International Journal of Innovation Studies 8 (2024) 237–248

Contents lists available at ScienceDirect

International Journal of Innovation Studies

journal homepage: www.keaipublishing.com/en/journals/international-journal-of-innovation-studies

Reliability and validity of the public innovation Hexagon (PIH) as applied to the Spanish social services

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ARTICLE INFO

Keywords:
Organizational innovation
Innovation
Intra-organizational relations
Organizational culture
Survey construction and analysis

ABSTRACT

Social services are a protection system that seeks to assist people throughout their lives. Innovation is essential for enabling us to respond to the problems that society is currently facing and to adapt to our changing world. This paper validates an instrument based on the Public Innovation Hexagon (PIH), for measuring the degree to which an innovation culture is being implemented in the Spanish social services system. A sample group of social services professionals were asked to complete a questionnaire based on the variables that make up the PIH model. After our initial validation of the PIH model, we reduced the 42 initial items to 32, while maintaining the initial six dimensions. The objective was to eliminate redundant items and ensure that the resulting end model was more solid and reliable. The new improved model (PIHn) that we created achieved greater consistency with a smaller number of items while maintaining the initial six dimensions.

1. Introduction

The social services system responds to the social needs of people, groups, and collectives that require innovative actions. In this case, we would like to emphasize the importance of the adjective "social" to highlight the very specific nature of "social innovation" (Schröer, 2021; Raya Díez and López Peláez, 2017). This adjective is used because the innovations within social services provide additional benefits in that they tend to involve participative methodologies (Etxebeste, 2020, p. 34–35). As a result, these innovations can be considered "social" in terms of both their means and ends, as they seek to satisfy a range of social needs using processes that encourage the participation of society at large.

Today, social services in Spain are a well-structured, decentralized network of fundamental public resources and programs (Fantova, 2022) that operate at local, regional, and national levels and aim to provide comprehensive attention and support to vulnerable individuals and communities. They also seek to promote the well-being and equal opportunities of their users and help them become more self-reliant (Úriz et al., 2023).

The regional administrations in Spain, known as Autonomous Communities, have very wide-reaching powers in social services (Consejo General del Trabajo Social, 2023). The Autonomous Communities provide social services through two main structures: first, through community or general services (the management of which is delegated to local authorities), which provide the basic framework for primary social services and serve as a reference for the assessment of needs, planning and intervention; and second, through specialized social services, which are mainly run by regional authorities and deal with issues that are technically more

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https://doi.org/10.1016/j.ijis.2024.02.004
Received 20 October 2023; Received in revised form 6 December 2023; Accepted 5 January 2024
Available online 22 February 2024

complex and require more specific attention, such as homelessness and substance abuse (Alonso and Alemán, 2020).

The importance of incorporating a culture of social innovation into the social services system became evident when the European Commission developed the INNOSERV programme,[1] whose objective was to identify good practices in Europe that could be exported to other member states (Eurich and Langer, 2015). In Spain, innovation tendencies in social services were analyzed in some depth by the Social Information and Research Service (SIIS, 2019).

However, apart from some initiatives that we will later describe, little progress has been made regarding the measurement of the implementation of innovative practices, not only in social services but also in general in business activities involving the provision of services. The objective of this article is to fill this gap by presenting an instrument for the measurement of public innovation, namely, the Public Innovation Hexagon (or PIH), which was originally designed by Oliván (2020a, 2020b) and presented at the 27th Summit of Ibero-American Heads of State (SEGIB).[2] In our research, the PIH model was applied to measure innovation in social services. The model constructed an overall innovation index based on six dimensions (OPEN or opening; TRANS or *trans*-disciplinarity; FAST or rapidity; PROTO or a prototype approach; CO or collectivity; and TEC or technological). Each dimension comprises seven items, for a total of 42 items. The next stage was to analyze the reliability and validity of the index when applied to a specific social services field. After conducting a validation test, various shortcomings were detected, especially in terms of redundant items. Therefore, we decided to change the initial model, creating a new revised model whose validity and reliability were also tested. The new revised model provided much more satisfactory results and will be developed in more detail in future research. We believe this new model makes an important contribution to research in this field.

The article begins with a theoretical review of the research on innovation in services, particularly in public social services. On that basis, we reflect on current proposals for measuring innovation and the important advances in this direction offered by the PIH Model. We will also explain the theoretical principles on which the model's design was based. We then provide a detailed description of the methodology and research techniques applied. This is followed by the presentation of the most important results. The article finishes with the conclusions and a discussion regarding the most important contributions of this study and possible future lines of research that could help consolidate its most significant results.

1.1. Innovation in social services

The proposal presented here about innovation in public social services is situated at the intersection of three different analytical traditions. First, the tradition that studies innovation processes in the business world and which in recent decades has extended its scope to explore innovation in the service sector (Djellal and Gallouj, 2011) and the social economy (Desmarchelier et al., 2020). Second, some studies analyze how to integrate an innovation culture into the public sector (Bason, 2018; Pont, 2016). Finally, social innovation has been analyzed in the social services field (Schröer, 2021; Hernández-Ascanio et al., 2021; Raya Díez and López Peláez, 2017; Raya Díez, 2017; Fronek, 2017; Kemp and Palinkas, 2017).

According to these different traditions, social innovation refers to a dimension of innovation that is not strictly economic or technical and was originally identified by Schumpeter (1934), who focused particularly on the fact that the innovative strategies and actions of companies also had an impact on the social sphere. The same perspective was adopted by Fernández Esquinas et al. when they defined innovation as "any intentional change based on knowledge, when implemented, creates value of different kinds, both economic and social, for some segments of society" (Fernández Esquinas et al., 2021, p. 23). In this sense, all innovation could be regarded as social (Gurrutxaga, 2013; Raya Díez, 2017), with which we run the risk of making the adjective "social" (in "social innovation") redundant by draining it of any additional meaning or content. To find an operational meaning for the concept of social innovation with heuristic capacity, the literature points us toward innovative services or activities whose objective is to satisfy a social need (Mulgan, 2006). This author links them particularly to social entities or organizations, although others also emphasize the possibility of for-profit companies carrying out social innovation (Asongu, 2007), as manifested by the TEPSIE project (Theoretical, Empirical, and Policy Foundations for Social Innovation in Europe).[3]

Based on these ideas, the European Commission proposes the following definition of social innovation:

> Social innovation consists of (…) to find new ways of meeting social needs not adequately met by the market or the public sector … or to bring about the behavioral changes needed to tackle the major societal challenges, such as climate change. As well as meeting social needs and tackling societal challenges, social innovations empower people and create new social relationships and models of collaboration. Thus, they are innovative and good for society's capacity to innovate (European Commission, 2010, p. 21).

For an innovation to be considered social, it must comply with the following three conditions (Etxebeste, 2020, p. 34–35).

- As regards "what", social innovation refers to a wide diversity of different forms of innovation (in products, services, processes, organization, relations, etc.).
- As regards "how", i.e., methodology, social innovation must be highly participatory, that is, social in its means (Eito et al., 2021). Some authors identify social innovation exclusively with this aspect (Lallemand, 2001).

[1] https://cordis.europa.eu/project/id/290542/reporting.
[2] https://modelohip.net/.
[3] https://cordis.europa.eu/project/id/290771/reporting/es.

- As regards "what for", social innovation must also have social purposes; in other words, it must aim to satisfy social needs or, in more general terms, improve people's quality of life or improve territories and ecosystems (Cloutier, 2003).

This approach to social innovation does not shy away from the debate on the role of technology. While social innovation was initially posited as the opposite of organizational or technological innovation, today, it is widely accepted that this is a false dichotomy in that social innovation may originate from technological change, although it must not be limited solely to it (Djellal and Gallouj, 2011, p. 6; Howaldt et al., 2010, p. 24).

Finally, given the public nature of the question we are studying, we propose investigating social innovation from the perspective of public administration, a subject of increasing interest in academic research (Rønning et al., 2022). In Spain, for example, it has been claimed that "there are virtually no private services that consider themselves as social services" (Fantova, 2020, p. 59). For their part, most of the private services provided by non-profit organizations are financed with public funds (except residential care for elderly people). Viewing social services as services provided by public administration enables us to understand in addition that they have similar potentials and limitations as other parts of public administration in regard to introducing innovations (Ramió, 2021a, 2021b; Bason, 2018; El-Haddadeh et al., 2014), referring in particular to the technological dimension of innovative processes (Arrilucea et al., 2021).

Given the above, in this paper, we use a concept of innovation that covers the main ideas described earlier:

> A new or better service to cover an existing need; an alternative approach to an existing need or a new way of providing a service; a new service for a new need; a new form of governance; a new way of allocating resources; a new assessment method; greater professionalism in the service or new management methods; and establishing new practices (Crepaldi et al., 2012; quoted in De Rosa, 2017, p. 425).

In this sense, innovation in the social services field is translated into specific actions within an organization in three main ways: new perspectives on existing or "old" social needs, new practices to respond to "old" needs and new practices to meet new needs (Hawker and Frankland, 2012, p. 24).

1.2. Measuring innovation in social services

With respect to the measurement of innovation, the dominant approach was established by the Oslo Manual, which, although it has introduced some interesting new aspects in its latest edition (OECD and Eurostat, 2018), establishes four types of innovation (in the product, in the processes, in marketing and organization). The main weakness of approaches of this kind is that they are based on a strongly econometric, business-based outlook and do not adapt well to the measurement of innovation in the social sphere. One could argue that the criticisms levelled against the third edition of the Manual by Echeverría (2008) also apply to the new version. Other similar initiatives include "The European Innovation Scoreboard", which, in its 2021 edition,[4] presents a ranking order of countries and offers a version at the regional scale. However, its indicators would be difficult to apply at lower levels, such as at the organization level. The same applies to the "Global Innovation Index", which also has a 2021 edition and enables the level of innovation in different countries to be compared.[5]

If we look at the specific issue of the measurement of social innovation, Krlev et al. (2014) studied approximately 30 existing models. They found that most approaches took a meso-organizational or national perspective, but were not suitable for analyzing social innovation at the organization level.

With regard to innovation in the public sector, in the scientific literature, we find works on existing types of innovation (Chen et al., 2020) or strategies, conditions, and results (Criado et al., 2023); however, there has been no in-depth study of its measurement, as proposed in this article.

An example that is closer to home here in Spain was the project launched in 2013 by the Basque Innovation Agency, "Innobasque", which, in collaboration with Sinnergiak Social Innovation (UPV/EHU), developed a Regional Social Innovation Index known as the Resindex. Using three indices, they presented a set of innovation indicators generated from a questionnaire aimed at organizations: companies, third sector, universities, and technological centers (Unceta et al., 2016). Without being able to analyze it in detail, its principal virtue lies in that it measures not only social innovation but also the social orientation and the learning, socialization, and development capacities of organizations (Innobasque, 2013, p. 73). Its main limitation is that one of its three basic dimensions (the "index of orientation toward social issues") contradicted the objective being sought in that it included organizations that helped tackle social problems but did not innovate in any way.

Finally, other authors have tackled the challenge of measuring the social impact of innovation (Matías et al., 2015; Jaillier, 2021) but without developing a holistic model, in that they tend to center on the results of a given social innovation, overlooking any innovations in its organizational vision, resources, culture, or processes.

As a result, the study of social innovation is complicated not only by problems with metrics (in terms of the difficulty of obtaining specific, reliable results), but also by statistical, methodological, and even conceptual issues (Mihci, 2019).

To develop a model that meets our needs, we have recovered a proposal developed by Raúl Oliván (2020a and 2020b) within the framework of the LAAB Project of the Government of Aragón (PIH), which seeks to gain a better understanding of the processes of

[4] https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard.
[5] https://www.wipo.int/global_innovation_index/es/2021/.

public innovation by exploring the channels and paths through which these processes occur in reality. To achieve this, it is important to know more about the ecosystems in which the ideal environmental conditions for foment innovation are reproduced. In this way, innovation is approached from a systemic perspective (Fischer, 2001) rather than as a series of isolated events. In most cases, its success depends on favorable environmental conditions (Terstriep, 2016).

We identified six key dimensions that boost public innovation by analyzing the 105 methodologies in the Nesta repository (2018). Identifying these dimensions then enabled us, following the inverse process, to develop a self-diagnosis tool for the measurement of the integration of innovation based on six vectors (Oliván, 2020b, p. 12) (Fig. 1).

In general terms, the OPEN vector refers to opening up governments so that they can offer data with the capacity for transformation derived from the way the information is interpreted and presented and by ensuring that it is used to further the general interests of the people (Schnell, 2020; Innerarity, 2011; Chesbrough, 2003). The first push came with the Obama administration (Coglianese, 2009), although its principles were subsequently taken up by virtually all governments (Hong et al., 2018, p. 30). The open government principles of transparency include integrity, accountability, and stakeholder participation (Matasick et al., 2018), which are translated to the questions included in the questionnaire: Integrity (OPEN 2, OPEN 5, OPEN 7); Accountability (OPEN 3, OPEN 4); Stakeholder participation (OPEN 1, OPEN 6).[6]

The TRANS vector aspires to *trans*-disciplinarity, to the hybrid, to diverging thought, that is, to the dynamics engendered by the action of several levels of reality simultaneously (Nicolescu, 2009, p. 36). This involves thinking about organizations as a hyper-connected whole or as transware in the sense that they transcend both hardware (structure and buildings) and software (programmes and services), including them in processes of applied “nexonomics”, i.e., the use of linkages for the common good. The characteristics of transdisciplinarity are as follows (Insa, 2014): co-creation (questions: TRANS 3, TRANS 7); shared intelligence; and hybridisation (questions: TRANS 4, TRANS 6), which influence the development of the questionnaire (questions: TRANS 1, TRANS 2, TRANS 5).[7]

The FAST vector seeks to shorten distances, strengthen ties, and bring about relational productivity, aiming to guarantee life sustainability (La Colaborabora, 2021; Prow, 2013). "The challenge is to capture as much wasted time as possible and find ways to make the system go faster, not the people" (Miller, 2009, p. 4), which is closely related to technological innovations and their application to management action (Ji and Zhou, 2021) and is related to rapid reactions and adaptations to new events or situations (questions: FAST 1, FAST 2, and FAST 7), rapid transmission of information within the organization (questions: FAST 3 and FAST 6), and technological and human support in the acceleration of projects (questions: FAST 4 and FAST 5).[8]

The PROTO vector seeks to create a community, align visions, and reduce the abstraction of the conversation. It also seeks to strike a balance between *demos* and *kratos* by connecting discussions to action, in other words, promoting the capacity to create prototypes that address the problems or challenges facing organizations (Mootee, 2013). This is in the framework of a diverse ecosystem of private actors, universities, and civil society. The dimensions that make up this vector are (Lewis et al., 2020): imaginative and creative deliberation (questions: PROTO 2 and PROTO 6), the existence of design laboratories (questions: PROTO 1, PROTO 3 and PROTO 4), and the practical application of the projects and their feedback (questions: PROTO 5 and PROTO 7).[9]

The CO vector refers to achieving synchrony, collective intelligence, and a strong cohesive community through the design of a cross-disciplinary plan aimed at strengthening care, ties, and affections (Brandsen et al., 2018; Fernández, 2018). Its three basic dimensions are as follows (Bianchi et al., 2021, p. 1582): (a) supporting the collaborative process through innovative models and methods for enhancing a shared understanding of community problems and outcomes (questions: CO 3 and CO 6), (b) fostering the interplay between service policy and service delivery (questions: CO 4 and CO 5), and (c) combining a public service view with an institutional and interinstitutional view (questions: CO 1, CO 2 and CO 7).[10]

The TEC vector refers to the technology and digital transformation of organizations viewed in the sense of a rhizome (Deleuze and Guattari, 1977) with an increasing presence in public administrations (United Nations, 2020; Ramió, 2021) through which any public employee becomes a potential hub (or hyperconnected node) (HIP, 2021). It consists of three dimensions: development of technological infrastructures (questions: TEC 1, TEC 2, and TEC 3); technical support for technological development (questions: TEC 5 and TEC 7); and advanced technological development, such as Big Data, Machine Learning, and Artificial Intelligence (questions: TEC 4 and TEC 6).[11]

Each of these six dimensions may be analyzed separately, although it is true that there are strong links between them.

It is important to note that the initial PIH model contained 90 questions (15 per dimension). However, after two years of application, the author proposed a second version, in which the items that offered redundant information were eliminated, reducing the total number of questions to the 42 questions mentioned above (7 per dimension).

2. Methodology

This section describes the methodological process used in this research. In general terms, we should point out that it is based on a quantitative and documentary approach. The following sections describe the research methods and materials in detail.

[6] See Annex 1.
[7] See Annex 1.
[8] See Annex 1.
[9] See Annex 1.
[10] See Annex 1.
[11] See Annex 1.

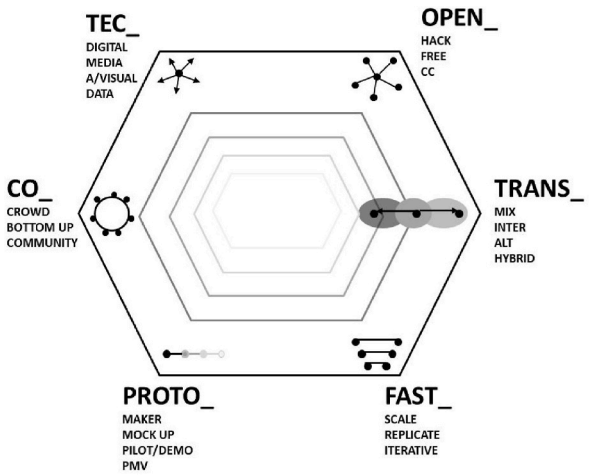

Fig. 1. Public innovation Hexagon (PIH).
Source: Oliván (2020b, p. 39)

2.1. Study universe and sample

The study universe was made up of 175 professionals ($n = 175$) from the Spanish Public Social Services System, with representatives from all 17 Spanish regions. This sample size is considered suitable for an exploratory analysis of the validity of an instrument of this kind (Roco-Videla et al., 2021). In line with these authors, as we planned to use statistics such as the mean, the standard deviation, or the correlation coefficient (or others derived from them), a sample size of more than 100 (they suggest between 50 and 100 subjects) was considered sufficient for an initial application.

Regarding the profile of the people who answered the questionnaire, 76.4% were women. The other variables used to establish the profile of the people who answered the questionnaire were as follows (Tables 1–4).

In terms of the academic qualifications of the people who answered the questionnaire, many (36.8%) did not specify their qualifications, but of those who did, 51.7% were social workers, 6.3% were psychologists, and 5.2% were social educators.

2.2. Questionnaire for measuring innovation

To measure the degree of innovation, we adapted the PIH questionnaire described above to the field of social services. The questionnaire comprises a total of 42 questions (see Annex 1) grouped into the six dimensions of the model.

The questions were formulated to obtain answers on a Likert scale. Each participant had to answer according to their degree of agreement or disagreement with the statement. There were five possible answers, which were labeled as follows: a) “Strongly agree”, which was given a score of 5; b) “Agree” (a score of 4); c) “Undecided” (3); d) “Disagree” (2); and e) Strongly disagree (1).

2.3. Application procedure

The questionnaire, created with Google Forms, was made available to professionals from the Spanish public social services systems between November 2022 and January 2023. The participants were invited to take part above all via the Twitter social network, although the questionnaire was also disseminated in other ways, such as through WhatsApp, email, and various professional associations (social work, social education, and psychology), as well as through the research team’s network of contacts. It could, therefore, be defined as an online non-probability survey applied at the national level. The main weakness of this methodology lies in the inherent limitations of a non-probability sample selection process. However, we believe that the use of statistical operations (regressions or Student’s *t*-test) is acceptable given that the interest here lies in testing the reliability of the model as a guide for future research studies (Hayashi et al., 2022).

The object of the study was made clear at the beginning of the questionnaire, and a final question was added to request their permission for the scientific use of the information they provided. This means that the questionnaire was self-administered (Díaz de Rada, 2021; Díaz de Rada et al., 2016).

3. Results

In this section, we analyze the goodness of fit of the PIH model for measuring social innovation in social services. To this end, we present the Cronbach’s alpha (Cronbach, 1951) coefficient values for each of the six dimensions that make up the GII index as a measure of their internal consistency. As explained earlier, we used seven items in each of these dimensions, and the results obtained reached the optimum level in all the cases. We also present the alpha values for the six dimensions that were constructed in this way,

Table 1
Administration to which they belong.

	Percentage
Municipal	59.2%
Sub-regional	11.5%
Regional	19.5%
Others (or not specified)	9.8%

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Table 2
Type of service.

	Percentage
Community Social Services	58.0%
Specialized Social Services	34.5%
Others	7.5%

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023

Table 3
Job title.

	Percentage
Social Worker	65.5%
Social Educator	8.6%
Manager	8.0%
Psychologist	5.7%
Sociocultural Animator	2.9%
Others	9.3%

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Table 4
N years' service.

	Percentage
Less than 2 years	6.3%
2–5 years	13.8%
6–10 years	12.6%
11–20 years	28.2%
Over 20 years	39.1%

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

which gives us some idea of their reliability with regard to the General Innovation Index (GII) (Table 5).

The coefficients obtained for the OPEN, TRANS, FAST, PROTO, and TEC dimensions have values between 0.80 and 0.90, which endorse their internal consistency and indicate their validity. However, the CO dimension and combining the six dimensions to form

Table 5
Cronbach's alpha coefficients for the six dimensions of the PIH model and for the GII.

Dimensions	Items	Cronbach's Alpha Coefficient
OPEN	OPEN_1, OPEN_2, OPEN_3, OPEN_4, OPEN_5, OPEN_6, OPEN_7	0.86
TRANS	TRANS_1, TRANS_2, TRANS_3, TRANS_4, TRANS_5, TRANS_6, TRANS_7	0.89
FAST	FAST_1, FAST_2, FAST_3, FAST_4, FAST_5, FAST_6, FAST_7	0.88
PROTO	PROTO_1, PROTO_2, PROTO_3, PROTO_4, PROTO_5, PROTO_6, PROTO_7	0.89
CO	CO_1, CO_2, CO_3, CO_4, CO_5, CO_6, CO_7	0.93
TEC	TEC_1, TEC_2, TEC_3, TEC_4, TEC_5, TEC_6, TEC_7	0.88
IGI	OPEN, TRANS, FAST, PROTO, CO, TEC	0.93

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

the General Innovation Index (GII) offer values of over 0.90 (0.93, to be precise, in both cases). This could indicate a certain degree of redundancy in the items that served to construct this dimension. In other words, different items measure the same aspect of a construct (Oviedo and Campo-Arias, 2005, p. 577). In this case, the redundant items should be eliminated, and when applicable, the entire redundant dimension should be eliminated.

With this in mind, we began by looking at the CO dimension, analyzing the Cronbach's alpha value that would be obtained if we eliminated each of its different items (Table 6).

The aim was to determine whether eliminating any of these items could reduce the Cronbach's alpha value to less than 0.90. As shown in Table 6, this did not occur in any of the cases. This finding suggests that the dimension as a whole is almost certainly redundant with the rest of the dimensions, as was also suggested by the high Cronbach's alpha value for the GII. This was confirmed when we eliminated the CO dimension from the IGI, as Cronbach's alpha fell to values considered correct (to 0.90). However, to eliminate CO, the model would be distorted and devalued, as it would lose its collaboration dimension, a key feature of innovation (Merlin-Brogniart et al., 2022; Unceta et al., 2019; Torfing, 2018).

Another option would be to eliminate the individual items in which redundancy has been discovered, namely.

- From OPEN, items 4 (active social networks), and 6 (participation in networks or associations).
- From TRANS, items 4 (taking decisions that take into account the wide diversity of voices) and 7 (transversal planning).
- From PROTO, item 3 (having a space for coming up with ideas).
- From TEC, item 3 (an internal network that connects the organization) and 5 (remote working).
- From CO, items 1 (Horizontal organization), 4 (Co-creation techniques), and 6 (Feeling of belonging).

After eliminating these items, we constructed a new revised PIH model (PIHn) composed of 32 items instead of the 42 items in the original model. The items were distributed among the different dimensions as follows: OPEN (5 items), TRANS (5 items), FAST (7 items), PROTO (6 items), TEC (5 items), and CO (4 items).

Table 7 shows the Cronbach's alpha coefficient for each new dimension and the new GIIn.

In this new model, the coefficients for all six dimensions had values between 0.80 and 0.90, which means that the model's internal consistency was reinforced. These results also suggest that the model is valid.

It is important to clarify that the new GIIn was constructed by standardizing the dimensions, in other words, by applying a correction to each dimension to ensure that the dimensions that included most items did not have greater weight in the final index.

Once we had established a new improved model based on the optimum alpha coefficient, the next stage was to analyze the model's goodness of fit. The first step involved analyzing the Pearson correlation coefficients between the six dimensions that make up the GIIn as a means of justifying the Cronbach's alpha coefficient for the GIIn; the latter is an estimate of the proportion of variance caused by the common factor between the elements.

The higher the correlation between the items, the more likely the scores for the items that make up the instrument will be consistent (Frías-Navarro, 2022, p. 18). In all these cases, except for one (OPENn with TECn), the Pearson correlation coefficient was high, at over 0.50 (Cohen, 1988, p 79–81), confirming the initial consistency indicated by the Cronbach's alpha coefficient. The detailed results are shown in Table 8, which highlights that in this new model, the new CO dimension (COn) displays higher levels of correlation, becoming a fundamental dimension of the GIIn. In addition, the overall GIIn index has very high levels of correlation with the set of dimensions that make it up, particularly with the COn dimension.

Another test involves checking whether the item measures the same as the overall total scale; in other words, to what extent the item contributes to the internal consistency or homogeneity of the scale. In our model, the corrected homogeneity index is obtained by the correlation coefficient between the score for the dimension and the total score for the GIIn scale (Frías-Navarro, 2022, p. 19). This operation was performed with each of the dimensions and with these six dimensions regarding GIIn.

As values greater than 0.4 were achieved in all the cases, the homogeneity levels were considered very good (Kline, 1999) (Table 9).

Finally, in the process of validating the reliability of the PIHn model, we also calculated the 95% confidence interval for these estimates. This enabled us to assess the accuracy of the estimate by observing its amplitude (as the amplitude increases, the accuracy decreases). This allowed us to weigh whether the lower bound of the confidence interval is suitable or should be adjusted (Frías--Navarro, 2022, p. 20) (Table 10).

As the lower bound of the confidence interval was found to be suitable, our internal consistency analysis showed that the items that make up the six dimensions and the GIIn had a Cronbach's alpha value that (at a confidence interval of 95%) remained within suitable

Table 6
Cronbach's alpha values for the CO dimension if each different item is eliminated.

Dimension	Items	Cronbach's Alpha value if the item is eliminated
CO	CO_1: Horizontal organization	0.92
	CO_2: Open architecture	0.91
	CO_3: Identification of stakeholders	0.92
	CO_4: Co-creation techniques	0.92
	CO_5: Bottom-up changes	0.92
	CO_6: Feeling of belonging	0.91
	CO_7: The organization is more than the sum of its parts	0.92

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Table 7
Cronbach's alpha values for each dimension and the GIIn index as a whole once all the redundant items had been eliminated.

Dimensions (n)	Items	Cronbach's alpha value
OPENn	OPEN_1, OPEN_2, OPEN_3, OPEN 5, OPEN_7	0.80
TRANSn	TRANS_1,TRANS_2,TRANS_3, TRANS_5, TRANS_6	0.83
FAST	FAST_1, FAST_2, FAST_3, FAST_4, FAST_5, FAST_6, FAST_7	0.88
PROTOn	PROTO_1, PROTO_2, PROTO_4, PROTO_5, PROTO_6, PROTO_7	0.88
COn	CO_2, CO_3, CO_5, CO_7	0.88
TECn	TEC_1, TEC_2, TEC_4, TEC_6, TEC_7	0.87
GIIn	OPENn, TRANSn, FAST, PROTOn, COn, TECn	0.90

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Table 8
Pearson correlation coefficients between the six dimensions of the PIHn model of innovation.

	OPENn	TECn	TRANSn	FAST	PROTOn	COn	GIIn
OPENn	1.00	0.485	0.558	0.602	0.560	0.522	0.727
TECn		1.00	0.576	0.649	0.701	0.647	0.802
TRANSn			1.00	0.783	0.697	0.800	0.875
FAST				1.00	0.789	0.758	0.886
PROTOn					1.00	0.718	0.867
COn						1.00	0.901
GIIn							1.00

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.
Significant correlations (p-value >0.01) were observed in all cases.

levels.

4. Discussion and conclusions

The objective of this study was to validate the Social Services an Innovation Index, which has been applied in different administrative spheres in Spain and Latin America and whose purpose is to measure the degree of innovation in the social services system. The initial proposal contained a total of 6 dimensions and 42 items. Our analysis revealed that the items in one of the dimensions (CO collaboration) of this index had excessively high Cronbach's alpha coefficients, indicating that they contained redundant information with regard to the other dimensions.

The redundancy of the items in the CO dimension with regard to the rest of the initial model occurred because, in reality, CO forms the background of the other dimensions, as explained earlier.

For these reasons, we prepared a new model that maintained the six dimensions, but reduced the number of items by deleting those found to be redundant. In this way, the model was reduced from 42 to 32 items. The consistency of this new model has been tested using other widely used research methods.

The analyses of correlation and consistency enabled us to conclude that the CO dimension is the one that most contributes to the innovation model, thus validating the literature on this question. The second most important contribution to the model comes from the PROTO dimension. The strength of these two dimensions could indicate, first, the need to establish collaboration strategies in regard to proposing possible changes in the organization of social services and, second, that when changes are implemented, this must be done by testing them first in a real situation so that improvements can be made before the changes are actually carried out.

This new model is an improvement on the initial model and must be tested in future research both in the field of social services (as tested here) and in other branches of the administration and other countries outside Spain. Suppose it can be validated in these new scenarios. In that case, we feel that it will then be ready for use and can be applied to representative samples of professionals from social services as a means of measuring the presence of innovation. We could also carry out comparative analyses between countries, which could give rise to new public policy strategies to reinforce the quality culture in public administration.

With respect to the main limitations of this study, we first highlight, as mentioned earlier in the methodology section, the question of the procedure followed to select the sample group. Another problem is that after eliminating the ten redundant items, there was an imbalance in the new GIIn in terms of the number of items in each dimension. Although this does not invalidate the model itself, in future research, it will likely be necessary to construct a compound index that takes this issue into account using participatory methodologies.

Ethics statement

Ethics approval was obtained from the Ethics Committee of the University of La Rioja. The participants provided their informed consent to participate in this study.

Table 9
Corrected item-total correlation (item-test correlation) for each of the six dimensions of the PIHn Model and for the GIIn.

Dimensions	Items	Corrected item-total correlation
OPENn	OPEN_1	0.50
	OPEN_2	0.58
	OPEN_3	0.55
	OPEN_5	0.63
	OPEN_7	0.65
TRANSn	TRANS_1	0.67
	TRANS_2	0.69
	TRANS_3	0.63
	TRANS_5	0.51
	TRANS_6	0.66
FAST	FAST_1	0.66
	FAST_2	0.69
	FAST_3	0.79
	FAST_4	0.58
	FAST_5	0.57
	FAST_6	0.55
	FAST_7	0.79
PROTOn	PROTO_1	0.68
	PROTO_2	0.73
	PROTO_4	0.70
	PROTO_5	0.73
	PROTO_6	0.58
	PROTO_7	0.74
COn	CO_2	0.77
	CO_3	0.79
	CO_5	0.65
	CO_7	0.75
TECn	TEC_1	0.65
	TEC_2	0.65
	TEC_4	0.73
	TEC_6	0.67
	TEC_7	0.78
GIIn	OPENn	0.61
	TRANSn	0.81
	FAST	0.85
	PROTOn	0.82
	COn	0.81
	TECn	0.71

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Table 10
Cronbach's alpha coefficient for the PIHn model and the GIIn.

Dimensions	Items	Confidence Intervals (al 95%)	
		Maximum	Minimum
OPENn	OPEN_1, OPEN_2, OPEN_3, OPEN_5, OPEN_7	0.75	0.84
TRANSn	TRANS_1, TRANS_2, TRANS_3, TRANS_5, TRANS_6	0.79	0.87
FAST	FAST_1, FAST_2, FAST_3, FAST_4, FAST_5, FAST_6, FAST_7	0.85	0.90
PROTOn	PROTO_1, PROTO_2, PROTO_4, PROTO_5, PROTO_6, PROTO_7	0.85	0.91
COn	CO_2, CO_3, CO_5, CO_7	0.85	0.91
TECn	TEC_1, TEC_2, TEC_4, TEC_6, TEC_7	0.84	0.90
GIIn	OPENn, TRANSn, FAST, PROTOn, Con, TECn	0.88	0.92

Source: drawn up by the authors based on the PIH questionnaire, 2022–2023.

Declaration of competing interest

The authors declare no conflicts of interest.

Annex 1: Dimensions and items in the questionnaire for measuring innovation

Dimensions	Items

(*continued on next page*)

(*continued*)

Dimensions	Items
OPEN Openness of the system	OPEN 1.- In general, our organization (or team) is open to the public. People know us and participate in our activities and projects, not only as users but also as leading actors. OPEN 2.- If you search for our name on the Internet, you will find a website that explains who we are and how to contact us easily. OPEN 3.- Our organization is managed transparently, we have a transparency portal, accountability tools, open data and other tools so that the public can determine in detail what we do. OPEN 4.- We have an active presence on social media and other channels for direct communication with our users. Most of the members of our team are also active on social networks. In addition, we do not just use them to talk, we also listen. OPEN 5.- The first people we open up to are the rest of our organization. The other teams, units or departments know what we do and can reach us easily. OPEN 6.- We participate in networks or associations where we exchange experiences, good practices and case studies to present our successes and learn from others. OPEN 7.- We use easy reading, clear communication or other strategies to improve accessibility to our contents. In general, our users understand us.
TRANS *Trans*-disciplinarity of the system	TRANS 1.- Our organization operates transversally. The departments are not rigidly compartmentalized and we do not work in silos. The teams cooperate with each other. TRANS 2.- In general, the heads of department and managers in our organization adopt a democratic leadership stance. They are not overly authoritarian and are easily approached. TRANS 3.- For each position, there is a manual explaining the job function, but in general each employee has a certain degree of freedom to do their job, especially if they meet their targets. TRANS 4.- When taking important decisions, a wide diversity of opinions are taken into consideration. The traditional legal-administrative or economic perspectives are not the only ones that count. TRANS 5.- It is relatively easy to change jobs via horizontal promotions, rotation schemes or special missions on which employees are temporarily engaged. TRANS 6.- Inter or cross-disciplinary work teams are created in which the workers learn from other professional approaches. The views of all the team members are combined, creating new knowledge. TRANS 7.- We work with secondment and other cross-disciplinary planning tools which breakdown the vertical structures of departments and oblige us to cooperate and sum together the visions and expectations of the whole organization.
FAST Speed of the response	FAST 1.- In general, our organization functions agilely. We combine long-term strategic plans with operational projects to provide a rapid response to new needs or contingencies. FAST 2.- When we launch a project, we are capable of transforming it as we go along. We do not have rigid immovable projects that have not been changed in years. FAST 3.- The decision chain is sufficiently flexible so as not to delay the development of new projects. FAST 4.- We have carried out project acceleration activities: hackathons, sprint books, design sprints, ideathons (or any other method for carrying out projects agilely) FAST 5.- Our organization has an office or team responsible for accelerating strategic projects: digital transformation offices, change management, urgent action group … FAST 6.- Our ordinary meetings do not last more than 60 min. We have an agenda and decisions are recorded in the minutes. FAST 7.- We know how to prioritize what is important. We are not always stuck in doing what is urgent, putting out fires. We select the challenges and start with those that create most impact but which are easy to resolve.
PROTO Capacity to create new answers	PROTO 1.- Our organization normally works with prototype models (services, products) to be able to identify their strengths and weaknesses before launching the definitive versions. PROTO 2. – We have a deeply rooted pilot-project culture. This enables us to experiment without fear of failure and, if we are successful, serves as inspiration for new programs. PROTO 3.- We have a space for making things or brain-storming, a creativity room, a laboratory or at least a suitable space for giving form to ideas. PROTO 4.- Although on occasions our work is very abstract, we work with infographics, diagrams and other visual organization tools, to enable everybody to understand our vision. PROTO 5.- The culture of our organization is no stranger to the idea of permanent beta, of projects which are open to continuous improvement and are never definitive. PROTO 6.- We have designers (services, graphic, web, product) in the teams. Or at least there are members of the team who have the minimum tools and design skills for this purpose. PROTO 7.- Although the tendering and procurement process may be complex and may lead to problems with our accounts or auditing systems, we are capable of launching experimental projects, and of correctly justifying why they are needed.
CO Collaboration	CO 1.- In general, our organization is quite horizontal and is not strongly hierarchized. All the members of the organization have mechanisms through which they can contribute and express their ideas. CO 2.- The bosses' offices, if they have them, are open to most of the members of the organization. The architecture of our organization is conducive to teamwork. CO 3.- We have identified all the stakeholders that influence our organization, such as suppliers, users or clients, agencies with which we collaborate, and we include them in the definition of our vision. CO 4.- We know and carry out co-creation techniques in the teams. Members of the public, users, are at the centre of our project design process. Before launching anything, we ask them. CO 5.- Changes in our organization are generally implemented with a bottom-up (rather than a top-down) approach. CO 6.- There is a certain sense of community within our organization, a sense of belonging, even pride in forming part of the project. This is strengthened with a common narrative about the organization, which is shared by the majority. CO 7.- One could say that there is synchrony between the members and the teams in our organization to such an extent that the organization creates more value than the sum of its parts.
TEC Technology and digital transformation	TEC 1.- In general, our organization is completing a successful transition to the digital knowledge society. TEC 2.- Most of our processes are digitalized which means that we have almost completely done away with paper, files …

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(*continued*)

Dimensions	Items
	TEC 3.- We have an internal network which connects everybody, at least, through a central server where we share information and an email services provider. TEC 4.- As all our activity is digitalized, we can take advantage of our advanced databases (big data) and extract value from them (reports, forecasts, indicators …). TEC 5.- The digitalization of workplaces in our organization enables almost all the members to work remotely when they are away on a trip or at home, without this causing a breakdown in the dynamics of the organization. TEC 6.- Our organization is no stranger to emerging technologies such as artificial intelligence, machine learning or blockchain, as it has pioneering projects in which it is applying them. TEC 7.- Our organization is not afraid of technological change. We have teams who are prepared for it and we are continually training other members to update their knowledge.

Source: drawn up by the authors on the basis of the PIH questionnaire, 2022–2023.

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