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**The systemic approach as an instrument to evaluate higher education systems:
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The systemic approach as an instrument to evaluate higher education systems: Opportunities and challenges

Abstract

This article aims to provide a systemic instrument to evaluate the functioning of higher education systems. Despite systemic instruments have had a strong impact on the management of public policy systems in fields such as health and innovation, higher education has not been widely discussed in applying this type of instrument. Herein lies the main gap that we want to close. The ultimate purpose of the evaluation instrument introduced here is thus to provide information for decision-makers, so these can identify the strengths/weaknesses in the functioning of their respective higher education systems from a systemic perspective.

To achieve the previous goal, we apply the methodological guidelines of the integrative review of the literature. An integrative review of the literature was chosen because it guides the extraction of quantitative evidence from the literature and its classification, with the purpose of integrating the results into an analytical framework. This resulting analytical framework is what we have labelled as the systemic evaluation instrument.

The paper makes three contributions to the literature. First, the different types of higher education institutions considered in the literature and the higher education systems analysis scales are evidenced. Second, we identify the capacities and functions examined by the literature so that higher education institutions and higher education systems can fulfil their missions. Third, a systemic evaluation framework for higher education institutions and higher education systems is presented. The article concludes with a discussion of the opportunities and challenges associated to the implementation of such a systemic framework for policymaking.

Keywords: higher education system; higher education institution; integrative review of the literature; systemic framework.

1.- Introduction

The main objective of this article is to design a systemic instrument to evaluate the functioning of a public policy system. A systemic approach or systems thinking is a methodological approach that has been widely used to evaluate diverse systems (e.g. health, environment, innovation). It originates from the work of von Bertalanffy (1968), in which it was first mentioned as an alternative method to Descartes' scientific reductionism. The methodological guidelines that this approach provides are based on the philosophy of holism and the theory of complexity (Waldrop, 1992). In essence, the systemic approach proposes that systems should be studied as entities rather than conglomerations of parts (Rosnay, 1977) and that demonstrating how a system works requires a deep understanding of the connections, interactions and behaviours of the elements that comprise them (Arnold, 2004).

The theoretical–practical concepts of the systemic approach arose in disciplines such as biology, ecology, psychology and cybernetics, although its application soon spread to social sciences and operations research, positioning it as an important instrument to analyse social systems and organisations (Mingers and White, 2010). This article focuses on analysing the opportunities and challenges that arise from adopting a systemic approach to evaluate the functioning of a multifunctional systems , as is the case of higher education systems (HESs). On reviewing the literature on HESs, it was found that most studies used an organisation-centred approach, characterised by three aspects: (i) studies reduce the system to a set of higher education institutions (HEIs)¹ defined by a nation-state and by national policies (Clark, 1986); (ii) they are evaluations that propose a set of indicators and standards that mark what is known as 'the typical organisation' and that prompt homogenising tendencies, known as coercive isomorphism, when they are caused by a common legal framework or as mimetic isomorphism when they originate as rankings or classifications (Benneworth et al., 2016; Bonaccorsi et al., 2007); (iii) studies are not always aligned with the objectives of public policies, as they focus on measuring the results of individual HEIs, and their objective is to compare or classify said HEIs (de la Torre et al., 2017; OECD, 2017a).

To solve this research problem, the article introduces a systemic evaluation instrument that departs with the following premises: (a) HEIs serve different roles in the system, and

¹ The acronym HEI is used in this article to refer to tertiary education training institutions that contain four levels: short-cycle tertiary education (level 5), bachelor's degree (level 6), master's degree (level 7), and doctorate (level 8) (UNESCO Institute for Statistics, 2014).

therefore, contribute in different ways to its operation (Porter, 1985); (b) the capacities of HEIs support the operation of the HES (Sarrico, 2010); (c) there are strengths and weaknesses in the HES operation that arise as a result of the relationship between the role and contribution of HEIs to said the system (Wieczorek and Hekkert, 2012).

The main reason for choosing this systemic approach lies in the impact that systemic instruments have had on managing other public policy systems, especially in the health and innovation sectors (Midgley, 2006; Smits and Kuhlmann, 2004). Despite the benefits other sectors have experienced, higher education has not been widely discussed in applying this type of instrument. Herein lies the main gap that we want to close.

In this sense, we believe that evaluating a system (of any kind) from a systemic perspective is necessary to explicitly and easily construct interpretable models for the system as a whole, instead of dividing it into elements as is done in the analytical method. In turn, this allows managers to get a quick 'picture' of how the HES is composed and how it works (Jackson, 2009). That is, systemic models generate knowledge for decision-making (Chapman, 2004), because they identify the weaknesses or strengths in an HES's functioning, in addition to indicating which HEIs exist and where they are weak/strong (Wieczorek and Hekkert, 2012).

Further, they are instruments that reduce the unwanted effects of isomorphism, as their design is based on the characterisation of who makes up the system. This means that they are designed to detect structural differences between existing elements, making underrepresented groups more visible. Moreover, these instruments strengthen the identity of a system, as they focus on evaluating the degree to which these systems fulfil the roles assigned to them by public policies.

Despite the absence of a commonly accepted definition in the literature, the systemic approach represents two analysis perspectives that are complementary: analysing the whole beyond the parts and assessing the parts in the context of the whole. In practice, this means, first, defining and characterising the system to be evaluated, and second, introducing the dimensions of the systemic analysis, namely, its structure and the functions it performs. In this article, we offer an integrative review of the literature to understand how these concepts are applied in HEIs' performance evaluations. Applying the methodological guidelines of the integrative review of the literature, we extract the quantitative evidence of the literature and its classification to combine the results into a conceptual framework (Torraco, 2016). This framework forms the basis of the systemic evaluation instrument that we propose in this article.

The remainder of the paper is structured as follows. Section 2 offers a brief historical review of the systemic approach and a summary of the main theoretical concepts that are the focus of our work. Simultaneously, it includes the different concepts, definitions and analytical perspectives available in the literature, which are necessary to conceptualise a systemic evaluation instrument. Section 3 presents the methodology that was followed in the literature review. Section 4 is structured in three parts. First, the different types of HEIs considered in the literature and the HES' analysis scales are analysed. Second, the capacities and functions examined in the literature are identified so that HEIs and HESs can achieve their missions. Third, the proposed systemic evaluation framework is presented. Section 5 explains the advantages offered by systemic instruments as a methodological alternative, as well as the opportunities and challenges associated with their implementation in the context of HESs. Finally, it concludes by discussing the implications of the research as well as new lines of research that can be derived from it.

2.- Literature review: a systemic approach to systems thinking

The term 'system' comes from the Greek word *σύστημα* *sustêma* that means 'coherent set'. In the literature, there are different and varied definitions of 'system', and each of these is conditioned by the discipline or problem to be solved (Donnadieu et al., 2003). In an effort to generalise this concept to all disciplines, von Bertalanffy (1968) suggested what is known today as the general systems theory.

Based on the generalisation proposed by von Bertalanffy (1968), a system is defined as an organisation made up of a set of elements that interact in an interrelated and interdependent manner to fulfil a function within a defined environment. This implies that regardless of the discipline, a system is characterised by 1) being formed by a set of elements, 2) the elements being related to each other, 3) operating in a certain environment, 4) aiming to achieve common objectives and 5) having the capacity for self-organisation. For studies that utilise the systemic approach, the practical application of this definition entails defining the system and its differences from the environment as well as the characterisation of the set of elements (structure) and their interactions (processes). These conditions turn out to be the greatest challenges in designing systemic evaluation instruments (Arnold, 2004), such as the one proposed in this article.

In social sciences, the first social systems theory was developed by Parsons (1971) who took a structural-functionalist approach. In contrast, Luhmann (1984) proposed the general social systems theory based on the fact that interactions (and not individuals) are

the constituent and reproductive units of the said systems. The starting point of Luhmann's thesis is defining a social system by differentiating the system and its environment, which he called self-referenced systems (Luhmann, 1984). The main limitation is that researchers, assuming that the system and the environment in which these operate are different, observe them independently and then correlate them, which to some extent makes a systemic approach meaningless (Stichweh, 2016).

Another key proposal of Luhmann's theory is interaction as the basic unit of social systems. Unlike sociologists such as Parsons, who defines action as the basic unit of systems (see the analysis of Parsons' theory in Cuff et al., 2006), in theoretical-systemic research, Luhmann's proposition is based on two assumptions. The first assumption refers to reducing the complexity of social systems into two components, structure and processes (Luhmann, 1984), while the second comprises recognising that the same element can interact simultaneously with different environments.

To better understand Luhmann's approaches, we turn to four key definitions that come from the social systems theory: environment, structure, processes and partial systems.

- **Environment:** It is the necessary context for self-referential processes to occur.
- **Structure:** It represents the possibilities of connecting each element with the rest in a relationship model, where possible connections are the results of choosing between the elements that make up the system and the elements available in the environment. A social system is identified by its structure, but it can change over time. A system's structure can activate or deactivate some system functions, which is why we speak of structural changes.
- **Process:** Processes, unlike structure, have a relationship with time. Processes mark events that are irreversible in time.
- **Partial systems:** Partial systems are seen from society's view and are characterised in terms of the role they play within the whole system.

Stichweh, a student of Luhmann, delves into the concepts of the structure and functional differentiation of social systems. Specifically, his ideas about inter-organisational systems and functional systems have been used to define university systems (Stichweh, 2016). First, the definition of the inter-organisational system is introduced as the relationships of observation, cooperation, interaction and competence developed by different HEIs. Labraña (2016), in an effort to highlight the 'glonacal' nature of HEIs, offers the definition of inter-organisational system to account for how HEI systems

operate simultaneously in various environments: global (world society), national (nation-state) and local (nearby territory). Second, and in relation to the concept of functional differentiation, functional systems, the education system and the science system are defined (Pfeffer and Stichweh, 2015).

The studies that address the analysis of the systemic approach are measured based on three basic concepts: holistic vision, complexity and interactions. These concepts have their own definition and scope in the main theories that are applied to social systems (Parsons, 1971; Luhmann, 1984). In addition, Donnadiou et al. (2003) describes other complementary concepts that help comprehend the empirical application of the systemic approach to analyse social systems, which we develop below.

2.1.- Holistic view

The methodological approach of the systemic view has two connotations (Borrás and Edquist, 2019): seeing the whole beyond the parts and seeing the parts in the context of the whole. The conceptual frameworks described in the literature to holistically define a system are primarily based on the theory of triangulation; thus, they seek to reduce the complexity of the system to three dimensions (Franklin et al., 1981). According to Le Moigne (1994), to define an object through triangulation it is required to consider a functional definition (what the object does), an ontological definition (what the object is), and a genetic definition (what the object becomes). In this way, a system would be represented by three dimensions or attributes, namely, composition, structure and functions. The composition explains the identity and variety of the elements that comprise the system, the structure represents the form of organisation and the grouping patterns of the elements in the environment, and the functions include all the ecological and evolutionary processes.

An holistic view aims to define the entire system and expresses both the interdependence of the elements that compose it and the coherent whole. This means that systemic evaluations face the challenge of being instruments that examine the whole as a 'unit' and also as the totality of the parts (which is not equal to the sum of the parts) (Rosnay, 1977). Luhmann (1984), referring to social systems, reframes the concept of the totality in what he calls the system differentiation theory, which is nothing more than differentiating the parts contained in the system. According to him, in highly differentiated systems, specialised elements coexist to fulfil certain functions, and more general elements carry out other activities that are common to all parties.

In the theory shared by Parsons (1971), the emphasis lies on the functions that the

elements fulfil, i.e. the contributions that an element makes to the system so that it works. In this sense, Parsons developed the notion of the ‘status role’, referring to the fact that each element has a certain position in the system and that the system has an expected behavioural pattern for the said role (Cuff et al., 2006).

Differentiating the elements allows the diversity (variety) of a system to be established (Birnbaum, 1983; Codling and Meek, 2009). In the literature, the concept of diversity is clearly related to the condition of homogeneity or heterogeneity of a system at a given moment (Agasisti and Bonomi, 2014). In contrast, the concept of differentiation is recognised as a dynamic process that leads to the emergence of new elements or to the transformation of existing ones (van Vught, 2008).

2.2.- Structure-function analysis

In a social system, structure and processes are mutually conditioned (Luhmann, 1984). A structure-function analysis comprises, first, evaluating the elements that are produced and reproduced to fulfil the essential functions of the system, and second, the functions that are activated or deactivated by the system’s structure. Thus, the loss (gain) of the elements that carry out essential functions or the deactivation (activation) of the essential functions can signify a systemic failure (feat) (Woolthuis et al., 2005). Despite these benefits, there are few examples of its application in empirical evaluations of systems guided by public policies.

To conduct this type of analysis, two initial definitions are needed. The first definition is related to the type of system to be evaluated, as the structure-function analysis perspective in an inter-organisational system is different from that of a functional system (Pfeffer and Stichweh, 2015). The second definition is regarding the processes that are indicative of the system’s essential functions and distinguishing their interactions between the environment and the system.

2.3.- Environment–system interaction

The concept of interaction refers to the influence of or exchange between elements that generates information flows in the system (Donnadieu et al., 2003). The systemic approach analyses the interaction that occurs between elements as well as the interaction between the elements and the environment. This starts with the assumption that they are bidirectional, non-linear relationships and that they go beyond a cause–effect relationship (Rosnay, 1977).

The general system theory characterises these interactions by adopting the concepts of inputs–outputs, transformation processes and feedback (Ackoff and Emery, 1972), where

inputs are the consumables (information, material or energy) that are required to produce results. Processes are the mechanisms or technologies used by each component to convert inputs into outputs. Outputs are the results obtained by the system's components that lead to the system's contribution to the environment. Outputs can also generate feedback by becoming system inputs.

Studies on public policy systems focus on studying two specific types of interactions (OECD, 2017b): the interactions and interdependencies that exist between the system elements and the two-way relationship that occurs between social organisations and the environment in which they develop. Theoretically, the environment in this type of system is socioeconomic and is defined by the scope of coverage of policies, restrictions and/or incentives. In general, it is common to find that the environment of these systems is coordinated by dynamics that originate in the nation-state, the market and in sector or social interests (Burke, 2005).

Another key approach to Luhmann's (1984) theory is the environment–system differentiation. According to Luhmann, a social system is structurally focused on the environment and without it, it could not exist. This means two things: first, environment–system interactions are bidirectional and second, the absence or weakness of these interactions can lead to systemic failures.

Specifically, public policy systems, including the HES, behave like a network in which the relationship between the institutional environment and the elements that comprise them is bidirectional but with clearly differentiated functions (Huisman et al., 2015). This means that a systemic approach to public policy systems should help map the surrounding dynamics of the system and understand how these dynamics affect the functioning of these elements and their relationship (OECD, 2017b).

3.- Methodology

The literature that evaluates the performance of HESs has grown exponentially in recent decades, especially in relation to HEIs' performance measurements, which has led to some systematic reviews in the literature (e.g. De Witte and López-Torres, 2017; Rhaiem, 2017; Gralka, 2018; Rodríguez and Aparicio, 2021). These studies describe the methodological characteristics of the mathematical models that are applied in higher education, but they do little to analyse the conceptual frameworks that underlie their evaluation. From the results of these reviews, it can be deduced that while this literature is rich in empirical studies that analyse the processes of a set of HEIs at different

organisational levels (e.g. departments, knowledge areas and HEIs) and geographic scales (e.g. national, regional and local), relatively few studies apply a holistic view of HES.

In this section, we examine this literature, applying the methodological approach of the integrative literature review (ILR) (Torraco, 2016). Among the multiple methodological alternatives for a literature review, an ILR was chosen because it guides the extraction of quantitative evidence from the literature and its classification, with the purpose of integrating the results into an analytical framework. The ILR is developed in four stages: 1) searching the literature, 2) developing and applying classification taxonomies, 3) data analysis and 4) integrating the results into an analytical framework. To meet the article's objectives, the ILR aimed to answer the following research questions: What types of HESs are seen in the literature? What functions and capacities are valued in HEIs?

The main sources of data are scientific articles published between January 1978 and February 2018 in peer-reviewed journals and indexed in bibliographic databases contained in the Web of Science, Scopus, Proquest, or EBCHOST platforms. The search query was constructed using a set of keywords frequently used in efficiency, productivity and performance studies at HEIs, resulting in the following search condition (efficiency OR productivity OR performance measurement) AND (higher education OR college OR university OR 'post secondary' OR postsecondary OR universities) AND ('data envelopment analysis' OR DEA OR SFA OR 'stochastic frontier').

The documents included in the review meet the following eligibility criteria: 1) The objective of the study is to evaluate the performance, efficiency, effectiveness or productivity in higher education; 2) It is an empirical or methodological study applicable to higher education and 3) The observation unit corresponds to a HEI. The result of the previous search yielded a final sample of 235 articles.

Once the sample has been defined, the objective is to extract evidence about the system, structure, processes and system–environment interaction considered (see Section 2), which was conducted in two stages. In the first stage we performed a discriminant analysis to test whether the geographic scope or mission purpose is appropriate to identify different types of HES. Discriminant analysis allowed us to achieve three purposes. First, it reduced the variability found in the variables included in our analysis through discriminant functions. To validate the statistical significance of the discriminant functions, we used the canonical correlation coefficient, and we used the p value of the Lambda Wilks statistic. Second, it tested whether there are significant differences within the defined groups. In our case, the groups belong to a set of studies from different

geographical scopes (global, national or local) or different mission purposes (teaching, research, outreach and their combinations).² To classify the studies, we used the Mahalanobis distance, which is calculated from the covariance matrix grouped within the group. Assigning a study to a specific group was validated using the cross-validation procedure.

In the second stage, the concepts of structure, function and systemic failures are introduced. The structure was established based on the composition and disposition of the actors and institutions that make up a HES. The processes are characterized as the relationship between the input and output variables associated with each mission, and were differentiated into functions (system) and capabilities (organization), applying the reference framework described by Rodríguez and Aparicio (2021). In this regard, a function was defined as the activities that are executed in the HEIs and that represent the teaching, research and outreach processes and whose outputs contribute directly to fulfilling the higher education policy objectives (OECD, 2017b). The capabilities then correspond to the set of processes that the HEIs execute autonomously to operate the above functions, obtaining results that are aimed at meeting their organisational objectives and indirectly contributing to the performance of the HES in which they are embedded. Finally, we checked which functions and capacities are predictors of the groups defined in the discriminant analysis.

To show whether the studies considered in the literature are similar or related to the functions and capacities that they characterise, we conducted a non-metric multidimensional scaling analysis (NMDS), which is a multivariate reduction technique (Borg et al., 2012). Similarity was calculated using the Jaccard index designed for binary variables of presence/absence, as is our study. The NMDS represents the similarities and differences between studies by distance on a two-dimensional coordinate map so that it is possible to interpret that the closer the studies are, the more similar they are with respect to the processes they observe. To understand how functions and capacities are distributed in multidimensional space and to know how close they are to each other, we applied the PROperty FITting Method (Ding, 2019) to the coordinates extracted from the NMDS analysis.

Finally, the systemic framework representing the different types of HES identified was constructed. The systemic framework reduced the complexity of the system in three

² University outreach, also known as the third mission, refers to any activities that HEIs conduct to interact with society. It generally includes two areas: knowledge transfer and social management (Laredo, 2007b).

dimensions: structure, functions and the environment–system relationship (Donnadieu et al., 2003). The structure dimension describes the HES organisation compared to what type of HEIs comprises it. The functional dimension focuses on characterising the functions and capacities that are analysed in the HES. Finally, the form of environment–system relationship is presented based on the type and frequency of the external factors examined in the studies and their potential use as systemic failures or feats.

4.- Results

As already indicated, a system is measured by the dimensions of elements, functions and interactions. Therefore, this section is structured in three parts. First, the different types of HEIs considered in the literature and the HES' analysis scales are analysed. The second part focuses on identifying the capacities and functions examined by the literature so that HEIs and HES can fulfil their missions. Finally, the third part presents the proposed systemic evaluation framework.

4.1.- HES typology

The central purpose of the first contribution is to identify and characterise the types of HESs found in the literature. Currently, one of the areas of greatest interest in higher education is classifying and typifying HEIs, mainly as a result of the increasing significance being given to rankings (Salmi, 2009; Agasisti and Johnes, 2015; Daraio et al., 2015; Guironnet and Peypoch, 2018). Numerous and varied types of HEIs are available in the literature, which differ from each other mainly in two aspects: 1) they are prescriptive or descriptive classifications, and 2) the classifications are based on one or more characteristics of HEIs (de La Torre et al., 2018).

In the reviewed literature, the structural dimension is the most commonly used to delimit a HES. This is explained by the fact that most studies focus their attention on homogenizing the samples according to the academic and sectoral nature of HEIs (Figure 1). Regarding academic nature, most studies analyse universities or university colleges (e.g. Coupet, 2017), i.e. institutions that offer academic training that corresponds primarily to levels 6, 7 and 8 of tertiary education according to the UNESCO classification (UNESCO Institute for Statistics, 2014). Few studies evaluate the performance of business schools (e.g. Hirao, 2012; Palocsay and Wood, 2014) or technical institutes with vocational offerings (e.g. Porto Gómez et al., 2018). Our results show that the public sector is of special interest to the research community, representing

25% of the evaluations. In contrast to that observed for the public sector, higher education's expansion of private non-profit or for-profit HEIs (Kwiek, 2017) is addressed by few articles ($n = 6$). It is thus possible to conclude that the literature is clearly inclined towards the evaluation of HEIs in contexts of structurally partial HESs, such as university-based HESs and public HESs.

[Figure 1 here]

Second, the results of the ILR show that much of the literature assumes that what happens in a HES is determined by national policies (Figure 2). While it is true that some of the studies observed HESs at local (4%) and global (9%) geographic scopes, most of these tend to be evaluated under the same indicators as the studies focused on the national level (Bonaccorsi et al., 2007; Rodríguez et al., 2021). In other words, the literature largely assumes that HESs must have the same capacities and contribute in the same way regardless of the environment in which they offer their activities. Likewise, the discriminant analysis shows that there is a high overlap between the different geographic scopes, which is corroborated by the low percentage (36.7%) of correctly classified studies.

As it can be observed in Figure 2, the results of our discriminant analysis show that, on the one hand, studies with a national focus could also be considered as global (37%) or local (32%). This could imply that the literature tends to replicate national priorities and realities at global and local levels, with unintended consequences for the development not only of the academic or scientific communities that operate in these contexts (Benneworth et al., 2016), but also of the policies designed and implemented in them. On the other hand, the discriminant analysis evidences that the processes modelled in the literature tend to be closer to global dynamics (42%) than to local ones (32%). This brings to light the growing interest of researchers in conducting cross-border comparisons and elaborating international rankings.

[Figure 2 here]

While the results of the previous analysis show that most of the studies (86%) are related to HESs linked to the nation-state, the analytical approaches to the global, national and local environments are different. As shown in Figure 3, the shaded areas that represent

the distribution of studies with a global scope (Quadrant I) and local scope (Quadrants II and III) are explained by vectors of functions and capacities that are different from those that explain studies with a national scope.³ Specifically, performance measurements approximate the global environment from the dynamics of HEIs in employability, scientific production, doctoral research and internationalisation, the local environment mainly from entrepreneurial activities and consulting income and the national environment, notably, from HEI capacities (Quadrant IV). It can thus be concluded that the HESs observed in the literature are mainly targeting the processes related to education and the extension of the science system towards innovation. This need to differentiate HESs should be considered by public administrators to avoid replicating national priorities in the global and local contexts and generate systems capable of responding to local dynamics and demands for innovation.

At the same time, it can be observed how the studies adopting a global perspective (red polygonal shape) tend to consider such issues as employability, internationalisation, doctoral research, scientific production or the transfer of intellectual assets as relevant dimension in their analysis. On the opposite extreme, in the studies that adopt a local perspective (black polygone) the most relevant dimensions of analysis appear to be the improvements in teaching along the demands of the local firms, increasing the income from consulting activities to local actors, and promoting an entrepreneurial behaviour in the territory. Finally, the studies that adopt a national viewpoint (grey polygon) appear as the most comprehensive, as they embrace all of the dimensions considered in the previous two cases (global and local), while also showing particular attention to graduation rates and research income.

[Figure 3 here]

Our results also show how the literature on HES analyses functional (i.e. they focus on a concrete mission) and multifunctional systems (i.e. they combine at least two different missions) (see Figure 4). About 33.6% of the articles analyse the level of performance of HEIs and HESs, focusing on outputs related to a single university mission. In line with Pfeffer and Stichweh (2015), of the three university missions, the literature covers the training mission more frequently (49 articles) and research and knowledge transfer (i.e.

³ For the details on the functions and capacities that are identified in the literature, please see Section 4.2.

extension) less frequently (34 articles). The results of our discriminant analysis show how studies are divided into four groups (Figure 4).

The studies that observe multifunctional HESs (quadrants III and IV) focus their attention on production in teaching and research (centroids 1, 2 and 6), including in some cases, the results in administration and management activities (centroids 3 and 5). In turn, quadrants I and II include those studies that aim to evaluate the production of HEIs in research and innovation (centroids 4, 7 and 8). The studies considered in the research were classified according to these two discriminant functions, which together explain 88.9% of the total variance. Our analysis also showed that the discriminated eight groups (i.e. each represented by a different centroid) are statistically dissimilar ($\lambda = 0.002$; $P < 0.005$), and that they classified 79% of the cases correctly (73.7% by cross-validation).

[Figure 4 here]

4.2.- Capacities and functions

The objective of this second section is to identify which capacities and functions are examined by the literature. As in the previous section, here too we rely on the results from the ILR. As we have already indicated, we can conclude that in the literature on HESs, there is great concern for covering the three university missions, although the dominant perspective is that of jointly measuring teaching and research. Although the variables used to assess each mission confirm the results of previous reviews (e.g. De Witte and López-Torres, 2015; Rhaïem, 2017; Gralka, 2018), our results also show that the selection of the variables used for each mission are related to very different functions of HESs and imply different capacities in HEIs. Table 1 evidences the frequencies (%) of the functions and capacities identified in the literature, based on the scale of operations of the HES (i.e. Global, National, Local). It also includes the total number of articles that include each of these functions and capacities, so it is possible to identify which of these are most commonly targeted in the literature. As it can be observed, our results point to the existence of certain imbalances in measuring the three university missions (see Rodríguez and Aparicio, 2021).

The results of our ILR reveal that there are seven functions (F) and nine capacities (C) that contribute to fulfilling the higher education policy objectives. One of these goals is the formation of human capital, which is mainly achieved through the measurement of completion and graduation rates (F1). Very few studies have focused on other educational

policy objectives such as the type of professional activity of the recent graduates (F2) or the delivery of continuous education (F3). In this regard, it is also common and recurrent in the literature to assess the ability of HEIs to attract students (C1). Also, despite the interest of governments in the quality of education, few studies deal with the capacities required to support the training processes of HEIs, such as reducing school dropout (C2), producing academic programs and accrediting their quality (C3), fostering internationalization (C4), generating income from student enrolment (C5), or improving the operations of academic programs (C9-T).

Another central intention of HEIs is to contribute to innovation (OECD, 2017b), being this understood as a process that generates added value from research results (Brennan et al., 2014). This implies the fulfilment of the objectives not only of higher education policies, but also those of science, technology, and innovation policies (Laredo, 2007a). Our results show that as regards the research mission the literature focuses on examining the new knowledge generated by HEIs (F5), measuring the activity levels in pre-doctoral and post-doctoral research (F4), while as regards the third mission the literature focuses on the conversion of research results into intellectual assets (F6) and the development of entrepreneurial activities (F7). In turn, as to the capacities considered by the literature in relation to research it is worth highlighting the ability of HEIs to generate new sources of income from competitive funds (C6) and improving the operations of research programs (C9-R), while the capacities related to the third mission include the income from consulting activities, either due to the provision of research services or to the licensing of intellectual assets (C7) and improving the operationalization of knowledge transfer activities (C9-TC).

[Table 1 here]

Table 2 shows the functions and capacities based on the main mission of the HEIs. In this regard, Table 2 differentiates between the studies that focus on functional systems, or on multifunctional systems. According to our results, the teaching mission is primarily represented by educational achievement measures (F1) such as graduation rates (82% of articles), and student attraction (C1, 41% of articles), while fewer studies assess other HEIs' functions such as employability (F2, 12%) or continuous education (F3, 2%), or other capacities such as the quality assurance of academic programs (C3, 14%), the reduction of student dropouts (C2, 10%), the resources mobilized for teaching activities

(C5, 8%), or the improvement of academic operations (C9-T, 2%).

In relation to research, and as expected, practically the entire literature examined considers the function of generating new knowledge through scientific production (F5). However, other studies also consider HEIs' ability to obtain external funding for research activities (C6, 37%), or improving the operations of research activities (C9-R, 9%). It is also worth noting that in some countries the pre-doctoral and post-doctoral training (F4, 9%) is primarily related to the research mission, which means that pre-doctoral training is sometimes used both to evaluate teaching and research performance.

Finally, Table 2 also corroborates the results from previous scholars as regards the functions and capacities that are related to the outreach mission (i.e. knowledge transfer), (Laredo, 2007a; Molas-Gallart and Castro-Martínez, 2007; Palomares-Montero and García-Aracil, 2011; Giuri et al., 2019). In this regard, the variables most commonly used to evaluate the performance of HEIs in this third mission include the income due to knowledge transfer activities (C7, 89%) and the conversion of research results into intellectual assets (F6, 89%). Other measures not that frequently used to characterize HEIs' performance in relation to their outreach mission include the support of entrepreneurial activities (F7, 22%) and the operational improvement of knowledge transfer activities (C9-TC, 11%).

[Table 2 here]

4.3.- Introducing a systemic evaluation framework

The objective of this third section is to present the systemic evaluation framework that we are proposing as an instrument to evaluate HESs. Based on the results above (Sections 4.1 and 4.2), we build a systemic framework that integrates the aspects of structure, function and the environment–system relationship (Figure 5), which are the three dimensions that the literature considers as relevant to provide an holistic perspective of a system (Haynes, 2008).

[Figure 5 here]

The system's structure will be reflected by the diversity of elements that coexist in the HES. The rationale for considering this first dimension in our framework structure is because it allows to identify which are the roles of HEIs that turn out to be decisive in the

viability and performance of the HES (Jackson, 2009). In addition, it also allows to explore the potential transformations that the previous roles may have over time and their possible impact on the sustainability of the system. In addition, the dynamics of the structure's change will depend on the speed and direction of the differentiation and diversification processes that occur in the elements that constitute the system (Rossi, 2009).⁴ The challenge to be addressed therefore is to classify the elements of the HES compared to their differentiation approaches and to examine whether the elements adopt similar approaches. In this sense, we find that the results offered in this section may be useful in understanding the structural diversity considered by HESs based on what has been explored in the literature.

The results of the ILR we have conducted support the idea that the structural dimension should be the basis for systemic evaluations of HESs due to two main reasons. First, because assuming that the same HEI can work simultaneously in HESs of different geographical scales, implies necessarily that HEIs have the required capacities to adopt different roles, depending on the structure of the HES in each location. And second, because the fact that the same HEI fulfils several roles can positively or negatively affect its overall performance, and that of the HES in which it is embedded.

The functional dimension of the previous systemic framework allows identifying the processes that are essential for the system to function well. The functional dimension is necessary to answer at least two questions: (i) What does the system do in relation to its environment? In other words, it allows to identify whether the HEI carries out the processes that are essential to meet the systemic objectives that were assigned to it; and (ii) Does it produce the results that contribute to the overall achievement of those goals? The processes undertaken within HESs embody the sequence of activities that are executed to transform inputs into results. In this sense, the elements of the HES work well if they meet the following conditions: (i) they carry out the processes that are necessary to develop indispensable capacities in the system's operation that we have called 'capacities' and (ii) they produce results that efficiently contribute to achieving the central objectives of the policies, which we have called 'functions'. Hence, from our point of view the development of the functional dimension can be approached from two perspectives. The first approach is that of multifunctional HESs, which allows to capture whether a HEI performs efficiently in the three university missions. The second approach

⁴ According to the evidence gathered in this ILR, we have observed that as to date, isomorphism seems to be more common than diversification at the level of HEIs and HESs.

relies on the understanding of functional HESs that are focused on performing in a single mission. In the case of partial systems, the basis of the evaluations is the functional aspect, since it is assumed that HEIs tend to specialize in those activities that generate competitive advantages. In this case, the purpose of systemic evaluation should be to consider the interdependencies between the set of functions and capabilities that are related to the fulfilment of social expectations.

One of the main uses of systemic instruments is to identify problems or obstacles that arise in the system's functioning (Edquist, 2011). Systemic problems negatively influence the direction and speed of processes, hampering the development and proper functioning of systems (Woolthuis et al., 2005). These failures have different origins and are of different natures. They can be failures of the system (internal failures), as they arise due to how the system is structured and how it works (Chapman, 2004). They can also be failures that arise from the environment in which the system operates (external failures) and that affect the interactions that occur within it. There are two types of structural failures. The first corresponds to problems related to the presence or absence of key actors. In the context of HESs, this type of structural failure could occur when, for example, a university does not fulfil the function of training doctors or seeking to contribute to society. The second type of structural problem is related to capacities, i.e. when the system's agents lack the ideal capacities to carry out their functions. As a result, structural problems must not only be identified at the level of each agent and type of agent but also in the total set of elements that makes up the system.

Finally, interaction problems are contextualised in the environment–system relationship. Our proposal in this regard is to focus on the dynamics related to state priorities, academic priorities and market forces, complying with the methodological condition of comparing institutions that are similar in their forms of production. This is concerned with identifying the obstacles that arise from the relationships, connections and interactions between the environment and the system or its parts (Weber and Rohrer, 2012). From our point of view further research needs to develop a classification scheme of the potential failures that may influence the performance of each type of HES. The challenge lies, on the one hand, in differentiating the priorities of the policies that govern the different geographical contexts in which HES operate. On the other hand, it is also necessary to link the objectives of higher education policies with the priorities of other sectoral policies.

5.- Conclusions and discussion

Literature on higher education offers some research using a systemic approach (e.g. Hemsley-Brown and Oplatka, 2010; Brennan et al., 2014; Pfeffer and Stichweh, 2015). These studies, however, are insufficient to empirically evaluate HESs because they do not contemplate the heterogeneity of HEIs and the absence of classification outlines of the functions and capacities that are developed within HESs, which results in systemic failures. This has led to one-size-fits-all evaluation models (Sánchez-Barrioluengo, 2014; Benneworth et al., 2016), which focus their attention on some specific HEIs and on some capacities and functions (Rodríguez and Aparicio, 2021). This distinction has consequences on its measurement, on the relative positions that HEIs occupy in international rankings, and therefore, on the policies applied to these organisations (López-Illescas et al., 2011). This means that the complexity of HESs represents one of the greatest challenges faced by public administrators in designing evaluation instruments (Chapman, 2004).

In addressing this research gap and trying to answer the research questions that have guided the comprehensive literature review carried out here, the article offers three contributions to the literature. First, the article contributes to the questions of how to define an HES and what types of HESs are seen in the empirical literature. In this regard, the article groups the different HESs according to their structural characteristics. Our second contribution points out that it is necessary to differentiate between the interactions that yield results for the system (which we call functions) and those that yield results for the organisation (which we call capacities). In this sense, the article identifies the capacities that are examined in HEIs and the functions of the HES that are included in the literature. Finally, the article offers a systemic evaluation framework, which is useful for administrators of higher education policies, as well as other related fields such as science, technology and innovation policy.

The first implication of the systemic evaluation instrument that is proposed in this article is that it helps to establish the directionality of public policies (Edler and Boon, 2018), as it seeks to align operational elements that make up the HES with public policy objectives. The purpose of this systemic framework is to go beyond merely describing the situation of a HES at a given moment and to delve into what and where the potential problems or failures that occur in the system are. The second implication of this framework is that capacities that must be developed for the system to function well can be characterised. In this sense, the lack of a classification outline for capacities and functions in the literature

has led to the use of a set of indicators that is leading to the hyper-development and underdevelopment of some capacities in HEIs.

Regarding the practical relevance of the systemic framework in identifying failures and strengths in the system's operation, further research should seek to validate it through case studies or by experts in the field. In this way, it will be possible to contribute to the literature with evidence of the benefits the use of systemic evaluations to implement public administration offers, in addition to being able to suggest which instruments offer specific solutions to address these problems.

Similarly, further research could apply this model of functions and capacities in different case studies to identify clusters of homogeneous HEIs based on their capacities and functions. In this way, the science, technology and innovation policies in which HEIs are intended to be included will better understand the specific characteristics of each typology of HEIs instead of defining one-size-fits-all type of policies, where all HEIs are considered to behave the same way.

Although there are advantages of adopting a systemic approach, it also entails a series of limitations and challenges in achieving an empirical application that can be applied generally. One of these limitations is related to the difficulty of analysing and deducing causality among the multiple dimensions considered, what requires further research. Another limitation is the ex-post nature of the study, as circumstances may change while the HES is being analysed. Finally, systemic frameworks have high demands in terms of the amount of data required, which can be a major limitation in countries where it is difficult to access data. This in turn makes it difficult to conduct comparative studies between countries, which may limit the generalisability of such frameworks.

References

Ackoff, R.L., Emery, F.E. (1972). *On purposeful systems*. London: Tavistock Publications.

Agasisti, T. (2009). Market forces and competition in university systems: Theoretical reflections and empirical evidence from Italy. *International Review of Applied Economics*, 23(4), 463–483.

Agasisti, T., Bonomi, F. (2014). Benchmarking universities' efficiency indicators in the presence of internal heterogeneity. *Studies in Higher Education*, 39(7), 1237–1255.

Agasisti, T., Johnes, G. (2015). Efficiency, costs, rankings and heterogeneity: the case of US higher education. *Studies in Higher Education*, 40(1), 60–82.

- Aigner, D., Lovell, C.A.K., Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics*, 6(1), 21–37.
- Arnold, E. (2004). Evaluating research and innovation policy: a systems world needs systems evaluations. *Research Evaluation*, 13(1), 3–17.
- Benneworth, P., Pinheiro, R., Sánchez-Barrioluengo, M. (2016). One size does not fit all! New perspectives on the university in the social knowledge economy. *Science and Public Policy*, 43(6), 731–735.
- Birnbaum, R. (1983). *Maintaining diversity in higher education*. Jossey-Bass, Inc., 433 California St., San Francisco, CA 94104.
- Bonaccorsi, A., Daraio, C. (2008). The differentiation of the strategic profile of higher education institutions. New positioning indicators based on microdata. *Scientometrics*, 74(1), 15–37.
- Bonaccorsi, A., Daraio, C., Lepori, B., Slipersæter, S. (2007). Indicators on individual higher education institutions: addressing data problems and comparability issues. *Research Evaluation*, 16(2), 66–78.
- Borg, I., Groenen, P., Mair, P. (2012). *Applied Multidimensional Scaling*. New York: Springer.
- Borrás, S., Edquist, C. (2019). *Holistic Innovation Policy: Theoretical Foundations, Policy Problems, and Instrument Choices*. Oxford: Oxford University Press.
- Brennan, J., Broek, S., Durazzi, N., Kamphuis, B., Ranga, M., Ryan, S. (2014). *Study on Innovation in Higher Education: Final report*. European Commission Directorate for Education and Training Study on Innovation in Higher Education. Publications Office of the European Union, Luxembourg.
- Burke, J.C. (2005). The many faces of accountability. In J.C. Burke (Ed.), *Achieving accountability in higher education: balancing public, academic, and market demand* (pp. 1–24). Michigan State University: Willey.
- Carvalho, T., Videira, P. (2019). Losing autonomy? Restructuring higher education institutions governance and relations between teaching and non-teaching staff. *Studies in Higher Education*, 44(4), 762-773.
- Chapman, J. (2004). *System failure: Why governments must learn to think differently*. Demos.
- Clark, B. (1986). *The Higher Education System. Academic Organization in Cross National Perspective*. University of California Press.
- Codling, A., Meek, L.V. (2009). *Twelve propositions on diversity in higher education*.

- Higher Education Management and Policy, 18(3), 1–24.
- Coupet, J. (2017). Strings attached? Linking Historically Black Colleges and Universities public revenue sources with efficiency. *Journal of Higher Education Policy and Management*, 39(1), 40–57.
- Coupet, J., Barnum, D. (2010). HBCU efficiency and endowments: An exploratory analysis. *International Journal of Educational Advancement*, 10(3), 186–197.
- Cuff, E. C., Sharrock, W.W., Francis, D.W. (2006). *Perspectives in sociology*. Fifth edition. New York: Routledge.
- Daraio, C., Bonaccorsi, A., Simar, L. (2015). Rankings and university performance: A conditional multidimensional approach. *European Journal of Operational Research*, 244(3), 918–930.
- De la Torre, E.M., Agasisti, T., Perez-Esparrells, C. (2017). The relevance of knowledge transfer for universities' efficiency scores: an empirical approximation on the Spanish public higher education system. *Research Evaluation*, 26(3), 211–229.
- De La Torre, E.M., Casani, F., Sagarra, M. (2018). Defining typologies of universities through a DEA-MDS analysis: An institutional characterization for formative evaluation purposes. *Research Evaluation*, 27(4), 388–403.
- De Savigny, D., Adam, T. (Eds.) (2009). *Systems thinking for health systems strengthening*. World Health Organization.
- De Witte, K., López-Torres, L. (2017). Efficiency in education: a review of literature and a way forward. *Journal of the Operational Research Society*, 68(4), 339–363.
- Dill, D. (1997). Higher education markets and public policy. *Higher Education Policy*, 10(3–4), 167–185.
- Ding, C. (2019). Examining item content validity using property fitting analysis via multidimensional scaling. *International Journal of Methods in Psychiatric Research*, 28(1), e1771.
- Donnadieu, G., Durand, D., Neel, D., Nunez, E., Saint-Paul, L. (2003). L'Approche systémique: de quoi s'agit-il?, *Synthèse Des Trav. Du Groupe AFSCET "Diffus. La Pensée Systémique"* pp. 1–11.
- Edler, J., Boon, W.P. (2018). The next generation of innovation policy: Directionality and the role of demand-oriented instruments. Introduction to the special section. *Science and Public Policy*, 45(4), 433–434.
- Edquist, C. (2011). Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). *Industrial and Corporate Change*, 20(6),

1725-1753.

Fischer, M., Kauder, B., Potrafke, N., Ursprung, H.W. (2017). Support for free-market policies and reforms: Does the field of study influence students' political attitudes? *European Journal of Political Economy*, 48, 180–197.

Gallopín, G. (2003). A systems approach to sustainability and sustainable development. Economic Commission for Latin America and the Caribbean.

Giuri, P., Munari, F., Scandura, A., Toschi, L. (2019). The strategic orientation of universities in knowledge transfer activities. *Technological Forecasting and Social Change*, 138, 261–278.

Gralka, S. (2018). Stochastic frontier analysis in higher education: A systematic review. CEPIE Working Paper 05/18. Technische Universität Dresden. ISSN 2510-1196. Available: <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa2-324599>

Guironnet, J. P., Peypoch, N. (2018). The geographical efficiency of education and research: The ranking of US universities. *Socio-Economic Planning Sciences*, 62, 44- 55.

Haynes, P. (2008). Complexity theory and evaluation in public management. *Public Management Review*, 10(3), 401–419.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., Smits, R.E.H.M. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, 74(4), 413–432.

Hemsley-Brown, J., Oplatka, I. (2010). Universities in a competitive global marketplace: A systematic review of the literature on higher education marketing. *International Journal of Public Sector Management*, 19(4), 316–338.

Hirao, Y. (2012). Efficiency of the top 50 business schools in the United States. *Applied Economics Letters*, 19(1), 73–78.

Huisman, J., Lepori, B., Seeber, M., Frølich, N., Scordato, L. (2015). Measuring institutional diversity across higher education systems. *Research Evaluation*, 24(4), 369–379.

Jackson, M. C. (2009). Fifty years of systems thinking for management. *Journal of the Operational Research Society*, 60(1), S24-S32.

Kwiek, M. (2017). De-privatization in higher education: a conceptual approach. *Higher Education*, 74(2), 259–281.

Labraña, J. (2016). El concepto de sistema de los sistemas de educación superior: el caso chileno. *Calidad En La Educación*, (44), 276–299.

Laredo, P. (2007a). Revisiting the third mission of universities: Toward a renewed

- categorization of university activities? *Higher Education Policy*, 20(4), 441–456.
- Laredo, P. (2007b). The third mission of Universities, UNESCO workshop. *The Third Mission of Universities*, 1–11.
- Le Moigne, J.L. (1994). *La théorie du système général: théorie de la modélisation*. FeniXX.
- López-Illescas, C., de Moya-Anegón, F., Moed, H.F. (2011). A ranking of universities should account for differences in their disciplinary specialization. *Scientometrics*, 88(2), 563–574.
- Luhmann, N. (1984). *Soziale systeme: grundriss einer allgemeinen theorie*. Suhrkamp.
- Marginson, S. (2006). Dynamics of national and global competition in higher education. *Higher Education*, 52(1), 1-39.
- Marginson, S. (2007). The public/private divide in higher education: A global revision. *Higher Education*, 53(3), 307–333.
- Marginson, S., Rhoades, G. (2002). Beyond national states, markets, and systems of higher education: A glonacal agency heuristic. *Higher Education*, 43(3), 281–309.
- Midgley, G. (2006). Systemic intervention for public health. *American Journal of Public Health*, 96(3), 466-472.
- Mingers, J., White, L. (2010). A review of the recent contribution of systems thinking to operational research and management science. *European Journal of Operational Research*, 207(3), 1147–1161.
- Molas-Gallart, J., Castro-Martínez, E. (2007). Ambiguity and conflict in the development of “Third Mission” indicators. *Research Evaluation*, 16(4), 321–330.
- Molas-Gallart, J., Salter, A., Patel, P., Scott, A., Duran, X. (2002). *Measuring Third Stream Activities: Final report to the Russell Group of Universities*. Brighton: SPRU, University of Sussex.
- OECD. (2017a). *Benchmarking Higher Education System Performance: Conceptual framework and data. Enhancing Higher Education System Performance*. Paris: OECD.
- OECD. (2017b). *Systems Approaches to Public Sector Challenges*. Paris: OECD.
- Palocsay, S., Wood, W.C. (2014). An Investigation of U.S. Undergraduate Business School Rankings Using Data Envelopment Analysis With Value-Added Performance Indicators. *Journal of Education for Business*, 89(6), 277–284.
- Palomares-Montero, D., García-Aracil, A. (2011). What are the key indicators for evaluating the activities of universities?. *Research Evaluation*, 20(5), 353–363.
- Parsons, T. (1971). *The system of modern societies*. Englewood Cliffs, N.J.: Prentice-

Hall.

Pfeffer, T., Stichweh, R. (2015). System Theoretical Perspectives on Higher Education Policy and Governance. In J. Huisman, H. de Boer, D. Dill, M. Souto-Otero (Eds.), *The Palgrave International Handbook of Higher Education Policy and Governance* (pp. 152–175). Palgrave MacMillan.

Porter, M. (1985). *Competitive Advantage: Creating and sustaining superior performance*. New York: Free Press.

Porto Gómez, I., Zabala-Iturriagoitia, J.M., Aguirre Larrakoetxea, U. (2018). Old wine in old bottles: The neglected role of vocational training centres in innovation. *Vocations and Learning*, 11(2), 205-221.

Rhaim, M. (2017). Measurement and determinants of academic research efficiency: a systematic review of the evidence. *Scientometrics*, 110(2), 581–615.

Rodríguez, D.Y., Aparicio, J. (2021). Introducing a functional framework for integrating the empirical evidence about higher education institutions' functions and capabilities: a review. *Journal of Entrepreneurship, Management and Innovation*, in press.

Rodríguez, D.Y., Zabala-Iturriagoitia, J., Aparicio, J. (2021). Grupos Estratégicos en el sector privado de la educación superior. *Educación XX1*, 24(1), 165-187.

Rosnay, J. (1977). *El Macroscopio*. Madrid: Editorial AC.

Rossi, F. (2009). Increased competition and diversity in higher education: An empirical analysis of the Italian University system. *Higher Education Policy*, 22(4), 389–413.

Sáez, F. (2009). *Complejidad y Tecnología de la Información*. Madrid: Fundación Rogelio Segovia Ed.

Salmi, J. (2009). *The challenge of establishing world class universities*. Washington DC: The World Bank.

Sánchez-Barrioluengo, M. (2014). Articulating the “three-missions” in Spanish universities. *Research Policy*, 43(10), 1760–1773.

Sarrico, C. (2010). On Performance in Higher Education: Towards performance governance. *Tertiary Education and Management*, 16(2), 145–158.

Smits, R., Kuhlmann, S. (2004). The rise of systemic instruments in innovation policy. *International Journal of Foresight and Innovation Policy*, 1(1–2), 4–32.

Stichweh, R. (2016). Estructura social y semántica: La lógica de una distinción sistémica. *Revista Mad*, (35), 1–14.

Stichweh, R. (2016). Social Structure and Semantic: The Logic of a Systemic Distinction. *Revista Mad-Revista del Magister en Análisis Sistémico aplicado a la Sociedad*, 35, 1-

14.

Torraco, R.J. (2016). Writing Integrative Literature Reviews: Using the Past and Present to Explore the Future. *Human Resource Development Review*, 15(4), 404–428.

UNESCO Institute for Statistics. (2014). ISCED Fields of Education and Training 2013, 2013. Available: <https://doi.org/10.15220/978-92-9189-150-4-en>

van Vught, F. (2008). Mission diversity and reputation in higher education. *Higher Education Policy*, 21(2), 151–174.

von Bertalanffy, L. (1968). *General System Theory: Foundations, Development, Applications*. New York: George Braziller.

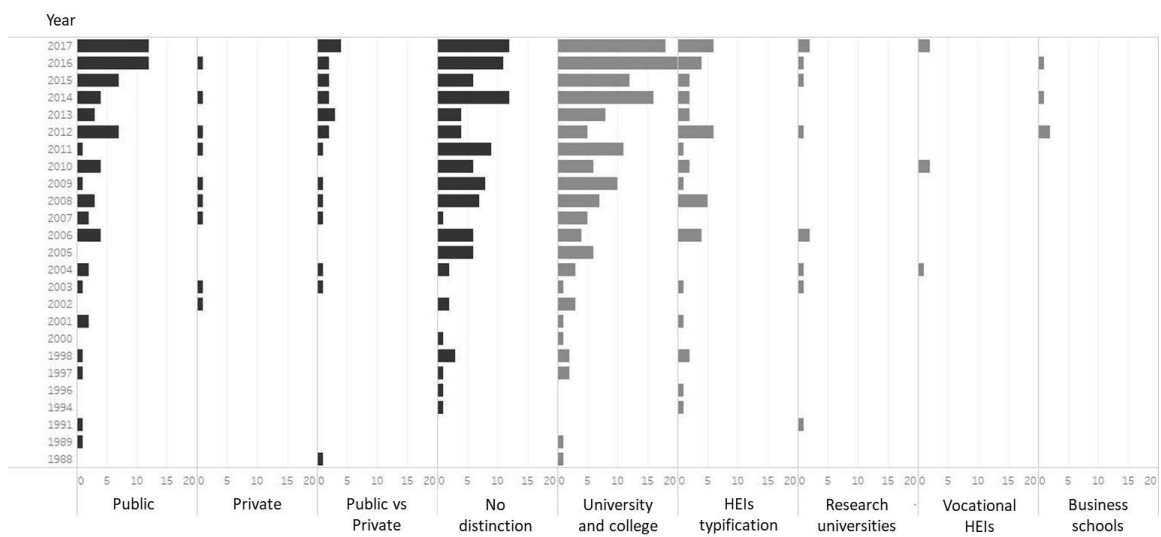
Waldrop, M.M. (1992). *Complexity: The emerging Science at the Edge of Order and Chaos*. New York: Simon and Schuster Paperbacks.

Weber, K.M., Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive “failures” framework. *Research Policy*, 41(6), 1037–1047.

Wieczorek, A.J., Hekkert, M.P. (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, 39(1), 74-87.

Woolthuis, R.K., Lankhuizen, M., Gilsing, V. (2005). A system failure framework for innovation policy design. *Technovation*, 25(6), 609–619.

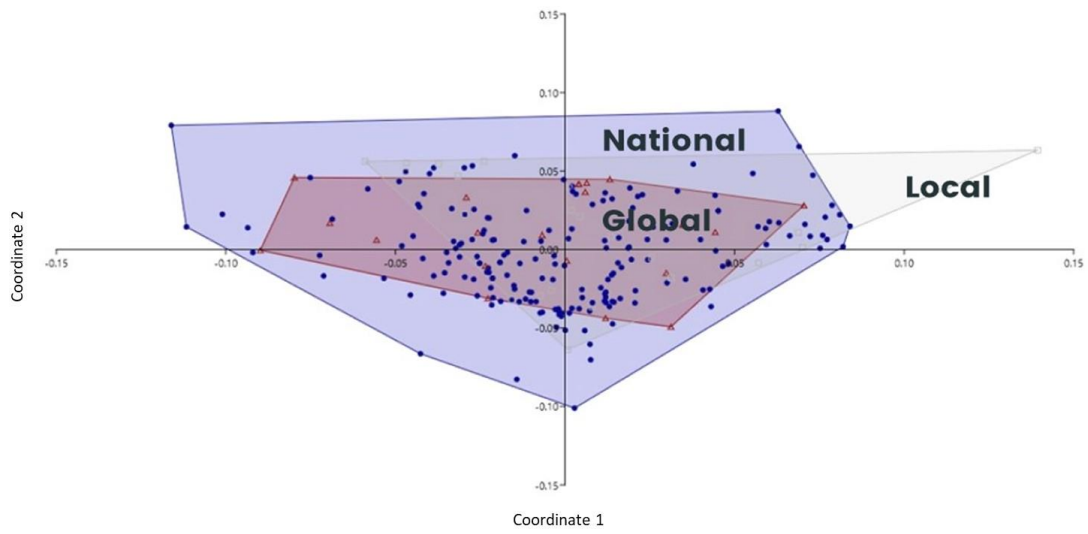
Figure 1.- HEI typology considered by the literature¹



Source: own elaboration.

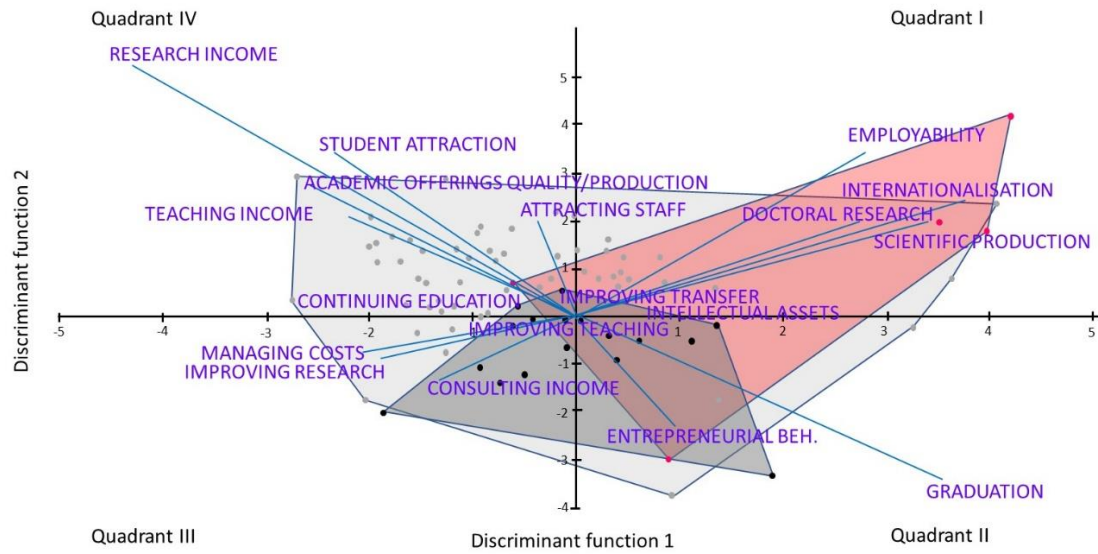
¹ Year 2018 is excluded because the time coverage is not representative.

Figure 2.- Multidimensional analysis of the variables used in the literature (1978-2018) to determine HES' analysis scale



Source: own elaboration.

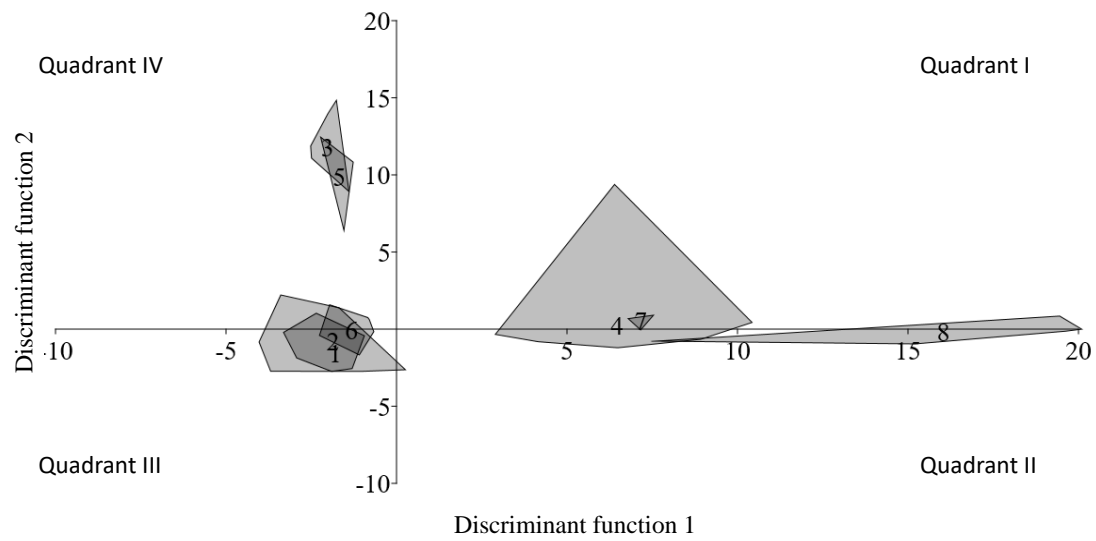
Figure 3.- Discriminant analysis by type of environment



* Notes: Discriminant Function 1 (explains 67.3% of the variance), Discriminant Function 2 (explains 32.7% of the variance). Global Environment (red), National Environment (grey), Local Environment (black).

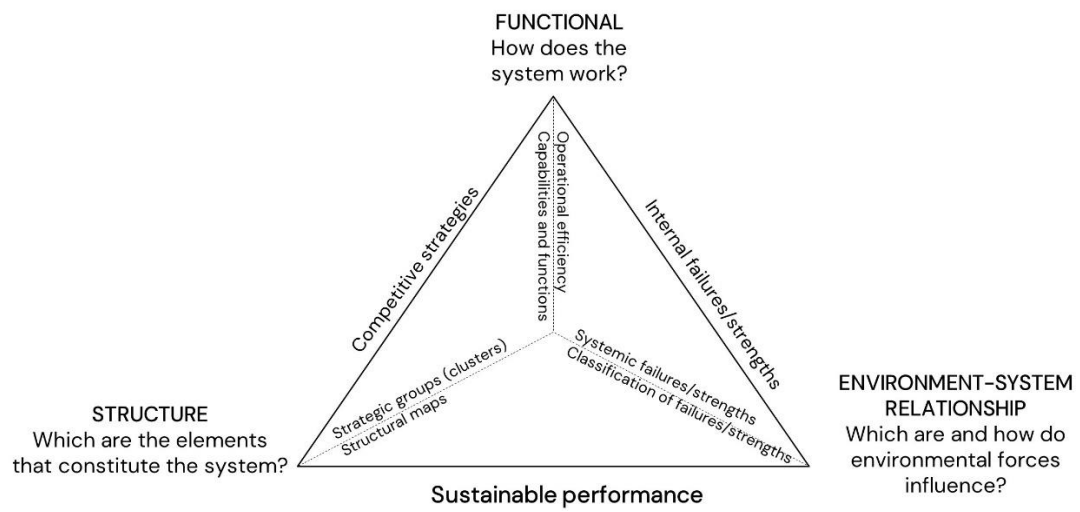
Source: own elaboration.

Figure 4.- Classifying studies by outreach focus of HEIs



* Notes: The centroids of the previous Figure are: 1. Teaching, 2. Teaching and Research, 3. Teaching, Research and Administration, 4. Teaching, Research and Extension, 5. Administration, 6. Research, 7. Research and Extension, and 8. Extension.
Source: own elaboration.

Figure 5.- Systemic evaluation framework



Source: own elaboration.

Table 1.- Relative frequencies (%) of the functions and capacities based on the scale of operations of the HES

	Function (F) / Capacity (C)	System scale			TOTAL
		Global	National	Local	# of articles
Teaching mission					
F1	Educational achievement	0.64	0.51	0.63	126
C1	Attracting students	0.32	0.40	0.29	89
F2	Employability	0.18	0.07	-	17
C3	Academic production/Quality assurance	-	0.09	-	17
C5	Mobilise resources-teaching	-	0.07	-	13
C2	Reducing dropouts		0.08		11
C9-T	Improving academic operations	-	0.05	0.04	10
C4	International mobility	0.18	0.03	-	9
F3	Continuous education	-	0.01	-	2
Research mission					
F5	Generating new knowledge	0.55	0.41	0.38	98
C6	Mobilising resources-research	0.23	0.38	0.21	82
F4	Pre-doctoral and post-doctoral research	0.27	0.16	0.13	39
C9-R	Improving research operations	-	0.08	0.08	17
Outreach mission (Knowledge transfer)					
C7	Income due to knowledge transfer	0.05	0.10	0.13	23
F6	Generating intellectual assets	0.09	0.09	0.08	21
C9-TC	Improving transfer activities	-	0.07	0.08	16
F7	Entrepreneurship activities	0.05	0.02	0.08	6
Administrative management					
C8	Attracting academic staff	0.05	0.06	-	12
C9-M	Improving administrative management	-	0.01	-	2
TOTAL - # of articles		22	187	24	235

Source: own elaboration.

Table 2.- Relative frequencies (%) of the functions and capacities based on the main mission of HEIs

		Functional systems			Multifunctional systems
	Function (F) /Capacity (C)	Teaching	Research	Extension	
Teaching mission					
F1	Educational achievement	0.82	-	-	0.55
C1	Attracting students	0.41	-	-	0.44
F2	Employability	0.12	-	-	0.07
C3	Academic production/Quality assurance	0.14	-	-	0.06
C5	Mobilise resources-teaching	0.08	0.06	-	0.04
C2	Reducing dropouts	0.10	-	-	0.04
C9-T	Improving academic operations	0.02	-	-	0.06
C4	International mobility	-	-	-	0.06
F3	Continuous education	0.02	-	-	0.00
Research mission					
F5	Generating new knowledge	-	1.00	-	0.50
C6	Mobilising resources-research	-	0.37	-	0.48
F4	Pre-doctoral and post-doctoral research	0.12	0.09	-	0.23
C9-R	Improving research operations	-	0.09	-	0.09
Outreach mission (Knowledge transfer)					
C7	Income due to knowledge transfer	-	0.09	0.89	0.07
F6	Generating intellectual assets	-	0.18	0.89	0.04
C9-TC	Improving transfer activities	-	-	0.11	0.09
F7	Entrepreneurship activities	-	-	0.22	0.02
Administrative management					
C9-M	Improving administrative management	0.20	0.09	-	0.08
C8	Attracting academic staff	0.04	-	-	0.06
TOTAL - # of articles		49	19	11	156

Source: own elaboration.