

Peris-Ortiz, Marta; García-Hurtado, Dayanis; Prado Román, Alberto

Article

Measuring knowledge exploration and exploitation in universities and the relationship with global ranking indicators

European Research on Management and Business Economics (ERMBE)

Provided in Cooperation with:

European Academy of Management and Business Economics (AEDEM), Vigo (Pontevedra)

Suggested Citation: Peris-Ortiz, Marta; García-Hurtado, Dayanis; Prado Román, Alberto (2023) : Measuring knowledge exploration and exploitation in universities and the relationship with global ranking indicators, European Research on Management and Business Economics (ERMBE), ISSN 2444-8834, Elsevier, Amsterdam, Vol. 29, Iss. 2, pp. 1-12, <https://doi.org/10.1016/j.iedeen.2022.100212>

This Version is available at:

<https://hdl.handle.net/10419/294114>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>



Measuring knowledge exploration and exploitation in universities and the relationship with global ranking indicators



Marta Peris-Ortiz^{a,*}, Dayanis García-Hurtado^{b,1}, Alberto Prado Román^{c,1}

^a Universitat Politècnica de València, Spain. CETYS University, Mexico

^b Universidad de Ciego de Ávila Máximo Gómez Báez, Cuba

^c Universidad Rey Juan Carlos, Spain

ARTICLE INFO

Article History:

Received 9 June 2022

Revised 16 December 2022

Accepted 19 December 2022

Available online 20 January 2023

Keywords:

Knowledge exploration

Knowledge exploitation

University rankings

JEL Classification:

O31

O32

ABSTRACT

This study examines the primary external control mechanism of universities (i.e. international rankings) to assess their knowledge exploration and exploitation performance. A taxonomy of indicators from the perspective of ambidexterity is presented. The most prestigious global university rankings are assessed within this theoretical framework. Exploration and exploitation indicators in the rankings are analysed in relation to the input, output and outcomes of universities. The results indicate a predominance of exploitation indicators in rankings. The potential managerial implications of this imbalance in indicators are discussed.

© 2022 The Author(s). Published by Elsevier España, S.L.U. on behalf of AEDEM. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

1. Introduction

For over a decade, global university rankings have played an increasingly prominent role in the global higher education landscape (Erkkilä & Piironen, 2020). The importance of rankings is due to causes related to changes in trends in higher education contexts, relations between universities, social demands and higher education policies. Hazelkorn (2011) indicated that the transition to knowledge intensive economies leads to the internationalisation of higher education, always seeking cutting-edge knowledge wherever it is found and the global search for talents. This situation has led to a change in the management of universities, which is increasingly linked to other complementary knowledge agents, comprising an extensive global network. Identifying these world leaders in different knowledge sectors requires the supply of reliable, transparent and accessible disclosure by institutions about their performance (Devece, Palacios-Marqués, Llopis-Albert & Galindo-Martín, 2017). Hence a classification of universities has arisen that measures performance by means of indicators (Daraio & Bonaccorsi, 2015; Peters, 2019). amongst them, university rankings have become particularly relevant (Selten,

Neylon, Huang & Groth, 2020). There is a variety of indicators that measure quality in research, teaching and interaction with the environment. Universities with the best positions in rankings are considered to be world class because of their performance in research. They are highly innovative with sufficient resources to implement high-quality research projects.

The evidence also indicates that global university classifications have become a major communication channel for teaching and research performance. Students, families, governments and other stakeholders use rankings to decide in which universities to study and how much they must financially allocate (Collins & Park, 2016; Johnes, 2018). The world's main rankings include the Academic Ranking of World Universities, The Times Higher Education, the Quacquarelli Symonds (QS) World and SIR World Universities Ranking. Nevertheless, the usefulness of these classifications to measure universities has been questioned (Stergiou & Lessenich, 2013). Several research projects suggest that the indicators that are used are not actually a measure of university excellence, but a commodification channel of higher education (Lynch, 2015; Olcay & Bulu, 2017). Another criticism in relation to rankings is that they create expectations about prestigious universities that feed each other, which means that the top ranked institutions always remain in a strong position (Sauder & Espeland, 2007). This phenomenon occurs especially with rankings primarily based on opinion surveys. Despite all these criticisms, the impact of rankings is unquestionable, affecting

* Corresponding author.

E-mail address: mperis@doe.upv.es (M. Peris-Ortiz).

¹ All authors have participated equally in study design, the collection, analysis and interpretation of data and in the writing of the report of this research.

the decisions of students and leading university and government institutions that finance education (Marginson, 2014; Perez-Esparrells & Orduna-Malea, 2018).

With university rankings gaining influence as a method of performance control, universities develop strategies to improve their position in these rankings (Rajdeep, Dearden & Lilien, 2008). Recent studies have shown that universities that act strategically to align their control metrics with academic ranking indicators achieve a significant increase in their ranking (Allen, 2021; Dowsett, 2020). Likewise, institutions have appeared at the international level with an interest in measuring, managing and evaluating performance in universities (Cortés, Rivera & Carbonell, 2022; Ordorika & Lloyd, 2015). Universities adopt management systems to improve the efficiency, effectiveness, profitability and quality of their policies, programmes, projects and services (Hoglund, Martensson, & Thomson, 2021) so that decision making is based on clear causal models and measurable results. In strategic management, large-scale universities have the most sophisticated management systems to achieve strategic objectives. However, in numerous cases, the university control systems are deficient, and it is unclear how to exercise control and which control mechanisms are suitable for the exploration and exploitation of knowledge (García-Hurtado, Devece, Zegarra-Saldaña, & Crisanto-Pantoja, 2022). This difficulty in control is essentially due to the objectives of universities. While the private sector has several objectives that are much more specific, the public sector and particularly universities have much more generic and ambiguous objectives, such as the development of science and knowledge for the general good with an efficient and effective use of the resources and budgeted funds (Balabonien & Večerskienė, 2014).

Consequently, given the influence of rankings on university management, this paper has the general aim of classifying the indicators of the main global university rankings, with a focus on knowledge exploration and exploitation. This paper provides a taxonomy of the indicators used in the selected international rankings using the conceptual approach of exploitation and exploration (March 1991). In addition, each indicator is qualified according to types of inputs, processes, outputs and outcomes. The main result is that there are differences in approaches amongst rankings, and an imbalance usually exists between leader and follower indicators and exploitation indicators. There is also an imbalance between exploitation indicators with international repercussion (leaders) and with a regional impact (followers).

This paper is structured as follows. In the literature review section, exploration and exploitation strategies of universities are explained. Next, the paper analyses the role of control systems in these strategies and performance indicators as a key control element. It subsequently describes the methodology used to analyse the rankings, followed by the analysis of results and the discussion. Finally, the conclusions are presented.

2. Literature review

2.1. Exploitation and exploration strategies in universities

The focus on exploration and exploitation strategies has been extensively covered in the business management literature to analyse the allocation of resources to innovation (Bedford, 2015). However, in the university context, ambidexterity (i.e. proficiency in both exploration and exploitation) has scarcely been used or studied. Exploration includes searching, variation, risk taking, experimentation, games, flexibility, discovery and innovation (March 1991).

Exploration in universities entails the acquisition of scientific knowledge by researchers, either by assimilating existing knowledge or creating new knowledge. The result of exploration in universities is observed in the creation and communication of new knowledge. It can be clearly seen in university rankings with indicators linked to

the publication of research in scientific journals. The indicators employed in these university classifications measure the production and repercussion of knowledge. However from a management perspective, it would be of interest for scientific production to be classified as radical or incremental (Benner & Tushman, 2003; O'Reilly & Tushman, 2013). Nevertheless, this division of scientific production is only measured in these indicators as a proxy, considering the impact of the academic paper and the journal where it has been published.

Exploitation involves the application of knowledge, mostly through collaboration with companies, to produce innovation in technologies, products and productive processes (Benner & Tushman, 2003; Boronat-Navarro & García-Joerger, 2019). As explained by Atuahene-Gima (2005), exploitation perfects and extends current knowledge, seeking efficiency and improvements to facilitate innovation. Knowledge exploitation is observed in different ways such as the transfer of knowledge and technologies (Abramo, D'Angelo & Di Costa, 2011; Giones, 2019). Likewise, exploitation can be spearheaded by universities themselves by the promotion of entrepreneurial actions and the creation of spin-offs (Barba-Sánchez, Mitre-Aranda & Brío-González, 2022). Universities also exploit existing skills by training professional staff and perfecting their teaching and university degree programmes.

Based on the proposal by March 1991, Table 1 shows different activities classified as knowledge exploration or exploitation. Universities are in constant interrelation with stakeholders (students, employers, industries and governments), which means that innovation management models are adopted, as is the case of open innovation. Razak, Murray and Roberts (2014) showed that through the adoption of open innovation, it is possible to increase capabilities to market products created in universities. Thus, it can align the results of university innovations with the needs of the environment (Al-ashaab, Flores, Magyar & Doultsinou, 2011; Caballero-Fernández, López-Miguens & Lampón, 2014; Imamoglu, Huseyin, Turkcan & Yavuz, 2019; Razak et al., 2014; Safón, 2019). Open innovation is a way of exploiting the knowledge generated in universities to create innovations in companies. The studies in Table 1 show how these activities have positive effects on the innovation performance of universities.

To achieve optimum performance, organizations must find a balance between exploration and exploitation, hence being able to explore new possibilities while exploiting existing ones (March 1991). The balance between both strategies Duncan (1976) is defined as organizational ambidexterity. The concept of ambidextrous strategies is well defined in the literature. Several studies have examined their organizational background. Considering the contradictions between exploitation and exploration, research has studied the role of organizational structure, organizational learning, technological innovation and strategic management (Auh & Menguc, 2005; Bradach, 1997; Danneels, 2002; Gupta, Smith & Shalley, 2006; Raisch & Birkinshaw, 2008; Smith & Tushman, 2005).

The strategies outlined by an organization make it possible to achieve its objectives. However it is essential to measure and correct deviations from the plan. In this sense, ambidextrous organizations must control the balance between exploitation and exploration. In the entrepreneurial context, studies have examined the required control mechanisms for those who simultaneously pursue exploration and exploitation (Bedford, 2015; Bisbe & Otley, 2004). In contrast, the literature on university contexts is insufficient.

2.2. The role of control systems in the exploitation and exploration of knowledge

The concept of management control was introduced by Robert Anthony (1965, p. 17), who described it as "the process through which managers ensure that the resources are obtained and are used in an effective and efficient way to achieve the organization's

Table 1
Exploitation and exploration strategies in universities.

Exploitation	Activity	Source
Creation or implementation of innovations in industry	Open innovation	(Imamoglu et al., 2019)
	Co-operation projects	(Garrido-Moreno & Padilla-Meléndez, 2012)
	Networking	(Devece, Palacios & Martínez-Simarro, 2017); (Peris-Ortiz, Devece Carañana & Navarro-García, 2018)
		(Greenaway & Rudd, 2014)
		(Razak et al., 2014)
	Knowledge transfer	(Garrido-Moreno & Padilla-Meléndez, 2012)
	Technology transfer	(Abramo et al., 2011; Giones, 2019).
	Patents and licenses, copyrights	(Razak et al., 2014);
	Creation of technology parks, spin-offs	(Da Silva & Segatto, 2017)
	Consultancy contracts	
Professional staff training	Consultant firms	
	Innovation projects	
	Update and creation of university degrees (bachelor's degrees, master's degrees)	(Boult et al., 2009)
	New online training methods	
	New learning methodologies	
	PhD programmes	(Boden, 2019)
	Permanent training courses	(Schulte, 2019)
Specialised seminars		
Exploration		
Knowledge acquisition and creation	Research projects	(Greenaway & Rudd, 2014)
	Research grants	
	Creation of research groups	
	Research projects, collaboration in scientific publications	(Amador, Pérez, López-Huertas & Rodríguez-Font, 2018)
	Research activities	(Blass & Hayward, 2014)
	Organization of conferences	
Visits at research centres		

objectives". Extensive literature was subsequently developed to deal with control in organizations from different perspectives, including formal and mechanistic control systems (Amat, Carmona & Roberts, 1994), those focused on psychosocial aspects (Seiler & Barlett, 1982) and those focused on cultural and anthropological aspects (Langfield-Smith, 1997). Early studies established a clear independence between the planning system and the control system. However, it was soon shown that a control system covers strategy formulation, implementation and control (Ferreira & Otley, 2009). This change of perspective has also made it possible to introduce control systems as a tool in innovation management by organizations. The most flexible and dynamic control systems can help manage such unpredictable activities as innovation (García-Fernández, Claver-Cortés & Tarí, 2022; Simons, Davila, & Kaplan, 2000; Syed, Wiener, Mehmood, & Abdelrahman, 2021).

In recent years, universities have introduced management control systems (MCSs) to improve their teaching and research performance and to measure and monitor results in both the long and short term (Peris-Ortiz, García-Hurtado & Devece, 2019). The adoption of these models is conditioned by factors such as the limited availability of financial resources, the need to allocate them effectively, quality assurance in university processes and growing competition in

research and teaching (Reda, 2017). These changes have created challenges in the form of the efficient use of resources, the implementation of competition structures and broader relations with external stakeholders. These challenges have required the introduction of suitable management systems, organizational structures and planning and control tools (Centele, Martini & Campedelli, 2013). An MCS allows universities to know their improvements in organizational performance. They can adjust to changes in the environment and verify whether a set of indicators continues to be relevant for the control of organizational performance (Pietrzak, Paliszkievicz & Klepacki, 2015). There are no studies in the literature that link the development of ambidextrous strategies in universities to the MCS. Nevertheless, once exploitation and exploration activities have been classified in universities (Table 1), the implementation of control systems that benefit these strategies can be identified. Table 2 shows previous research projects that refer to the adoption of different MCS approaches to improve performance.

2.3. Management indicators

Measuring university performance in knowledge exploitation and exploration is of vital importance to establish a balance between

Table 2
Adoption of control systems in universities.

Focus	Influence on performance	Source
Management control system (MCS)	Management control, development of research projects	(Agyemang & Broadbent, 2015; Centele et al., 2013)
Levers of control (LoC) framework	Measuring teaching performance	(Pilonato & Monfardini, 2020)
Performance measurement system (PMS)	Quality, performance indicators, sustainable performance, PMS introduction in universities	(Arena, Arnaboldi, Azzone & Carlucci, 2009; Balabonien & Večerskienė, 2014; Nisio et al., 2018; Rodríguez-Hernández, Cascallar, & Kyndt, 2020)
Balanced scorecard (BSC)	Excellence in performance, strategic control, monitoring performance and adjusting to changes, ensuring quality	(Al-ashaab et al., 2011; Al-Hosaini & Sofian, 2015; Franceschini & Turina, 2013; Ismail & Al-Thaoiehie, 2015; Pietrzak et al., 2015; Reda, 2017; Yu, Hamid, Ljab, & Pei, 2009)

both activities and obtain satisfactory results. According to Ferreira and Otley (2009), “key performance measurements are the financing and non-financing measures used at different levels in the organizations to assess the success in the achievement of their objectives, Critical Success Factors, strategies and plans, and hence satisfy the expectations of the different interested parties”. Other definitions refer to these measures as performance indicators. Performance indicators can be quantified in terms of the resources and achievements of specific objectives of a company (Budimir, Lutinsky & Idbek, 2016). Kaplan and Norton (2000) reported that indicators can be viewed as specific formulations of a company's strategic choices. The real results achieved in diverse measures reflect how well a company has been successful in accomplishing these strategic choices. The indicators have three basic functions: (1) control, permitting managers and employees to assess and control performance of resources; (2) communication, disclosing performance to internal employees and stakeholders; (3) perfectionism (improvement), identifying deviations in relation to objectives and, depending on the magnitude of these deviations, making adjustments in the plan (Franceschini et al., 2019). Performance indicators are classified into four categories: input, process, output and outcome (Bente & Friestad, 2016; Budimir et al., 2016; Şencan & Karabulut Tuğba, 2015).

Identifying performance indicators to measure exploration and exploitation offers the advantage of focusing on essential aspects of organizations from two different perspectives. However, the use of performance indicators in universities is not simply a technical activity but also a response to the objectives predetermined by the organization's strategy and policy, which involve a high degree of design complexity (Palomares-Montero, García-Aracil & Castro-Martínez, 2008). Accordingly, the indicators used to measure exploitation must be differentiated from those for exploration. Also, omissions must be avoided because what is measured tends to eliminate what is not measured. Hence, omissions can be as influential as measurements (Ferreira & Otley, 2009).

The university performance measurement literature deals with the importance of indicators to measure the inputs that universities require to produce their outputs (Budimir et al., 2016). Sahney, Banwet and Karunes (2004) proposed the following inputs, processes and outputs to measure performance in higher education: (1) inputs: human, physical and financial resources; (2) processes: teaching, learning, research, administrative activities and knowledge transformation; (3) outputs: tangible and intangible results.

Input indicators involve human, physical and financial resources that are allocated to processes, activities and services in universities (Şencan & Karabulut Tuğba, 2015). Budimir et al. (2016) also identified the principal inputs of raw materials (students: A Levels, attending a comprehensive school, foreign), employment services, human capital services, physical capital services, consumables, institutional characteristics and environmental factors. This category expresses the relative effort to create new knowledge (exploration) and communicate and transfer existing knowledge (exploitation). It includes tangible indicators related to knowledge exploration, such as the number of researchers financially allocated to exploration activities usually earmarked for research projects and grants. There are also intangible indicators in the inputs, which are more complex to measure. Examples are existing knowledge and the professional networks of teaching and research staff. There are also indicators of common inputs for which it is difficult to distinguish between teaching activities (pure exploitation) and research (both exploration and exploitation). For example, one common indicator for both strategies is human resources allocated to teaching and research.

Output indicators reflect the results that are produced, including immediately measurable results and the direct consequences of activities to produce these results. Outputs can be used to measure the performance of a university in four output categories: (1) teaching activities, (2) results of research activities, (3) results of consultancy

services and (4) production of cultural and social activities (De Kruijf & De Vries, 2018). These types of outputs are purely for exploitation, except the results of research activities, which may be for both exploitation and exploration. For example, one indicator that measures the number of publications in scientific journals is a proxy indicator of exploration. However, the development of innovation, either in collaboration with companies or independently by the university to be subsequently exploited by patents or spin-offs, is exploitation.

The indicators to assess the international rankings of universities can be classified into knowledge exploration or knowledge exploration indicators. Exploration outputs are difficult to measure directly, but they can be measured indirectly through bibliometric indicators based on the articles published in scientific journals. The excellence of the scientific production of an institution is linked to the creation of knowledge and world leadership. It is reflected in the publication of scientific articles in the world's most influential journals in their knowledge sector (SIR World Report), in high-impact journals such as *Nature* and *Science* (ARWU), in the number of citations of published articles and in internationally acclaimed awards (e.g. the Nobel prize). The absorption of knowledge is reflected in low-impact articles, publications in low-impact journals, non-indexed local scientific journals and national and regional awards with little relevance at the international level. Exploitation outputs are measured in knowledge transfer indicators, the number of generated patents, spin-offs and income from consulting (Chang, Yihsing, Martin, Chi & Tsai-lin, 2016).

The outcome indicators combine qualitative and quantitative measures of the indirect effects of activities. According to De Kruijf and De Vries (2018), outcomes have intermediate and long-term effects, and their measurement is diffuse, abstract and not clearly quantifiable. This category represents an evolution of what is done, which is the measurement of the intentional or non-intentional effect in relation to outputs. For example, studies show that the input and output of the innovations are stimulus motors in China's economy (Xiong et al., 2020). According to the *Organización Mundial de la Propiedad* (2019) report, China registered 46.4% of patent applications at the international level, which reflects the size of its economy and development level. This situation corresponds to very high human development indexes. Hong Kong, for example, occupies the fourth position at the global level, with an index of 0.939 (PNUD, 2019). Exploitation outcomes are found in North America and Europe. They occupy the second and third rank in the classification of the global innovation index (Dutta, Lanvin, & Wunsch-Vincent, 2019). They are the regions with the highest human development indexes (PNUD, 2019). The Iberian American region only recorded 1.7% of innovations at the global level. It occupies the fifth position in the classification of the global innovation index (Dutta, Lanvin, & Wunsch-Vincent, 2019). In this region, development indicators are poor. GDP dropped around 3% in 2019, and employment productivity, which is equivalent to approximately 40% of that of the European Union, has remained stagnant and has even decreased in several countries. Only 57% of Iberian American citizens have Internet access. Likewise around 40% of Iberian Americans are at risk of returning to poverty and have informal jobs as well as weak social protection (OECD, *Economic Commission for Latin America and the Caribbean*, 2019). The relationship between innovation and the development of regions is very complex to measure and differs by region and sector. However, there is undoubtedly a close relationship between the exploitation of knowledge and the development of a region.

Process indicators are those that include the means used to deliver educational programmes, research activities and services within the institutional environment (Bente & Friestad, 2016). Process indicators supply information to understand outputs and outcomes. In the case of linked activities in exploitation, they provide data on the quality of teaching and learning activities. They include indicators such as the retention rate of students in the first year and the percentage of accredited careers.

Indicators can also be classified considering the time of indicator measurement. The time of indicator measurement refers to anticipatory (ex-ante) control or a posteriori (ex-post) control (Franceschini et al., 2019). Anticipatory control permits correcting deviations which can affect an organization’s objectives (Falqueto, Hoffmann, Gomes & Onoyama Mori, 2020; García-Hurtado, Naranjo-Pérez & Devece, 2018). Dziallas and Blind (2019) distinguished between ex-ante and ex-post indicators in relation to innovation, pointing out that ex-ante indicators are linked to the creation, exploration and assessment of new ideas and are a preliminary step to achieving innovation performance. This vision assumes, in the context of universities, that ex-ante control is directly related to knowledge exploration indicators. Exploration inputs and outputs are a form of prior control. For example, a large number of personnel dedicated to research (input), high incomes from research (input) and publications with a high impact (output) are ex-ante measures of successful innovation performance (exploitation) by a university. In contrast, ex-post indicators refer to new products and services launched in the business sector (Dziallas & Blind, 2019) and are linked to those of knowledge exploitation output in the university. Ex-post indicators constitute a classic control process and can be used to judge performance impact (Franceschini et al., 2019). In this study, exploitation and exploration activities are separated and analysed independently so that inputs and outputs are distinguished in both processes. However, at the same time, the true aim of all exploration activity, even if it provides results that are self-justified such as publications and awards, is to improve exploitation activities and consequently maintain the ex-ante time vision. In this sense, in university rankings, the output indicators achieved in research projects (ex-ante), teaching and innovation (ex-post) are usually predominant. Indicators such as patents or knowledge transfer are also ex-post.

3. Methodology

One of the aims of this paper is to identify, classify and analyse the management indicators of exploitation and exploitation in the most prestigious university rankings. To attain this aim, a mixed qualitative method was followed using documentary analysis and a literature review. As a starting point, documentary analysis of the most relevant university rankings from different groups of information sources

was carried out (Table 3). The first group consisted of rankings primarily based on opinion surveys and combined with other objective data. The Quacquarelli Symonds (QS) ranking and World University Rankings are in this group. The second group consists of rankings based on bibliometrics. This group contains rankings that almost exclusively use quantitative data derived from research results (scientific articles and bibliographical quotes) or from their Internet presence (web pages, links and Internet mentions). They include the Academic Ranking of World Universities (ARWU) and SCImago, which uses Scopus as a source. The research was carried out using secondary sources of available information on the websites of institutions that assess university management.

The second step consisted of creating a taxonomy of the indicators used in the selected international rankings, using the reference of the conceptual approach of exploitation and exploration (March 1991). Taxonomy is related to an empirical scheme of classification, suitable for descriptive analysis (Saidani, Yannou, Leroy, Cluzel & Kendall, 2019; Salvador-Carulla et al., 2010; Tojeiro-Rivero, Rosina & Badillo, 2019). In addition, each indicator was qualified according to types of inputs, processes, outputs and outcomes.

4. Results

4.1. Exploration and exploitation indicators in the Academic Ranking of World Universities (ARWU)

The Academic Ranking of World Universities (ARWU) is one of the most well-known international classifications. It involves a list compiled by a team of specialists in bibliometrics from the Jiao Tong University in Shanghai (China). This list includes the world’s most prestigious higher education institutions, with excellent performance in research and innovation. It considers indicators such as Nobel Prizes, Fields Medals, highly cited researchers and papers published in *Nature* or *Science* (ARWU, 2019). The ARWU ranking measures academic performance and research indicators of universities with excellent research results. The classification of indicators following the established criteria is shown in Table 4.

The taxonomy of the indicators that ARWU uses in relation to the exploration and exploitation of knowledge in universities was carried out. In the knowledge exploration sector, the ranking measures

Table 3
Global university rankings.

No	Ranking	Institute	Methodology	Criteria and weightings
1	Academic Ranking of World Universities (ARWU)	Shanghai Ranking Consultancy	Bibliometrics	Quality of education (10%) Quality of faculty (40%) Research output (40%) Per capita performance (10%)
2	The World University Rankings		Partial bibliometrics	Teaching (30%) Research (30%) Citations (30%) International outlook (7.5%) Industry Income (2.5%)
3	QS World University Rankings (QS-W)	Quacquarelli Symonds (QS)	Partial bibliometrics	Academic reputation (40%) Employer reputation (10%) Faculty/student Ratio (20%) Citations per faculty (20%) International faculty ratio/international student ratio (5% each)
3.1	QS World University Rankings Latin America (QS-LA)	Quacquarelli Symonds (QS)	Partial bibliometrics	Research impact and productivity Teaching commitment Employability Online impact
4	SIR World	SCImago Research Group	Bibliometrics	Research (50%) Innovation (30%) Societal (20%)
4.1	SIR Iber	SCImago Research Group	Bibliometrics	Research (50%) Innovation (30%) Societal (20%)

Table 4
ARWU exploration and exploitation indicators.

Classification	Indicator type	Indicator	Weight	Control source	Knowledge creation role	Indicator time
Exploration	Output	Papers published in <i>Nature</i> and <i>Science</i>	20%	External	Leader	Ex-ante
	Output	Highly cited researchers	20%	External	Leader	Ex-ante
	Output	Papers indexed in Science Citation Index-Expanded and Social Science Citation Index	20%	External		Ex-ante
	Output	Per capita academic performance of institution	10%	Internal		Ex-ante
	Output	Staff of institution winning Nobel Prizes and Fields Medals	20%	External	Leader	Ex-ante
Exploitation	Output	Alumni of institution winning Nobel Prizes and Fields Medals	10%	External	Leader	Ex-post

output indicators related to publications in prestigious journals and the number of citations. The Nobel Prize and Fields Medals indicators are interesting because they are indicators of knowledge creation and leadership in the knowledge field. Obtaining these awards requires the results of a research project to involve a contribution or discovery and constitute an advance for modern science (Selten et al., 2020). It is considered an output because it is defined as “those who work at an institution at the time of winning the prize”. Likewise, the weighting of the scores decrease the longer the time that has passed since winning the prize.

4.2. The world university ranking

The British newspaper *The Times* publishes a supplement called *Times Higher Education* (THE). Its World University Ranking is an international classification of the most well-known and influential universities that combines bibliometric methodology with opinion surveys (Times Higher, 2020).

The performance indicators in the THE ranking (Times Higher, 2020) measure five areas: teaching (the learning environment), research (volume, income and reputation), citations (impact of research), international perspective (staff, students and research) and industry income (knowledge transfer). In the exploration of knowledge dimension, input indicators (see Table 5) are related to human resources in the creation of knowledge. The indicators of the proportion of international personnel and international collaboration measure the university’s capacity to attract the talent of teachers from other countries. In this sense, the ranking considers exploration as an input indicator, which makes it possible to have high level personnel to develop new knowledge fields. The THE ranking considers it as a measurement of success in the international university context. The output indicators are similar to those for the ARWU ranking. They are quantitative indicators related to the number of publications and the publication’s impact by means of citations. The knowledge transfer indicator is an output indicator for knowledge exploitation that measures the university’s capacity to supply industry with innovations, inventions and consultancy services. This category captures

this knowledge transfer activity by observing how much research income an institution obtains, based on the number of academic staff it employs (Times Higher, 2020). The reputation survey has a large weighting in the ranking. To a large degree, it is an indicator that measures the university’s reputation. It is a qualitative measure of the quality of the university’s processes and is considered an exploitation output.

4.3. QS world ranking

The QS World Ranking of Universities (QS-W) is a ranking that is primarily prepared based on academic staff opinions. It is an international classification that has been prepared and published online since 2011 by the Quacquarelli Symonds Group. The QS-W is mainly focused on exploitation measures. The indicators with the greatest weighting (50%) are the repercussions of the quality of universities, measured in qualitative terms by opinion surveys to employees and academic staff. Table 6 shows the classification of its indicators.

4.4. QS Latin America University Ranking

One of the most critical aspects in international rankings is to carry out classification without specifically defining the context. For example, publication and citation indicators are essentially based on publications with historical prestige and managed by researchers who belong to universities in English-speaking countries. This situation suggests that they favor English-speaking authors (Peters, 2019), especially in the social sciences, where the mastery of language plays a crucial role in the communication of knowledge. Accordingly, since 2011, QS publishes an edition that recognizes Latin American universities (QS-LA). This edition conserves global ranking indicators, such as academic reputation, employer reputation and the faculty-to-student ratio, as well as other indicators specifically adapted to the region (Table 7). It also includes an input indicator related to human resources in exploration. Likewise, it measures exploitation output in the quantity of faculty publications.

Table 5
THE ranking exploration and exploitation indicators.

Classification	Indicator type	Indicator	Weighting	Control source	Indicator time
Exploration	Input	Proportion of international staff	2.5%	Internal	Ex-ante
		International collaboration	2.5%	Internal	Ex-ante
	Output	Research productivity	6%	External	Ex-ante
		Citations (research influence)	30%	External	Ex-ante
Exploitation	Input	Staff-to-student ratio	4.5%	Internal	Ex-ante
		Doctorate-to-undergraduate ratio	2.25%	Internal	Ex-ante
		Institutional income	2.25%	Internal	Ex-post
	Output	Income from research	6%	Internal	Ex-ante
		Proportion of international students	2.5%	Internal	Ex-ante
		Doctorates-awarded-to-academic-staff ratio	6%	Internal	Ex-post
		Industry income (knowledge transfer)	2.5%	Internal	Ex-post
		Reputation survey	18%	External	Ex-post
		Academic reputation survey	15%	External	Ex-post

Table 6
QS World University Rankings exploration and exploitation indicators.

Classification	Indicator type	Indicator	Weighting	Control source (internal/ external)	Indicator time
Exploration	Output	Citations per faculty	20%	External	Ex-ante
		Academic reputation	40%	External	Ex-post
Exploitation	Input	Student-professor ratio	20%	Internal	Ex-ante
		International faculty	5%	Internal	Ex-ante
		International students	5%	Internal	Ex-ante
		Employer reputation	10%	External	Ex-post

Table 7
QS Latin America University Ranking exploration and exploitation indicators.

Classification	Indicator type	Indicator	Weighting	Control source	Indicator time
Exploration:	Input	Staff with PhD	10%	Internal	Ex-ante
		International research network	10%	External	Ex-ante
	Output	Papers per faculty	5%	External	Ex-ante
		Citations per paper	10%	External	Ex-ante
Exploitation	Input	Academic reputation	30%	External	Ex-post
		Faculty-to-student ratio	10%	Internal	Ex-ante
	Output	Employer reputation	20%	External	Ex-post
		Web impact	5%	External	Ex-post

4.5. Classification of the Scimago Research Group

Scimago Research Group developed the SIR, a ranking that classifies universities into two groups: SIR World, for international universities that published at least 100 documents in Scopus-indexed journals in the last year of the analyzed period, and SIR Iber, for Latin American universities that published at least one paper in Scopus-indexed journals. It assesses three factors: research with (50% weighting), innovation (30% weighting) and social (20% weighting). Unlike the other rankings, it has a larger number of indicators (17 in total). The research indicators measure knowledge exploration, while the innovation and social impact indicators assess exploitation (see Table 8). The indicators are objective and quantitatively measured, excluding opinion surveys.

5. Discussion

Fig. 1 shows the weighting of indicators for each of the analyzed rankings distributed amongst exploration and exploitation. The rankings pay more attention to exploitation indicators. The QS and THE rankings assess performance in knowledge exploitation, with,

respectively, 80% and 59% weightings on opinion surveys. However, in the ARWU and SIR World rankings, the highest indicator weighting is in knowledge exploration. According to March 1991, the balance between exploration and exploitation measures can be favorable for universities because they permit the achievement of results in both the short and long term.

Exploration performance is measured in the input indicators related to human resources allocated to the creation and communication of knowledge. These indicators are not present in all analyzed rankings. Only the THE and QS-LA rankings consider this measurement. The THE ranking measures international collaboration and the proportion of international staff. These indicators are a measure of the capacity of the organization to attract international talent and secure the creation and absorption of knowledge. QS-LA measures the number of professors with PhDs.

The output indicators measure the results and direct consequences of research. There is considerable similarity in the rankings in these indicators, where results are measured by the number of scientific articles generated by the institution's staff, as well as indicators such as the productivity of research or publications by faculty. QS-W only measures the impact of knowledge creation on citations by

Table 8
Scimago Research Group exploration and exploitation indicators.

Classification	Indicator type	Indicator	Weight	Control source	Indicator time	
Exploration:	Input	International collaboration	3%	External	Ex-ante	
		Open access	2%	External	Ex-ante	
		Scientific talent pool	2%	External	Ex-ante	
		Not own journals output	5%	External	Ex-ante	
		Own journals	3%	External	Ex-ante	
		Output	Normalised impact (leadership output)	13%	External	Ex-ante
			Excellence with leadership	8%	External	Ex-ante
			Output	8%	External	Ex-ante
	High quality publications		2%	External	Ex-ante	
	Scientific leadership		2%	External	Ex-ante	
	Excellence		2%	External	Ex-ante	
	Altmetrics		10%	External	Ex-ante	
	Number of backlinks		10%	External	Ex-ante	
	Exploitation	Output	Web size	10%	External	Ex-ante
			Innovative knowledge	5%	External	Ex-post
			Patents	10%	External	Ex-post
Technological impact			5%	External	Ex-post	

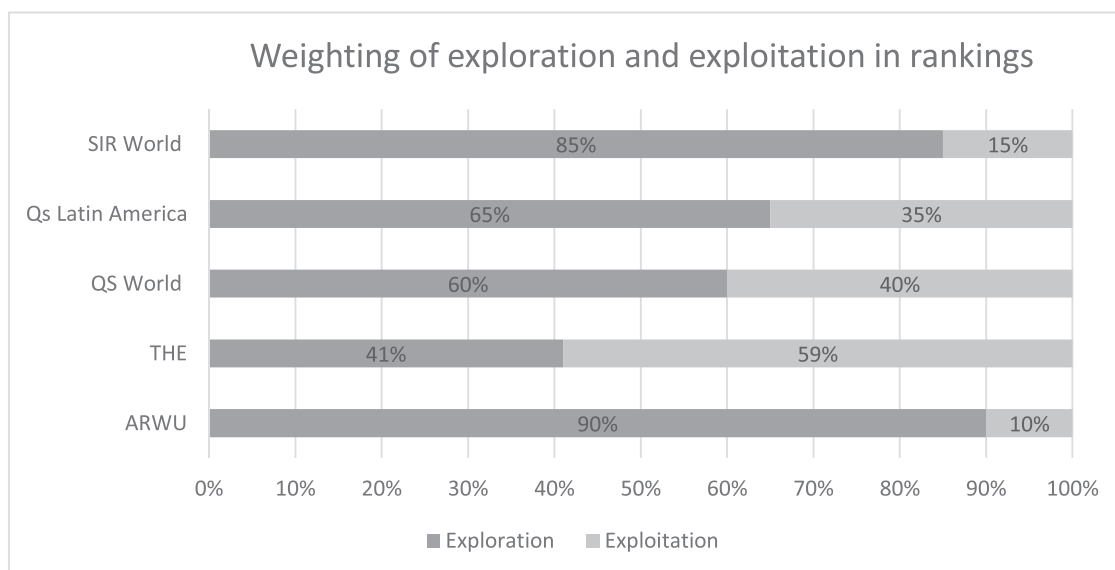


Fig. 1. Weighting of exploration and exploitation in rankings.

faculty. The outcome indicators are related to the repercussion of the outputs in the economy and society in general. In the context of higher education, *Al-Hosaini and Sofian (2015)* reported that the educational sector has become the main contributor to a country's economy, facilitating employment, improving the productivity infrastructure, increasing export revenues and substantially contributing to the development of cities and regions. Although the world's main economies have the highest indexes in quality of local universities (QS), patent applications and quality of scientific publications, the relationship is complex. There is a feedback effect between industry, a region's wealth and its scientific production. In the knowledge exploitation category, the indicators provide information on the exploitation of existing knowledge in teaching activities and knowledge transfer to industry and society in general. This knowledge transfer is counted regardless of whether it is carried out in innovations, patents or the creation of new business models through spin-offs and entrepreneurial actions.

The most common input indicators in the rankings are the student-professor ratio and the proportion of international students. The exploitation outputs are captured by indicators such as income from research, technology transfer, patents and knowledge transfer. The impact of teaching activity is usually measured by essential opinion surveys, although several rankings lack these indicators (ARWU and SIR-W).

The analysis presented in this study reveals the difference in approaches amongst different rankings, and the internal imbalance that usually exists between leader and follower indicators and exploitation indications. There is also little difference between exploitation indicators with an international repercussion (leader) and regional impact (follower). The balance between exploitation and exploration is essential to measure the ambidextrous performance of universities. In this sense, there is a trend to measure exploration indicators in the following rankings: QS-W, QS-LA and THE, whereas the ARWU and SIR World rankings show a balance between the number of indicators for both of these crucial activities.

ARWU measures indicators in which only leading research universities can be assessed. Hence, it is limited to a communication channel for elite universities that have the best performance in research. Other rankings publish editions for specific regions. QS-LA and SIR Iber provide coverage of Latin American universities to communicate their results, with a specific focus on indicators that show exploitation activities in the local environment.

6. Conclusions and theoretical and practical implications

This study contributes to the literature on knowledge exploration and exploitation in universities and the relationship with global rankings. The analysis of the indicators of the most prestigious university rankings shows that these rankings have different objectives and that these objectives are in most cases complementary. A greater quantity of exploration indicators in the measurement of university performance entails focusing on experimentation and the search for new knowledge. These indicators measure the university's ability to excel in exploration. To achieve this goal, suitable policies must be implemented in the medium and long term. Exploitation indicators measure the university's performance in the transfer of this knowledge to society (*March 1991*).

This study has practical implications for decision makers in higher education around the world. The proposal arising from this study is to include indicators to detect the knowledge absorption capacity of follower universities. Examples include publications in all kinds of indexed journals and their impact, the organization of prestigious conferences, participation in research projects with leading universities and national and regional awards received by researchers, regardless of their international impact. This approach would reveal the exploitation capacity of follower universities, which are limited by their resources, size and history. It is also important to carry out a classification by knowledge areas and results in exploration.

With regard to exploitation, other types of indicators could be introduced that measure new organizational forms in the production of innovations. Examples include networking, open innovation and participation in crowdsourcing activities (*Devece, Palacios & Ribeiro-Navarrete, 2019; Mira-Solves et al., 2021*). It would also be possible to assess the impact of students in the regional or national context, measured by the average salary of graduates or the number of entrepreneurs. This approach would facilitate better knowledge of the balance and performance of universities. It would be useful as a decision-making tool not only for potential customers (students and private companies) but also for public regional managers and the individual directors of universities.

This paper is not without limitations. The main limitations are due to the qualitative method used in the ranking analysis. Future research can deepen the taxonomy of indicators using quantitative methods that provide greater generalisation of results. Finally, it would be of interest to differentiate between regional and global

rankings and common indicators for knowledge exploration and exploitation.

Declarations of Competing Interest

None.

References

- Abramo, G., D'Angelo, C., & Di Costa, F. (2011). University-industry research collaboration: A model to assess university capability. *Higher Education*, 62(2), 163–181. doi:10.1007/s10734-010-9372-0.
- Agemang, G., & Broadbent, J. (2015). Management control systems and research management in universities: An empirical and conceptual exploration. *Auditing & Accountability Journal*, 28(7), 1018–1046. doi:10.1108/AAJ-11-2013-1531.
- Al-ashaab, A., Flores, M., Magyar, A., & Doultsinou, A. (2011). A balanced scorecard for measuring the impact of industry- university collaboration. *Production Planning and Control*, 22(5–6), 554–570.
- Al-Hosaini, F., & Sofian, S. (2015). A review of balanced scorecard framework in Higher Education Institution (HEIs). *International Review of Management and Marketing*, 5(1), 26–35.
- Allen, R. M. (2021). Commensuration of the globalized higher education sector: How university rankings act as a credential for world-class status in China. *Compare: A Journal of Comparative and International Education*, 51(6), 920–938. doi:10.1080/03057925.2019.1686607.
- Amador, S. R., Pérez, M. D., López-Huertas, M. J., & Rodríguez-Font, R. J. (2018). Indicator system for managing science, technology and innovation in universities. *Scientometrics*, 115, 1575–1587. doi:10.1007/s11192-018-2721-y.
- Amat, J., Carmona, S., & Roberts, H. (1994). Context and change in management accounting system. A Spanish case study. *Management Accounting Research*, 5(2), 107–122.
- Anthony, R. N. (1965). *Planning and Control Systems: A Framework for Analysis*. Boston, MA: Division of Research, Graduate School of Business Administration, Harvard University.
- Arena, M., Arnaboldi, M., Azzone, G., & Carlucci, P. (2009). Developing a performance measurement system for university central administrative services. *Higher Education Quarterly*, 63(3), 237–263. doi:10.1111/j.1468-2273.2008.00415.x.
- ARWU. (2019). Methodology. Retrieved July 15, 2020, from <http://www.shanghairanking.com/ARWU-Methodology-2019.html>.
- Atuahene-Gima, K. (2005). Resolving the capability-rigidity paradox in new product innovation. *Journal of Marketing*, 69, 61–83.
- Auh, S., & Menguc, B. (2005). Balancing exploration and exploitation: The moderating role of competitive intensity. *Journal of Business Research*, 58, 1652–1661.
- Balabonien, I., & Večerskiene, G. (2014). The peculiarities of performance measurement in universities. *Procedia-Social and Behavioral Sciences*, 156, 605–611. doi:10.1016/j.sbspro.2014.11.249.
- Barba-Sánchez, V., Mitre-Aranda, M., & Brío-González, J. del (2022). The entrepreneurial intention of university students: An environmental perspective. *European Research on Management and Business Economics*, 28(2), 100184. doi:10.1016/j.iedeen.2021.100184.
- Bedford, D. S. (2015). Management control systems across different modes of innovation: Implications for firm performance. *Management Accounting Research*, 28, 12–30. doi:10.1016/j.mar.2015.04.003.
- Benner, M., & Tushman, M. L. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of Management Review*, 28(2), 238–256.
- Bente, L., & Friestad, H. (2016). Management control systems and student performance in Norwegian primary education: An exploratory case study. *Journal of Management Control*, 27, 323–350. doi:10.1007/s00187-016-0233-6.
- Bisbe, J., & Otley, D. (2004). The effects of the interactive use of management control systems on product innovation. *Accounting, Organizations and Society*, 29, 709–737. doi:10.1016/j.aos.2003.10.010.
- Blass, E., & Hayward, P. (2014). Innovation in higher education; will there be a role for “the academe/university” in 2025? *European Journal of Futures Research*, 2(41), 1–9. doi:10.1007/s40309-014-0041-x.
- Boden, K. E. (2019). Pedagogical innovation among university faculty. *Creative Education*, 10, 848–861. doi:10.4236/ce.2019.105063.
- Boronat-Navarro, M., & García-Joerg, A. (2019). Ambidexterity, alliances and environmental management system adoption in Spanish hotels. *Sustainability*, 11(20), 5815. doi:10.3390/su11205815.
- Boult, T. E., Chamillard, A. T., Lewis, R., Polok, N., Stock, G., & Wortman, D. (2009). Innovations in university education in innovation: Moving beyond the B. S. *International Journal of Innovation Science*, 1(4), 167–177. doi:10.1260/1757-2223.1.4.167.
- Bradach, J. (1997). Using the plural form in the management of restaurant chains. *Administrative Science Quarterly*, 42, 276–303.
- Budimir, V., Lutitsky, I., & Idlbek, R. (2016). Performance indicators development in function of higher education quality monitoring. *Entrepreneurship, Business and Economics*, 2(3), 17–46. doi:10.1007/978-3-319-27573-4.
- Caballero-Fernández, G., López-Miguens, M. J., & Lampón, J. F. (2014). La universidad española y su implicación con la empleabilidad de sus graduados. *Revista Española de Investigaciones Sociológicas*: (pp. 23–46)146.
- Centele, S., Martini, M., & Campedelli, B. (2013). Factors affecting the development of management control systems in universities. *Economia Aziendale Online*, 4(2), 167–183.
- Chang, Y., Yihsing, P., Martin, B. R., Chi, H., & Tsai-lin, T. (2016). Entrepreneurial universities and research ambidexterity: A multilevel analysis. *Technovation*, 54, 7–21. doi:10.1016/j.technovation.2016.02.006.
- Collins, F., & Park, G.-S. (2016). Ranking and the multiplication of reputation: Reflections from the frontier of globalizing higher education. *Higher Education*, 72(1), 115–129. doi:10.1007/s10734-015-9941-3.
- Cortés, J. D., Rivera, L., & Carbonell, K. B. (2022). Mission statements in universities: Readability and performance. *European Research on Management and Business Economics*, 28(2), 100183. doi:10.1016/j.iedeen.2021.100183.
- Da Silva, E., & Segatto, A. P. (2017). Innovation in universities: Brazilian academic research in the period of 2001–2010. *International Journal of Innovation*, 5(3), 289–310.
- Danneels, E. (2002). The dynamics of product innovation and firm competences. *Strategic Management Journal*, 23, 1095–1121.
- Daraio, C., & Bonaccorsi, A. (2015). Rankings and university performance: A conditional multidimensional. *European Journal of Operational Research*, 244, 918–930. doi:10.1016/j.ejor.2015.02.005.
- De Kruijf, J. A. M., & De Vries, M. S. (2018). Contextualizing the trend from output to outcome measurement: The Dutch pension system. *Public Money & Management*, 38(1), 954–962. doi:10.1080/09540962.2017.1389544.
- Devece, C., Palacios, D., & Martínez-Simarro, D. (2017). Effect of information management capability on organizational performance. *Service Business*, 11, 563–580. doi:10.1007/s11628-016-0320-7.
- Devece, C., Palacios, D., & Ribeiro-Navarrete, B. (2019). The effectiveness of crowdsourcing in knowledge-based industries: The moderating role of transformational leadership and organizational learning. *Economic Research-Ekonomska Istraživanja*, 32(1), 335–351. doi:10.1080/1331677X.2018.1547204.
- Devece, C., Palacios-Marqués, D., Llopis-Albert, M.-Á., & Galindo-Martín, C. (2017). Information Systems Strategy and its Relationship with Innovation Differentiation and Organizational Performance. *Information Systems Management*, 34(3), 250–264. doi:10.1080/10580530.2017.1330002.
- Dowsett, L. (2020). Global university rankings and strategic planning: A case study of Australian institutional performance. *Journal of Higher Education Policy and Management*, 42(4), 478–494. doi:10.1080/1360080X.2019.1701853.
- Duncan, R. B. (1976). The ambidextrous organization: Designing dual structures for innovation. *The Management of Organization*, 1, 167–188.
- Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2019). *The global innovation index 2019: Creating healthy lives—The future of medical innovation*. Cornell University, INSEAD and WIPO.
- Dziailas, M., & Blind, K. (2019). Technovation Innovation indicators throughout the innovation process: An extensive literature analysis. *Technovation*, 80–81, 3–29. doi:10.1016/j.technovation.2018.05.005 February 2017.
- Erkkiä, T., & Piironen, O. (2020). Trapped in university rankings: Bridging global competitiveness and local innovation. *International Studies in Sociology of Education*, 29(1–2), 38–60. doi:10.1080/09620214.2019.1634483.
- Falqueto, J. M. Z., Hoffmann, V. E., Gomes, R. C., & Onoyama Mori, S. S. (2020). Strategic planning in higher education institutions: What are the stakeholders' roles in the process? *Higher Education*, 79(6), 1039–1056. doi:10.1007/s10734-019-00455-8.
- Ferreira, A., & Otley, D. (2009). The design and use of performance management systems: An extended framework for analysis. *Management Accounting Research*, 20(4), 263–282.
- Franceschini, F., Galetto, M., & Maisano, D. (2019). Theory and practice of key performance indicators. *Designing performance measurement systems*.
- Franceschini, F., & Turina, E. (2013). Quality improvement and redesign of performance measurement systems: An application to the academic field. *Quality & Quantity: International Journal of Methodology*, 47(1), 465–483. doi:10.1007/s11135-011-9530-1.
- García-Fernández, M., Claver-Cortés, E., & Tari, J. J. (2022). Relationships between quality management, innovation and performance: A literature systematic review. *European Research on Management and Business Economics*, 28(1), 100172. doi:10.1016/j.iedeen.2021.100172.
- García-Hurtado, D., Devece, C., Zegarra-Saldaña, P. E., & Crisanto-Pantoja, M. (2022). Ambidexterity in entrepreneurial universities and performance measurement systems. A literature review. *International Entrepreneurship and Management Journal*. <https://doi.org/10.1007/s11365-022-00795-5>.
- García-Hurtado, D., Naranjo-Pérez, R., & Devece, C. (2018). Management tools to contribute to the efficacy in the process of managerial of the organizational strategy in the University of Ciego de Ávila. *EDULEARN 2018 proceeding* (pp. 6164–6168).
- Garrido-Moreno, A., & Padilla-Meléndez, A. (2012). Open innovation in universities what motivates researchers to engage in knowledge transfer exchanges? *International Journal of Entrepreneurial Behaviour & Research*, 18(4), 417–439. doi:10.1108/13552551211239474.
- Giones, F. (2019). University - industry collaborations: An industry perspective. *Management Decision*, 57(12), 3258–3278. doi:10.1108/MD-11-2018-1182 University.
- Greenaway, D., & Rudd, C. D. (Eds.). (2014). *The Business Growth Benefits of Higher Education*. London: Palgrave Macmillan.
- Gupta, A. K., Smith, K. E. N. G., & Shalley, C. E. (2006). The interplay between exploration and exploitation. *Academy of Management Journal*, 49(4), 693–706.
- Hazelkorn, E. (2011). *Rankings and the Reshaping of Higher Education: The Battle for World-Class Excellence*. New York: Palgrave MacMillan. <https://doi.org/10.1057/9780230306394>.
- Hoglund, L., Martensson, M., & Thomson, K. (2021). Strategic management, management control practices and public value creation: The strategic triangle in the

- Swedish public sector. *Accounting, Auditing & Accountability Journal*, 34(7), 1608–1634. doi:10.1108/AAAJ-11-2019-4284.
- Imamoglu, S. Z., Huseyin, I., Turkcan, H., & Yavuz, A. (2019). The mediator role of innovation between university-industry collaboration and firm. *Journal of Global Strategic Management*, 13(1), 071–080.
- Ismail, T., & Al-Thaoiehie, M. (2015). A balanced scorecard model for performance excellence in Saudi Arabia's higher education sector. *Journal of Accounting Auditing and Performance Evaluation*, 11(3–4), 255–280. doi:10.1504/JAAPE.2015.071574.
- Johnes, J. (2018). University rankings: What do they really show? *Scientometrics*, 115(1), 585–606. doi:10.1007/s11192-018-2666-1.
- Kaplan, R., & Norton, D. (2000). Having trouble with your strategy? Then map it. *Harvard Business Review*, 78(5), 167–178.
- Langfield-Smith, K. (1997). Management control systems and strategy: A critical review. *Accounting, Organizations and Society*, 22(2), 207–232. [https://doi.org/10.1016/S0361-3682\(95\)00040-2](https://doi.org/10.1016/S0361-3682(95)00040-2).
- Lynch, K. (2015). Control by numbers: New managerialism and ranking in higher education. *Critical Studies in Education*, 56(2), 190–207. doi:10.1080/17508487.2014.949811.
- March, J. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71–89.
- Marginson, S. (2014). University Rankings and Social Science. *European Journal of Education*, 49, 45–59. <https://doi.org/10.1111/ejed.12061>.
- Mira-Solves, I., Estrada-Cruz, M., & Gómez-Gras, J. M. (2021). Analysing academics' entrepreneurial opportunities: The influence of academic self-efficacy and networks. *European Research on Management and Business Economics*, 27(2), 100152. doi:10.1016/j.edeen.2021.100152.
- Nisio, A., De Carolis, R., & Losurdo, S. (2018). Introducing performance management in universities: The case of a university in Southern Italy. *International Journal of Management in Education*, 12(2), 132–153. doi:10.1504/IJME.2018.10009659.
- OECD, Economic Commission for Latin America and the Caribbean, CAF Development Bank of Latin America and European. (2019). *Perspectivas económicas de América Latina 2019: Desarrollo en transición*. OECD Publishing, Paris: doi:10.1787/g2g9ff1a-es.
- O'Reilly, C. A., & Tushman, M. L. (2013). Organizational ambidexterity: Past, present, and future: 27 (pp. 324–338). *Academy of Management Perspectives*. *Academy of Management Perspectives*, 27(4), 324–338. <https://doi.org/10.5465/amp.2013.0025>
- Olcay, G. A., & Bulu, M. (2017). Is measuring the knowledge creation of universities possible?: A review of university rankings. *Technological Forecasting and Social Change*, 123, 153–160. <https://doi.org/10.1016/j.techfore.2016.03.029>.
- Orderika, I., & Lloyd, M. (2015). International rankings and the contest for university hegemony. *Journal of Education Policy*, 30(3), 385–405.
- Organización Mundial de la Propiedad Intelectual. (2019). *Datos y cifras de la OMPI sobre PI*, Edición de 2019. Ginebra:OMPI. doi:10.34667/tind.40544.
- Palomares-Montero, D., García-Aracil, A., & Castro-Martínez, E. (2008). Evaluación de las instituciones de educación superior: Revisión bibliográfica de sistema de indicadores. *Revista Española de Documentación Científica*, 31(2), 205–229.
- Perez-Esparrells, C., & Orduna-Malea, E. (2018). Do the technical universities exhibit distinct behaviour in global university rankings? A Times Higher Education (THE) case study. *Journal of Engineering and Technology Management*, 48, 97–108. doi:10.1016/j.jengtecman.2018.04.007.
- Peris-Ortiz, M., Devece Carañana, C. A., & Navarro-García, A. (2018). Organizational learning capability and open innovation. *Management Decision*, 56(6), 1217–1231. doi:10.1108/MD-02-2017-0173.
- Peris-Ortiz, M., García-Hurtado, D., & Devece, C. (2019). Influence of the balanced scorecard on the science and innovation performance of Latin American universities. *Knowledge Management Research & Practice*, 4(17), 373–383. doi:10.1080/14778238.2019.1569488.
- Peters, M. A. (2019). Global university rankings: Metrics, performance, governance. *Educational Philosophy and Theory*, 51(1), 5–13. doi:10.1080/00131857.2017.1381472.
- Pietrzak, M., Paliszkiwicz, J., & Klepacki, B. (2015). The application of the balanced scorecard (BSC) in the higher education setting of a Polish university. *Online Journal of Applied Knowledge Management*, 3(1), 151–164.
- Pilonato, S., & Monfardini, P. (2020). Performance measurement systems in higher education: How levers of control reveal the ambiguities of reforms. *The British Accounting Review*, 52(3) 100908. doi:10.1016/j.bar.2020.100908.
- PNUD. (2019). *Informe sobre Desarrollo Humano 2019*.
- Raisch, S., & Birkinshaw, J. (2008). Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of Management*, 34(3), 375–409.
- Rajdeep, G., Dearden, J. A., & L.Lilien, G. (2008). The university rankings game: Modeling the competition among universities for ranking. *The American Statistician*, 62(3), 232–237. doi:10.1198/000313008x332124.
- Razak, A. A., Murray, P. A., & Roberts, D. (2014). Open innovation in universities: The relationship between innovation and commercialisation. *Knowledge and Process Management*, 21(4), 260–269. doi:10.1002/kpm.
- Reda, N. W. (2017). Balanced scorecard in higher education institutions: Congruence and roles to quality assurance practices. *Quality Assurance in Education*, 25(4), 489–499. doi:10.1108/QAE-09-2015-0038.
- Rodríguez-Hernández, C. F., Cascallar, E., & Kyndt, E. (2020). Socio-economic status and academic performance in higher education: A systematic review. *Educational Research Review*, 29, 100305. <https://doi.org/10.1016/j.edurev.2019.100305>.
- Safón, V. (2019). Inter-ranking reputational effects: An analysis of the Academic Ranking of World Universities (ARWU) and the Times Higher Education World University Rankings (THE) reputational relationship. *Scientometrics*, 121(2), 897–915. doi:10.1007/s11192-019-03214-9.
- Sahney, S., Banwet, D. K., & Karunes, S. (2004). Conceptualizing total quality management in higher education. *The TQM Magazine*, 16(2), 145–159. doi:10.1108/09544780410523044.
- Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., & Kendall, A. (2019). A taxonomy of circular economy indicators. *Journal of Cleaner Production*, 207, 542–559. doi:10.1016/j.jclepro.2018.10.014.
- Salvador-Carulla, L., Salinas-Pérez, J. A., Martín, M., Grané, M., Gibert, K., Roca, M., et al. (2010). A preliminary taxonomy and a standard knowledge base for mental-health system indicators in Spain. *International Journal of Mental Health Systems*, 4(29), 1–10.
- Sauder, M., & Espeland, W. N. (2007). Rankings and reactivity: How public measures recreate social worlds. *American Journal of Sociology*, 113(1), 1–40. doi:10.1086/517897.
- Schulte, B. (2019). Innovation and control: Universities, the knowledge economy and the authoritarian state in China. *Nordic Journal of Studies in Educational Policy*, 5(1), 30–42. doi:10.1080/20020317.2018.1535732.
- Seiler, R. E., & Barlett, R. W. (1982). Personality variables as predictor of budget system characteristics. *Accounting, Organizations and Society*, 7(4), 381–403.
- Selten, F., Neylon, C., Huang, C.-K., & Groth, P. (2020). A longitudinal analysis of university rankings. *Quantitative Science Studies*, 1(3), 1109–1135. doi:10.1162/qss_a_00052.
- Şencan, H., & Karabulut Tuğba, A. (2015). Monitoring of educational performance indicators in higher education: A comparison of perceptions. *Educational Sciences: Theory & Practice*, 15(2), 359–376. doi:10.12738/estp.2015.2.2426.
- Simons, R., Davila, A., & Kaplan, R. S. (2000). *Performance measurement & control system for implementing strategy: Text & cases*. Prentice Hall PTR.
- Smith, W. K., & Tushman, M. L. (2005). Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science*, 16, 522–536.
- Stergiou, K. I., & Lessenich, S. (2013). On impact factors and university rankings: From birth to boycott. *Ethics in Science and Environmental Politics*, 13, 101–111. doi:10.3354/esep00141.
- Syed, T. A., Wiener, M., Mehmood, F., & Abdelrahman, M. (2021). Control-style ambidexterity and information systems project performance: an expanded view of control activities. *European Journal of Information Systems*. doi:10.1080/0960085X.2021.1977728.
- Times Higher Education. (2020). *The World University Rankings. Methodology for overall and subject rankings for the Times Higher Education World University Rankings*. Retrieved July 15, 2020, from https://www.timeshighereducation.com/sites/default/files/the_2020_world_university_rankings_methodology_pwc.pdf.
- Tojeiro-Rivero, D., Rosina, M., & Badillo, E. R. (2019). Radical innovations: The role of knowledge acquisition from abroad. *Review of Industrial Organization*, 55, 173–207. doi:10.1007/s11151-018-9659-3.
- Xiong, A., Xia, S., Peter, Z., Cao, D., Jing, Y., & Li, H. (2020). Can innovation really bring growth? The role of social filter in China. *Structural Change and Economic Dynamics*, 50, 50–61. doi:10.1016/j.strueco.2020.01.003.
- Yu, M. L., Hamid, S., Ijab, M. T., & Pei, S. H. (2009). The e-balanced scorecard (e-BSC) for measuring academic staff performance excellence. *High Educ*, 57, 813–828. <https://doi.org/10.1007/s10734-009-9197-x>.