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A Holistic Maturity Model for Quality Assessment and Innovation in Peruvian Universities

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Abstract: This study proposes a holistic maturity model to evaluate and optimize the performance of Peruvian universities. It addresses key dimensions such as favorable governance, university talent (including students, faculty, and administrators), substantial resources, and results. It is based on the Design Science Research methodology and the Mettler framework. On the other hand, the Delphi method was selected for its ability to consolidate expert opinion. Aiken's V coefficient was used to determine content validity, evaluating criteria such as clarity, relevance, and coherence, to ensure the reliability of the instrument. This model defines concrete practices for each maturity level, facilitating the progressive implementation of improvements in different university contexts. It contributes to Education 4.0 through the IT strategic alignment practices of the enabling governance dimension, promoting the implementation of personalized teaching methods and hybrid learning models. Regarding the Society 5.0 approach, the model prioritizes social impact and environmental sustainability through university social responsibility, ensuring that universities contribute to human and technological development. Finally, this proposal will support decision making in university management and educational policies in Peru and in international contexts.

Keywords: holistic maturity model; higher education; Peruvian universities; educational improvement; maturity instrument

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1. Introduction

The study of maturity models is not a recent phenomenon. It commenced in 1986 with Humphrey's introduction of Crosby's ideas on maturity quantification in software engineering (Chrissis et al., 2011). In a globalized world that demands adaptability and continuous improvement (Kuhn, 2000), these models have emerged in various industries as essential tools to assess and improve the current state of processes, objects or people, with the goal of achieving and enhancing organizational capabilities and ensuring continuous improvement (Adekunle et al., 2022; Ferraro et al., 2023). Its way of measuring maturity is through levels (Vasylieva et al., 2023). Each level is shown sequentially and progressively; moving to the next level is only possible if the requirements of the current level are met (Latif et al., 2021). Maturity models facilitate the continuous assessment and enhancement of educational quality at universities through the implementation of standardized practices and ongoing assessment (Carvalho et al., 2020; Pereira et al., 2023; Tocto-Cano et al., 2020), support decision making (Pazur Anicic & Divjak, 2020), and improve educational quality, through the implementation of standardized practices and continuous assessment

(Espinoza-Guzmán & Zermeño, 2017). Therefore, they have become valuable tools for assessing and continuously improving university processes, as they provide a systematic way to identify gaps and improve organizational practices (Carvalho et al., 2020).

The main challenge facing Latin American universities lies in their ability to remain as leading institutions in the advancement of science and technology. In addition, in the short term, these institutions must focus on training researchers and conducting high-level research (Bringas et al., 2015). According to Torres-Samuel et al. (2018), public universities in Latin America are aware of the importance of making changes and adapting to global trends in higher education, which demand greater efficiency and quality in the services provided. In the Peruvian context, universities are required to adapt to new global perspectives and societal demands, as well as to implement a comprehensive governance system capable of transforming bureaucratic institutions into competitive organizations (Carrasco et al., 2015; Chiyón et al., 2012). It is, therefore, imperative that universities adopt a holistic maturity model in order to address the inherent complexity and specific challenges they face in terms of governance, educational quality, and responsiveness to social and technological demands. Despite advances in the application of maturity models in various sectors, there are significant gaps in the literature on models that comprehensively cover all the critical dimensions of universities, especially in Latin American contexts, where cultural, economic, and political particularities strongly influence the performance and strategies of educational institutions (Ferradaz et al., 2020). The critical dimensions are the actions that guide university activity, such as governance, institutional autonomy, talent management, IT strategic alignment, culture of excellence (De Boer & Denters, 1999; Ozdem, 2011), academic quality, research and knowledge production, social responsibility, sustainability, and internationalization. Evaluating these dimensions highlights the urgent need for a holistic maturity model for Peruvian universities.

The analysis of the reality of the 96 licensed universities (Licensed universities, https://www.sunedu.gob.pe/lista-de-universidades-licenciadas/, accessed on 1 December 2024) and more than 100 accredited study programs (Accredited study programs, https://app.sineace.gob.pe/Reportes/Acreditacion.aspx, accessed on 1 December 2024) shows us that quality assurance policies and licensing and accreditation models are, to a large extent, disjointed in terms of results and impacts. This situation leads us to question how to measure the maturity of universities holistically. In the Peruvian context, a maturity model is needed, since the country's sociocultural and regional diversity forces universities to adapt to disparities, especially in the highlands and jungle areas, to ensure an inclusive education (Martín-Cuadrado et al., 2021). Moreover, it is crucial to reinforce governance and research policies to enhance the quality of education (Millones-Gómez et al., 2021). Technological challenges, accentuated by the pandemic, demand digital skills and better technological resources (Martín-Cuadrado et al., 2021; Velásquez & Lara, 2021). Although international models can improve competitiveness, they must be adjusted to the Peruvian context (Chiyón et al., 2012).

Therefore, the main objective of this study was to design a Maturity Model for Peruvian Universities (MMU-PE). This model is structured around five levels, four key dimensions, fourteen components, and thirty-nine critical variables, as well as specific maturity practices, which together allow for an in-depth and contextualized assessment of university performance. The methodology for developing the maturity model is based on the Design Science Research (DSR) guidelines, covering up to the third phase (design model). In this phase, the maturity model was designed and the maturity assessment instrument was validated using the Delphi method and Aiken's V coefficient.

2. Theoretical Foundations

The theoretical foundations of this research address the basic principles of a maturity model. University governance involves relationships between institutions and the state, addressing policies, structures, and stakeholder influence (Shin & Jones, 2022). A clear strategic vision and detailed plans are essential to align institutional goals and guide strategic planning (Girotto et al., 2015; Ozdem, 2011). Risk management and organizational culture strengthen universities control and ability to adapt to changing environments (Useche & Pedroza, 2021; Zambrano et al., 2024). Strategic IT alignment ensures that technology investments support institutional goals, enhancing organizational performance (Dent, 2015; Kalumbilo & Finkelstein, 2014; Wilmore, 2014). Academic leadership is crucial for managing educational change and influencing organizational practices (Nica, 2013). The regulatory framework affects autonomy, management, and transparency, allowing universities to operate independently and foster innovation (De Boer & Denters, 1999; Rymarzak et al., 2020). Finally, a culture of excellence based on shared values, innovation, and continuous improvement drives the achievement of high standards and sustainable results (Devaraju et al., 2021; Shukla, 2023; Wiśniewska & Grudowski, 2024).

Universities are hubs of talent convergence and key players in technological innovation and knowledge (Cai, 2022). University talent management includes strategies to recruit, train, and select students, ensuring their comprehensive development through co-curricular activities, mentoring, and mental health support (de Prada Creo et al., 2021; Ratliff et al., 2023). Also, fostering interdisciplinary collaboration and research networks improves the quality and impact of research by linking teaching with research activities from early stages (de Miranda Grochocki & Cabello, 2023). Impact assessment should take into account social relevance, scientific quality, and tangible changes in society (Kueffer et al., 2012). On the other hand, internationalization strengthens university reputation through inclusive strategic policies, attraction of international talent, and presence in global rankings, which enriches learning and fosters global approaches in teaching and research (Cunningham et al., 2024).

In terms of technology management, these have a significant impact on the quality of academic and administrative processes (Rico-Bautista et al., 2021). The integration of physical and digital infrastructures is transforming education. This change creates a holistic and adaptive academic environment (Khawaja, 2022; Omodan, 2024). In addition, the availability and appropriate location of equipment and facilities are essential. They ensure the smooth functioning of academic services (Riyanto et al., 2021). With respect to the diversification of revenue sources, this is of paramount importance for the long-term financial sustainability of universities. The implementation of strategies such as collaboration with industry and innovation in funding is fundamental to the attainment of this objective (C. Silva et al., 2021). Furthermore, it is essential to manage liquidity in order to maintain financial viability in uncertain environments (Irvine & Ryan, 2019). In terms of psychological support models, the importance of offering systematic assistance stands out. This support is essential to address mental health issues in students and faculty (Gridneva et al., 2022).

With regard to graduate follow-up and university social responsibility, these elements contribute to the governance cycle. Both contribute to enhancing the quality of education and social impact of institutions. Graduate follow-up assesses the efficacy of academic programs. Furthermore, it facilitates the adaptation of educational offerings to the demands of the labor market, thereby reinforcing institutional reputation (Ebzeeva & Dugalich, 2023). University social responsibility initiatives include environmental management and community outreach. These actions reinforce the social mission of universities (Chen & Vanclay, 2021; Saraswati et al., 2023).

Maturity and excellence models differ in their focus and purpose. While maturity models assess specific processes or organizational areas, allowing you to measure departmental or process progress, excellence models drive overall performance by aligning strategic and operational decisions to maximize efficiency and effectiveness. A prime example is the EFQM model, which takes an integrated approach to quality management and encompasses results, customer focus, information management, and employee satisfaction (Gabriela-Livia, 2021). Although this model is classified as excellence, it can also be applied to assess organizational maturity (European Foundation for Quality Management, 2021; Portman, 2022).

3. Related Works

The existing literature presents several maturity models designed to assess and improve processes in higher education institutions, tailored to specific contexts and objectives. These models employ mixed methodologies, including literature reviews, interviews, case studies, and scientific design approaches (Anthony & Antony, 2020; Pazur Anicic & Divjak, 2020; Pereira et al., 2023; Rizun & Pankowska, 2022). These include the Lean Six Sigma (LSS) model, the learning analytics model, and the Balanced Scorecard-based educational management model, evaluated through experts and official documents (Barra et al., 2021; Freitas et al., 2020). Specific models have also been developed, such as the MM-ICLS, focused on integrated career and learning services, and the HE-BIA, which measures the ability to implement Business Intelligence systems in universities (Cardoso & Su, 2022; Luke & Bartlett, 2024). However, most of these models do not consider the particularities of Peruvian universities, such as resource limitations or governance structures, which highlights the need for a contextualized model (Souza et al., 2022; Tocto-Cano et al., 2020).

4. Methodological Proposal of the Maturity Design for Universities

The methodology for designing the maturity model is proposed based on the guidelines of The Design Science Research (DSR) (Hevner et al., 2004) and Mettler's methodology (Mettler, 2010). DSR was chosen because of its focus on generating knowledge through innovative solutions to meaningful problems, structured in models, methods, constructs, and instances, which is ideal for addressing the complexity of designing a maturity model. Mettler's methodology was selected for its ability to provide a structured and practical framework for the development of maturity models, which integrates criteria adaptable to specific contexts, such as Peruvian universities. Figure 1 shows the research design. The research extends to the third stage of Mettler's methodology, the design stage of the maturity model. At this stage of development, the Delphi method and Aiken's V coefficient for content vidity were adopted.

4.1. Design of the Maturity Model Step by Step

4.1.1. Identifying the Need and Opportunity

In Peru, the "National Policy for Higher and Technical-Productive Education" (MINEDU, 2020) was implemented in 2020 as a measure to address the public problem of a population with insufficient competences to exercise their profession and to carry out research and innovation. One of the identified causes of this problem is the "weak articulation of control, promotion, and quality assurance". In other words, progress is limited in terms of licensing and accreditation processes (Moreno & De los Santos, 2024). While it is true that in Peru, the state has the National Superintendence of University Higher Education (SUNEDU) to supervise and control quality through the licensing process, as well as the Ministry of Education (MINEDU) to promote it and the National System of Evaluation, Accreditation and Certification of Educational Quality (SINEACE) to guarantee

it through accreditation, it is important that these bodies work in a coordinated manner so as not to overlap and hinder the control, promotion, and guarantee of university quality. The MMU-PER is novel and necessary as a method and tool that integrates quality control and quality assurance. It assesses both overall performance and progress in improving the efficiency and effectiveness of universities. Furthermore, it can be considered an emerging and innovative phenomenon due to the lack of evidence in the scientific literature of holistic maturity models in the context of Peruvian universities. It also implies an approach to models of excellence, such as the European Model of Excellence EFQM.

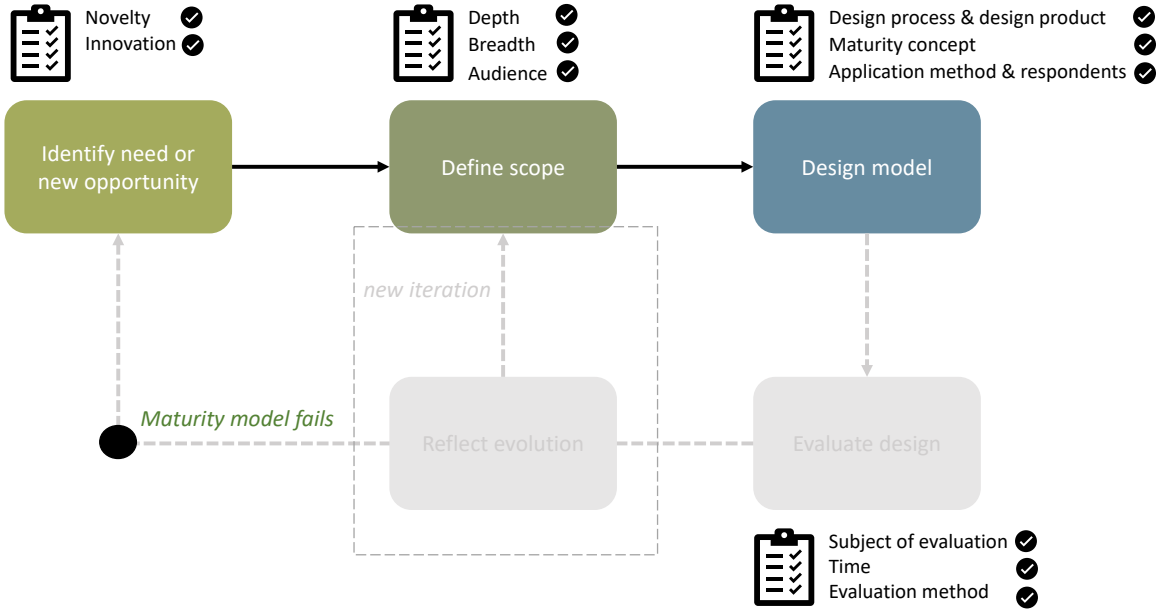

Figure 1. Methodology for the design of the university maturity model.

4.1.2. Define Scope

The MMU-PER encompasses a holistic assessment of the maturity of Peruvian universities, both internally and in comparison with other universities. This assessment is characterized by its organizational and inter-organizational approach, as it involves the evaluation of one university in relation to others. The target audience of the model is university managers, since they are the ones who have the capacity to make decisions, and its approach covers both management and technology.

4.1.3. Model Design

The authors take into consideration the recommendation of Mettler (Mettler, 2010), which distinguishes three concepts of maturity: process-oriented, object-oriented, and people-oriented. The MMU-PER is distinguished by being a model that integrates the three concepts of maturity. The process-oriented approach has as its main objective to improve the overall efficiency of universities. On the other hand, the object-oriented approach seeks to achieve a predefined level of maturity in universities. Finally, the people-oriented approach aims to strengthen soft skills in the university environment. The objective of measuring maturity encompasses several influencing factors (multidimensional), being able to measure the global maturity of the university as well as the maturity of its areas. The MMU-PER is structured on the basis of four main types of elements, called: Dimensions (Ds), Components (Cs), Critical Variables (CVs), and Maturity Practices (MPs), which together will allow universities to determine their level of maturity. The Ds are composed of Cs and these in turn of CVs. A group of MPs form the CVs; that is, they are related through a hierarchical structure, as shown in (Figure 2). In total, 4 Ds, 14 Cs, 39 CVs, and

324 MPs have been defined. For each MP, there is an incremental measurement scale based on a rating from 1 to 5; this scale forms the Maturity Level (ML) and is associated with the structure in Table 1.

Table 1. Description of the MMU-PE maturity levels.

Maturity Level	Description
1. Emerging	At this level, universities are reactive and lack formal processes. Decisions rely heavily on personal initiative and activities are flexible to meet immediate needs, but without a clear focus on continuous improvement. The lack of formal structure can lead to inconsistent responses to challenges.
2. Formalized	At this level, universities begin to establish basic structures to formalize core processes. Policies and procedures are implemented to bring coherence to institutional activities, while maintaining a degree of flexibility for academic autonomy. While innovation and individual initiative are still valued, they are now supported by a more defined framework that ensures repeatability and operational stability.
3. Collaborative	At this level, universities strike a balance between process formalization and flexibility. Departments and academic units collaborate, share best practices, and work on common projects, without losing their operational independence. Decision making is inclusive and collaboration becomes a pillar for organizational innovation and improvement.
4. Cohesive	This level is characterized by a highly effective alignment of processes with the university's strategic objectives. There is synergistic integration among the different units, allowing for smooth and effective collaboration. The university acts as a unified system, with clearly defined strategies and goals shared by all participants, which promotes a cohesive and results-oriented environment.
5. Adaptive	At the highest level of maturity, the university has not only achieved total cohesion in its processes, but is also able to adapt quickly to changes in the academic, social, and professional environment. It is characterized by a culture of continuous improvement, innovation, and strategic flexibility. This university not only responds efficiently to current challenges, but also anticipates and leads change in its sector, always maintaining its autonomy and adaptability.

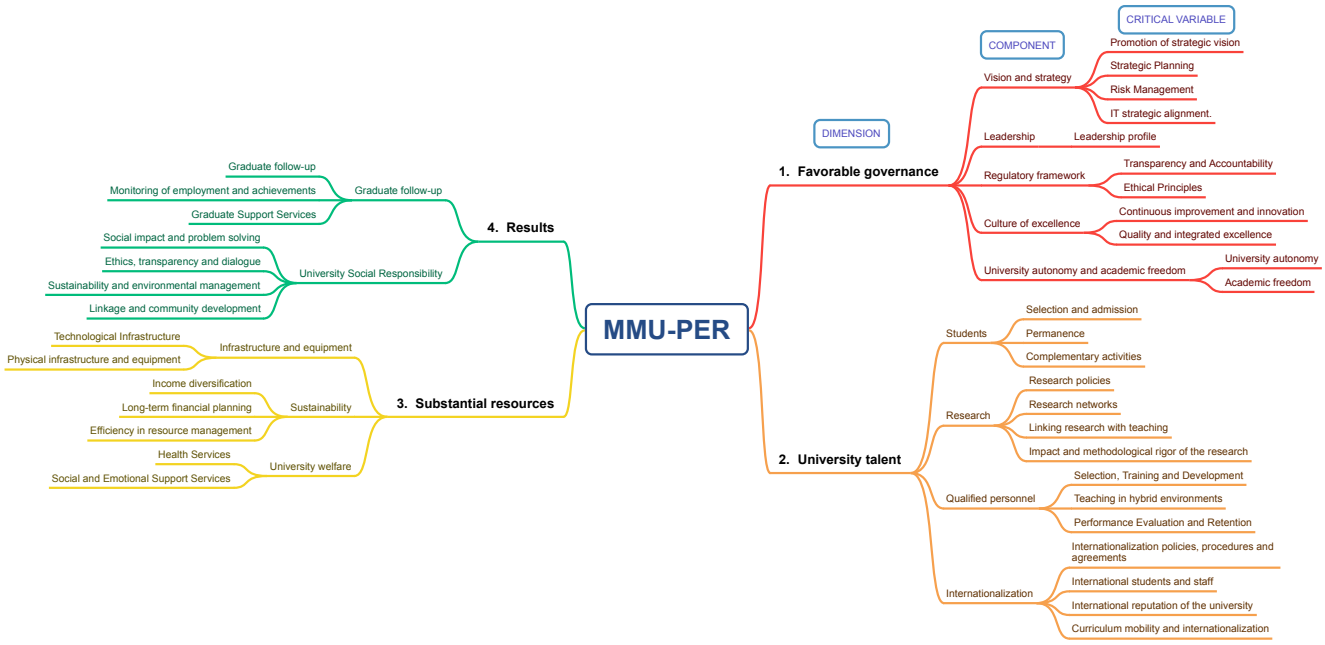

Figure 2. Structure of the MMU-PE.

The following elements were considered for the definition and validation of the MMU-PE. Maturity levels: the literature review method and the researchers' prior knowledge of university education were used. Dimensions: The dimensions "Favorable governance", "University talent", and "Substantial resources" were evaluated using the literature review method, especially following the recommendations of Jamil Salmi (Salmi, 2009). It is a benchmark in the study of world-class universities, since it analyzes the rankings and characteristics of these universities with the collaboration of the World Bank. The "Results" dimension was developed based on institutional accreditation models such as SINEACE-Peru and CNA-Chile. Components and critical variables: the literature review method, Jamil Salmi's publication (Salmi, 2009), and institutional accreditation models such as SINEACE-Peru and CNA-Chile were used, using an alignment matrix between these methods. Maturity practices: these were defined based on the analysis and contextualization of institutional regulations and the literature review method (Table 2). These maturity practices gave rise to the creation of an instrument designed to measure the maturity of Peruvian universities. It should be noted that the maturity practices are the result of an in-depth analysis of the different models of licensing and accreditation of study and institutional programs, which guarantees university quality through levels of maturity in the implementation of Peru's national policies.

Table 2. Preparation of maturity practices of universities.

ML	Maturity Practices
1	Based on the Institutional License model for universities—SUNEDU.
2	Based on the Institutional Relicensing Model—SUNEDU.
3	Based on the Institutional Accreditation Model—SINEACE.
4	Based on the Accreditation Model for Study Programs—SINEACE.
5	Prepared on the basis of an exhaustive bibliographic review and taking into account the experience of experts in University Higher Education.

Maturity Calculation

The Maturity Level (ML) is a property of each CV; it is a measure of its status to sustain the development of the university. It is determined by measuring the ML of its CVs based on their MPs (an example is presented in Table 3). The ML achieved is the highest level at which all the MPs (including those of the previous levels) have been met. The MLs of each CV are then weighted according to the weights that each university would assign according to its reality (see Table 4), and the result of this weighting is the final ML of the C. That is, the ML of a C is the weighted sum of the MLs of its constituent CVs (see Equation (1)):

$$ML(C) = \sum_{i=1}^{n} ML(CV_i) \cdot P_i \quad (1)$$

where $P_i = [0,1] \,/\, P_i \in \mathbb{R} \wedge \sum P_i = 1$ is the weighted CV_i, n is the number of Critical Variables, and $ML(CV_i) \in \{1,2,\ldots,5\}$.

Table 3. Evaluation of the critical variable: fostering strategic vision (ML 2).

ML	Evaluation	Maturity Practice
1	Complies	The university has established clear and measurable institutional objectives.
2	Complies	The university has a well-defined organizational structure, supported by regulatory and management instruments.
	Complies	The authorities and members of the governing bodies guarantee compliance with the University Law and the development of their functions.
3	Non-compliant	The university implements an educational model that adjusts to its strategic plan, context, scientific-technological advances, and social and labor market demand.
4	Non-compliant	The purposes of all curricula are clearly defined, aligned with the institutional mission and vision, and have been constructed in a participatory manner.
5	Non-compliant	The university conducts periodic evaluations of its curricula and the fulfillment of its strategic objectives.
	Non-compliant	The university implements improvement actions based on assessment results, ensuring adaptation to emerging needs and trends in higher education and the work environment.

Table 4 shows the weights for the CVs of the Cs of the D "Favorable Governance".

An example of a maturity calculation for the "Vision and strategy" component is shown below:

$$ML(C) = 2 \cdot 0.3 + 2 \cdot 0.4 + 1 \cdot 0.2 + 3 \cdot 0.1 = 1.9 \text{ rounded to } 2 \quad (2)$$

$$ML(D) = \frac{(2+3+4+2+3)}{4} = 3.5 \text{ rounded to } 4 \quad (3)$$

This means that the maturity level of the "Vision and strategy" component is 2 and that of the "Favorable governance" dimension is 4, in other words, this reflects a cohesive university.

Validation of the MMU-PE Instrument

According to (Supo & Zacarias, 2024), instrument design goes through a qualitative phase (content validity) and quantitative phases (construct validity, reliability, stability, criterion, and performance). In this research, the purpose of the researchers is to validate the instrument in the qualitative phase, that is, to perform content validity by means of expert judgment. For this purpose, the Delphi method and Aiken's V coefficient, tools recognized for their effectiveness in consolidating professional consensus, were used.

Table 4. Dimensions, components, and critical variables of the maturity model for universities.

Dimension	Components	Critical Variable			
Favorable governance ML 3	Vision and strategy ML 2	Fostering strategic vision ML 2	Strategic Planning ML 2	Risk Management ML 1	IT strategic alignment ML 3
		0.3	0.4	0.2	0.1
	Leadership ML 3	Leadership profile ML 3			
		1			
	Regulatory framework ML 4	Transparency and Accountability ML 3	Ethical Principles ML 4		
		0.4	0.6		
	Culture of excellence ML 2	Continuous Improvement and Innovation ML 2	Integrated quality and excellence ML 1		
		0.5	0.5		
	University autonomy and academic freedom ML 3	University Autonomy ML 4	Academic freedom ML 2		
		0.5	0.5		

- Delphi method

Delphi surveys are based on the idea that group responses are superior to individual responses (Sablatzky, 2022), and are used to reach agreement among a group of people with expertise in a particular area (Drumm et al., 2022). The instrument was designed using the Alchemer survey tool (Alchemer survey tool, http://s.alchemer.com/s3/Maturity-Model, accessed on 1 December 2024). The Delphi method was used to select a group of university quality specialists, composed of 39 external evaluators (Guidelines for Serving as an External Evaluator of Higher Education Institutions, https://busquedas.elperuano.pe/api/visor_html/2004469-1, accessed on 1 December 2024). The selection criteria were external evaluators of university quality, certified by SINEACE, and renowned international research professors. The participants were selected through a rigorous process that guaranteed their suitability as experts in the area of university quality. In the case of the Peruvian external evaluators, they were identified through the official registry of the SINEACE, which certifies their experience in teaching, research, evaluation, and educational management. The Chilean evaluators were selected on the basis of their academic and professional trajectory, based on their publications and projects in the area of engineering research at recognized universities. All participants met the requirements of having at least a master's degree, as well as proven experience in evaluation and educational quality. To ensure transparency, the Peruvian evaluators were shared the link of the instrument through a WhatsApp group called "Red de Evaluadores SINEACE", and with the Chilean evaluators the link of the instrument was sent to them also by WhatsApp. Thus, participants confirmed their willingness and voluntariness to participate in the study through an explicit consent sent by direct message to the WhatsApp group. The information was exported to an Excel file and subsequently processed. This procedure ensures the replicability of the selection in future research.

- Content validity

Validity involves demonstrating that the instrument measures what it purports to measure, including content validity, criterion validity, and construct validity (Vetter & Cubbin, 2019). Content validity refers to the process of assessing the validity of assessment items by analyzing their content, using expert judgment and the assessment items themselves (Suhaini et al., 2021). To assess the content validity of an instrument, Aiken's V coefficient (V) in relation to the Agreement Index (AI) and the Binomial Test (BP) is the most appropriate (Escurra Mayaute, 1988). Aiken's V coefficient uses dichotomous (0 or 1) or polytomous (more than 2 values) values (Escurra Mayaute, 1988). The values considered valid must be greater than 0.70 (Merino Soto & Livia Segovia, 2009). In our case, the formula for dichotomous responses was applied:

$$V = \frac{S}{n(c-1)} \tag{4}$$

where S is the sum of the weights assigned by the experts, n is the number of experts, and c is the number of values on the rating scale (in this case 2). The results were classified according to the critical variable and the number of experts. Formula (4) was used to calculate Aiken's V coefficient for each critical variable and the values were averaged to determine Aiken's V of the components and dimensions.

5. Results

The content validity analysis of the MMU-PER instrument, based on Aiken's V coefficient, was carried out for the critical variables of the five components of the Favorable Governance dimension. The evaluation was carried out through the judgment of five

experts, considering three main validity criteria: coherence, relevance, and clarity. The results obtained showed values highly valid, which reflects a high content validity. This is considered an acceptable indicator of validity.

Table 5 summarizes the values of Aiken's V coefficient for each component. The highest coefficient, 1.00, was observed in the Relevance criterion, achieved by all the components analyzed. In contrast, the lowest coefficient, 0.82, was observed in the Clarity criterion, specifically associated with the leadership component.

Aiken's V values for each maturity practice make up the critical variables, which in turn make up the components and dimensions. See https://github.com/etocto/MMU-PER/blob/1dabec6bee421e13f2a89327c79dc37c062d56dc/D_Gobierno%20Favorable.xlsx (accessed on 1 December 2024).

Table 5. Aiken's V coefficient of the components of the favorable governance dimension.

		Validity Criteria		
		Coherence	**Relevance**	**Clarity**
Component	Vision and Strategy	0.99	1.00	0.83
	Leadership	0.99	1.00	0.82
	Regulatory framework	0.99	1.00	0.96
	Culture of excellence	0.99	1.00	0.92
	University autonomy and academic freedom	0.96	1.00	0.86
Dimension	Favorable governance	0.99	1.00	0.88

In the second dimension, university talent, the results of the content validity analysis using Aiken's V coefficient show values highly valid. This analysis was carried out after the evaluation of six experts, who took into account the critical variables of the four components evaluated.

Table 6 presents Aiken's V coefficients for each component. The highest coefficient, 1.00, was reached in the Relevance criterion, and was achieved for all the components analyzed. On the other hand, the lowest coefficient, 0.86, was reached in the Clarity criterion, associated with the internalization component.

For the results of the components and critical variables of the university talent dimension, see https://github.com/etocto/MMU-PER/blob/1dabec6bee421e13f2a89327c79dc37c062d56dc/D_Talento%20Universitario.xlsx (accessed on 1 December 2024).

Table 6. Aiken's V coefficient of components of the university talent dimension.

		Validity Criteria		
		Coherence	**Relevance**	**Clarity**
Component	Students	0.96	1.00	0.92
	Investigation	0.99	1.00	0.92
	Qualified Personnel	0.97	1.00	0.88
	Internalization	0.99	1.00	0.86
Dimension	University Talent	0.98	1.00	0.90

In the third dimension, substantial resources, the results of the content validity analysis, measured by Aiken's V coefficient, show high values close to one. This analysis was carried out by five experts, who evaluated the critical variables of the three components of this dimension.

Table 7 shows the values of Aiken's V coefficient for each component evaluated. The highest coefficient, 1.00, was reached for the Coherence and Relevance criteria, and was

achieved for all the components evaluated. In contrast, the lowest coefficient, 0.88, is associated with the Clarity criterion and the Sustainability component.

For the results of the components and critical variables of the substantive resources dimension, see https://github.com/etocto/MMU-PER/blob/1dabec6bee421e13f2a89327c79dc37c062d56dc/D_Recursos%20Sustanciales.xlsx (accessed on 1 December 2024).

Table 7. Aiken's V coefficient of components of the substantial resources dimension.

		Validity Criteria		
		Coherence	**Relevance**	**Clarity**
Component	Infrastructure and Equipment	1.00	1.00	0.97
	Sustainability	1.00	1.00	0.88
	Welfare university	1.00	1.00	0.91
Dimension	Substantial Resources	1.00	1.00	0.92

In the fourth dimension, results, the values of Aiken's V coefficient indicate high content validity. This analysis was performed by five experts, who evaluated the critical variables of the two main components of this dimension.

Table 8 shows Aiken's V coefficients for the components of this dimension. The highest coefficient, 1.00, was observed in the Relevance criterion, achieved by both components evaluated. In contrast, the lowest coefficient, 0.92, was observed in the Coherence criterion, associated with the University Social Responsibility component, and in the Clarity criterion, associated with the graduate follow-up component.

For the results of the components and the critical variables of the results dimension, see https://github.com/etocto/MMU-PER/blob/1dabec6bee421e13f2a89327c79dc37c062d56dc/D_Resultados.xlsx (accessed on 1 December 2024).

Table 8. Aiken's V coefficient of components of the results dimension.

		Validity Criteria		
		Coherence	**Relevance**	**Clarity**
Component	Graduate follow-up	0.97	1.00	0.92
	University Social Responsibility	0.92	1.00	0.95
Dimension	Results	0.95	1.00	0.94

6. Discussion

The study proposes the development of the holistic maturity model MMU-PER, which has been specifically designed to evaluate the performance of Peruvian universities. The results demonstrate high content validity in the evaluated dimensions, aligning with prior studies on maturity models applied to educational institutions. These studies have underscored the pivotal role of content validity in ensuring the efficacy of proposed models (Pereira et al., 2023; Rizun & Pankowska, 2022). In comparison with Mettler's work (Mettler, 2010), on maturity models in information systems, it also highlights the importance of validation through rigorous methods such as Delphi and Aiken's V coefficient. However, it has a more limited scope and does not adopt an integrative approach, as is proposed in this study. Furthermore, the integration of the dimensions of governance, university talent, substantial resources, and results in the MMU-PER coincides with the trends observed in other maturity models within the global university context, such as the EFQM model, which also advocates an integrated and holistic approach (European Foundation for Quality Management, 2021; Portman, 2022). However, unlike these models, the MMU-PER stands

out for its specific adaptation to the Peruvian context, taking into account the socio-cultural and regional specificities that affect universities located in highland and jungle areas. This aspect has received little attention in the existing literature (Martín-Cuadrado et al., 2021). The model includes variables that evaluate university social responsibility and its positive impact on communities through sustainable projects. In addition, it addresses geographic challenges through innovative strategies, such as hybrid teaching approaches, and promotes environmental sustainability, with special emphasis on the rainforest. This approach fosters the adaptation of universities to their particularities, links academic programs to labor demands, and encourages the participation of teachers and students in interdisciplinary projects with social and economic impact. In addition, the model provides strategic guidelines for designing inclusive policies that address regional disparities, integrating strategies that enhance sustainability and align academic programs with labor market demands. This approach allows universities to better adapt to local needs and foster their social and economic impact.

In contrast to the maturity models described by Tocto-Cano et al. (2020), which focus on specific areas such as university entrepreneurship or IT governance, and from Anthony and Antony (2020) with a more focused model such as Lean Six Sigma in higher education, which focuses primarily on operational efficiency, this model integrates a number of different factors, including the quality of university talent, the availability of substantial resources, and the results of management, in order to provide a more comprehensive view of university performance. The proposal of this model makes the gap of greater impact with respect to existing maturity models in the field of higher education. This may be the reason for the high coherence and relevance observed in the validation of the model (Miranda et al., 2021; Morawska-Jancelewicz, 2022). In addition to its adaptability to the Peruvian context, the MMU-PER has a high potential for application in other international environments, particularly in Europe and Latin America. In Europe, it could complement established models such as the EFQM Excellence Model, integrating Education 4.0 and Society 5.0 approaches. For example, in European countries, the MMU-PER could strengthen internationalization and curriculum design strategies aligned with global demands, in line with the advances of similar models that seek to improve graduate employability through strategic planning and academic program design (Pazur Anicic & Divjak, 2020). In Latin America, MMU-PER can support administrative and academic management by applying the enabling governance dimension. For example, in Brazil, a maturity model for academic process management has enabled universities to optimize their administrative and academic management to address contemporary challenges (D. F. A. Silva & Cabral, 2010). These examples demonstrate that the MMU-PER, thanks to its hierarchical structure and comprehensive approach, can be adapted to reduce regional disparities, foster educational equity, and maximize social impact through hybrid technologies and sustainable approaches. It is important to consider the methodological and contextual limitations of this study when interpreting the results. Firstly, the focus on content validation using the Delphi method and Aiken's V coefficient is a robust approach; however, it may limit the generalisability of the results due to the subjective nature of expert judgement. Secondly, although the sample of evaluators is extensive, it is primarily focused on Peruvian experts, which could make it challenging to apply the model to contexts outside Peru. A further limitation of the study is that it is confined to the third stage of Mettler's methodology, without undertaking a comprehensive evaluation of the model in real-world contexts. This may result in discrepancies between the theoretical validation and the practical applicability of the model in various Peruvian universities. Similarly, the absence of a longitudinal evaluation precludes the observation of the model's evolution over time and its capacity to adapt to changes in the educational environment. To address these limitations, future validation studies of the MMU-PER

maturity model should be expanded through case analyses in Peruvian universities representative of different regions and socioeconomic contexts. Furthermore, it would be advantageous to integrate mixed validation techniques that encompass both construct and external validity, thereby enhancing the generalizability of the findings. Another area of future research could focus on the adaptation and evaluation of the MMU-PER in other Latin American contexts. This would allow for a broader comparison and the identification of common and divergent areas in the maturity of universities in the region. Finally, it is recommended that a longitudinal study be developed to observe how university maturity evolves over time. This would provide valuable data for the continuous improvement of the proposed model.

7. Conclusions

This study has devised a University Maturity Model for Peruvian universities (MMU-PER), which integrates the dimensions of favorable governance, university talent, substantial resources, and results in a holistic manner. The most significant findings include the validation of the model's content, demonstrated by high Aiken's V coefficients in all the dimensions evaluated. This suggests that the MMU-PER is a robust framework that has been specifically adapted to the Peruvian context. This maturity model is designed not only to assess institutional performance, but also to promote continuous improvement and to address the specific needs of universities in a globalised environment. The design of this maturity model was informed by a synthesis of existing models and empirical evidence from a range of bibliographic sources, as well as university accreditation and licensing documents. This proposed model has great potential to be extended and applied in the Latin American region, since it would effectively adapt to the sociocultural and technological particularities of higher education institutions in the region. Its integrated and cross-cutting approach allows for a holistic assessment of key aspects such as strategic management and social linkage, which facilitates the implementation of coherent and sustainable strategies. Moreover, by incorporating principles of innovation, digitalization, and strategic governance, this model will not only measure institutional performance, but will also foster continuous improvement and the ability of universities to adapt to the current challenges of higher education. Its structure allows transitioning towards more modern and efficient educational models, aligned with global trends such as Education 4.0 and Society 5.0. In this way, the proposed model represents a valuable tool to transform and strengthen universities in the region, contributing to their integral development and improving their competitiveness in a global context. This synthesis involved the delineation of levels, dimensions, components, critical variables, and maturity practices. The MMU-PER provides a clear and validated structure that allows universities to measure their maturity in several key areas, thereby facilitating a more efficient management approach oriented towards academic and organizational excellence.

This study is based on empirical research, as it is informed by data collected from experts in the field of educational quality. The data have been analyzed using the Delphi method and Aiken's V coefficient, which have been employed to validate the content of the proposed model. The methodological approach has enabled the development of a reliable measurement instrument that is adapted to the specific context of Peruvian universities. The MMU-PER employed a multi-method approach, comprising a literature review, expert validation, and design science research, to develop and validate a maturity model tailored to the specific context of Peruvian universities. The methodology adopted ensures that the model is theoretically sound and practically applicable, and provides a reliable framework for assessing and improving university performance. The MMU-PER has significant implications for the development and administration of Peruvian

universities. It offers a framework that assesses and encourages ongoing enhancement at all levels of university organization.

It is recommended to implement the MMU-PE in a representative set of Peruvian universities to evaluate its applicability in diverse contexts and measure its impact on continuous improvement. Additionally, it is important to promote the training of university management teams in the use of the model, ensuring an effective adoption of its principles and tools.

In future work, longitudinal studies could be carried out to analyze how universities evolve through maturity levels, identifying good practices and areas for improvement. It is also suggested to explore the integration of the MMU-PE with data analysis technologies and artificial intelligence systems, which could facilitate a more dynamic and predictive evaluation (such as da Silva et al., 2023; Iftikhar et al., 2023; López-Gonzales et al., 2024) of institutional performance. Finally, the adaptation of the model to other Latin American countries could be a key step to strengthen higher education in the region, respecting the cultural and socioeconomic particularities of each country.

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