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Article

# Incidence of university sustainability on university performance: An exploratory analysis from five private Latin American universities

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**Abstract:** Sustainability has become a generalized concern for society, specifically businesses, governments, and academia. In the specific case of universities, sustainability has been approached from different perspectives, some viewing it from environmental practices, management initiatives, operational criteria, green buildings, and even education for sustainable development. This research focuses on sustainability as a managerial practice and investigates how it affects the performance of five private universities in Medellin, Colombia. For this purpose, a literature review using a mixed sequential approach, including bibliometric and content analysis, was initially conducted. In the s second phase, more than 5000 responses from students, professors, and employees of the five mentioned private universities were collected. A previously validated instrument for both sustainability and performance was applied in the quantitative phase, and a novel dimensionality of the constructs was proposed by conducting an exploratory factor analysis using the SPSS software. Results were then processed through a structural equation analysis with the Smart PLS software. The impact of sustainability on university performance is verified, making some managerial recommendations.

**Keywords:** exploratory approach; private universities in Medellin-Colombia; structural equation modelling; university performance; university sustainability

## 1. Introduction

In times of rapid adaptation for survival, higher education institutions (HEI's) are being forced to achieve sustainability objectives (Benito Olalla and Merino, 2019). University sustainability (US), including environmental, economic and social practices (Blasco et al., 2019), should be ingrained in the university mission statement (Lopez and Martin, 2018) and must be a priority for HEI's (Fülöp et al., 2022). Further, given the crucial role HEI's play in the sustainable development of society (Tiron-Tudor et al., 2020), university performance (UP), including the functions of teaching, research and extension (Urdari et al., 2017), and the administrative supporting operations (Asif and Searcy, 2014), has become a topic of particular interest. Institutions with a socially responsible performance become more sustainable and competitive (Fülöp et al., 2023).

HEI's must constantly aim to attain long-term competitiveness and sustainability of goal achievement (Altahat and Atan, 2018), considering that US goes beyond the substantial function of teaching to include aspects such as purchases, transportation,

governance, ethics, laws, food, water, energy, innovation and hazardous waste (Drahein et al., 2020). Further, digitalization is playing a crucial role in ensuring the sustainability of HEI's in the long term (Fülöp et al., 2023). HEI's with a remarkable performance in the mentioned aspects are better prepared for addressing societal challenges and display greater accountability, transparency and continuous improvement (Plummer et al., 2021). This, in turn, contributes to society's sustainable advancement (Dlouhá et al., 2018).

It is acknowledged that, in the industry, sustainability practices positively impact organizational performance (Annunziata et al., 2018). Little is known, however, about the relationship between these two constructs in the university environment. Filling this gap is particularly important in private universities, where key performance indicators become a relevant point of differentiation to attract new students (Cayon et al., 2017).

De Filippo et al. (2019) note that universities usually measure sustainability by adopting standardized indicators that do not correspond to international dynamics. Further, Cavicchi and Vagnoni (2018) identify the absence of information systems that facilitate the collection and management of sustainability data as one of the significant obstacles for weighing the US construct. The literature has two streams to measuring US from an external perspective. The first approach limits the dimensionality of the construct to the environmental, economic and social aspects (Blasco et al., 2019). The second path considers eight US dimensions: strategy and structure, teaching and learning, research, extension outreach, networking, campus, governance, and assessment and reports (Hernández-Diaz et al., 2021). In both scales, US's dimensions emerge from the researchers' hypotheses, not the data.

Regarding the measurement of UP, HEI's often rely on well-established performance indices, such as the HEI-Community Partnership Performance Index (Plummer et al., 2021), or the Higher Education Performance Index (Khalid et al., 2021). Abubakar et al. (2018) and Hernandez-Diaz et al. (2020) take a different avenue to measure UP, considering the two subsystems that comprise the construct: the academic and the administrative. Once again, however, the subdimensions arise from the researchers' hypotheses instead of the empirical data.

The present research aims to investigate how US affects UP. For this purpose, data from students, academic staff and administrative staff belonging to five high-quality private universities in Medellín, Colombia, was collected. Once the data was compiled, the first step was determining the dimensionality of both constructs employing an exploratory methodology. In the second step, the influence of US on UP was determined through confirmatory factor analysis.

As explained, the existence of measurement instruments of the US and UP constructs was acknowledged, and they were used as a starting point in developing the instrument used for this study; however, the present research aimed to identify the dimensions of US and UP emerging from the data.

The paper is structured as follows: a literature review of the terms associated with US and UP is initially administered using the VOSviewer® software to run the bibliometric analysis. Next, the study displays a theoretical framework for the US and UP constructs. The following section describes the methods and results of the measurement model (through Exploratory Factor Analysis—EFA) and that of the

structural model (through Confirmatory Factor Analysis—CFA). Lastly, a discussion of the results and conclusions are presented.

## 2. Review of the literature on university sustainability and university performance

After the formulation of the research question, a literature review of the terms related to university sustainability and university performance was conducted through a sequential mixed-methods approach (Mingers, 2001). The first step consisted of applying a quantitative methodology through bibliometric analysis, using mathematical and statistical methods for indexed publications (Durieux and Gevenois, 2010). The results were then interpreted using content analysis (Stemler, 2015), where each resulting cluster was reviewed more in-depth. A pearl growing technique (Schlosser et al., 2006) was applied for the quantitative sample selection, and qualitative data was screened using the PRISMA technique (Moher et al., 2009). **Table 1** shows the research protocol.

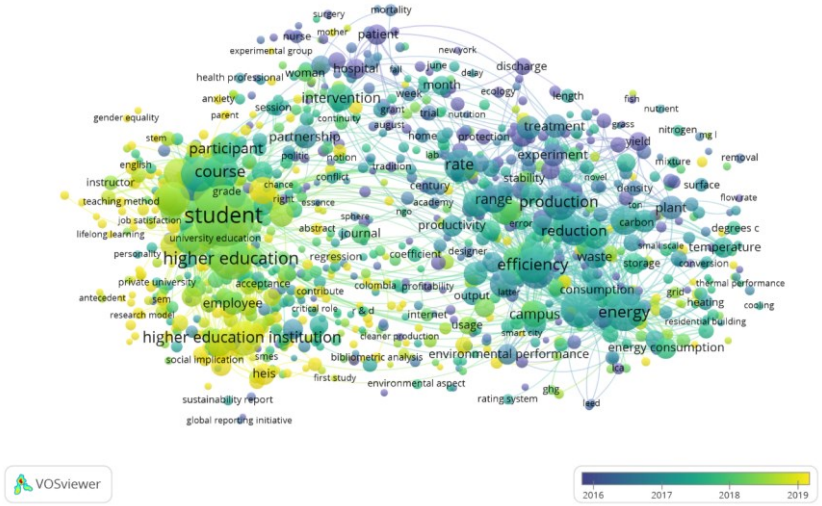
**Table 1.** Research protocol for the review of the literature.

| Criteria | Quantitative approach | Qualitative approach |
|---|---|---|
| Role of the theory | Deductive | Inductive |
| Research strategy | Simulation | Discourse analysis |
| Unit of Analysis | Word Co-occurrence | Content of concepts |
| Sample | 3248 documents from Web of science. These documents results from the following search equation: THEME(( sustainab* ) AND ( “performan*” OR “achievem*” OR “executi*” OR “accomplish*” OR “discharg*”) AND ( “universit*” OR “colleg*” OR “higher education” OR “varsity”) ) | 32 documents from Web of science. These documents results from the following search equation applied only to the title: (( sustainab* ) AND ( “performan*” OR “achievem*” OR “executi*” OR “accomplish*” OR “discharg*”) AND ( “universit*” OR “colleg*” OR “higher education” OR “varsity”)) |
| Variables | Dependent variable. e.g., relationship between words- and independent variables. e.g., occurrence, concurrence-. | Concepts and relations among them |
| Analysis of results | Bibliometric analysis | Content analysis |

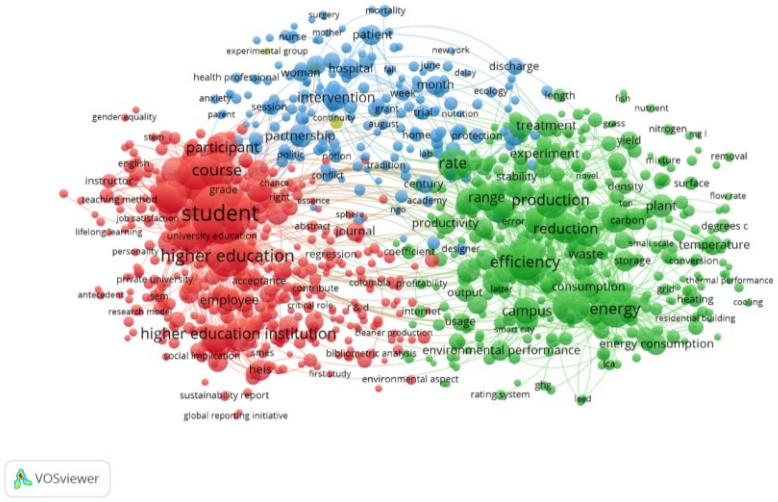
Source: Authors’ own construction.

The extracted bibliographic information—i.e., the author, work title, source, and summary—of the 3.954 publications was analyzed through the VOSviewer® software, version 1.6.17. Then, clustering algorithms were applied to transform the most frequent terms into clusters (van Eck and Waltman, 2010), as shown in **Figure 1**.

Content analysis for the 32 documents classified as the most relevant was conducted, considering which cluster or clusters each paper belongs to. Clusters were renamed according to their topic. The first cluster associates to education for sustainable development, the second to the construction and maintenance of the campus, and the third to the social dimension of sustainability.




**(a)**




**(b)**

**Figure 1.** Knowledge map for the most frequent terms about "university sustainability" and "university performance": **(a)** knowledge map classified by year; **(b)** knowledge map classified by cluster.
Source: Authors' own construction.

In particular, concepts like course, skill, learning, teaching, perception, attitude, competency, curriculum, and motivation compose the first cluster associated with education for sustainable development. Terms such as energy, building, efficiency, cost, production, rate, reduction, water, construction, control, and campus conform to the second cluster related to the construction and maintenance of the campus. Notions like intervention, partnership, site, hospital, patient, care, discharge, medicine, woman, disease, and protection correspond to the third cluster, linked to the social dimension of sustainability. Finally, the fourth cluster contains words like control group and experimental group, which are relevant to the studies' methodological design, so this cluster was not considered.

- Cluster 1: education for sustainable development

The first identified cluster relates to education's role in achieving sustainable development. HEI's are indispensable actors in the reflection, adaptation and learning of sustainability science (Plummer et al., 2021). This becomes fundamental, considering that education is one of the leading suppliers of a sustainable developmental map for global economic prosperity (Memon and Liu, 2019). Education is crucial in forming human capital for economic endurance (Khalid et al., 2021).

In the long term, quality higher education positively affects employability, an essential element for sustainable development (Moya Clemente et al., 2020). For this reason, HEI's should be prepared to implement a sustainable performance measurement system that supports their decision-making process linked to sustainable development actions (Cavicchi and Vagnoni, 2018; Plummer et al., 2021).

An important aspect to consider is how students learn and the tools available to achieve satisfactory results. For instance, various trajectory movements, such as classrooms, laboratories, libraries, and others inside and outside the campus, may influence sustainable academic performance and, thus, sustainable development (Hossain et al., 2022). Also, frequently used communication tools among students, such as social media applications, considerably impact education sustainability and may enhance students' academic performance by increasing active collaborative learning and engagement (Alamri et al., 2020). Further, massive open online courses can boost students' learning performance (Yang and Lee, 2021).

- Cluster 2: construction and maintenance of the campus

The literature states that ten thematic axes describe sustainable operations in HEI's: governance and policy, laws, ethics and integrity, teaching, purchases, transportation, energy, water, food, innovation, and hazardous waste (Drahein et al., 2020). While some sustainable green building award certifications spur the establishment of technologies to save electricity and water (Zang et al., 2022), the implementation of circularity construction principles to diminish environmental consequences and augment social equity and economic development of campus facilities, enhancing the performance of students and academic staff is also suggested (Korançe, 2021).

When considering campus maintenance, information and communication technologies play a critical role in achieving sustainable development goals (Anasi et al., 2018). This goes from implementing an educational supply chain management (Jauhar et al., 2018) to applying higher education's sustainability tracking, assessment and rating systems (Roosa and Mischen, 2022). Such technologies also support scoring methods that help determine and prioritise the most relevant sustainability indicators for HEI's (Li et al., 2018).

- Cluster 3: social dimension of sustainability

HEI has three sustainability dimensions: environmental, economic and social (Blasco et al., 2019). While clusters 1 and 2 cover the environmental and economic dimensions, this third cluster focuses on the social dimension of sustainability.

To begin with, it is essential to accentuate the part played by innovation in supporting firms to become more sustainable and how HEI's help enterprises to achieve such sustainability-oriented innovation (Jones and Corral de Zubielqui, 2017). Activities outside the educative institutions, such as networking or coalitions to

examine advancement in the implementation of sustainable practices, may positively affect the sustainable development of society as a whole (Dlouhá et al., 2018). More and more, HEI's are expected to achieve sustainability objectives to serve students and communities better (Nagy and Somosi, 2020).

Similarly, through their study programs, HEI's are called to promote sustainability-driven entrepreneurship (Biberhofer et al., 2019) and research performance (Zhao et al., 2021). This helps the organizations' long-term competitiveness and sustainability of goal achievement (Altahat and Atan, 2018). Such sustainable practices should be embedded in the university's mission statement (Lopez and Martin, 2018). Once again, communication and measurement of sustainable development implementation strategies are crucial to enhance the university community's engagement with the ideal (Awuzie and Abuzeinab, 2019; De Filippo et al., 2019). University rankings should include sustainability criteria (Burmann et al., 2021).

## 3. A theoretical framework for university sustainability and performance

Sustainability, as a practice that seeks to balance economic, social, and environmental development considering the well-being of current and future generations (Keskin et al., 2013), has influenced society, organizations, and universities. Consequently, companies that incorporate sustainability must implement values, philosophies, and approaches to contribute to social welfare (Soyka, 2012). Among these corporations, the role of HEI's stands out, as they are responsible for raising awareness among their students (Lozano, 2006).

Sustainability principles in HEI's cover various thematic areas utilized to evaluate service operations (Drahein et al., 2020). As sustainability calls for a unified procedure for social, environmental and economic aspects (Tiron-Tudor et al., 2020), different organizational components as structure, commitment, culture, and planning have a repercussion on a sustainable execution (Roosa and Mischen, 2022). Specifically, several approaches to incorporate sustainability can be considered in the context of HEI's. For instance, some universities refer to (1) management initiatives, (2) practices at the environmental level (Amaral et al., 2015), (3) green building parameters (Hugé et al., 2018; Medrano et al., 2008), (4) operating criteria (Hernández-Diaz et al., 2021), and even (5) elements of education for sustainable development (Malik et al., 2019).

Various tools are employed to assess university sustainability (Kapitulčinová et al., 2018). Among the responsibilities being measured by such tools are the ones in charge of the academic staff (teaching and research) and those supervised by the management staff (operations, engagement and outreach, and administration, including assessment and reporting) (Hernández-Diaz et al., 2021).

Further, two dimensions should be considered when measuring UP: the academic and administrative subsystem (Hernandez-Diaz et al., 2020). The academic subsystem includes HEI's core functions of teaching-learning, research and extension (Urdari et al., 2017), while the administrative subsystem consists of financial, human, and infrastructure resources plus internationalization (Abubakar et al., 2018).

Using existing scales to measure university sustainability (Hernández-Diaz et al., 2021) and university performance (Hernandez-Diaz et al., 2020), this paper follows an exploratory approach to determine the dimensions comprising both constructs. Students, teaching staff and administrative staff belonging to private universities with different backgrounds, expertise, academic offerings and philosophical stances are considered, given that the institutions' organizational characteristics influence their sustainability performance (Roosa and Mischen, 2022). The relationship between the two constructs is also established.

## 4. Methods and results of the measurement and structural models

After establishing the research problem and conducting the literature review on university sustainability and university performance, this section presents the methods and results of the measurement and structural models.

### 4.1. Methods of the measurement and structural models

**Table 2** describes the research protocol followed for fieldwork based on Escobar-Sierra et al. (2021).

**Table 2.** Research protocol to conduct fieldwork.

| Criteria | Quantitative approach |
|---|---|
| Reasoning in research | Deductive |
| Research question | How does University Sustainability affect performance in five high-quality private universities in Medellín Colombia? |
| Research strategy | Case study |
| Unit of Analysis | University sustainability and university performance |
| Sample | 5.344 responses of different stakeholders of five universities in Medellín, Colombia, South America |
| Data collection technique | University sustainability (US) and performance (UP) scale. |
| Data analysis technique | Exploratory factor analysis for the measurement model using SPSS® software, and Partial Least Squares structural equation modelling using SmartPLS® |
| Expected results | Constructs that grouped observed variables of "US" and "UP" for five high-quality private universities in Medellín, Colombia |

Source: Authors' own construction.

The university sustainability (US) scale (Hernández-Diaz et al., 2021) and the university performance (UP) scale (Hernandez-Diaz et al., 2020) were adopted in the survey study. A total of 5.344 valid responses were collected from students (3.212 responses), teachers (1.158 responses), and administrative staff (974 responses) of five private universities located in Medellin, Colombia. Respondents were asked to read affirmative statements and indicate their agreement level, using a 5-point scale ranging from "strongly disagree" to "strongly agree".

The original US scale (Hernández-Diaz et al., 2021) considers the following eight factors: (1) strategy and structure, (2) teaching and learning, (3) research, (4) extension-outreach, (5) networking, (6) campus, (7) governance, and (8) assessment & reports. Furthermore, the original UP scale (Hernandez-Diaz et al., 2020) includes six factors grouped as follows: (1) academic, (2) research, (3) assessment, (4)

internationalization, (5) extension, and (6) resources.

The following section presents the results of the measurement and structural models. An exploratory approach was applied to search for patterns to find new elements emerging from the collected data (Hair et al., 2017).

## 4.2. Results of the measurement model

An exploratory factor analysis (EFA) was applied to the data collected from the five mentioned private universities to review the measurement model. After running the EFA, including an extensive dataset, the adequacy of the model was verified through the Kaiser-Meyer-Olkin (KMO) index and Cronbach alpha results for the collected data, using the SPSS® software for data analysis:

KMO for US $Kaiser - Meyer - Olkin = 0.966$

Cronbach alpha for US $Cronbach\ alpha = 0.922$

KMO for UP $Kaiser - Meyer - Olkin = 0.871$

Cronbach alpha for UP $Cronbach\ alpha = 0.818$

Results confirm the model's reliability, as a KMO index above 0.8 shows good sampling adequacy (Howard, 2016). Further, a Cronbach alpha more significant than 0.7 signals internal consistency or how each item measures the same concept (Bryman and Cramer, 2001; Lazenbatt et al., 2005). Finally, **Tables 3** and **4** present the pattern matrices resulting from the EFA for US and UP, using Promax as the rotation method and Maximum likelihood as the extraction method.

**Table 3.** US Pattern matrix.

| | | Factor | | | | | | | | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Item** | **1 Governance** | **2 Campus** | **3 Assessment & Reports** | **4 Academic courses** | **5 Learning** | **6 Networking** | **7 Strategy & Commun.** | **8 Social** | | |
| SC1 | Sustainability as part of strategy | 0.054 | 0.042 | −0.012 | −0.008 | 0.074 | −0.040 | 0.776 | −0.242 | 4.02 | 1.606 |
| SC2 | Coordination of sustainability | −0.013 | −0.006 | 0.168 | 0.164 | −0.043 | 0.074 | 0.455 | −0.070 | 3.00 | 2.183 |
| SC3 | Communication of sustainability | 0.031 | 0.022 | 0.017 | 0.108 | −0.001 | 0.015 | 0.519 | 0.001 | 3.58 | 1.800 |
| L1 | Acquirement of sustainability skills | 0.100 | −0.002 | −0.038 | −0.100 | 0.713 | 0.045 | 0.115 | −0.071 | 4.00 | 1.438 |
| L2 | Learning of sustainability topics | −0.023 | −0.008 | 0.054 | 0.038 | 0.809 | −0.029 | −0.028 | 0.037 | 3.56 | 1.644 |
| AC1 | Offering of sustainability programs | 0.023 | −0.056 | 0.005 | 0.828 | 0.022 | −0.096 | 0.032 | 0.073 | 2.71 | 2.152 |
| AC2 | Campus to learn about sustainability | −0.108 | 0.061 | −0.012 | 0.366 | 0.233 | −0.041 | 0.040 | 0.275 | 2.98 | 1.938 |
| AC3 | Offering of continuing education courses in sustainability | 0.056 | 0.027 | −0.037 | 0.734 | −0.099 | 0.042 | 0.040 | −0.025 | 2.53 | 2.215 |
| N1 | Sustainability networks | −0.041 | −0.042 | 0.092 | −0.041 | 0.005 | 0.737 | 0.098 | 0.001 | 2.78 | 2.266 |
| N2 | Collaborative activities in sustainability | 0.014 | −0.023 | −0.019 | 0.005 | 0.007 | 0.902 | −0.071 | 0.002 | 2.63 | 2.288 |
| N3 | Creation of public policies | 0.018 | 0.081 | −0.001 | 0.043 | 0.016 | 0.408 | −0.055 | −0.046 | 2.70 | 2.237 |
| C1 | University's Environmental Management Program | 0.039 | 0.487 | 0.007 | −0.012 | −0.025 | 0.023 | 0.226 | −0.036 | 3.48 | 1.982 |
| C2 | Campus buildings built under sustainability guidelines | 0.007 | 0.770 | 0.011 | 0.084 | 0.037 | −0.054 | −0.046 | −0.121 | 3.25 | 1.993 |

**Table 3.** (*Continued*).

| | | Factor | | | | | | | | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Item** | **1 Governance** | **2 Campus** | **3 Assessment & Reports** | **4 Academic courses** | **5 Learning** | **6 Networking** | **7 Strategy & Commun.** | **8 Social** | | |
| C3 | University's Landscape and Biodiversity program | −0.059 | 0.746 | −0.061 | −0.060 | −0.019 | −0.050 | −0.037 | 0.049 | 3.64 | 1.994 |
| C4 | Purchasing and consumption | −0.030 | 0.404 | 0.025 | −0.031 | −0.009 | 0.042 | −0.062 | 0.268 | 3.07 | 1.991 |
| S1 | Extracurricular activities related to sustainability | 0.072 | 0.047 | 0.081 | 0.121 | 0.015 | 0.007 | −0.295 | 0.683 | 3.22 | 1.908 |
| S2 | Health and prevention campaigns | 0.343 | −0.061 | −0.047 | −0.033 | −0.042 | −0.079 | 0.042 | 0.415 | 4.01 | 1.540 |
| S3 | Participation in university's wellbeing programs | 0.346 | −0.099 | −0.056 | −0.098 | −0.050 | 0.022 | 0.059 | 0.428 | 4.07 | 1.436 |
| G1 | University's decision−making bodies | 0.667 | 0.001 | 0.001 | 0.014 | 0.072 | 0.005 | −0.075 | −0.008 | 3.84 | 1.645 |
| G2 | University's regulations | 0.677 | −0.076 | −0.042 | 0.041 | 0.042 | −0.037 | 0.033 | −0.031 | 4.33 | 1.370 |
| G3 | Ethical problems and corruption | 0.515 | 0.081 | 0.086 | 0.138 | −0.001 | 0.051 | −0.102 | −0.061 | 3.46 | 2.034 |
| AR1 | Sustainability Reports | 0.023 | −0.032 | 0.637 | 0.026 | −0.048 | −0.082 | 0.275 | −0.035 | 2.69 | 2.317 |
| AR2 | Sustainability rankings | −0.033 | −0.065 | 0.892 | 0.000 | 0.017 | 0.011 | −0.162 | 0.068 | 2.14 | 2.341 |
| AR3 | Sustainability certifications | 0.003 | 0.104 | 0.595 | −0.080 | 0.046 | 0.060 | 0.033 | 0.042 | 2.56 | 2.317 |
| Reliability (Cronbach's Alpha) | | 0.668 | 0.729 | 0.792 | 0.758 | 0.746 | 0.767 | 0.692 | 0.617 | | |

Source: Authors' creation using SPSS® software.

**Table 4.** UP Pattern matrix.

| | | Factor | | | | | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|---|
| | **Item** | **1 Institutional image** | **2 Research** | **3 Internationalization** | **4 Financial resources** | **5 Academic** | | |
| A1 | Research and teaching for academic reputation | 0.231 | 0.193 | −0.038 | −0.071 | 0.307 | 4.34 | 1.258 |
| A2 | Small class sizes and individual supervision | −0.009 | −0.037 | 0.016 | −0.020 | 0.561 | 3.19 | 1.640 |
| R1 | Research impact | −0.071 | 0.643 | −0.051 | 0.028 | 0.128 | 3.44 | 1.891 |
| R2 | Research groups | −0.015 | 0.862 | 0.033 | −0.034 | −0.090 | 3.47 | 1.725 |
| R3 | Technological developments (patents) | 0.075 | 0.555 | 0.028 | 0.116 | −0.071 | 3.79 | 1.717 |
| FR1 | Consultation services and training | −0.012 | 0.005 | −0.013 | 0.688 | −0.023 | 2.91 | 2.144 |
| FR2 | Diversified revenues | 0.009 | 0.078 | −0.022 | 0.631 | −0.040 | 2.95 | 2.159 |
| I1 | International mobility | 0.141 | 0.047 | 0.342 | 0.138 | 0.095 | 3.42 | 1.794 |
| I2 | Attraction of international students | 0.022 | −0.005 | 0.997 | −0.109 | −0.070 | 2.85 | 1.906 |
| I3 | Attraction of international academics | −0.136 | 0.011 | 0.492 | 0.174 | 0.131 | 2.12 | 1.823 |
| II1 | Academic support services | 0.779 | −0.020 | 0.037 | −0.043 | −0.067 | 4.55 | 0.963 |
| II2 | Infrastructure | 0.700 | −0.032 | −0.016 | 0.148 | −0.063 | 4.32 | 1.178 |
| II3 | Brand positioning | 0.609 | 0.021 | −0.045 | −0.084 | 0.126 | 4.57 | 0.897 |
| Reliability (Cronbach's Alpha) | | 0.728 | 0.741 | 0.703 | 0.602 | 0.396 | | |

Source: Authors' creation using SPSS® software.

EFA results show 24 items included in the US scale grouped into eight factors or latent variables, labelled as (1) strategy & communication, (2) learning, (3) academic courses, (4) networking, (5) campus, (6) social, (7) governance, and (8) assessment & reports. In addition, 13 items of the UP scale were grouped into five factors or latent variables labelled as (1) academic, (2) research, (3) financial resources, (4) internationalization, and (5) institutional image. EFA was applied for cases where links between the observed and latent variables were unknown or uncertain, aiming to determine how and to what extent the observed variables are linked to their underlying factors, constructs, or latent variables (Byrne, 2010). The proposed model maintains the number of factors for the US with a novel categorization of the sub-themes. For UP, on the other hand, the new model proposes five factors instead of six, considering a different arrangement of the sub-themes.

EFA findings were then triangulated using the PLS software to validate internal consistency, convergent validity, and discriminant validity, as suggested by Hair et al. (2017). The model shows an adequate internal consistency, as all factors but one have Cronbach's alpha values ranging between 0.602 and 0.936. Composite reliability values range between 0.767 and 0.941 for all factors. Regarding convergent validity, all the observed variables show values higher than 0.72 in indicator reliability. In comparison, all the AVE values are more significant than 0.55. Lastly, the HTMT confidence index demonstrates that none of the confidence intervals of the relationships established between latent variables includes zero, indicating discriminant validity. Consequently, the significance and relevance of the measurement model constructed from the exploratory approach is confirmed.

## 4.3. Results of the structural model

Once the EFA, and according to its results, the structural model for the incidence of US on UP in five high-quality private universities in Medellín, Colombia, was established, considering the previously suggested factors. SmartPLS 3 was used for second and third-order factors using the repeated indicator approach to obtain (1) the PLS Algorithm, (2) Bootstrapping, and (3) Blindfolding, as shown in the **Figures 2**–**4** below.

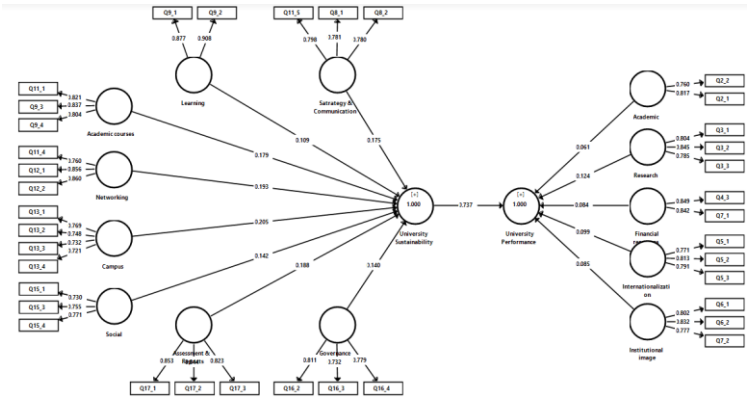



**Figure 2.** PLS Algorithm for US influence on UP.

Source: Authors' creation using SmartPLS® software.

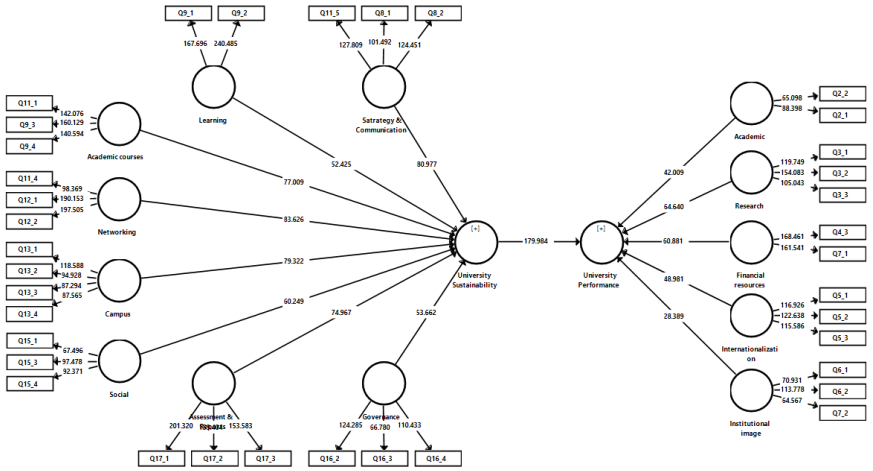



**Figure 3.** Bootstrapping for US influence on UP.

Source: Authors' creation using SmartPLS® software.

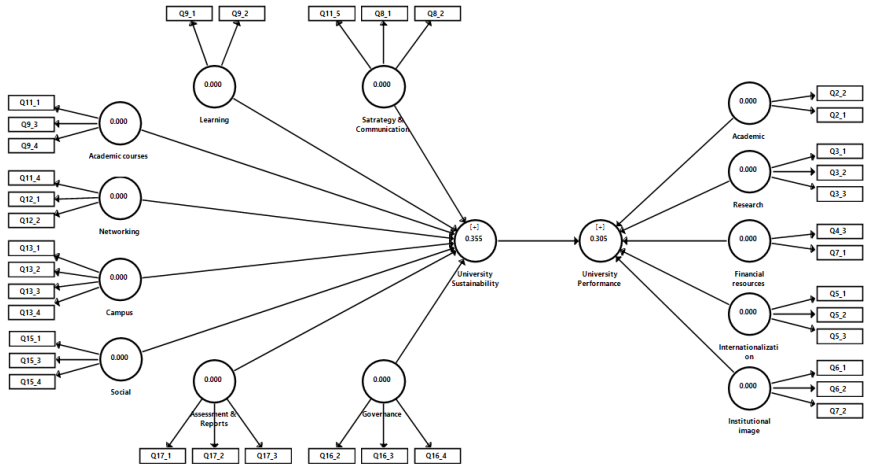



**Figure 4.** Blindfolding for US influence on UP.

Source: Authors' creation using SmartPLS® software.

After running the structural model, its adequacy was verified through the systematic evaluation of PLS-SEM results proposed by Hair et al. (2017). The authors propose two stages: (a) evaluation of the model's reflective measurements and (b) evaluation of the structural model. The evaluation of the measurement model was referenced previously. For the evaluation of the structural model, coefficients of determination (R2), predictive relevance (Q2), size and significance of path coefficients, and F2 effect sizes were considered (Hair et al., 2017). Regarding the coefficients of determination (R2), the index for both US and UP is close to 1.00. For the predictive relevance (Q2), the values for US and UP were above zero (0.355 and 0.305, respectively). As for the size and significance of path coefficients, values are close to zero for all relationships between latent variables. Further, the F2 of the effect sizes for all the relationships of the latent variables with US and UP are above 0.15, showing a significant effect. Consequently, the permittivity and significance of the structural model is confirmed.

## 5. Results discussion

The study's results align with a stream of previous research. For instance, this

study is aligned with authors who raise the need to include mission statements (Lopez and Martin, 2018), social or cultural indicators (Li et al., 2018), and other leadership metrics (Altahat and Atan, 2018) when studying sustainability for university and non-university organizations. Regarding UP, the proposed scale considers research indicators that Zhao et al. (2021) recommended. Overall, the results of this study confirm and deepen the previous hypothesis of Blasco et al. (2019) on the positive effect of university sustainability on the achievement of performance objectives.

On the other hand, this research is at variance with some authors' previous proposals. For example, unlike De Filippo et al.'s (2019) proposal, which measures US using standard indicators, or Kapitulčinová et al.'s (2018) toolset to promote sustainability integration in all dimensions of higher education practice, this study measures US using a previously designed scale (Hernández-Diaz et al., 2021) and determines its dimensionality from the empirical data. Furthermore, the research only considers the perception of internal stakeholders such as faculty, administrative employees and students, contrary to the multi-stakeholder approach proposed by Cavicchi and Vagnoni (2018). It does not adopt the data stored in the information systems of each participating university as suggested by these same authors.

## 6. Conclusions and recommendations

The study offers a valid and reliable model to measure the impact of US on UP. The dimensionality of both constructs was established through SEM using a robust data set from five private Colombian universities. The strength of this relationship is relevant, since sustainability should be preeminent for HEI's (Fülöp et al., 2022) to attain satisfactory performance indices (Khalid et al., 2021).

Results show that eight dimensions comprise US: strategy and communication, learning, academic courses, networking, campus, social, governance, and assessment reports. Further, the five dimensions that encompass UP are academic, research, financial resources, internationalization, and institutional image. For US, the highest-impact dimensions are campus, networking, and assessment and reports, while for UP, the most relevant dimensions are research, internationalization, and institutional image. The analysis of the data shows that US positively influences UP.

The importance of the role played by HEI's in society's sustainable development is indisputable, as education constitutes one of the main tools to delineate a plan towards viable social, economic and environmental prosperity (Memon and Liu, 2019; Tiron-Tudor et al., 2020). It is crucial for HEI's to exhibit a satisfactory performance if they endure as sustainable institutions over time (Blasco et al., 2019). This study offers a novel approach for measuring US and UP, where the dimensionality of both constructs derives from the quantitative data, considering a significant sample size. Such an approach enhances former investigations on the US (Amaral et al., 2015; Hernández-Diaz et al., 2021) and UP (Abubakar et al., 2018; Hernandez-Diaz et al., 2020).

Although the importance of US and UP has been widely acknowledged in the literature (Awuzie and Abuzeinab, 2019; Drahein et al., 2020; Plummer et al., 2021; etc.), the scarce availability of valid and reliable mechanisms to measure both constructs has limited further research on the influence one has on the other. The

exploratory analysis of the data reveals a new dimensionality for US and UP, considering a distinct classification of the sub-themes that comprise the reviewed constructs.

Following the development of a novel scale to measure the US and UP, derived from the collected quantitative data, the analysis unveils the significant and positive influence that the US has on UP. This finding is pertinent since HEI's are essential actors in the sustainable development of society through their core functions of education, innovation and research, so they should strive to reach an outstanding performance (Tiron-Tudor et al., 2020).

Some limitations of the study should be acknowledged. Although the number of responses is significant, data was collected from five private universities in the same geographic region, making results less generalizable. Also, the study focused on universities' internal actors (students, teaching staff and administrative staff), leaving out the views of external stakeholders. Further, cultural aspects are not considered, as the study was conducted within a particular context.

Future research could further focus on US and UP's relationships with other relevant constructs. Further, HEI's with a public and private nature from diverse regions or countries should be considered to enhance the results' generalizability. The view of external stakeholders, such as employers, alums and governmental institutions, should also be included in future studies. Also, it would be interesting to research if diverse cultural dimensions affect the incidence of the US on UP.

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