls for proposals. This is materialized by some environmental management managed by another institution where the centre is located. Moreover, 3 out of 9 TC are at proactive level. These centres are characterized by having an internally controlled Environmental Management System, carrying out some actions to promote the care of the environment within the centre, the reduction of waste generated and the consumption of energy and water. These centres also have lines of research related to improving the environment and reducing impacts, recognize their challenges and/or those of the sector with which they work in environmental matters, and carry out external actions that demonstrate a commitment to the environment. Finally, 4 of the centres are at strategic maturity level. They have adopted and can demonstrate that environmental management is one of their strategic activities, incorporate it throughout the innovation process and promote it in the sector they work for. Furthermore, they have succeeded in making environmental management permeate other activities and interests of the institute.

Results in Figure 6 show that 1 TC is at a proactive maturity level. This implies that they do consider the inclusion of stakeholders in their innovation processes, although they tend to do so in the "usual" stages, i.e., in

the early stages of market research and in the final stages of user analysis or prototyping. We want to highlight that surprisingly three TC practice PE at the strategic level, i.e., stakeholders are well defined and the issues that affect them are also integrated into the innovation processes. They use co-creation and co-design of their projects together with social actors, which implies a great added value for the social impact of the projects. We would also like to highlight that we have not found any institute that systematically maps its stakeholders or legitimises the social value of its activities, the latter aspects the most difficult to achieve.

Results in Figure 7 show that all TC are at a proactive or strategic maturity level. From this it can be concluded that this is the most uniformly developed area of RI across all CT.

Results in Figure 8 show that most of the TC (8 out of 9), are at this level. All the centres are actively looking for new SMEs to collaborate with on innovation projects and other activities. All the centres are also looking to collaborate with third sector or public sector organizations on national or European funding projects. In addition, some of them have dissemination projects of their activities or different types of collaboration with the same type of organizations. However, 3 of them do not have a proactive strategy to increase their collaborations with organizations located in developing countries. When they do interact with such organizations, it is at the initiative of the organizations themselves, who seek the services of the institute for some kind of activity. Only one centre classifies as strategic in this area. This TC not only has a strategy to find new partners and clients, but also has a target-based monitoring system that allows to verify, on an individual level, whether the targets are being met. This strategic level could be implemented in all centres, as it represents a change in the way human resources are managed and does not imply significant changes in the centre's activities.

4. Conclusions

After studying the results obtained in the evaluation of each of the centres, we were able to draw the following conclusions for each of the RI areas. We have classified the conclusions into three groups, those that summarise the negative aspects detected in the evaluation of the centres, those that summarise the negative aspects and finally those guidelines for strategies that should be implemented as soon possible.

4.1. Gender equality area

Positive aspects found

- All TC have an equality plan.
- Gender balance in the composition of the workforce (51.55%), positions of responsibility and management positions.
- Inclusive, neutral and non-discriminatory communication.

Negative aspects found

- Gender mainstreaming in the different stages of the innovation or research process.
- Gender balance in the different areas of knowledge.
- It is still a feminised issue.

Should be implemented soon

- Recruitment strategies
- Outcomes and impacts of research/innovation should be different for men and women.
- Thinking and orienting the product/innovation considering gender.

4.2. Environment area

Positive aspects found

- The area of environment is a mature topic for IT that has been worked on for a long time.
- Requirements in the area have changed according to sector dynamics, legislation and market trends.
- The centres have incorporated environmental and sustainability-related lines of work into their activities.

Negative aspects found

- The management and control of emissions and consumption still has room for improvement.
- Strategies for the reduction and compensation of CO2 emissions should be promoted.

Should be implemented soon

- Planning in relation to the calculation, measurement and reduction of the carbon footprint is one of the most important challenges for ITs.
- The incorporation of an integrated approach considers the connection between environmental management and other management systems and performance indicators.
- Measuring some aspects of environmental management, such as waste and travel, during project development is a challenge for ITs.
- The development of actions that contribute to environmental management beyond the activities of ITs is a challenge for ITs and the private sector in general.

4.3. Public engagement area

Positive aspects found

- Use co-creation and co-design with social actors, greater social impact to the project.

Negative aspects found

- Inclusion of stakeholders in 'usual' stages.
- Few specific channels designed for stakeholder engagement.

Should be implemented soon

- Stakeholder mapping.
- Stakeholder observatories.
- Prepare channels to enable stakeholder participation.
- Disseminate social awareness of activities.

4.4. Educational area

Positive aspects found

- All TCs are at a proactive or strategic maturity level.
- Actions: Courses, Professional training programmes.
- Use of various social media.
- Identification of target audiences.

Should be implemented soon

- To propose a dual sense of communication as a bonus.
- To communicate the activity carried out in the centre.
- To raise awareness of certain issues among the population.

4.5. Inclusive innovation

Positive aspects found

- Integration in the business, political and social environment.
- Strategies for increasing partnerships (SMEs, third sector, public sector, internationalisation).

Negative aspects found

- Collaboration in technology development projects with micro and small enterprises.
- Reaching out to organisations related to the public and third sectors.

Should be implemented soon

- Monitoring relationships with traditionally under-represented organisations.
- Look for opportunities for new products and services.
- Act as lever for community development.

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