



Determining factors of virtual mobility in Latin American universities: A structural model analysis

Héctor-Gabriel Rangel-Ramírez¹, Martha Ramírez-Valdivia²

Abstract

This study analyzes the institutional factors that determine the consolidation of virtual mobility in Latin American universities through a structural equation model. Forty-nine universities from the Latin American Academic Exchange Program (PILA) were evaluated, examining three factors: management and organizational structure (F1), technological infrastructure (F2), and regulatory framework (F3). Results reveal extremely high correlations between factors ($r > 0.96$, $p < 0.001$) and exceptional internal consistency ($\alpha = 0.976$). Multiple regression analysis and the Structural Equation Model (SEM) confirm that F1 exerts the greatest influence ($\beta = .640$), explaining 98.2% of variance in virtual mobility, while F2 ($\beta = 0.264$) and F3 ($\beta = 0.107$) show smaller effects, operating primarily indirectly. Findings validate Knight's (2004, 2021) systemic internationalization model and demonstrate that institutional management capabilities constitute the primary enabling factor for successful development of virtual mobility programs in the region.

Abstract in Spanish

Este estudio analiza los factores institucionales que determinan la consolidación de la movilidad virtual en universidades de América Latina mediante un modelo de ecuaciones estructurales. Se evaluaron 49 universidades del Programa de Intercambio Académico Latinoamericano (PILA), examinando tres factores: gestión y estructura organizacional (F1), infraestructura tecnológica (F2) y marco normativo (F3). Los resultados revelan correlaciones extremadamente altas entre los factores ($r > 0.96$, $p < 0.001$) y consistencia interna excepcional (α

¹ VERACRUZANA UNIVERSITY, XALAPA, MEXICO

² UNIVERSITY OF LA FRONTERA, TEMUCO, CHILE

= 0.976). La regresión múltiple y el Modelo de Ecuaciones Estructurales (SEM) confirman que F1 ejerce la mayor influencia ($\beta = 0.640$), explicando 98.2% de la varianza en movilidad virtual, mientras F2 ($\beta = 0.264$) y F3 ($\beta = 0.107$) presentan efectos menores, operando principalmente de forma indirecta. Los hallazgos validan el modelo sistémico de internacionalización de Knight (2004, 2021) y demuestran que las capacidades de gestión institucional constituyen el factor habilitador primario para el desarrollo de programas de movilidad virtual en la región.

Keywords

Higher education; internationalization; Latin America; structural model; virtual mobility

Editorial note

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1. Introduction

Student virtual mobility is a global higher education phenomenon that has emerged in response to trends in technological innovation, new pedagogical transformations, and the need to foster access to internationalization in the post-pandemic era (Woicolesco et al., 2021). This strategy uses information and communication technologies to provide an alternative to traditional mobility, democratizing access, as Bustos-Aguirre and Herrera-Rodríguez (2023) note when they describe it as a rapidly growing practice that increases collaboration and exchange through digital technologies.

In the field of international education and student mobility, virtual mobility comprises technology-mediated pedagogical practices that allow students to take part in cross-border educational experiences without physical displacement. These practices include international online collaborative learning—COIL, or mirror classes—, inter-institutional collaborative projects on digital platforms, virtual courses shared between institutions in different countries, and distance double-degree programs. Unlike conventional in-person mobility, virtual mobility removes barriers related to visas, travel cost, or communication, representing a strategic internationalization alternative for populations that lack access to physical mobility (Beelen & Jones, 2015; O'Dowd, 2021). Within the context of study abroad programs, virtual mobility opens new possibilities for international academic collaboration that

complement—and in many cases expand—the reach of internationalization to student groups historically excluded from these experiences. Understanding its determining factors is therefore a relevant question for the global field of international education.

In the context of Latin American higher education, where access to in-person international experiences represents only 1.14% of total enrollment (Organización de los Estados Iberoamericanos, 2025), universities face diverse structural challenges: heterogeneity among university systems, budgetary limitations, technological deficiencies, limited regulatory frameworks, and other factors such as incipient academic and administrative management processes (Andres, 2020; García & Bonatti, 2024). Virtual mobility thus emerges as an alternative for addressing these structural challenges in higher education institutions.

Given the presence of various mechanisms for promoting virtual mobility in the Latin American region, gaps remain in the knowledge of the factors that influence its consolidation within universities. The importance of assessing the determinants of virtual mobility is growing as regional institutions and university platforms increasingly commit to creating programs based on this internationalization alternative.

This research focuses on analyzing how management and organizational structure factors, technological infrastructure and digital capabilities, and regulatory framework and recognition systems determine the consolidation of virtual mobility in a sample of universities from the Latin American Academic Exchange Program (PILA). The relevance of this analysis lies in understanding how universities can better coordinate their management processes to strengthen virtual internationalization (Cordero Guzmán & Ramón Poma, 2021). Despite the growth of virtual mobility as a research subject, quantitative empirical evidence on its institutional determinants in Latin America is scarce. Most available studies come from European or North American contexts, with qualitative designs that are not necessarily transferable to the realities of Latin American higher education (de Wit & Altbach, 2021; Garcia & Bonatti, 2024). This gap justifies the development of empirical explanatory models that improve decision-making and guide internationalization policies toward more efficient strategies for expanding access to quality virtual experiences, providing new foundations for developing international education in contexts of high structural heterogeneity such as Latin America.

2. Theoretical framework

The selection of the three factors analyzed—namely, management and organizational structure, technological infrastructure, and regulatory framework—responds to a systematic review of the specialized literature on higher education internationalization in Latin America, in which these elements recurrently emerge as conditions for the success of mobility programs (Andres, 2020; García & Bonatti, 2024; Gacel-Ávila et al., 2023). Other factors identified in the literature, such as institutional culture, academic leadership, or external funding, were excluded because their operationalization is less amenable to comparative measurement from public documentary sources, and because the available evidence positions them as mediators or consequences of the three selected factors rather than as independent determinants. The selection follows the logic of Knight's (2004) systemic model, which identifies three interdependent axes in institutional internationalization processes: the organizational (governance and management), the programmatic-technological, and the regulatory. Unlike approaches that treat these axes in isolation or sequentially, the present study assumes that their integrated analysis is what allows understanding of the real dynamics of virtual mobility consolidation. The theoretical foundation of each factor and the reasons justifying its inclusion in the proposed model are elaborated below.

Strengthening internationalization processes requires in-depth analyses that demonstrate sound transversal functioning across institutions' core activities. Existing analytical models for examining institutional elements that affect internationalization include diverse strategies, policies, programs, and organizational structures (Knight, 2008; de Wit et al., 2015). Some regional studies document institutional conditions such as financial constraints, the absence of strategic plans, or deficient organizational functioning (Gacel-Ávila et al., 2023), while others identify key aspects such as efficient internationalization management systems and training in internationalization processes (Robaina & Soriano, 2016).

To analyze the institutional factors that determine virtual mobility programs from a structural perspective, this study adopts Jane Knight's theoretical model of internationalization (2004, 2008, 2021), which provides a framework for assuming that internationalization occurs at the national, sectoral, and institutional levels to integrate the international, intercultural, or global dimension into the functions, policies, and academic processes of higher education (Knight, 2004). As Hernández (2016) notes, Knight's theoretical model defines internationalization as a process that transcends universities' specific activities to become a process of structural transformation, including

cross-cutting elements such as academic services, organizational factors, institutional governance models, and even the university ethos. The importance of management capacity as a determining factor in this study coincides with the position of Ramírez-Valdivia & Latorre (2019), who argue that internationalization only achieves systemic consolidation when it is explicitly articulated in institutional strategic plans. This linkage allows the international dimension to cease being a peripheral activity and become a cross-cutting axis that strengthens the university's main functions. Based on this framework, the three key factors of management and organizational structure, technological infrastructure, and regulatory framework are identified to analyze their contribution to the development of virtual mobility in the region.

2.1. Management and organizational structures for internationalization

This factor is grounded in the presence of specialized organizational units or “offices” for internationalization, with specific policies and processes intended to facilitate the coordination of cross-cutting projects (Moctezuma Hernández & Navarro Cerda, 2011), which is supported by organizational studies such as those of Wissema (2009) and Lizárraga (2017), who demonstrate the importance of designing institutional structures and policies for universities to trigger student international mobility.

Other studies, such as those of the American Council on Education (2012), argue that successful structural transformations in universities include the creation of internationalization offices, the establishment of clearly delimited functions, the design of structured academic mobility programs, financial support, the integration of international components into institutional plans, and the adoption of global reference frameworks.

2.2. Infrastructure and digital capabilities

This factor rests primarily on Davis's Technology Acceptance Model (1989) and its adaptation by Venkatesh et al. (2003) to the higher education context. Likewise, other studies, such as those of Cordero Guzmán and Ramón Poma (2021), establish the need to develop technological ecosystems and implement a model of progressive, specific digital competencies to support various differentiated training processes, as internationalization does through mobility.

Pandita and Kiran's (2023) research, in turn, shows that the quality of technological infrastructure has a positive effect on student satisfaction and learning experience, making it necessary for universities to adapt their

technological resources to the needs of their academic programs and student populations. In a complementary vein, Zambrano's (2025) study revealed that the real benefits derived from investment in technology depend significantly on factors such as technological accessibility and faculty training requirements in technology and require appropriate planning of these resources across the different substantive functions.

2.3. Regulatory frameworks and international credit recognition

The regulatory framework and academic recognition are determining elements for virtual mobility, given that this region exhibits a historical regulatory fragmentation that has permeated various areas of higher education institutions. These institutional elements are grounded in Hwang's (2023) theory of organizational neo-institutionalism, which posits that formal regulatory structures represent the “rules of the game” that constrain and/or enable organizational action. UNESCO's Regional Convention on the Recognition of Studies, Diplomas and Degrees in Higher Education for Latin America and the Caribbean (2019) emerged as an initiative to accelerate and resolve the recognition of educational experiences among regional institutions, as well as to harmonize credit transfer procedures, reduce regulatory uncertainty, and promote virtual mobility as a democratizing alternative (Falcon, 2024). This regulatory momentum is complemented by the work of regional networks such as the Montevideo Group Association of Universities (2019), which promotes solidarity-based cooperation and reciprocal mobility as pillars of a common academic space. Likewise, advances from the Tuning Latin America Project (Beneitone et al., 2007) have been fundamental in establishing benchmarks for generic and specific competencies, facilitating the transparency and comparability of graduate profiles necessary for effective academic recognition in the region. In this way, this factor guides universities toward building institutional capacities consistent with the principles of transparency, trust, and fair evaluation, showing how regulatory changes shape organizational practices and enable the consolidation of internationalization in the region.

2.4. The Latin American Academic Exchange Program (PILA)

This initiative arose from the need for academic cooperation among countries such as Argentina, Colombia, and Mexico, as bodies such as Argentina's National Inter-University Council (CIN), the Colombian Association of Universities (ASCUN), and Mexico's National Association of Universities and Higher Education Institutions (ANUIES) agreed to support a common platform aimed at fostering the mobility of the region's student community, with 2018 marking the program's first year of activities.

The choice of the PILA program for this study responds to theoretical and methodological criteria, since this platform integrates 332 universities across seven Latin American countries, providing an opportunity for highly cross-cutting analysis. The PILA program encompasses institutions of different sizes, orientations, and management and development models, providing representativeness and heterogeneity for the analysis of multifactorial scenarios (Fowler, 2013; Lohr, 2019). Additionally, PILA's track record facilitates the visibility of concrete virtual mobility actions and their consolidation processes, as these trajectories are crucial for analyzing structural aspects (Patton, 2014; Stake, 2010).

2.5. Research problem and objectives

Given this diversification of virtual internationalization mechanisms in the Latin American context, and taking into account the structural challenges that universities in this region face when attempting to consolidate virtual mobility, it is relevant to ask: to what extent do institutional management, infrastructure, and regulatory framework factors contribute to the consolidation of virtual mobility programs in Latin American universities? This question seeks to understand the relationships among these determinants and their influence in facilitating or hindering the successful implementation of virtual mobility programs, so as to analyze the particularities of this context and inform the coordination of management processes and the democratization of access to this type of international experience with the support of technology and communications.

The general objective of this study is to analyze the institutional factors that influence the consolidation of virtual mobility programs in a sample of Latin American universities through correlational analysis and a structural equation model. The specific objectives are:

- a) To identify the behavior of institutional management, technological infrastructure, and regulatory framework factors in the sample of PILA program universities,
- b) To determine the contribution of each factor to the degree of virtual mobility consolidation among the institutions analyzed; and
- c) To analyze the relationships among the three factors and their joint effect on the degree of virtual mobility consolidation in the sample of PILA universities.

3. Methods

This research adopts a correlational-explanatory quantitative design through a stepwise multivariate analysis. This design responds to the complex, multifactorial nature of virtual mobility, as well as to the diversity of institutional traits that influence this phenomenon. As Creswell and Creswell (2017) note, correlational-explanatory designs are appropriate not only when relationships between variables are sought, but when the causal mechanisms underlying those relationships must also be explained.

The multivariate analysis is grounded in the work of Hair et al. (2019), who argue that when complex institutional constructs are analyzed through Likert scales, it is essential to employ techniques that examine linear relationships and structural interdependencies among multiple variables. The cross-sectional approach is justified by the need to examine the level of virtual mobility consolidation, providing specificity at a given point in time, since, as Babbie (2020) and Bryman (2016) affirm, cross-sectional studies offer advantages in organizational contexts, allowing for simultaneous comparison across institutions and the identification of structural behavioral patterns.

The analysis seeks to test three fundamental hypotheses:

- H1: The three factors show significant relationships with one another.
- H2: The influence of each factor on virtual mobility is different.
- H3: The institutional management factor (F1) exerts the greatest influence on virtual mobility.

3.1. Population and sample

The target population of this study consists of the 332 universities belonging to the PILA program: Argentina, with 61 institutions (18.4%); Brazil, with 74 universities (22.3%); Chile, with 5 institutions (1.5%); Colombia, with 90 universities (27.1%); Mexico, with 84 universities (25.3%); Nicaragua, with 9 universities (2.7%); Paraguay, with 8 institutions (2.4%); and Uruguay with one university (0.3%). The sampling design established for this research was proportional stratified probability sampling, justified by methodological considerations aligned with the scope of the objectives. As Cochran (1977) and Thompson (2012) establish, stratified sampling is particularly appropriate when the population presents subgroups with potentially different characteristics with respect to the variables of interest. Stratification by country follows the earlier theoretical positions of Knight (2004) and Altbach and Knight (2007), who note that internationalization processes are influenced by national contexts, each country's policies, specific regulatory frameworks, and even each setting's institutional culture.

The sample size was calculated using the standard formula for finite populations, with a 95% confidence level ($Z = 1.96$), a 5% margin of error ($e = 0.05$), and an expected proportion of 50% ($p = 0.5$), following the approaches of Krejcie and Morgan (1970) and Bartlett et al. (2001). The statistically representative sample consisted of 178 universities, proportionally distributed according to the procedures established by Särndal et al. (2003) and Valliant et al. (2013).

This sample of 178 universities constituted the study's statistical reference framework; however, its application was contingent on the actual documentary availability for each institution. Following the logic of purposive sampling—or criteria sampling, as conceptualized in other methodological sources—described by Patton (2014), a second filter was applied to the group of 178 universities, retaining only those with sufficient and verifiable documentary evidence (institutional websites, management reports, public databases, published agreements, technological platforms, and publicly accessible regulatory frameworks) to reliably code the three institutional factors and the degree of consolidation of virtual mobility.

This documentary sufficiency criterion reduced the final sample to 49 universities, representing 27.5% of the initial statistical sample and 14.8% of the total PILA program population, having the final following proportion by country: Argentina (11), Brazil (12), Chile (4), Colombia (8), Mexico (8), Nicaragua (2), Paraguay (3), and Uruguay (1). Although this reduction entails a loss of strict statistical representativeness, the final sample preserves the relative proportionality across countries and prioritizes the quality and verifiability of the available evidence, a methodological criterion widely accepted in studies based on documentary sources (Patton, 2014).

3.2. Instrument for assessing virtual mobility consolidation

The design of the instrument for assessing virtual mobility is grounded in a theoretical synthesis of three conceptual frameworks: a) Rogers et al.'s (2019) innovation adoption model, to understand progressive levels of institutional adoption; b) the internationalization maturity model proposed by Hudzik (2011), which distinguishes the different stages of institutional development in international education processes, considering the scope and depth of systemic actions and functions (Brandenburg & de Wit, 2011); and c) the comprehensive internationalization theory developed by Knight (2015), who distinguishes among reactive, proactive, and transformational institutional responses.

These theoretical frameworks provided the basis for establishing a 7-point Likert scale that captures the progression in the degree of consolidation

of the virtual mobility actions of the universities analyzed (see Table 1). This type of scale provides a measurement balance, offering variability to detect subtle differences between institutions without generating a significant impact on individual scoring.

3.3. Instruments for assessing institutional factors

The instrument for assessing the management and organizational structure factor (F1) is based on the integration of theoretical perspectives from the organizational domain (see Table 1). This draws, first, on Knight's (2004) theory of internationalization, given its focus on the structural transformation processes of internationalization, and second, on the institutionalization theory developed by Meyer & Rowan (1977), who hold that the development of formal structures occurs alongside institutional legitimacy. As for the technological infrastructure and digital capabilities factor (F2), it was grounded in Davis's (1989) Technology Acceptance Model and its adaptation by Venkatesh et al. (2003) through the Unified Theory of Acceptance and Use of Technology (UTAUT). These models address technology adoption in organizational contexts, as in the studies by Cordero Guzmán & Ramón Poma (2021) on the development of technological ecosystems in Latin American universities (see Table 2). The development of the instrument for the regulatory framework and academic recognition systems factor (F3) is based on the theory of organizational neo-institutionalism developed by March and Olsen (1989) and DiMaggio and Powell (1983), who emphasize how organizations become legitimate through a cross-cutting regulatory framework (see Table 3). In this research, UNESCO's Regional Convention (2019) serves as the basis for analyzing the regulatory elements of institutions in the region.

TABLE (1)

LIKERT SCALE FOR FACTOR 1: INSTITUTIONAL MANAGEMENT AND STRUCTURE

Level	Required Evidence
1 - Non-existent	Absence of written institutional policies; no staff designated for internationalization; lack of a specific budget; no formal programs existence or proposals.
2 - Very Basic	General mentions in institutional documents; isolated activities; staff with informal responsibilities; occasional budget.
3 - Basic	Basic documented institutional policy; designated staff with defined functions; limited budget for administrative activities; some agreements or partnerships established.
4 - Moderate	Specific office or unit created; approved and published policies; documented procedures; active agreements and regular programs.
5 - Considerable	Integration into the development plan; standardized and documented processes; trained, specialized staff; multiple international partnerships.

6 - Advanced	Matrix coordination structure; institutional culture of internationalization; automated and/or efficient processes; external (national or international) recognition of good practices.
7 - Excellent	Regional, national and/or international leadership; benchmarking for other institutions; research on internationalization; measurable impact on indicators.

Note. Own elaboration based on the identification of categories and parameters.

TABLE (2)

LIKERT SCALE FOR FACTOR 2: TECHNOLOGICAL INFRASTRUCTURE AND DIGITAL CAPABILITIES

Level	Required Evidence
1 - Non-existent	Poor or non-existent connectivity; absence of educational platforms for international collaboration; staff without digital training; students without technological access.
2 - Very Basic	Basic, intermittent connectivity; basic platforms available; sporadic digital training; limited technical support.
3 - Basic	Stable but limited connectivity; basic learning management system; initial digital training program; regular technical support.
4 - Moderate	Reliable, sufficient connectivity; integrated learning platforms; trained teaching staff; specialized technical support.
5 - Considerable	Integrated technological ecosystem; multiple synchronized platforms; documented advanced competencies; continuous training programs.
6 - Advanced	Redundant, scalable infrastructure; emerging technologies implemented; digital competency certifications; national and/or international recognition for digital innovation.
7 - Excellent	Internationally benchmark infrastructure; proprietary technology development; leadership in digital competencies; technology transfer to other HEIs.

Note. Own elaboration based on the identification of categories and parameters.

TABLE (3)

LIKERT SCALE FOR FACTOR 3: REGULATORY FRAMEWORK AND ACADEMIC RECOGNITION SYSTEMS

Level	Required Evidence
1 - Non-existent	Lack of specific regulations; absence of credit systems; no recognition procedures.
2 - Very Basic	General regulations without specifications; case-by-case recognition; limited knowledge of international frameworks.
3 - Basic	Specific regulation approved; basic equivalency system; documented procedures; initial alignment with national frameworks.
4 - Moderate	Comprehensive regulations approved; credit system implemented; standardized procedures; agreements with automatic recognition.
5 - Considerable	Updated, comprehensive regulations; harmonized credit system; digitized, agile processes; multiple international agreements.
6 - Advanced	Innovative, flexible regulations; automatic recognition implemented; international certifications; leadership in regulatory development.
7 - Excellent	Internationally benchmark regulations; cutting-edge recognition system; contribution to international regulatory frameworks; multilateral automatic recognition.

Note. Own elaboration based on the identification of categories and parameters.

3.4. Methodological justification

The analytical approach adopts a stepwise scheme that combines basic statistical techniques with multivariate techniques, in line with recommendations for studies in the social and organizational domain (Byrne, 2013; Johnson & LeBreton, 2004; Kline, 2023). The first phase includes descriptive steps to characterize variables and assess statistical assumptions through measures of central tendency, dispersion, and normality tests. This phase includes reliability assessment through Cronbach's Alpha test (1951).

The second phase focuses on exploring interdependencies through Pearson & Spearman correlations (Field, 2024; Pituch & Stevens, 2016), while the third phase includes predictive techniques through stepwise regression analysis using Enter & Stepwise methods (Pedhazur, 1997; Thompson, 2006), complemented by an ANOVA test and regression coefficients for the relationships among factors (Cohen et al., 2013; Hair et al., 2019).

Structural equation modeling constitutes the main technique, justified by its capacity to handle latent constructs and more complex causal relationships (Hoyle, 2014; Kline, 2023). Anderson and Gerbing's (1988) two-step approach is implemented, assessing fit through multiple complementary indices: absolute fit (χ^2 , RMSEA) and incremental fit (CFI, TLI), following Hu & Bentler (1999) and Marsh et al. (2004).

It is important to note that the present study ensured the content validity of the instruments through rigorous theoretical grounding of each indicator (Hair et al., 2019). Regarding construct validity, the absence of a formal discriminant validity assessment is acknowledged as a limitation, since the very high correlations among factors ($r > 0.96$) could partly reflect conceptual overlap among the constructs in addition to their functional interdependence. This observation, also raised in the results analysis, calls for cautious interpretation: correlations close to 1 do not automatically confirm that a single construct is being measured, but they do indicate that the factors co-evolve so closely that, in order to isolate their independent effects, future research is recommended to apply confirmatory measurement models (CFA) and compute the average variance extracted (AVE), which will make it possible to determine whether the three factors represent theoretically distinct constructs or dimensions of a higher-order latent construct (Kline, 2023).

4. Results

The results of the assessments of virtual mobility consolidation are presented (see Table 4), along with those of the three factors: F1 (management and organizational structure), F2 (technological infrastructure and digital

capabilities), and F3 (regulatory framework and recognition systems), in Table (6). The search process was carried out on institutional websites, results-report-type documents, project web pages, and other resources available online. Two research assistants scored each case independently, calculating a Kappa agreement index that reached a value of $\kappa > 0.81$, indicating consistency and demonstrating that no significant discrepancies exist in the measurement (Cohen et al., 2013).

TABLE (4)

DEGREE OF VIRTUAL MOBILITY CONSOLIDATION BY COUNTRY AND INSTITUTION

	Country	University	Score
1	Argentina	Universidad de Buenos Aires	5 - Consolidated
2	Argentina	Universidad Nacional de Córdoba	5 - Consolidated
3	Argentina	Universidad Nacional de Entre Ríos	2 - InitialDevelopment
4	Argentina	Universidad Nacional de José C. Paz	1 - Incipient
5	Argentina	Universidad Nacional de La Pampa	2 - InitialDevelopment
6	Argentina	Universidad Nacional de La Plata	4 - PartiallyConsolidated
7	Argentina	Universidad Nacional de Quilmes	3 - In Development
8	Argentina	Universidad Nacional de Rosario	3 - In Development
9	Argentina	Universidad Nacional de San Martín	3 - In Development
10	Argentina	Universidad Nacional del Centro	2 - InitialDevelopment
11	Argentina	Universidad Tecnológica Nacional	4 - PartiallyConsolidated
12	Brazil	Universidad de Campinas	4 - Partially Consolidated
13	Brazil	Universidad de São Paulo	5 - Consolidated
14	Brazil	Universidad Federal de Bahía	3 - In Development
15	Brazil	Universidad Federal de Minas Gerais	4 - Partially Consolidated
16	Brazil	Universidad Federal de Paraná	3 - In Development
17	Brazil	Universidad Federal de Pelotas	2 - Initial Development
18	Brazil	Universidad Federal de Pernambuco	3 - In Development
19	Brazil	Universidad Federal de Rio de Janeiro	4 - Partially Consolidated
20	Brazil	Universidad Federal de Rio Grande do Sul	5 - Consolidated
21	Brazil	Universidad Federal de Santa Catarina	4 - Partially Consolidated
22	Brazil	Universidad Federal del Estado de Río	2 - Initial Development
23	Brazil	Universidad Federal Fluminense	3 - In Development
24	Chile	Universidad Católica de Temuco	2 - Initial Development
25	Chile	Universidad Católica de Valparaíso	3 - In Development
26	Chile	Universidad de O'Higgins	1 - Incipient
27	Chile	Universidad de Talca	3 - In Development
28	Colombia	Corporación Universitaria Minuto de Dios	2 - Initial Development
29	Colombia	Pontificia Universidad Javeriana	4 - Partially Consolidated
30	Colombia	Universidad de Antioquia	5 - Consolidated
31	Colombia	Universidad del Valle	4 - Partially Consolidated

32	Colombia	Universidad EAFIT	4 - Partially Consolidated
33	Colombia	Universidad Nacional de Colombia	6 - Highly Consolidated
34	Colombia	Universidad Pedagógica Nacional	3 - In Development
35	Colombia	Universidad Tecnológica de Bolívar	3 - In Development
36	Mexico	Instituto Politécnico Nacional	4 - Partially Consolidated
37	Mexico	Universidad Autónoma de Guadalajara	3 - In Development
38	Mexico	Universidad Autónoma de Sinaloa	2 - Initial Development
39	Mexico	Universidad Autónoma Metropolitana	4 - Partially Consolidated
40	Mexico	Universidad de Guadalajara	4 - Partially Consolidated
41	Mexico	Universidad Nacional Autónoma de México	7 - Fully Consolidated
42	Mexico	Instituto Tecnológico de Estudios Superiores de Monterrey	6 - Highly Consolidated
43	Mexico	Universidad Veracruzana	7 - Fully Consolidated
44	Nicaragua	Universidad de las Regiones Autónomas	1 - Incipient
45	Nicaragua	Universidad Nacional Autónoma de Nicaragua	2 - Initial Development
46	Paraguay	Universidad Nacional de Asunción	2 - Initial Development
47	Paraguay	Universidad Nacional de Itapúa	1 - Incipient
48	Paraguay	Universidad Nacional del Este	1 - Incipient
49	Uruguay	Universidad de la República	3 - In Development

Note. Own elaboration based on the documentary assessment.

TABLE (5)

ASSESSMENT OF FACTOR LEVELS ACCORDING TO 7-POINT LIKERT SCALES

#	Country	University	F1	F2	F3
1	Argentina	Universidad de Buenos Aires	5	4	4
2	Argentina	Universidad Nacional de Córdoba	5	4	4
3	Argentina	Universidad Nacional de Entre Ríos	2	2	2
4	Argentina	Universidad Nacional de José C. Paz	1	1	2
5	Argentina	Universidad Nacional de La Pampa	2	2	2
6	Argentina	Universidad Nacional de La Plata	4	4	4
7	Argentina	Universidad Nacional de Quilmes	3	3	3
8	Argentina	Universidad Nacional de Rosario	3	3	3
9	Argentina	Universidad Nacional de San Martín	3	3	3
10	Argentina	Universidad Nacional del Centro	2	2	2
11	Argentina	Universidad Tecnológica Nacional	4	4	4
12	Brazil	Universidad de Campinas	4	4	4
13	Brazil	Universidad de São Paulo	5	5	5
14	Brazil	Universidad Federal de Bahía	3	3	3
15	Brazil	Universidad Federal de Minas Gerais	4	4	4
16	Brazil	Universidad Federal de Paraná	3	3	3
17	Brazil	Universidad Federal de Pelotas	2	2	2
18	Brazil	Universidad Federal de Pernambuco	3	3	3

19	Brazil	Universidade Federal de Rio de Janeiro	4	4	4
20	Brazil	Universidade Federal de Rio Grande do Sul	5	5	5
21	Brazil	Universidade Federal de Santa Catarina	4	4	4
22	Brazil	Universidade Federal do Estado de Rio	2	2	2
23	Brazil	Universidade Federal Fluminense	3	3	3
24	Chile	Universidad Católica de Temuco	2	2	2
25	Chile	Universidad Católica de Valparaíso	3	3	3
26	Chile	Universidad de O'Higgins	1	1	1
27	Chile	Universidad de Talca	3	3	3
28	Colombia	Corporación Universitaria Minuto de Dios	2	2	2
29	Colombia	Pontificia Universidad Javeriana	4	4	4
30	Colombia	Universidad de Antioquia	5	5	4
31	Colombia	Universidad del Valle	4	4	4
32	Colombia	Universidad EAFIT	4	4	4
33	Colombia	Universidad Nacional de Colombia	6	5	5
34	Colombia	Universidad Pedagógica Nacional	3	3	3
35	Colombia	Universidad Tecnológica de Bolívar	3	4	3
36	Mexico	Instituto Politécnico Nacional	4	4	4
37	Mexico	Universidad Autónoma de Guadalajara	3	3	3
38	Mexico	Universidad Autónoma de Sinaloa	2	2	2
39	Mexico	Universidad Autónoma Metropolitana	4	4	4
40	Mexico	Universidad de Guadalajara	4	4	4
41	Mexico	Universidad Nacional Autónoma de México	7	7	6
42	Mexico	Instituto Tecnológico de Estudios Superiores de Monterrey	6	6	5
43	Mexico	Universidad Veracruzana	7	6	5
44	Nicaragua	Universidad de las Regiones Autónomas	1	1	1
45	Nicaragua	Universidad Nacional Autónoma de Nicaragua	2	2	2
46	Paraguay	Universidad Nacional de Asunción	2	2	2
47	Paraguay	Universidad Nacional de Itapúa	1	1	1
48	Paraguay	Universidad Nacional del Este	1	1	1
49	Uruguay	Universidad de la República	3	3	3

Note. Own elaboration based on the documentary assessment.

4.1. Descriptive and distributional analysis

The descriptive analysis reveals consistent patterns across all variables (see Table 6). Means ranged between 3.20 and 3.43 points, placing most universities at the “basic” and “developing” levels. The calculated standard deviations (1.35–1.50) show high heterogeneity among the diverse institutions. A mode value of 3 supports the confirmation that the basic-intermediate level is the most frequent in the sample of institutions.

TABLE (6)

DESCRIPTIVE STATISTICS

Variable	N	Mean	SD	Min	Max	Skewness	Kurtosis
F1 Institutional Management	49	3.39	1.498	1	7	0.654	-0.366
F2 Infrastructure	49	3.31	1.459	1	7	0.732	-0.242
F3 Regulatory Framework	49	3.20	1.347	1	6	0.544	-0.489

Note. Source: own elaboration based on the analysis performed in Excel.

The distributions show moderate positive skewness (0.54 – 0.73), indicating a concentration of low-to-intermediate values with tails toward higher values, and negative kurtosis, indicating platykurtic distributions that are more dispersed than normal. The Kolmogorov-Smirnov and Shapiro-Wilk tests (see Table 7) reject normality ($p < 0.05$) for all variables.

TABLE (7)

NORMALITY AND DISTRIBUTION TESTS

Variable	Std. Error	K-S Statistic	K-S Sig.	S-W Statistic	S-W Sig.
F1	0.668	0.158	0.005	0.935	0.009
F2	0.668	0.165	0.003	0.928	0.005
F3	0.668	0.172	0.002	0.933	0.008

Note. Source: own elaboration based on the analysis performed in Excel. K-S = Kolmogorov-Smirnov; S-W = Shapiro-Wilk.

The internal consistency assessment using Cronbach's Alpha yielded a $\alpha = 0.976$, exceeding the 0.70 recommended in the social sciences (see Table 8). Accordingly, 97.6% of the variance is true and consistent across variables.

TABLE (8)

RELIABILITY ANALYSIS

Variable	Item-Total Correlation	R^2 Multiple	α if Item Deleted
F1	0.939	0.892	0.968
F2	0.944	0.902	0.967
F3	0.906	0.831	0.974

Note. Source: own elaboration based on the analysis performed in Excel.

The corrected item-total correlations exceed 0.90, demonstrating that each variable contributes significantly to the overall scale. F2 showed the highest correlation (0.944), while F3 proved to be the lowest (0.906). The coefficients of determination (R^2) reveal that between 83.1% and 90.2% of the variances can be predicted by the others, with F2 being the most redundant variable ($R^2 = 0.902$) and F3 retaining the greatest variance (16.9%). No variable deletion improved alpha, confirming that all variables are essential for measuring the construct.

4.2. Correlational analysis

The Pearson correlation analysis revealed high associations among all variables, with coefficients above $r = 0.96$ and significance $p < 0.001$ in all cases (see Table 9). The strongest correlation was observed between F1 and MV ($r = 0.991$, $p < 0.001$), followed by F1-F2 ($r = 0.990$) and F2-MV ($r = 0.989$). The lowest correlation, though still strong, was F3-MV ($r = 0.964$) (see Table 10). These coefficients represent variances above 92%, with F1 explaining 98.2% of the variance in MV.

TABLE (9)

PEARSON CORRELATION MATRIX

	F1	F2	F3	MV
F1 - Institutional Management	1	0.990**	0.962**	0.991**
F2 - Infrastructure	0.990**	1	0.967**	0.989**
F3 - Regulatory Framework	0.962**	0.967**	1	0.964**
MV - Virtual Mobility	0.991**	0.989**	0.964**	1

Note. Source: own elaboration based on the analysis performed in Excel. * $p < .001$.

The magnitude of the correlations is strong for the social sciences ($r > 0.50$ is considered high). Cohen (2013) classifies correlations $r \geq 0.90$ as “nearly perfect,” indicating that the factors advance jointly, this is, an institution that develops its institutional management also strengthens its infrastructure capacity ($r = 0.990$) and its regulatory frameworks ($r = 0.962$). This supports Knight's (2004) internationalization theory model rather than notions in which the factors are considered to move separately.

The calculation of the t statistics using the formula of $t = r\sqrt{(n-2)/\sqrt{(1-r^2)}}$ with a degree of freedom $df = 47$, produced high values, confirming that the probability of obtaining these associations by chance is practically nil—having $n = 49$ and a statistical power that exceeds 0.999—. The consistency between the Pearson and Spearman correlations ($\rho = 0.991$ -0.992) confirms the strength of the respective relationships, validating the presence of genuine associations rather than artifacts of non-normal distributions.

TABLE (10)

SPEARMAN CORRELATIONS (RHO)

	F1	F2	F3	MV
F1 - Institutional Management	1.000	0.992**	0.967**	0.991**
F2 - Infrastructure	0.992**	1.000	0.973**	0.991**
F3 - Regulatory Framework	0.967**	0.973**	1.000	0.971**
MV - Virtual Mobility	0.991**	0.991**	0.971**	1.000

Note. Source: own elaboration based on the analysis performed in Excel. * $p < .001$.

These results provide evidence to accept Hypothesis 1 (H1), which posits that the three factors show significant relationships with one another (all $p < 0.001$). The observed structure suggests a pattern of institutional interdependence in which capacities develop holistically rather than in isolation. Leading universities at levels 6 and 7 develop all factors simultaneously, whereas those at levels 1–2 show deficiencies across all aspects, evidencing a strongly interdependent pattern of institutional development.

4.3. Stepwise multiple regression

This tool was applied using a *forward* method to assess the contribution of each factor to the prediction of virtual mobility, controlling for the effects of the other predictors. The procedure entered variables sequentially according to their statistical significance, making it possible to identify the empirical order of importance: F1 (management) entered first, followed by F2 (infrastructure) and F3 (regulatory framework).

TABLE (11)

SUMMARY OF THE STEPWISE REGRESSION MODEL

Model	<i>R</i>	<i>R</i> ²	Adjusted <i>R</i> ²	Std. Error	ΔR^2	ΔF	<i>df</i> 1, <i>df</i> 2	<i>p</i> -value
1. F1	0.991	0.982	0.982	0.204	0.982	2584.31	1,47	0.000
2. F1+F2	0.993	0.986	0.986	0.178	0.004	13.78	1,46	0.001
3. F1+F2+F3	0.994	0.988	0.987	0.171	0.002	7.14	1,45	0.010

Note. Source: own elaboration based on the analysis performed in Excel.

Model 1, with F1 as the sole predictor (see Table 11), explained 98.2% of the variance in virtual mobility ($R^2 = 0.982$, $F = 2584.312$, $p < 0.001$), a very high value indicating that institutional management is nearly sufficient on its own to predict MV. The addition of F2 increased the R^2 to 0.986 ($\Delta R^2 = 0.004$, $p = 0.001$), a small but significant contribution, as it reduces the prediction error from 0.204 to 0.178 points. Finally, F3 raised the R^2 to 0.988 ($\Delta R^2 = 0.002$, $p = 0.010$), with a final standard error of 0.171 points.

The near equality between R^2 and Adjusted R^2 (0.987-0.988) confirms the absence of overfitting, meaning the predictors add a genuine, non-artificial explanation. The final standard error of estimate represents only $\pm 2.4\%$ of the scale's range (7 points), allowing for 95% confidence intervals, exceeding the social-science average, where errors of 10% to 15% are quite common.

4.4. Analysis of variance (ANOVA) and overall model significance

Table (12) decomposes the total variance in MV (108.859) into variance explained by the model (107.543; 98.8%) and residual variance (1.316; 1.2%).

The F statistic = 1224.179 ($df = 3, 45$; $p < 0.001$) represents the ratio between the Mean Square Regression ($MSR = 35.848$) and the Mean Square Error ($MSE = 0.029$), indicating that the variance explained by the three factors is 1,224 times greater than the unexplained variance.

TABLE (12)

REGRESSION MODEL ANOVA

Source	Sum of Squares	df	Mean Square	Statistic F	p -value
Regression	107.543	3	35.848	1224.179	0.000
Residual	1.316	45	0.029		
Total	108.859	48			

Note. Source: own elaboration based on the analysis performed in Excel.

The value of F , extremely high, exceeds the strictest critical threshold by a factor of 169 ($F(3,45) = 7.23$ for $\alpha = 0.001$), showing that the probability of obtaining these results under the null hypothesis ($\beta_1 = \beta_2 = \beta_3 = 0$) is practically zero. The significance of $p = 0.000$ (< 0.001) makes it possible to categorically reject the null hypothesis and conclude that the full model significantly predicts MV consolidation in Latin American universities.

4.5. Regression coefficients and hypothesis testing

The resulting regression equation is: $MV = 0.034 + 0.645(F1) + 0.273(F2) + 0.120(F3)$. The unstandardized coefficients (B) indicate the change in MV for each one-unit increase in the predictor, holding the others constant. The standardized coefficients (Beta) make it possible to compare the relative importance of the predictors in standard deviation units, revealing the hierarchy of factors: $\beta_1 = 0.640 > \beta_2 = 0.264 > \beta_3 = 0.107$.

TABLE (13)

REGRESSION COEFFICIENTS

Variable	B	$SE(B)$	Beta	t	p	VIF
Constant (MV)	0.034	0.053	-	0.647	0.521	-
F1 - Institutional Management	0.645	0.106	0.640	6.071	0.000	34.462
F2 - Infrastructure	0.273	0.109	0.264	2.507	0.016	34.238
F3 - Regulatory Framework	0.120	0.045	0.107	2.673	0.010	9.143

Note. Source: own elaboration based on the analysis performed in Excel.

Table (13) shows that factor F1 presents the highest standardized coefficient ($\beta = 0.640$), far higher than F2 ($\beta = 0.264$, difference = 0.376, $Z = 3.26$, $p = 0.001$) and F3 ($\beta = 0.107$, difference = 0.533, $Z = 4.88$, $p < 0.001$). This indicates that for each standard deviation increase in institutional management, virtual mobility (MV) increases by 0.640 standard deviations, controlling for F2 and F3. This suggests that improving institutional management by one level increases MV by 0.645 points, equivalent to a significant advance in consolidation.

Factor F2 has a moderate effect ($\beta = 0.264$, $p = 0.016$), contributing approximately 2.4 times less than F1. Its unstandardized coefficient ($B = 0.273$) indicates that each point of technological improvement adds 0.273 points to MV. Factor F3 shows the smallest effect ($\beta = 0.107$, $p = 0.010$), being 6 times less influential than F1, although still statistically significant.

The variance inflation factors (VIF) reveal severe multicollinearity: $VIF_1 = 34.462$ and $VIF_2 = 34.238$ (critical threshold $VIF > 10$), indicating that 97.1% of the variance in F1 and F2 is predictable from the other factors. F3 shows a VIF of 9.143, just below the threshold, but equally problematic. Although the multicollinearity values detected are high ($VIF > 34$), they should not necessarily be interpreted as a measurement error or instrument redundancy. On the contrary, from an institutional sociological perspective, this phenomenon suggests institutional isomorphism (DiMaggio & Powell, 1983). Within the context of the PILA program universities, management (F1), infrastructure (F2), and regulation (F3) have evolved symbiotically, converging with one another as an adaptive response to the regional internationalization standards. Thus, the high correlation reflects that, in the context of Latin America, virtual mobility does not depend on isolated efforts but on a systemic block in which institutional capacities operate as an indivisible unit.

These results support the acceptance of Hypothesis 2 (H2) since the factors have significantly different influences on virtual mobility. Likewise, these data support the acceptance of Hypothesis 3 (H3), since factor F1 exerts the greatest influence ($\beta = 0.640$, $t = 6.071$, $p < 0.001$), explaining 98.2% of the variance in MV on its own. The empirical hierarchy confirms that F1 is the primary enabling factor upon which the other institutional capacities are built.

4.6. Structural equation modeling (SEM)

A structural equation model (SEM) was built to validate causal relationships among the three institutional factors and virtual mobility, acknowledging the covariances between predictors that multiple regression treats as problematic. The specified model included three direct structural relationships ($F1 \rightarrow MV$, $F2 \rightarrow MV$, $F3 \rightarrow MV$) and three covariances among exogenous factors ($F1 \leftrightarrow F2$, $F1 \leftrightarrow F3$, $F2 \leftrightarrow F3$), estimated using maximum likelihood.

4.6.1. Goodness-of-fit

In SEM, goodness of fit assesses the model's ability to reproduce the relationships observed in the data. Unlike multiple regression, SEM requires more rigorous validation because it specifies not only predictive relationships but also the structure of covariances among variables. The question addressed by goodness of fit is: is our theoretical model ($F1, F2, F3 \rightarrow MV$, with covariances

among $F1 \leftrightarrow F2 \leftrightarrow F3$) a valid and parsimonious representation of the reality observed across the 49 universities?

Table (14) shows that the fit indices demonstrate that the theoretical model correctly fits the observed data. The χ^2 statistic = 2.847 and $p = 0.241$ does not reject the null hypothesis of perfect fit, indicating that the discrepancies between the observed and modeled covariance matrices are attributable to chance. The χ^2/df ratio = 1.424 is optimal (criterion < 3.0), suggesting that the model is parsimonious without unnecessary complexity.

TABLE (14)

SEM MODEL FIT INDICES

Index	Value	Criterion	Interpretation
χ^2 (chi-square)	2.847	$p > 0.05$	Excellent
Value p	0.241	> 0.05	Acceptable fit
χ^2/df (normed chi-square)	1.424	< 3.0	Excellent
CFI (Comparative Fit Index)	0.999	> 0.95	Excellent
TLI (Tucker-Lewis Index)	0.998	> 0.95	Excellent
RMSEA (Root Mean Square Error of Approximation)	0.094	< 0.10	Acceptable
SRMR (Standardized Root Mean Square Residual)	0.015	< 0.08	Excellent

Note. Source: own elaboration based on the analysis performed in Excel.

The incremental fit indices ($CFI = 0.999$, $TLI = 0.998$) far exceed the 0.95 threshold, indicating that the proposed model reproduces 99.9% of the observed covariation, better than a null model. The $RMSEA = 0.094$ is acceptable (< 0.10), although slightly above the ideal value (< 0.08), reflecting the complexity of modeling strong relationships with a moderate sample ($n = 49$). The $SRMR = 0.015$ is excellent (< 0.08), confirming minimal discrepancies between matrices.

4.6.2. Structural coefficients and direct effects

The standardized coefficients confirm the regression results but allow direct and indirect effects to be examined simultaneously (see Table 15). $F1 \rightarrow MV$ shows the highest coefficient ($\beta = 0.645$, C.R. = 6.071, $p < 0.001$), uniquely explaining 41.6% of the variance. $F2 \rightarrow MV$ shows a moderate effect ($\beta = 0.273$, $p = 0.012$), contributing an additional 7.4%. $F3 \rightarrow MV$ has the smallest direct effect ($\beta = 0.120$, $p = 0.008$), adding 1.4% of variance. The model jointly explains $R^2 = 0.988$ of the variances in virtual mobility.

TABLE (15)

STRUCTURAL COEFFICIENTS AND EFFECTS

Relationship	β Direct	SE	p	β Indirect	β Total	R ² Partial
F1 → MV	0.645	0.106	0.000	0.346	0.991	0.416
F2 → MV	0.273	0.109	0.012	0.716	0.989	0.074
F3 → MV	0.120	0.045	0.008	0.844	0.964	0.014
Total						0.988

Note. Source: own elaboration based on the analysis performed in Excel.

The covariances among factors are extremely high: $F1 \leftrightarrow F2 = 0.990$ ($p < 0.001$), $F1 \leftrightarrow F3 = 0.962$ ($p < 0.001$), $F2 \leftrightarrow F3 = 0.967$ ($p < 0.001$), confirming the interdependence structure observed in the correlations. These associations are not causal effects but rather an acknowledgment that the factors develop jointly through processes of institutional isomorphism.

The analysis of indirect effects reveals critical patterns for understanding how the institutional factors operate. F1 exerts 65.1% of its total effect directly ($0.645/0.991 = 0.651$) and 34.9% indirectly through its covariances with F2 and F3. By contrast, F2 exerts only 27.6% of its effect directly ($0.273/0.989 = 0.276$), operating 72.4% indirectly through its relationship with F1. F3 shows the most extreme pattern: only 12.4% direct effect ($0.120/0.964 = 0.124$) and 87.6% indirect, functioning mainly as a complement to F1 and F2.

This structure reveals a hierarchical model of internationalization in which F1 (management) acts as the primary enabling factor whose influence is mostly direct, while F2 (infrastructure) is an intermediate factor that partly depends on F1, and F3 (regulatory framework) is a derived factor whose effect operates almost entirely through the other two. The SEM model thus provides evidence for the three hypotheses: it confirms that the factors are significantly interrelated (covariances $p < 0.001$, H1), that they have different influences on MV (distinct direct effects, H2), and that F1 exerts the greatest influence both directly and in total (H3). The model's ability to decompose direct and indirect effects offers a deeper understanding of how institutional management conditions and mediates the impact of infrastructure and regulation on the consolidation of virtual mobility.

5. Concluding discussion

This study provides empirical evidence on the institutional determinants of virtual mobility in Latin American universities, validating Knight's (2004, 2021) systemic model of internationalization. The statistical analyses converge on three findings that confirm the proposed hypotheses. First, the three institutional factors, management and organizational structure

(F1), technological infrastructure (F2), and regulatory framework (F3), show high relationships ($r > 0.96$, $p < 0.001$) and exceptional internal consistency ($\alpha = 0.976$), demonstrating that they evolve holistically rather than as independent elements. Second, these factors exert very different influences on the consolidation of virtual mobility, revealing an empirical hierarchy among them. Third, the institutional management factor stands out as the dominant factor, explaining 98.2% of the variance in virtual mobility on its own, surpassing the contribution of the infrastructure factor ($\Delta R^2 = 0.4\%$) and the regulatory ($\Delta R^2 = 0.2\%$).

The structural equation model confirms the proposed causal structure and reveals mediation patterns in which F1 operates as the primary enabler with a mostly direct effect (65.1%), while F2 and F3 function as complementary factors whose effects operate substantially through their interdependence with institutional management (72.4% and 87.6% indirect effects, respectively). This hierarchical structure contradicts deterministic assumptions in education policy and reinforces Wissema's (2009) model of organizational relationships regarding third-generation universities, in which administrative capabilities and institutional policies constitute the foundations for technological and regulatory innovations.

Likewise, the results have strong implications for Knight's (2004, 2021) internationalization assumptions. The high multicollinearity observed, far from representing a methodological problem, implies that processes of co-evolution and institutional isomorphism (Hwang, 2023) are characteristic of university development in the region, meaning that Latin American higher education institutions do not develop the three factors sequentially but simultaneously, in response to the pressure of global models from other regions (Brandenburg & de Wit, 2011). This trend suggests that Latin American institutions continue to face structural obstacles that prevent each factor from strengthening in isolation, since, without solid management structures, technological investments fail to reach efficiency, and without that level of performance, there is no opportunity for regulatory frameworks to be modified, adapted, and to evolve. Likewise, this study contributes an empirically validated model that responds to the gap identified by García and Bonatti (2024), grounded in the models of Hudzik (2011) and Rogers et al. (2019). By demonstrating that measurable institutional factors explain 98.8% of virtual mobility consolidation, it offers an evidence-based path to democratizing international educational experiences in the region.

The $R^2 = 0.988$ obtained is very high for the social sciences, where values above 0.40 are considered substantial (Cohen, 2013). This explanatory capacity suggests that the model captures the virtual mobility phenomenon almost

completely, leaving little room (1.2%) for additional variables. This validates the theoretical sufficiency of Knight's framework and suggests that future research should focus less on identifying new factors and more on understanding the mechanisms of integrated institutional development. The massive indirect effects of F2 and F3 support organizational neo-institutionalism: regulations and technologies do not directly impact institutional performance but must first be implemented through effective management structures (UNESCO-IESALC, 2023).

For the field of international education, these findings have implications that transcend the Latin American context. First, the results empirically demonstrate why virtual mobility matters as an area of study: it is not a reduced or compensatory version of in-person mobility, but rather an internationalization modality with its own institutional conditions and documented democratizing potential (Beelen & Jones, 2015; O'Dowd, 2021). It is imperative, however, to recognize that implementing a CHIL (Collaborative Hybrid International Learning) model carries critiques and tensions. The literature identifies unintended consequences that can perpetuate asymmetric power dynamics in the absence of deep reflective practice on the part of those involved (Crabtree, 2013). In crisis contexts, authors such as Bryan et al. (2022) suggest that risk management must shift from a purely transactional approach to a relational and decolonial one, in which decisions are made horizontally with Global South partners to ensure equity and social justice (Opazo et al., 2015).

Second, the study responds to a gap repeatedly noted in the literature: the absence of quantitative models explaining which institutional conditions favor virtual internationalization programs in contexts of high diversity and structural inequality (de Wit & Altbach, 2021; Gacel-Ávila et al., 2023). Third, the finding that institutional management ($\beta = 0.640$) explains substantially more variance than technological infrastructure ($\beta = 0.264$) provides direct evidence for debates on which investments generate the greatest impact in expanding virtual mobility, challenging the dominant assumption that prioritizes technological investment as the primary lever of change in the region's internationalization policies. These results are directly useful for those responsible for student mobility programs, managers of internationalization offices, and organizations that fund international academic collaboration initiatives in Latin America.

For those responsible for institutional policy, these findings suggest that universities at emerging levels should prioritize establishing internationalization offices with qualified staff and key functions before investing in technology or signing agreements involving the transfer of virtual

mobility credits. As Moctezuma Hernández and Navarro Cerda (2011) note, institutional learning requires organizational structures that facilitate cross-cutting coordination. Similarly, universities at a medium level of consolidation should strengthen the coordination between management and technological infrastructure through digital competencies (Cordero Guzmán & Ramón Poma, 2021).

For regional or national public policymakers, the results suggest creating incentives that span from infrastructure to comprehensive strengthening, since this analysis reveals that developing management capacities ($\beta = 0.640$) generates a greater impact than investing solely in technology ($\beta = 0.264$), the dominant approach in Latin America according to García and Bonatti (2024).

This study also has limitations. The cross-sectional design precludes definitive inferences, and the sample of 49 universities limits generalizations; furthermore, other variables such as regional leadership or organizational culture, which could explain part of the remaining variance, were not included. Future research could employ multilevel designs, regional comparative analyses, and post-pandemic studies (Woicolesco et al., 2021).

In terms of a future research agenda, the findings open at least five research opportunities. First, longitudinal studies for examining whether the simultaneous evolution of the three factors is stable over time or whether a more efficient development sequence exists for different institutional contexts. Second, replication of the analysis in subregions (the Caribbean, Central America) and in more homogeneous university systems, to assess the model's replicability. Third, the application of confirmatory factor analysis (CFA) and the calculation of average variance extracted (AVE), to establish more rigorously whether the three factors constitute theoretically distinguishable dimensions of a higher-order construct, given that the extremely high correlations observed ($r > 0.96$) raise legitimate questions about discriminant validity between constructs (Kline, 2023). Fourth, the incorporation of individual-level variables, such as institutional leadership, organizational culture, or pedagogical innovation, which could help explain the residual variance not accounted for by the model. Finally, research on the impact of emerging virtual mobility modalities that are redefining the possibilities of international experience and require new analyses for their understanding.

In terms of institutional policy, these findings shift the focus from technical investment to strategic investment. For decision-makers in Latin America, the evidence is conclusive: technological infrastructure and regulatory frameworks, although necessary, remain inert without robust organizational management to drive them. In the short term, a university

seeking internationalization should not prioritize solely the acquisition of licenses or digital connections, but rather the strengthening of its management teams and the agility of its administrative structures. In a resource-constrained environment, investing in management capacity (F1) is not merely an option but an efficient way to close the region's mobility gap and foster connectivity for academic integration.

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Ethical approval

This study relied exclusively on publicly accessible documentary information (institutional websites, reports, and regulatory documents), without direct intervention with individuals or the collection of personal or sensitive data and therefore did not require review by an institutional ethics committee.

Conflict of interest statement

The authors declare that they have no conflict of interest regarding the research, authorship, and/or publication of this article.

Data availability statement

The documentary database built from the assessment of the 49 universities in the PILA program, as well as the resulting statistical analyses, may be requested directly from the corresponding author within three years of the study's publication.

CRedit author statement

Rangel-Ramírez: conceptualization, methodological design, quantitative analysis, original draft writing. **Ramírez-Valdivia:** validation, statistical supervision, writing, review, and editing.

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Author biography

Héctor-Gabriel Rangel-Ramírez, Ph.D., full-time researcher at the Institute for Research and Advanced Studies in Economics and Social Sciences (IISES) at Universidad Veracruzana, Mexico. Holds a master's degree in economics and business and a Ph.D. in Education. His research focuses on higher education internationalization, education policy, and education for global citizenship. He is a member of Mexico's National System of Researchers (SNII), under the Ministry of Science, Humanities, Technology, and Innovation (SECIHTI).

Martha Ramírez-Valdivia, Ph.D., Associate Professor at Universidad de La Frontera, is a specialist in Quality Management Systems in higher education, manufacturing, and health. She holds an Industrial Engineering degree from UNI (Nicaragua), an M.Sc. from Missouri-Columbia (USA), and a Ph.D. in Engineering Sciences from PUC-Chile. She has led research, publications, consulting projects, and initiatives in Chile, the USA, and Nicaragua. She is a former Regional Vice President of IISE and a board member of the Melton Foundation.