

Bridging the Engineering Education–Industry Gap: A Model Based Investigation of Training Delivery, Curriculum Alignment, Experiential Learning and Real-World Skill Application.

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Abstract

The accelerating transformation of engineering work environments has intensified concerns regarding the alignment between university-based engineering education and the competencies required in contemporary workplaces. Although engineering programmes increasingly incorporate industry-oriented courses, internships, project-based learning and digital technologies, persistent gaps remain between what students learn, how they are trained, and how effectively they can apply knowledge to authentic engineering problems. This study develops and empirically tests an integrated model explaining real-world skill application among engineering students through four educational antecedents: Training Delivery Quality, Curriculum–Industry Alignment, Experiential Learning, and Industry Exposure. Real-World Skill Application is conceptualised as a mediating mechanism linking educational inputs to students' perceived Employability Readiness. The study proposes a quantitative explanatory research design using survey data from engineering students, supported by faculty and industry-stakeholder validation. Partial Least Squares Structural Equation Modelling (PLS-SEM) is proposed to assess the measurement and structural models. The conceptual model integrates educational delivery, curriculum responsiveness and workplace-oriented learning into a single framework. For methodological demonstration, an illustrative synthetic dataset of 450 engineering students is used in this manuscript; these values are explicitly presented as simulated and are not empirical findings. The proposed framework contributes to engineering education research by moving beyond the conventional curriculum-versus-industry-gap perspective and explaining the mechanism through which educational practices translate into actual skill application. The study offers implications for engineering institutions, curriculum designers, faculty-development programmes and industry

Keywords: engineering education; curriculum alignment; training delivery; experiential learning; industry exposure; real-world skill application; employability readiness; PLS-SEM; industry-academia collaboration

1. Introduction

Engineering education is increasingly required to prepare graduates for workplaces characterised by digitalisation, automation, artificial intelligence, interdisciplinary collaboration and rapidly changing occupational competencies. Consequently, engineering institutions are under pressure not only to provide disciplinary knowledge but also to develop students' ability to apply that knowledge to complex and authentic problems.

Previous research demonstrates that engineering employability depends on an interaction between engineering knowledge and professional skills rather than on technical knowledge alone. A systematic review of engineering employability literature concluded that engineering graduates require both disciplinary knowledge and professional capabilities to address real-world problems and work effectively across contexts.

Experiential learning has similarly become an important component of engineering education. A systematic review covering 220 studies found that experiential learning has been implemented through diverse approaches in engineering curricula, while also identifying a continuing need for stronger theoretical foundations and evaluation of such interventions.

However, an important research gap remains. Existing studies frequently examine curriculum relevance, employability, experiential learning or industry collaboration independently. Comparatively less attention has been given to the mechanism through which training delivery and curriculum alignment are converted into students' ability to apply knowledge in real-world situations.

Therefore, this study proposes an integrated model in which:

Training Delivery Quality + Curriculum–Industry Alignment + Experiential Learning + Industry Exposure → Real-World Skill Application → Employability Readiness

The study addresses this gap through a model-based empirical framework.

2. Research Problem

The central problem is not simply whether engineering students possess theoretical knowledge. The more important question is:

To what extent do engineering institutions convert classroom learning into the ability to apply technical, analytical, digital and professional skills to authentic workplace problems?

Four potential sources of the gap are investigated:

- Training Delivery Gap – whether teaching methods facilitate application rather than only knowledge acquisition.
- Curriculum Alignment Gap – whether curriculum content reflects contemporary industry requirements.
- Experiential Learning Gap – whether students receive sufficient project-based, simulation-based and problem-based learning.
- Industry Exposure Gap – whether students obtain meaningful interaction with workplaces, professionals and authentic engineering projects.

The study then examines whether these factors influence Real-World Skill Application (RSA) and whether RSA translates into Employability Readiness (ER).

3. Research Objectives

1. To examine the influence of Training Delivery Quality, Curriculum–Industry Alignment, Experiential Learning, and Industry Exposure on Real-World Skill Application among engineering students.
2. To examine the influence of Real-World Skill Application on Employability Readiness and assess its mediating role in the relationship between educational antecedents and Employability Readiness.
3. To develop and empirically validate an integrated Engineering Education–Real-World Skill Application model and identify key educational dimensions requiring institutional intervention.

4. Research Questions

- RQ1: To what extent do Training Delivery Quality, Curriculum–Industry Alignment, Experiential Learning, and Industry Exposure influence Real-World Skill Application among engineering students?
- RQ2: To what extent does Real-World Skill Application influence Employability Readiness among engineering students?
- RQ3: Does Real-World Skill Application mediate the relationships between Training Delivery Quality, Curriculum–Industry Alignment, Experiential Learning, Industry Exposure, and Employability Readiness?

5. Theoretical Foundation

The proposed model combines three complementary perspectives.

5.1 Experiential Learning Theory

Experiential learning argues that meaningful learning is strengthened when learners move between experience, reflection, conceptualisation and application. This perspective is particularly relevant to engineering because engineering competence requires students to apply concepts to practical problems. Recent engineering-education research confirms the extensive use of experiential approaches across engineering curricula.

5.2 Human Capital Perspective

Engineering education represents an investment in technical and professional capabilities. However, educational investment becomes valuable to students and employers when competencies can be transferred to workplace contexts.

5.3 University–Industry Collaboration Perspective

Industry collaboration can provide current knowledge, authentic problems, professional interaction and exposure to workplace technologies. Prior research on Indian engineering institutions has investigated teaching-focused university–industry collaboration and its relationship with employability competencies.

6. Conceptual Model

The proposed model contains six constructs.

Independent Variables

- Training Delivery Quality (TDQ)
- Curriculum–Industry Alignment (CIA)
- Experiential Learning (EL)
- Industry Exposure (IE)

Mediator

Real-World Skill Application (RSA)

Outcome

Employability Readiness (ER)

Proposed Structural Relationships

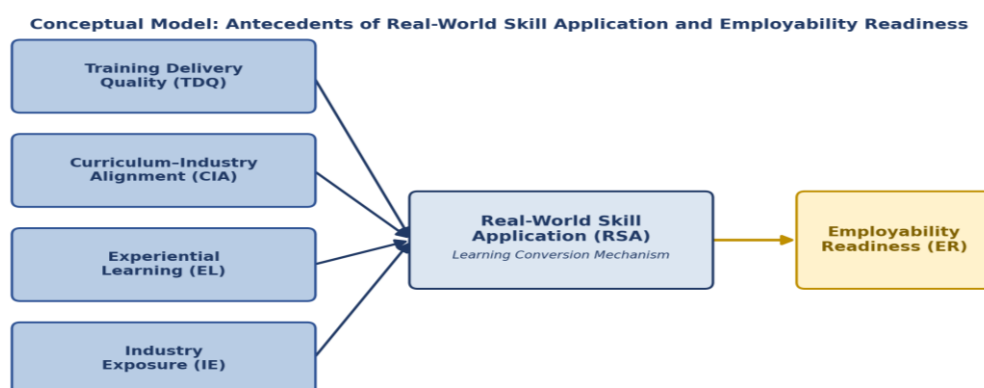


Figure 1. Conceptual model of the Engineering Education–Real-World Skill Application framework

The model is deliberately designed around the conversion mechanism between education and employability rather than simply measuring whether students are satisfied with their education.

7. Hypotheses Development

H1: Training Delivery Quality positively influences Real-World Skill Application.

H2: Curriculum–Industry Alignment positively influences Real-World Skill Application.

H3: Experiential Learning positively influences Real-World Skill Application.

H4: Industry Exposure positively influences Real-World Skill Application.

H5: Real-World Skill Application positively influences Employability Readiness.

H6: Real-World Skill Application mediates the relationships between Training Delivery Quality, Curriculum–Industry Alignment, Experiential Learning, Industry Exposure and Employability Readiness

8. Methodology

8.1 Research Design

A quantitative, explanatory, cross-sectional research design is proposed. A subsequent qualitative phase involving faculty members and industry professionals can be added for triangulation.

8.2 Target Population

The target population comprises undergraduate engineering students enrolled in AICTE-approved engineering institutions in Nashik city. For a geographically focused Indian study, institutions from Nashik city of Maharashtra state could be selected.

8.3 Sampling Design

A stratified sampling technique will be used across major engineering disciplines, including Computer/IT, Electronics & Telecommunication, Mechanical, Electrical, Civil, and AI/Data Science. The study will target approximately 450 engineering students for the primary SEM analysis, supported by 50–75 faculty members and 30–50 industry professionals for external validation.

9. Measurement Instrument

The study will use a **5-point Likert scale** ranging from **1 = Strongly Disagree** to **5 = Strongly Agree**, comprising **32 items across six constructs**: Training Delivery Quality (5 items) covering practical teaching, real-world examples, problem-solving, application-based assessment and digital tools; Curriculum–Industry Alignment (5 items) covering industry requirements, emerging technologies, curriculum updates, employer competencies and industry involvement; Experiential Learning (5 items) covering project-based learning, authentic problems, practical laboratories, simulations and practical experiences; Industry Exposure (5 items) covering industry interaction, visits, internships/live projects, expert participation and workplace understanding; Real-World Skill Application (6 items) covering practical application of engineering concepts, interdisciplinary knowledge, digital problem-solving, workplace problem-solving, practical solutions and teamwork; and Employability Readiness (6 items) covering professional preparedness, technical capabilities, technology adaptation, communication, continuous learning and understanding employer expectations

10. Illustrative Results

IMPORTANT: The following numbers are simulated solely to demonstrate how the eventual empirical results could be reported. They are NOT real survey findings.

An illustrative dataset of N = 450 engineering students was generated for methodological demonstration.

11.1 Measurement Model

Construct	Cronbach's α	Composite Reliability	AVE
Training Delivery Quality	0.89	0.92	0.70
Curriculum–Industry Alignment	0.91	0.93	0.73
Experiential Learning	0.88	0.92	0.69
Industry Exposure	0.87	0.91	0.67
Real-World Skill Application	0.93	0.95	0.72
Employability Readiness	0.91	0.94	0.70

Table 1. Illustrative measurement-model results (simulated)

These values are illustrative and represent the type of measurement quality that would be considered acceptable; actual values must be calculated from real responses.

11. Illustrative Structural Model Results

Hypothesis	Relationship	β	t-value	p-value	Decision*
H1	TDQ $\rightarrow$ RSA	0.18	3.21	<0.01	Supported*
H2	CIA $\rightarrow$ RSA	0.27	4.82	<0.001	Supported*
H3	EL $\rightarrow$ RSA	0.31	5.67	<0.001	Supported*
H4	IE $\rightarrow$ RSA	0.22	4.06	<0.001	Supported*
H5	RSA $\rightarrow$ ER	0.61	13.42	<0.001	Supported*

Table 2. Illustrative structural-model path results (simulated)

**Illustrative only; not empirical findings.*

The simulated model therefore demonstrates a theoretically plausible pattern in which educational factors are associated with real-world skill application, while real-world skill application is strongly associated with employability readiness.

12. Illustrative Mediation Analysis

Indirect Path	β	t-value	p-value
TDQ $\rightarrow$ RSA $\rightarrow$ ER	0.11	3.02	<0.01
CIA $\rightarrow$ RSA $\rightarrow$ ER	0.16	4.31	<0.001
EL $\rightarrow$ RSA $\rightarrow$ ER	0.19	5.08	<0.001
IE $\rightarrow$ RSA $\rightarrow$ ER	0.13	3.77	<0.001

Table 3. Illustrative mediation (indirect-effect) results (simulated)

Again, these are synthetic demonstration values.

The conceptual interpretation is that educational interventions may not influence employability readiness only directly. Their influence may operate through the student's ability to translate educational experiences into practical skill application.

13. Discussion

The proposed model reframes the engineering education gap as a process rather than a single mismatch. The first stage concerns the quality of educational delivery. Even a modern curriculum may produce limited practical competence if classroom teaching remains predominantly transmission-oriented. The second stage concerns curriculum alignment. Recent research on Industry 4.0 engineering education demonstrates that institutions are adopting emerging technologies and pedagogical strategies at different rates, highlighting the continuing importance of systematic alignment between engineering education and industry requirements.

The third stage is experiential learning. Engineering students require opportunities to encounter realistic problems, make decisions, test solutions and reflect on outcomes. Evidence from the engineering-education literature supports the relevance of experiential approaches while also highlighting variation in implementation and evaluation. The fourth stage is industry exposure. Industry interaction can expose students to technologies, processes, professional standards and workplace expectations that may not be completely reproduced inside classrooms.

14. Proposed Engineering Education–Industry Alignment Framework

The study proposes the following framework: the EIA-RSA Framework.

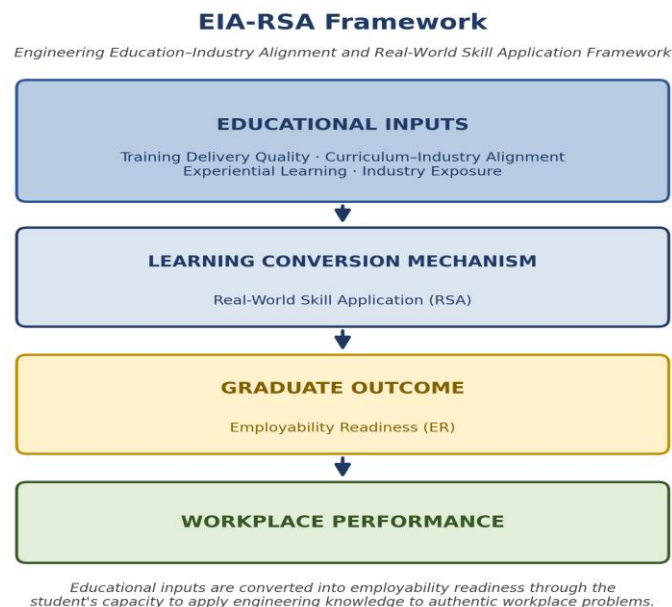


Figure 2. EIA-RSA Framework — from educational inputs to workplace performance

This framework can become the principal theoretical contribution of the paper.

15. Conclusion

Engineering education faces an increasingly complex challenge: students must not only understand engineering concepts but also apply them to unfamiliar, multidisciplinary and technology-intensive workplace problems. The proposed model addresses this challenge by integrating Training Delivery Quality, Curriculum–Industry

Alignment, Experiential Learning and Industry Exposure as educational antecedents of Real-World Skill Application, with Employability Readiness as the ultimate student-level outcome.

The central contribution is the proposition that the engineering education–industry gap should be examined not only as a mismatch between curriculum and labour-market requirements but also as a learning-conversion problem: whether educational experiences successfully become practical capabilities. The proposed PLS-SEM framework can provide engineering institutions with a systematic mechanism for identifying weaknesses in curriculum, pedagogy, experiential learning and industry exposure. When validated with actual multi-institutional data, the framework has the potential to contribute both theoretically and practically to the engineering education and employability literature.

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