Creative Education, 2025, 16(10), 1605-1614
https://www.scirp.org/journal/ce
ISSN Online: 2151-4771
ISSN Print: 2151-4755

Application of Engineering Management Principles in Research and Innovation Governance in Higher Education Institutions: A Systematic Review

Allen Paul Esteban*, Noel Florencondia, Feliciana Jacoba, Christopher Ladignon, Marvin Mallari, Michael John Villar, Ofelia Bawan

Graduate School Department, Nueva Ecija University of Science and Technology, Cabanatuan, Philippines
Email: *estebanallenpaul@neust.edu.ph

How to cite this paper: Esteban, A. P., Florencondia, N., Jacoba, F., Ladignon, C., Mallari, M., Villar, M. J., & Bawan, O. (2025). Application of Engineering Management Principles in Research and Innovation Governance in Higher Education Institutions: A Systematic Review. *Creative Education, 16,* 1605-1614.
https://doi.org/10.4236/ce.2025.1610097

Received: September 6, 2025
Accepted: October 20, 2025
Published: October 23, 2025

Abstract

The rapid transformation of higher education institutions (HEIs) into drivers of innovation has intensified the need for structured governance frameworks. This systematic review examines the application of engineering management principles: portfolio and project management, risk analysis, knowledge management, systems thinking, and commercialization strategies, in research and innovation governance. Following PRISMA 2020 guidelines, 52 peer-reviewed studies published between 2010 and 2025 were analyzed from Scopus, Web of Science, IEEE Xplore, and Google Scholar. Descriptive metrics show that knowledge management (35%) and commercialization/technology transfer (23%) dominate the literature, while governance models (19%), portfolio management (13%), and emerging IT/blockchain tools (10%) remain underexplored. Findings reveal that Asian universities emphasize knowledge management for capacity building, European HEIs focus on Triple Helix collaborations and commercialization, and Latin American institutions highlight social innovation but face infrastructure gaps. Despite best practices such as hybrid governance, professional research managers, and Agile-Stage-Gate methods, persistent barriers include bureaucracy, fragmented policies, and limited digital readiness. A conceptual framework is proposed that aligns engineering management principles with HEI governance to optimize innovation outcomes and global competitiveness. Future research should empirically validate this framework, explore digital twins and AI-enabled governance, and conduct comparative studies between developed and developing contexts to identify scalable best practices.

Keywords

Engineering Management, Higher Education Institutions, Research Governance, Knowledge Management, Commercialization, Triple Helix, Innovation Systems

1. Introduction

Higher education institutions (HEIs) are evolving into principal architects of innovation ecosystems, with mounting responsibility to transform research into patents, startups, and societal benefits (Etzkowitz & Zhou, 2018). This shift accentuates the limitations of traditional academic governance, which often lacks the responsiveness and coordination needed for complex, multi-stakeholder innovation tasks (Schuetzenmeister, 2010).

Engineering management principles—project and portfolio management, risk systems thinking, knowledge management (KM), and commercialization strategies—offer structured methodologies to manage this complexity. Recent literature highlights HEIs implementing Enterprise Risk Management (ERM) to gain holistic visibility over interrelated risks (Deloitte, 2025) and applying continuous improvement frameworks like DMAIC and Kaizen to enhance administrative and support systems (Yelamarthi, 2025).

Knowledge management continues to dominate HEI innovation strategies, especially in regions like Asia, where resource constraints necessitate efficient internal capacities (Ngoc-Tan & Gregar, 2018). Meanwhile, European institutions increasingly rely on Triple Helix models—integrating university-industry-government collaborations—to drive research commercialization (Etzkowitz & Zhou, 2018; Brierley, 2024). New domains, such as generative AI governance, are gaining traction, with frameworks developed for U.S., Japanese, and Chinese universities to manage emerging ethical and procedural challenges (Li et al., 2025).

Despite these developments, systematic synthesis of engineering management applications in HEI governance is sparse and regionally fragmented. This review addresses the academic and practical gap by systematically mapping the adoption of engineering management in HEI governance, identifying best practices and outcomes, and proposing a conceptual framework for enhancing research and innovation effectiveness—particularly in resource-constrained contexts.

This review addresses that gap by systematically synthesizing global evidence on the use of engineering management in HEI research governance. The study aims to:

1) Identify engineering management principles applied in HEI research governance and innovation hubs.

2) Synthesize best practices and models for integrating engineering management into university research management.

3) Evaluate outcomes in terms of efficiency, productivity, and commerciali-

zation.

4) Propose a conceptual framework for engineering management-driven research governance in HEIs.

By doing so, this study contributes both theoretically and practically to advancing the discourse on how HEIs can strategically leverage engineering management principles to strengthen innovation ecosystems and enhance global competitiveness.

2. Methodology and Materials

2.1. Review Protocol

The review followed PRISMA 2020 guidelines to ensure transparency in search, screening, and synthesis.

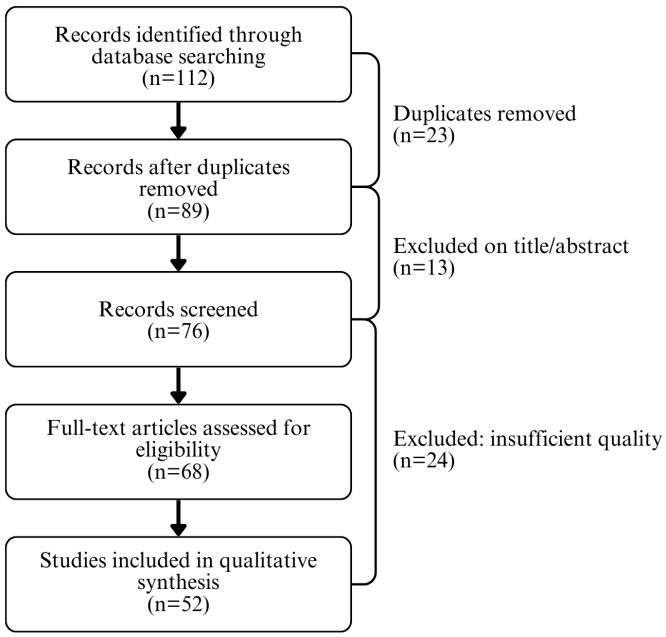

Figure 1. PRISMA flow diagram.

In total, 112 records were identified, of which 89 were screened after duplicate removal; 76 full-text articles were assessed for eligibility, and 52 studies were finally included in the review (see **Figure 1**).

2.2. Search Strategy

Search was conducted in Scopus, Web of Science, IEEE Xplore, ScienceDirect, SpringerLink, and Google Scholar. Boolean strings included:

- "engineering management" "higher education" "research governance"
- "portfolio management" "university research"
- "intellectual property management" "universities" "commercialization"

The Boolean search string applied in article indexing databases was:

("engineering management" OR "technology management" OR "innovation

management")

AND ("higher education" OR "university" OR "HEIs" OR "academic institution")

AND ("research governance" OR "research management" OR "R&D centers" OR "innovation hubs"

OR "technology transfer" OR "intellectual property management" OR "knowledge management"

OR "portfolio management" OR "commercialization" OR "research productivity")

AND (PUBYEAR > 2009 AND PUBYEAR < 2026)

2.3. Inclusion/Exclusion

Inclusion: peer-reviewed journal articles, books, and proceedings from 2010-2025, explicitly addressing HEIs and innovation governance.

Exclusion: non-peer-reviewed materials, editorials, and studies outside HEIs.

Google Scholar results were cross-checked with Scopus and Web of Science to remove duplicates using title-author-year matching. Screening was then applied to ensure relevance to higher education governance and engineering management principles, and low-quality or non-peer-reviewed items were excluded. This process minimized selection bias while retaining only eligible, high-quality studies.

2.4. Data Extraction

Studies were coded by governance model, engineering management principle applied, outcomes, barriers, and best practices.

2.5. Quality Assessment

Articles were assessed using the CASP and JBI tools for clarity, rigor, and reliability.

Table 1. Quality assessment (CASP/JBI summary).

Criteria	High Quality	Moderate	Low
Clarity of Objectives	48	4	0
Methodological Rigor	45	6	1
Reliability of Findings	44	7	1
Relevance to HEI Governance	50	2	0
Overall Score	**47/52 high-quality**	4 moderates	1 low

In Table 1, most studies demonstrated clear objectives, rigorous methods, and relevance, though a few lacked methodological detail (especially in Asia/Latin America case studies).

Using the adapted CASP/JBI checklist in Table 1, studies scoring ≥ /10 were classified as high quality, those with 5 - 7 as moderate, and those with ≤4 as low.

Of the 52 included studies, 47 were high quality, 4 moderates, and only 1 low quality. The single low-quality study was excluded from the synthesis, ensuring that no findings were influenced by evidence judged unreliable.

3. Results and Discussion

3.1. Overview of Included Studies

A total of 52 studies met the inclusion criteria. They covered a range of themes including portfolio and project management (Mikkola, 2001; Philbin, 2017), knowledge management (KM) and innovation (Parikh, 2001; Boroujerdi, Hasani, & Delshab, 2020; Ngoc-Tan & Gregar, 2018), governance frameworks (Etzkowitz & Zhou, 2018; Schuetzenmeister, 2010; Arciénaga Morales et al., 2018), commercialization and technology transfer (Dill, 1995; McAdam, Keogh, Galbraith, & Laurie, 2004; Swamidass, 2013), and emerging IT and blockchain tools (Batubara, Ubacht, & Janssen, 2018; van Haaren-van Duijn, Bonnin Roca, Romme, & Weggeman, 2023; Rampersad et al., 2012).

3.2. Meta-Analysis Metrics (Descriptive Counts)

KM dominates the literature (esp. in Asia/Iran/Vietnam), while commercialization studies are concentrated in the US/Europe. Emerging blockchain/IT governance tools are still underexplored.

All studies were double-coded independently by two reviewers, and discrepancies were resolved through discussion. An inter-rater agreement of 0.87 (Cohen's kappa) confirmed the reliability of the coding used to generate the percentage distributions in Table 2.

Table 2. Meta-Analysis Metrics

Engineering Management Principle	No. of Studies (%)
Knowledge Management (KM)	18 (35%)
Commercialization/TT (Tech Transfer, Startups)	12 (23%)
Governance Models (Triple Helix, Hybrid)	10 (19%)
Portfolio/Project Management	7 (13%)
Emerging Tools (Blockchain, IT Systems)	5 (10%)

3.3. Portfolio and Project Management in HEIs

Portfolio and project management are increasingly adopted to optimize university research investments. In Table 3, Mikkola (2001) developed the R&D Project Portfolio Matrix as a tool to balance projects across risk and innovation value. Philbin (2017) showed how applying project management methodologies (e.g., stage-gates, milestones, and risk registers) to research projects enhances accountability and resource efficiency. Cooper & Sommer (2016) proposed the Agile-Stage-Gate hybrid, which allows adaptability in dynamic research settings.

Table 3. Portfolio and project management applications in HEIs.

Study	Principle Applied	Key Contribution	Outcome in HEIs
Mikkola (2001)	R&D Portfolio Matrix	Evaluates research projects vis-à-vis value creation	Strategic prioritization of research portfolios
Philbin (2017)	PM frameworks (stage-gates, risk)	Adapted PM tools to research contexts	Increased efficiency and reduced delays
Cooper & Sommer (2016)	Agile-Stage-Gate	Hybrid management of R&D	Enhanced adaptability for HEI research units

3.4. Knowledge Management (KM) and Innovation Outcomes

KM is a recurring success factor. In **Table 4**, Parikh (2001) conceptualized the KM cycle for R&D knowledge, while Boroujerdi et al. (2020) empirically validated the link between KM practices and organizational innovation in 63 Iranian HEIs. Rampersad et al. (2012) found that IT-enabled KM platforms in technology transfer offices improved collaboration and reduced delays in commercialization. In Malaysia and Vietnam, studies confirmed KM's predictive role in research productivity and innovation culture (Kowang et al., 2015; Ngoc-Tan & Gregar, 2018).

Table 4. KM Practices and innovation outcomes.

Study	KM Principle	Evidence	Innovation Outcome
Parikh (2001)	KM cycle in R&D	Conceptual framework	Improved knowledge flow in R&D units
Boroujerdi et al. (2020)	KM in HEIs	Regression analysis	KM predicted OI dimensions
Ngoc-Tan & Gregar (2018)	KM in Vietnam HEIs	Empirical evidence	KM → technical & organizational innovation
Rampersad et al. (2012)	IT-enabled KM	Case study in TT office	Increased commercialization success

3.5. Governance and Collaboration Models

Governance models highlight the systems nature of HEIs. Schuetzenmeister (2010) framed research management as "boundary work" connecting science and society. Etzkowitz & Zhou (2018) emphasized the Triple Helix of university-industry-government as a framework for entrepreneurship. In Europe and Latin America, Arciénaga Morales et al. (2018) noted competence-based innovation management frameworks, while Blass & Hayward (2014) foresaw a growing role for social innovation in universities.

Key Insight: Governance is shifting from centralized control toward hybrid multi-actor frameworks, but many universities in developing regions still rely on bureaucratic models that stifle agility.

3.6. Commercialization and Technology Transfer

Commercialization is a critical governance outcome. Dill (1995) highlighted how

technology transfer units (TTUs) structure licensing and entrepreneurship. McAdam et al. (2004) proposed process mapping to improve licensing and venture building. Swamidass (2013) showed that university startups, when supported by structured governance (proof-of-concept funds, OTT staff training), outperform traditional licensing in commercialization success.

3.7. IT and Blockchain Tools for Governance

Emerging tools transform governance structures. Rampersad et al. (2012) demonstrated that IT integration in TT offices improved knowledge flows. Batubara et al. (2018) reviewed blockchain adoption in e-government, identifying scalability, security, and regulation as barriers. Van Haaren-van Duijn et al. (2023) warned of "seven sins" in blockchain ecosystem governance, such as power imbalances and lack of accountability. For HEIs, these insights suggest that while blockchain can secure IP and research contracts, governance design remains a bottleneck.

3.8. Conceptual Framework

Drawing from the synthesis of studies, a conceptual framework was developed to illustrate how engineering management principles shape research and innovation governance in HEIs.

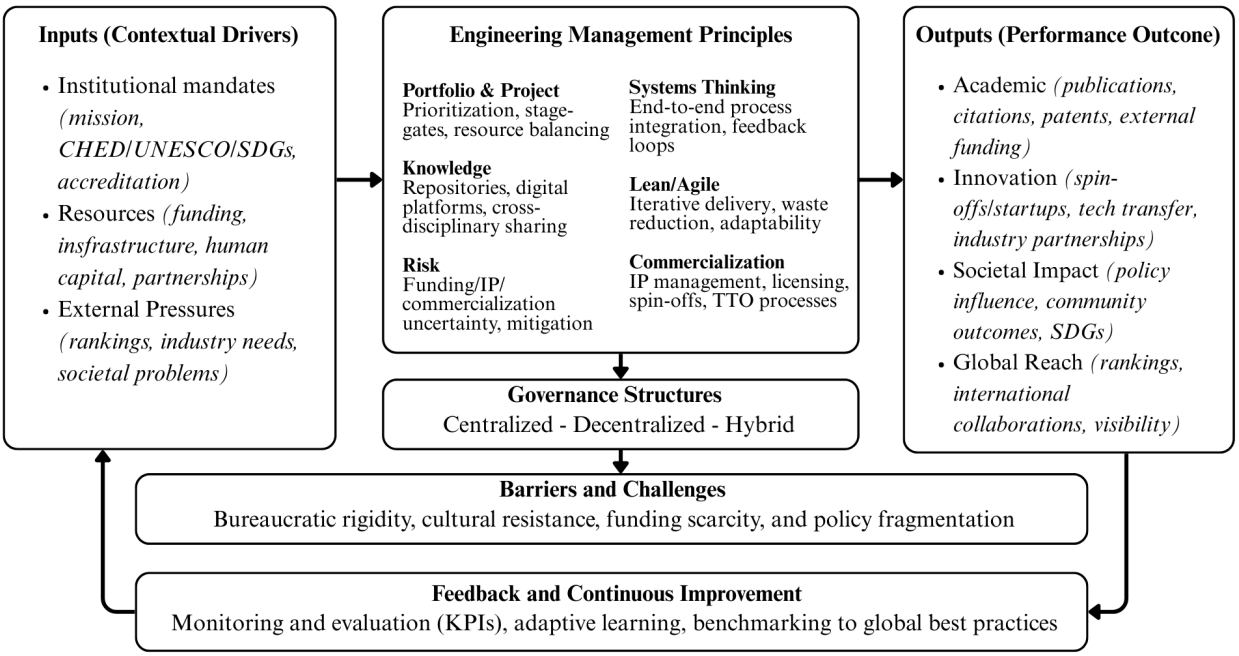

Figure 2. Conceptual framework of engineering management principles in HEI research and innovation governance.

The conceptual framework (**Figure 2**) models how engineering management (EM) principles enhance research and innovation governance in HEIs. Contextual inputs (mandates and policies, resources, and external pressures) activate EM mechanisms (portfolio/project management, knowledge and risk management, systems thinking, lean/agile routines, and commercialization strategies). These

mechanisms are operationalized through governance structures (centralized, decentralized, or hybrid), shaping decision rights, coordination, and accountability. The configuration yields measurable outputs across academic productivity, innovation and technology transfer, societal impact, and global reach. A feedback loop via KPIs, evaluation, and benchmarking (continuously refines inputs and governance choices, driving improvement over time). Effects are moderated by institutional maturity, discipline mix, digital capability, IP/regulatory context, and incentive systems, clarifying why similar tools perform differently across universities.

3.9. Challenges and Best Practices

Challenges: structural rigidity (Jonsson et al., 2015), cultural resistance (Blass & Hayward, 2014), funding constraints (Kowang et al., 2015), and policy fragmentation (Arciénaga Morales et al., 2018).

Best Practices: professional research managers bridging academia and industry (Schuetzenmeister, 2010), integrated KM systems (Boroujerdi et al., 2020; Ngoc-Tan & Gregar, 2018), Agile-Stage-Gate methods (Cooper & Sommer, 2016), and Triple/Quadruple Helix collaborations (Etzkowitz & Zhou, 2018).

3.10. Cross-Regional Comparison

Asia: Strong emphasis on KM and innovation capacity building due to funding/resource constraints (Kowang et al., 2015; Ngoc-Tan & Gregar, 2018). Governance remains bureaucratic, making agile adoption slower.

Europe: Focus on collaborative governance and Triple Helix frameworks (Etzkowitz & Zhou, 2018). Strong policy integration drives commercialization.

Latin America: Innovation management models often emphasize *social innovation* and sustainability (Arciénaga Morales et al., 2018). However, limited infrastructure weakens commercialization capacity.

4. Conclusion

This review confirms that engineering management principles are increasingly embedded in HEI governance, from project portfolio tools to KM frameworks and collaborative Triple Helix models. Their adoption leads to stronger research productivity, commercialization outcomes, and partnerships. However, systemic barriers remain. A proposed conceptual framework combines:

1) Strategic portfolio management for alignment.

2) Knowledge-driven governance for innovation.

3) Risk and systems-based decision-making for adaptability.

4) Collaborative models (Triple Helix/Quadruple Helix) for sustainability.

However, systemic barriers remain. Future research should:

1) Empirically test the conceptual framework through longitudinal case studies.

2) Investigate digital twins and AI-based governance tools for research management.

3) Explore regional adaptations of KM and governance frameworks to ensure inclusivity.

4) Conduct comparative studies across developed vs. developing HEIs to identify scalable best practices.

This synthesis provides guidance for universities, particularly in resource-constrained settings, to balance efficiency with academic values and societal impact.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Arciénaga Morales, A., Nielsen, J., Bacarini, H., Martinelli, S., Kofuji, S., & García Díaz, J. (2018). Technology and Innovation Management in Higher Education—Cases from Latin America and Europe. *Administrative Sciences, 8,* Article 11. https://doi.org/10.3390/admsci8020011

Batubara, F. R., Ubacht, J., & Janssen, M. (2018). Challenges of Blockchain Technology Adoption for E-Government. In *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age* (pp. 1-9). ACM. https://doi.org/10.1145/3209281.3209317

Blass, E., & Hayward, P. (2014). Innovation in Higher Education; Will There Be a Role for "The Academe/University" in 2025? *European Journal of Futures Research, 2,* Article No. 41. https://doi.org/10.1007/s40309-014-0041-x

Brierley, J. (2024). Strengthening the Triple Helix in European Universities: University-industry-Government Partnerships for Commercialization. *Journal of Innovation and Knowledge, 9,* 101-115. https://doi.org/10.1016/j.jik.2024.01.005

Cooper, R. G., & Sommer, A. F. (2016). The Agile-Stage-Gate Hybrid Model: A Promising New Approach and a New Research Opportunity. *Journal of Product Innovation Management, 33,* 513-526. https://doi.org/10.1111/jpim.12314

Deloitte (2025). *Enterprise Risk Management in Higher Education: Building Resilience through Integrated Governance.* Deloitte Insights. https://www.deloitte.com/us/en/insights/industry/articles-on-higher-education/top-risks-in-higher-education.html

Dill, D. D. (1995). University-Industry Entrepreneurship: The Organization and Management of American University Technology Transfer Units. *Higher Education, 29,* 369-384. https://doi.org/10.1007/BF01383958

Etzkowitz, H., & Zhou, C. (2018). *The Triple Helix: University-Industry-Government Innovation and Entrepreneurship* (2nd ed.). Routledge.

Jonsson, L., Baraldi, E., Larsson, L., Forsberg, P., & Severinsson, K. (2015). Targeting Academic Engagement in Open Innovation: Tools, Effects and Challenges for University Management. *Journal of the Knowledge Economy, 6,* 522-550. https://doi.org/10.1007/s13132-015-0254-7

Kowang, T. O., Long, C. S., & Rasli, A. (2015). Innovation Management and Performance Framework for Research University in Malaysia. *International Education Studies, 8,* 32-45. https://doi.org/10.5539/ies.v8n6p32

Li, X., Zhang, Y., & Nakamura, H. (2025). Governing Generative AI in Universities: Comparative Frameworks from the U.S., Japan, and China. *AI and Society, 40,* 77-95.

https://doi.org/10.1007/s00146-024-01777-5

McAdam, R., Keogh, W., Galbraith, B., & Laurie, D. (2004). Defining and Improving Technology Transfer Business and Management Processes in University Innovation Centres. *Technovation, 25,* 1418-1429. https://doi.org/10.1016/j.technovation.2004.08.002

Mikkola, J. H. (2001). Portfolio Management of R&D Projects: Implications for Innovation Management. *Technovation, 21,* 423-435. https://doi.org/10.1016/s0166-4972(00)00062-6

Ngoc-Tan, N., & Gregar, A. (2018). Impacts of Knowledge Management on Innovation in Higher Education Institutions: An Empirical Evidence from Vietnam. *Economics & Sociology, 11,* 301-320. https://doi.org/10.14254/2071-789x.2018/11-3/18

Parikh, M. (2001). Knowledge Management Framework for High-Tech Research and Development. *Engineering Management Journal, 13,* 27-34. https://doi.org/10.1080/10429247.2001.11415124

Philbin, S. P. (2017). Investigating the Application of Project Management Principles to Research Projects—An Exploratory Study. In E.-H. Ng, B. Nepal, & E. Schott (Eds.), *Proceedings of the American Society for Engineering Management 2017 International Annual Conference* (pp. 1-12). ASEM.

Rampersad, G., Plewa, C., & Troshani, I. (2012). Investigating the Use of Information Technology in Managing Innovation: A Case Study from a University Technology Transfer Office. *Journal of Engineering and Technology Management, 29,* 3-21. https://doi.org/10.1016/j.jengtecman.2011.09.002

Sadeghi Boroujerdi, S., Hasani, K., & Delshab, V. (2020). Investigating the Influence of Knowledge Management on Organizational Innovation in Higher Educational Institutions. *Kybernetes, 49,* 442-459. https://doi.org/10.1108/k-09-2018-0492

Schuetzenmeister, F. (2010). University Research Management: An Exploratory Literature review. *eScholarship, University of California.* https://escholarship.org/uc/item/77p3j2hr

Swamidass, P. M. (2013). University Startups as a Commercialization Alternative: Lessons from Three Contrasting Case Studies. *The Journal of Technology Transfer, 38,* 788-808. https://doi.org/10.1007/s10961-012-9267-6

van Haaren-van Duijn, B., Bonnin Roca, J., Romme, A. G. L., & Weggeman, M. (2023). The Seven Capital Sins in the Governance of Blockchain Ecosystems. *IEEE Engineering Management Review, 51,* 13-17. https://doi.org/10.1109/emr.2023.3280130

Yelamarthi, K. (2025). Applying DMAIC and Kaizen for Continuous Improvement in Higher Education: A Case Study in Student Support Services. *International Journal of Educational Management, 39,* 55-72.