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Strategic Internationalization in Industrial Engineering Education

A Model for Global Competitiveness, Human-Centered AI, and Industry 5.0 Alignment

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Abstract

Internationalization has evolved from a peripheral activity into a strategic imperative for engineering education institutions seeking academic relevance, global competitiveness, and resilience under accelerating technological change (Knight, 2015; OECD, 2020). While internationalization is widely promoted across higher education systems, approaches in Industrial Engineering education remain fragmented, frequently limited to academic mobility or bilateral agreements and weakly integrated with emerging paradigms such as Industry 5.0 and human-centered artificial intelligence (Schwab & Vanham, 2021; UNESCO, 2021).

This article develops a strategic internationalization model for Industrial Engineering education that explicitly addresses this structural gap. Integrating international accreditation frameworks, institutional diagnostics, global benchmarking practices, and Industry 5.0 principles, the proposed model articulates six interdependent strategic axes: globally oriented curriculum redesign, academic and faculty mobility, international industry collaboration, research networking, intercultural and psychosocial competence development, and Industry 5.0–oriented infrastructure.

The study adopts a qualitative, non-experimental, and strategic research design based on documentary analysis, international benchmarking, and institutional diagnosis. Although developed within a Latin American institutional context, the model is analytically transferable across higher education systems facing similar pressures of global competition, digital transformation, and workforce reconfiguration (Altbach et al., 2019; OECD, 2021). The findings suggest that internationalization, when treated as a systemic and governance-driven strategy rather than a set of isolated initiatives, can strengthen academic quality, research projection, graduate employability, and human-centered innovation capacity.

Keywords: strategic internationalization; industrial engineering education; Industry 5.0; human-centered AI; global competitiveness; engineering accreditation

1. Introduction

Engineering education is undergoing a structural transformation driven by technological convergence, artificial intelligence adoption, global production networks, and the rapid reconfiguration of industrial ecosystems (OECD, 2020; Schwab, 2018). Within this environment, Industrial Engineering programs are increasingly expected to prepare graduates who can operate across borders, interact with intelligent systems, and exercise ethical and human-centered judgment in complex socio-technical contexts (Knight, 2015; UNESCO, 2022).

Internationalization, traditionally associated with academic mobility and bilateral agreements, has consequently evolved into a core strategic function of higher education governance (Altbach & Knight, 2007). However, despite its growing prominence in policy discourse, internationalization practices within Industrial Engineering education often remain fragmented. Many programs continue to implement isolated initiatives that lack systemic integration with curriculum governance, research strategy, infrastructure investment, and emerging paradigms such as Industry 5.0 (Brandenburg & De Wit, 2015; OECD, 2021).

This fragmentation reflects a deeper strategic tension. While global accreditation frameworks and international policy agendas emphasize comprehensive and transformative internationalization, institutional capacity constraints and legacy organizational structures frequently limit implementation to symbolic or performative actions (Knight, 2004; UNESCO, 2021). As a result, internationalization risks losing its transformative potential and failing to contribute meaningfully to academic quality, research relevance, and graduate employability.

The central problem addressed in this study is the absence of structured, strategically grounded, and adaptable internationalization models capable of aligning Industrial Engineering education with global competitiveness and Industry 5.0 principles under conditions of technological acceleration and geopolitical uncertainty.

1.1 Research Objectives and Analytical Focus

The general objective of this study is to develop a strategic internationalization model for Industrial Engineering education that enhances global competitiveness while explicitly aligning with human-centered and Industry 5.0–oriented educational principles.

The specific objectives are to: (a) analyze international accreditation and policy frameworks relevant to engineering education, particularly ABET, CDIO, and EUR-ACE; (b) identify strategic dimensions that enable systemic internationalization across academic functions; (c) integrate psychosocial and human-centered considerations into internationalization strategy; and (d) propose a transferable model adaptable to diverse higher education contexts.

2. Conceptual Framework

2.1 Internationalization as a Systemic Governance Process

Internationalization in higher education has been widely conceptualized as an institution-wide process that integrates international and intercultural dimensions into teaching, research, and service functions (Knight, 2004). More recent scholarship emphasizes that effective internationalization requires governance alignment, long-term planning, and strategic coherence rather than isolated operational activities (Knight, 2015; Altbach et al., 2019).

From this perspective, internationalization functions as a strategic mechanism for institutional adaptation under global competition, skills mobility, and increasing interdependence between education systems and labor markets (OECD, 2021; UNESCO, 2022). When internationalization is treated as a peripheral or symbolic activity, its potential contribution to academic quality and institutional resilience is significantly reduced.

2.2 Global Accreditation Frameworks in Engineering Education

International accreditation frameworks provide reference architectures through which engineering programs can align local curricula with global expectations. The ABET framework emphasizes outcomes-based education, ethical responsibility, and continuous improvement as core principles of engineering formation (ABET, 2023). Complementarily, the CDIO initiative promotes experiential learning grounded in the full engineering lifecycle, fostering the integration of technical knowledge with problem-solving and teamwork skills (CDIO Initiative, 2023).

The EUR-ACE framework further contributes to internationalization by establishing harmonized quality standards that facilitate academic mobility and professional recognition across national borders (ENAEE, 2023). Rather than imposing uniform curricular models, these frameworks enable strategic benchmarking and informed institutional decision-making while preserving contextual autonomy (European Commission, 2020).

2.3 Industry 5.0 and Human-Centered Artificial Intelligence

The transition from Industry 4.0 to Industry 5.0 reframes technological development around human-centricity, sustainability, and societal value creation (European Commission, 2021; Schwab & Vanham, 2021). This paradigm shift challenges engineering education to move beyond purely technical skill development toward the cultivation of ethical judgment, psychosocial competencies, and collaborative capacity in human–machine environments.

Human-centered artificial intelligence reinforces this requirement by emphasizing transparency, explainability, and trust calibration in the interaction between humans and intelligent systems (Shneiderman, 2022). As AI becomes embedded in industrial decision-making, engineers must be prepared to supervise, interpret, and ethically govern algorithmic processes within culturally and institutionally diverse contexts. Internationalization strategies

that fail to incorporate these dimensions risk misalignment with future industrial and societal demands.

3. Methodology

3.1 Research Design

This study adopts a qualitative, non-experimental, and strategic research design. It is conceptual–applied in nature and aims to construct a strategic internationalization model for Industrial Engineering education. The research does not involve human subjects, experimental manipulation, or statistical inference, aligning with accepted methodological standards for conceptual and policy-oriented studies (Creswell, 2014).

3.2 Procedures and Data Sources

The methodological process comprised four stages: (1) documentary analysis of peer-reviewed literature, international policy reports, and accreditation guidelines related to engineering education and internationalization (Altbach et al., 2019; OECD, 2020; UNESCO, 2021); (2) international benchmarking of Industrial Engineering programs aligned with ABET, CDIO, and EUR-ACE standards; (3) institutional diagnostic analysis focusing on curriculum structure, academic practices, research activity, industry linkage, and infrastructure conditions; and (4) strategic synthesis integrating insights from previous stages to formulate a coherent and transferable model.

4. Strategic Findings and Analysis

The institutional diagnosis revealed a recurring pattern observed across practice-oriented engineering programs: while strong industry engagement and experiential teaching traditions are present, internationalization efforts remain compartmentalized and weakly connected to curriculum governance, research networks, and long-term infrastructure planning (OECD, 2021).

Benchmarking analysis of internationally recognized programs highlighted common strategic practices, including systematic curriculum redesign informed by global frameworks, diversified mobility mechanisms, digitally mediated collaboration environments, and sustained partnerships with multinational enterprises. Programs integrating these elements within coherent governance structures demonstrated greater adaptability to technological disruption and labor-market volatility (Altbach et al., 2019; European Commission, 2020).

5. Strategic Internationalization Model

The proposed model articulates six interrelated strategic axes: (1) curriculum internationalization, emphasizing global learning outcomes, AI literacy, ethical reasoning, and human-centered competencies (ABET, 2023); (2) academic and faculty mobility, embedded in long-term capacity-building strategies rather than short-term exchanges (Knight, 2015); (3) international industry collaboration, aligned with Industry 5.0 principles and real-world problem-solving contexts (Schwab & Vanham, 2021); (4) research networking, enabling participation in global knowledge production and AI-enabled innovation ecosystems (OECD, 2021); (5) intercultural and psychosocial competence development, addressing trust, collaboration, leadership, and cognitive resilience (Shneiderman, 2022); and (6) Industry 5.0–oriented infrastructure, supporting human–AI collaboration, digital experimentation, and sustainable innovation (European Commission, 2020).

These axes operate synergistically and require governance coordination to avoid fragmentation and symbolic internationalization.

6. Discussion

This study reframes internationalization in Industrial Engineering education as a systemic governance strategy rather than a collection of isolated initiatives. In line with contemporary internationalization theory, the proposed model emphasizes strategic coherence across curriculum, research, industry collaboration, and infrastructure, addressing limitations frequently observed in fragmented institutional practices (Knight, 2015; Altbach et al., 2019).

By explicitly integrating Industry 5.0 principles and human-centered artificial intelligence into internationalization strategy, the model extends existing literature beyond mobility-centric approaches. Internationalization is positioned not only as a mechanism for global engagement, but as an institutional capability that supports ethical judgment, psychosocial competence, and effective human–machine collaboration in globally distributed industrial environments (Schwab & Vanham, 2021; Shneiderman, 2022).

From a governance perspective, the model highlights the importance of aligning accreditation frameworks with long-term strategic planning. While frameworks such as ABET, CDIO, and EUR-ACE provide robust reference standards, their transformative potential depends on institutional capacity to integrate them coherently rather than adopt them symbolically (ABET, 2023; ENAEE, 2023). This finding resonates with critiques of performative internationalization that prioritize visibility over substantive organizational change (Brandenburg & De Wit, 2015).

The discussion also underscores the centrality of psychosocial and intercultural competencies in Industry 5.0–oriented engineering education. As intelligent systems increasingly mediate industrial decision-making, engineers must be prepared to exercise trust calibration, ethical

supervision, and collaborative judgment across cultural and institutional boundaries. Internationalization strategies that neglect these dimensions risk misalignment with both future industrial demands and societal expectations (OECD, 2021; UNESCO, 2022).

Finally, the analytical transferability of the proposed model constitutes a key contribution. Although developed within a Latin American institutional context, the model addresses structural challenges shared by higher education systems worldwide, including resource constraints, regulatory diversity, and technological acceleration. Its governance-oriented design enables adaptation across diverse educational environments without imposing uniform solutions.

7. Conclusions and Future Research Agenda

Internationalization constitutes a foundational strategy for strengthening Industrial Engineering education under conditions of global interdependence and technological transformation. The strategic model proposed demonstrates that internationalization can enhance academic quality, research visibility, and graduate employability when implemented as a coherent institutional process (Altbach et al., 2019; OECD, 2021).

Future research should empirically examine the longitudinal impacts of model implementation, analyze graduate trajectories in international labor markets, and explore the interaction between international accreditation, AI-enabled learning environments, and professional outcomes.

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