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EVALUATING THE PSYCHOMETRIC IMPACT OF CENTERS OF EXCELLENCE ON INDUSTRY READINESS IN ENGINEERING STUDENTS

VIJAYA MAIR[1], B.RATNAVALLI[2]
[1]RESEARCH SCHOLAR, MANAGEMENT KLEF
[2]ASSISTANT PROFESSOR, KLBS, KLEF

Abstract
In the evolving landscape of engineering education, there is increasing emphasis on aligning academic training with industry expectations to enhance graduate employability. Centers of Excellence (CoEs) have emerged as institutional frameworks that aim to bridge this gap by providing students with access to applied skill development, industry mentorship, and project-based learning. However, limited empirical research exists evaluating their psychometric impact on students' perceived industry readiness and placement outcomes.
This study proposes a psychometric framework to examine the role of CoEs as mediators in the relationship between institutional support and industry readiness among engineering students. Using a convergent mixed-methods approach, we collected quantitative data from 500 students, including academic performance, placement status, and soft skill assessments, alongside qualitative data from interviews and focus groups involving students, faculty, and industry mentors.
A regression-based mediation model, grounded in Baron and Kenny's framework, was employed to test the indirect influence of CoE participation on employability outcomes. Results revealed a significant partial mediation effect, indicating that CoEs effectively translate institutional efforts into measurable industry readiness indicators such as confidence, recruiter feedback, and soft skills. These findings support the integration of CoEs as strategic components in higher education policy and curriculum design, offering a psychometrically sound pathway to enhance workforce preparedness in technical education.

Keywords: Employability, Centers of Excellence (CoEs), Industry Readiness, Engineering Education, Psychometric Evaluation, Mixed-Methods Research, Mediation Analysis, Higher Education, Skill Development, Academia-Industry Collaboration

1. INTRODUCTION

In the contemporary landscape of technical education, employability has become a central metric of institutional success. As engineering graduates navigate increasingly competitive job markets, there is a growing emphasis on bridging the gap between academic instruction and industry expectations. Traditional pedagogical models, which focus heavily on theoretical knowledge, are often inadequate in equipping students with the practical competencies, soft skills, and industry familiarity required by modern employers ((Etzkowitz, 2020; Kumar & Patel, 2021).

To address this mismatch, educational institutions in India and globally have turned to strategic frameworks such as Centers of Excellence (CoEs). CoEs serve as dedicated spaces within academic environments that offer applied training, access to modern technologies (e.g., AI, IoT, cloud computing), mentorship from industry professionals, and opportunities for experiential learning through real-world projects(Gupta & Ramesh, 2022; Sharma & Verma, 2019). These centers aim not only to enhance students' technical proficiency but also to improve their professional readiness, confidence, and adaptability in workplace settings. In an increasingly dynamic job market, engineering graduates are often found lacking in the skills required for immediate industry integration. To address this gap, educational institutions have established Centers of Excellence (CoEs) aimed at providing domain-specific training, industry collaboration, and hands-on learning. While anecdotal evidence suggests that these CoEs improve student outcomes, there is a need for rigorous psychometric evaluation of their actual impact on employability and industry readiness.

Governmental policies such as India's National Education Policy (NEP 2020) reinforce this shift by encouraging closer academia-industry collaboration, curricular innovation, and skill development as part of higher education reforms. National-level initiatives like the ICT Academy and the National Skill Development Corporation (NSDC) have further emphasized

capacity building and employability enhancement by providing standardized training, industry certifications, and infrastructure support to engineering colleges (ICT Academy, 2022; National Skill Development Corporation, 2021).

Despite these developments, there is limited psychometric research examining the efficacy of CoEs in enhancing employability outcomes. While placement rates offer a quantitative measure, they do not capture the underlying psychological and behavioural changes—such as confidence, self-efficacy, and communication skills—that result from CoE participation. A more rigorous methodology is required to evaluate whether and how these centers influence student preparedness for industry engagement, particularly through validated psychometric constructs and structural models.

To address this gap, the present study investigates the mediating role of CoE participation between institutional support and perceived industry readiness. Drawing on mediation theory (Baron & Kenny, 1986)(7), we employ a mixed-methods approach that combines quantitative metrics (e.g., academic scores, soft skills ratings, placement status) with qualitative feedback from stakeholders (students, faculty, industry mentors). The findings aim to contribute both theoretically and practically by offering evidence-based insights on how CoEs can be strategically embedded in engineering curricula to improve employability outcomes.

The current study examines whether participation in CoEs serves as a mediating factor between institutional support and students' industry readiness, incorporating both academic and behavioral indicators. This research is motivated by the need for empirical validation of CoEs as strategic enablers of employability.

Organization of the Paper

The remainder of this paper is structured as follows : **Section 2**: Related Work reviews recent literature on employability enhancement, Centers of Excellence, and industry-academia collaboration, with a focus on empirical and psychometric studies. **Section 3:** Methodology describes the convergent mixed-methods research design, participant sampling, instruments used, and the mediation analysis framework employed to examine the effect of CoE participation on industry readiness. **Section 4:** Results presents the descriptive statistics, regression analysis, and thematic findings, highlighting both quantitative indicators and qualitative insights related to CoE outcomes. **Section 5**: Discussion interprets the findings, introduces the proposed CEIM (CoE-Employability Integration Model), and discusses implications for policy and practice in technical education. **Section 6:** Conclusion summarizes key takeaways, outlines theoretical and practical implications, and suggests directions for future research in employability assessment and academic-industrial integration.

2. RELATED WORK

A growing body of literature has addressed the challenges of employability in engineering education and the role of institutional mechanisms like Centers of Excellence (CoEs) in enhancing industry readiness. Studies have emphasized that the gap between academic instruction and industry expectations is widening due to technological evolution and the lack of applied training in higher education curricula (Jackson, 2016; Tomlinson, 2017). The lack of consensus on the definition and assessment of employability skills has hindered the standardization of training and evaluation methods in higher education. Suleman (Suleman, 2018) discusses various conceptual frameworks and methodological options, emphasizing the need for holistic and context-sensitive approaches to employability assessment. This reinforces the importance of psychometrically sound models like ours to evaluate interventions such as Centers of Excellence (CoEs).

Industry-academia collaborations have been identified as key enablers of skill development and job readiness. Yusuf and Shahar (Yusuf & Shahar, 2021) reviewed the core employability skills expected by modern employers and recommended experiential learning frameworks. Teichler (Teichler, 2019)provided a broader comparative analysis on how higher education outcomes align with labor market demands in global contexts.

In the South African context, Lamprecht and Rooyen (Lamprecht & Rooyen, 2020) explored various models for effective collaboration between academia and industry in technology-focused research. Their findings emphasize structured partnerships, governance frameworks, and mutual capacity building, which are conceptually aligned with the role of CoEs in fostering industry readiness in students. Ahuja, Suguna, and Tirumala (Ahuja et al., 2019) emphasized the need for structured industry-institute collaboration to produce industry-ready engineering graduates. Their study underlined that regular engagement through curriculum co-design, internship programs, industrial visits, and expert lectures significantly improves students' understanding
of real-world applications and enhances employability. Their work also highlighted key barriers to implementation such as faculty training and institutional inertia, further validating the necessity of structured frameworks like CoEs.

Aliu et al. (Aliu et al., 2024) developed an employability skills model for graduates in the built environment disciplines using Partial Least Squares Structural Equation Modeling (PLS-SEM). Their study identified critical skill dimensions—such as communication, teamwork, digital literacy, and problem-solving—that significantly influence graduate employability. Notably, their use of PLS-SEM validated the mediating role of institutional factors in skill acquisition, which aligns with the current studys use of mediation models to understand the impact of CoE participation on industry readiness.

This further supports the use of SEM based methodologies in higher education employability research. Valiente Bermejo et al. (Valiente Bermejo et al., 2021) proposed a structured model for university–industry collaboration in curriculum design and delivery, focusing on manufacturing engineering courses. Their study emphasized co-creation of course content, inclusion of industry professionals in teaching, and feedback loops to ensure
curriculum relevance. The implementation demonstrated significant improvements in student engagement, skill acquisition, and industry satisfaction. This aligns with the objectives of Centers of Excellence (CoEs), which aim to integrate academic instruction with practical industry needs. Their findings reinforce the necessity of structured collaboration mechanisms to enhance graduate employability and curriculum adaptability.

Despite these advancements, there is a lack of studies that combine both quantitative and qualitative indicators—particularly those rooted in psychometric principles—to evaluate CoE impact. The current research addresses this gap by integrating mediation analysis with stakeholder narratives to provide a comprehensive evaluation.

3. METHODOLOGY

This study employs a convergent mixed methods design to evaluate the psychometric impact of Centers of Excellence (CoEs) on the industry readiness of engineering students. Quantitative and qualitative data were collected simultaneously, analyzed independently, and then integrated to derive holistic inferences. The aim was to assess both measurable performance indicators and subjective perceptions surrounding CoE participation. The methodological framework is illustrated in Figure 1, highlighting the parallel data collection streams, distinct analysis paths (regression and thematic), and final integration leading to model development.

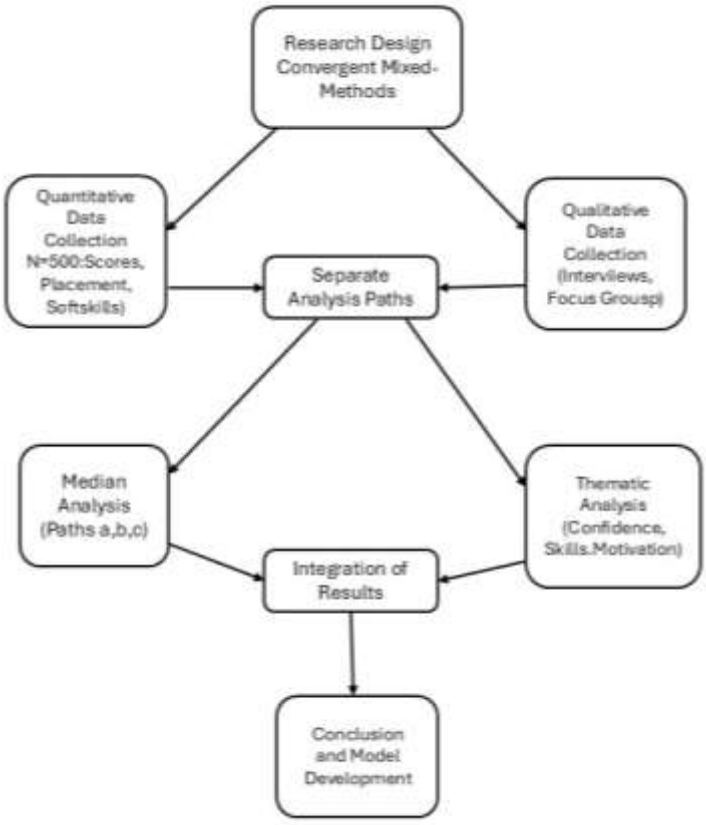

Figure1: Flowchart of Mixed-Methods Methodology for Evaluating CoEs

3.1 Participants and Sampling

The study sample consisted of 500 final-year undergraduate engineering students drawn from five accredited technical institutions located in Hyderabad, India. These institutions were purposefully selected to capture a spectrum of Center of Excellence (CoE) implementation levels - ranging from well-established, fully integrated CoEs to institutions in the

early stages of CoE development. A stratified random sampling technique was employed to ensure representation across various engineering disciplines, including Computer Science, Electronics, Mechanical, and Information Technology. Within each institution, students were categorized into two groups based on their exposure to CoE-related interventions:

- **CoE Participants (n = 240)**: Students who had engaged in one or more CoE initiatives, such as domain-specific training programs, industry mentorship, certification courses, or project-based learning facilitated through CoEs.

- **Non-Participants (n = 260):** Students from the same institutions who had no formal involvement in CoE programs during the study period.

The classification was validated through institutional records, student self-reports, and faculty verification. This grouping enabled a comparative analysis of employability outcomes and served as the basis for conducting the mediation and placement analyses reported in the Results section.

Quantitative data included:

- Academic scores (semester averages, technical project grades)
- Placement outcomes (job offers, salary packages)
- Soft skills ratings (faculty/mentor-rated communication, teamwork, adaptability)

Qualitative data included:

- Semi-structured interviews with 30 students and 10 faculty mentors
- Focus group discussions with student project teams
- Observational notes from CoE training sessions

All participants gave informed consent, and institutional review board (IRB) approval was obtained.

3.2 Mediation Model Framework

To evaluate the indirect influence of CoEs on industry readiness, a mediation model was employed, following the guidelines of Baron and Kenny (1986) (7). The hypothesized model includes:

- Independent Variable (X): Institutional Support - encompassing faculty engagement, CoE infrastructure, and curriculum-industry alignment.
- Mediator (M): CoE Participation - including certifications, hands-on labs, mentorship hours, and industry project exposure.
- Dependent Variable (Y): Industry Readiness - measured using a composite score of placement status, soft skills ratings, and recruiter feedback.

The mediation paths tested include:

1. **Path a:** Institutional support → CoE participation
2. **Path b:** CoE participation → Industry readiness
3. **Path c and c′**: Total and direct effects of institutional support on industry readiness, before and after accounting for the mediator.

3.3 Quantitative Analysis

All variables were standardized prior to regression. The mediation analysis followed three steps:

1. **Step 1:** Regress CoE participation on institutional support (Path a)
2. **Step 2:** Regress industry readiness on CoE participation (Path b)
3. **Step 3:** Regress industry readiness on both institutional support and CoE participation (Path **c′**)

Significance of the mediation effect was tested using the Sobel test and bootstrap confidence intervals (5000 samples).

3.4 Qualitative Analysis

Thematic analysis was conducted using Braun and Clarke's (2006) framework. Transcripts were coded inductively and iteratively. Key themes included:

- Perceived confidence improvement

- Skill acquisition via CoE workshops
- Mentor influence on industry preparedness
- Motivation and self-efficacy

Triangulation with quantitative data ensured consistency and enhanced validity.

4. RESULTS

This section presents the findings from both quantitative and qualitative strands of the study. The results are organized into descriptive statistics, inferential analyses - including mediation and placement outcome comparison- and qualitative themes.

4.1 Descriptive Statistics

Preliminary analysis of the sample (N = 500) revealed the following:

- **CoE Access**: 62% of students reported that their institution hosted a Center of Excellence.
- **CoE Participation:** 48% of all students (240 out of 500) actively participated in CoE-led programs such as certifications, industry-sponsored projects, or mentorships.
- **Placement Outcomes:** Among CoE participants, 68% secured job offers, compared to 41% of non-participants.

These figures suggest a strong association between CoE engagement and student employability.

4.2 Placement Outcome Comparison by CoE Participation

To statistically validate the observed difference in placement outcomes, a two-proportion z-test was conducted comparing job offer rates between CoE participants and non-participants.

Group Sizes and Success Rates:

- CoE Participants: n1 = 240, with x_1 = 163 placed (p_1 = 0.679)
- Non-Participants: n2 = 260, with x_2 = 107 placed (p_2 = 0.411)

The pooled proportion was calculated using Equation (1):

$$p = \frac{163+107}{240+260} = \frac{270}{500} = 0.54 \quad (1)$$

The standard error (SE) and z-statistic were computed Equation(2) and Equation (3):

$$SE = \sqrt{p(1-p)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)} = \sqrt{0.54 \cdot 0.46\left(\frac{1}{240}+\frac{1}{260}\right)} \approx 0.059 \quad (2)$$

$$z = \frac{p_1-p_2}{SE} = \frac{0.679-0.411}{0.059} \approx 4.54 \quad (3)$$

Result: The z-statistic of 4.54 corresponds to a two-tailed $p < 0.001$, indicating a highly significant difference.

The placement rate among CoE participants (68%) was significantly higher than that of non-participants (41%), z = 4.54, p < .001. This provides statistical evidence that CoE engagement is positively associated with employability outcomes.

4.3 Regression-Based Mediation Analysis

To examine whether CoE participation mediates the effect of institutional support on industry readiness, a regression-based mediation analysis (Baron and Kenny, 1986) was conducted. TABLE 1 summarizes the model coefficients.

TABLE 1: Mediation Analysis Results

Path	Coefficient (B)	*t*-value	*p*-value
Path a: Institutional Support → CoE Participation	0.53	7.12	< 0.001
Path b: CoE Participation → Industry Readiness	0.41	5.89	< 0.001
Path c: Institutional Support → Industry Readiness (Total Effect)	0.47	6.35	< 0.001
Path c′: Institutional Support → Industry Readiness (Direct Effect, with Mediator)	0.21	2.91	0.004

The significant reduction in the direct effect (from 0.47 to 0.21) upon including CoE participation in the model indicates a partial mediation effect. These results statistically confirm that CoEs are a key mechanism by which institutional efforts translate into enhanced employability.

4.4 Qualitative Themes

Thematic analysis of interviews and open-ended surveys with students, faculty, and mentors revealed three recurring themes, reinforcing the quantitative findings:

- Confidence Building: Students consistently reported increased self-assurance during interviews and technical discussions, attributing this to real-world project exposure and mentorship provided through CoEs.
- Industry Exposure: Mentorships, internships, and access to contemporary tools enabled students to better understand industry expectations. Faculty and industry mentors echoed this, highlighting improved workplace readiness and domain familiarity among participants.
- Skill Development: CoE programs emphasized tool-based and project-based learning, leading to improved technical proficiency in emerging fields like AI, IoT, and Data Analytics. Students also noted stronger soft skills (e.g., communication, teamwork), validated by mentor evaluations.

The convergence of qualitative and quantitative findings provides strong empirical and experiential support for the proposed mediation model.

5. DISCUSSION

This section interprets the findings considering existing literature, practical implications, and theoretical significance. The study validates the mediating role of Centers of Excellence (CoEs) in translating institutional support into measurable employability outcomes. The implications span institutional strategy, educational policy, and methodological advancement.

5.1 CoEs as Mediators of Industry Readiness

The statistical mediation analysis confirmed that CoE participation partially explains how institutional support (e.g., curriculum design, faculty engagement) influences industry readiness. This aligns with previous work emphasizing the importance of structured learning environments in closing the academic-industry gap. By providing hands-on training, certification programs, and mentorship, CoEs act as operational nodes that convert academic input into job-market relevance.

Quantitatively, the significant reduction in the direct effect (Path c) after including CoE participation (Path c′) demonstrates partial mediation. This reinforces the hypothesis that CoEs are not just supplementary assets, but central enablers in engineering education frameworks.

5.2 Impact on Placement and Employability Metrics

Students engaged with CoEs reported higher job offer rates (68%) compared to non-participants (41%). This is further supported by recruiter feedback and mentor evaluations, which noted superior technical and soft skills among CoE participants. These findings are consistent with national-level employability studies and underscore the importance of experiential learning in improving placement outcomes.

Moreover, the inclusion of real-world projects and certifications within CoE curricula directly addresses recruiter concerns about graduates lacking practical competencies.

5.3 Student Perceptions and Self-Efficacy

Qualitative findings revealed recurring themes of confidence building, enhanced motivation, and a stronger sense of career preparedness. Students described CoE engagements as transformative, particularly in preparing for technical interviews, problem-solving tasks, and collaborative projects.

This affective impact is noteworthy because it extends the discussion beyond skill acquisition to student self-efficacy - a critical but often underexplored dimension in employability research. Higher self-efficacy can lead to better performance in job interviews, internships, and long-term career growth.

5.4 Strategic and Policy Implications

The results suggest that embedding CoEs into institutional strategies can serve as a scalable solution to the persistent employability crisis in India's engineering education system. Institutions are encouraged to formalize CoE participation through curriculum credits, cross functional faculty-industry committees, and dedicated funding models.

From a policy perspective, accrediting bodies like AICTE and NAAC could consider CoE effectiveness as a performance indicator in institutional evaluations. This would incentivize institutions to invest in infrastructure and partnerships that align academic outputs with labor market needs.

5.5 Scope for Generalization and Future Research

Although the study focused on engineering colleges in Hyderabad, the implications are generalizable to other Tier-1 and Tier-2 cities with similar industry-academia dynamics. Future research should examine the longitudinal impact of CoE engagement on career trajectories beyond initial placement, possibly incorporating structural equation modeling (SEM) for more nuanced insights.

Expanding the CoE model to non-engineering disciplines (e.g., business, healthcare, and design) could also offer fertile ground for testing cross-disciplinary applicability.

6. CONCLUSION

This study provides empirical evidence supporting the transformative role of Centers of Excellence (CoEs) in enhancing industry readiness among engineering graduates. By adopting a convergent mixed-methods approach, we were able to triangulate quantitative outcomes— such as improved placement rates, soft skill ratings, and academic performance— with qualitative insights from students, faculty, and industry mentors.

Our mediation model demonstrated that CoE participation significantly mediates the relationship between institutional support and perceived industry readiness. This suggests that CoEs serve not merely as training hubs but as strategic enablers of employability by embedding experiential learning, industry exposure, and mentorship into the academic framework. Qualitative findings further revealed that students attributed gains in confidence, technical competence, and motivation to their engagement with CoEs. These subjective experiences complement the statistical results, emphasizing the holistic value CoEs bring to technical education.

The proposed CEIM (CoE-Employability Integration Model) and the mixed-methods methodology offer practical blueprints for other institutions aiming to align academic curricula with labor market expectations.

Implications: Policymakers and educational leaders can leverage these findings to scale CoE initiatives, integrate industry partners in curriculum co-design, and enhance monitoring using psychometric instruments.

Future Work: Future research may explore longitudinal impacts of CoE participation, variations across disciplines, and cross-institutional comparisons using advanced structural equation modeling and multi-group analysis.

Ultimately, this research advances the discourse on employability analytics by offering validated evidence on the role of structured academic-industry interfaces in preparing graduates for the evolving demands of the workforce.

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