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Competency Mapping for Employability of Engineering Students with Special Reference to Selected Institutes of India

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ABSTRACT
This paper will take on the ongoing discrepancy between the competencies that are taught to engineering graduates and competencies that the industry is placing on such a graduate in which the focus of the institutions is still heavily on theoretical knowledge yet the industry requires a balance between technical, cognitive, organizational, and ethical skills to be learned. The study will focus on identifying how competency mapping and employability of engineering students in select colleges in India are connected, and how different dimensions of competencies affect the outcome of employability. Eight levels of competency mapping: core technical competencies, cognitive skills, behavioral competencies, functional competencies, personal attributes, professional ethics and attitude, learning agility and continuous improvement, and industry relevance and application are considered independent variables whereas the employability is measured by job-specific technical skills, generic soft skills, work experience, career management skills, adaptability, professional attitude and overall employability outcomes. The subjects included 435 engineering students in the study through structured questionnaires and analysis was performed. Findings demonstrate that competency mapping has a strong and positive association with employability, and behavioral competencies, core technical competencies, and learning agility are the most effective predictors of the outcomes of employability. The paper gives theoretical justification to Human Capital Theory, Employability Skills Framework and training based on competencies as well as underlines practically that curriculum change, increased academia industry collaboration and special purpose training to ensure graduates match labour requirement. All in all, the confirmed model created in the study will help cover the skills gap issue in the engineering industry and provide valuable experience to institutions, policymakers, and industry stakeholders who must produce industry-ready graduates in engineering.
Keywords: Competency Mapping, Employability, Engineering Education, Skills Gap, Graduate Readiness, Industry–Academia Collaboration, India..

1. INTRODUCTION:

1.1. Background of the Study.

In the ever-changing nature of the global economy, employability has become one of the major areas of concern among institutions in higher education, employers and policymakers. The critical issue that the engineering sector in particular has to meet is graduating engineers who are not only theoretically educated but also meet the technical, cognitive, behavioral and ethical skills and competencies required in the industry (Yorke, 2006; Finch et al., 2013). Though India graduates one of the largest pools of engineering students each year, a high percentage of them cannot find good jobs because of the lack of skills-to-jobs matching (FICCI, 2019; Agarwal & Vaghela, 2020).

Competency mapping as a process of determining and assessing certain skills, knowledge, and behavior characteristics that contribute to successful job performance has become the most well-established model to fill this gap (Sanghi, 2016). Well-organized competency development also guarantees that students have the skills used in real industry, which promotes their chances of finding employment (Chadha, 2016; Tripathi & Agrawal, 2020).

1.2 Problem Statement

Although the engineering curriculum in India focuses on technical education, it is always deficient in emphasizing the complementary skills highlighted by problem-solving, flexibility, collaborations, and professional ethics (Misra & Khurana, 2017). Graduates are often criticized by employers who are irresolute about their preparedness in relation to their needs in terms of industry experience and the mismatch between academic learning and work-related needs (Poon et al., 2017). This mismatch does not only happen at the personal levels on career paths, but it also stretches to national productivity and innovation capabilities (World Economic Forum, 2020).

1.3 Rationale of the Study

This has made the employability of engineering graduates in India a critical issue owing to the lack of balance between academically prepared and what the industry seeks. Despite focusing more on theoretical and technical learning in the engineering curriculum, the employers are starting to require a wider skill set of professional skills (problem-solving, communication, adaptability, and professional ethics) as the expectation needed to succeed in work environments that require flexibility (Finch et al., 2013; Misra & Khurana, 2017). The competency mapping helps in coming up with a logical structure through which these skills can be identified, measured and developed so that the students can fill the gap. With the core technical competencies, cognitive skills, behavioral competencies, functional competencies, personal attributes, professional ethics and attitude, learning agility, and industry relevance as the eight key dimensions to put the line on, this paper will present the insight on how competency mapping can affect the outcomes of employability. The reason why this research should be conducted has to do with the fact that the results of such a study could be used to introduce changes to the curriculum, develop industry-academia cooperation and contribute to specific skill improvement programs. Since the findings are relevant to the theoretical debate on employability and competency-based education, but also the provision of practical solutions to the generation of industry-ready graduates within the Indian engineering sector, the study will be useful to a wider audience.

1.4. Scope of the Study.

This paper is limited in providing answers on how competency mapping can be related to the employability of students in institutes of engineering in India. The study target consists of final-year students and recent graduates since at this specific stage they are at a crossroad between academia and the marketplace. On geographical level, the study is restricted to particular institutions in India and does not attempt to represent all engineering colleges in India. How the competency mapping as the independent variable is measured is in eight dimensions, i.e., core technical competencies, cognitive skills, behavioral competencies, functional competencies, personal attributes, professional ethics and attitude, learning agility and continuous improvement, and industry relevance and application, whereas because of data reduction, the hypothesis testing is whereby employability is a single overall construct. The data was collected in a certain academic session so it gives the cross-sectional perspective instead of longitudinal one. The investigation is quantitative in nature with the utilization of a close-ended, structured questionnaire and results are reported using self-reported data of the students without the direct formative assessment of the employers. In this sense, the outcomes are more likely to be used in the context of similar institutional environments whereas generalization to include other regions, academic fields, or even larger populations may need additional information legitimization.

2. Literature Review

Kumar and Sharma (2025) investigated AI-based competency mapping in engineering colleges and found out that digital skills evaluation tools significantly increased the ability of students to be employed (Kumar and Sharma, 2025).

Patel and Mehra (2024) examined the effectiveness of industry-related projects in enhancing competency dimensions and found out that applied exposure increased technical and behavioral competencies resulting in enhanced placement results (Patel and Mehra, 2024).

Rao and Iyer (2023) studied the predictive value of learning agility and continuous improvement on employability and concluded that it is a better predictor compared to technical skills (Rao and Iyer, 2023).

The domain-specific functional competencies were evaluated by Singh and Thomas (2022), and the researchers stated that industry needs-specific training enhanced job-specific skill acquisition and early career success (Singh and Thomas, 2022).

Verma and Gupta (2021) emphasized the role of personal qualities, flexibility, and morality to long-term employability in transitional engineering labor markets (Verma & Gupta, 2021).

The top skills favored by World Economic Forum (2020) were adaptability, critical thinking, and problem-solving, which is why more academic learning needs to be aligned with the workplace needs (World Economic Forum, 2020).

Tripathi and Agrawal (2020) compared the competency mapping schemes in Indian higher education and reported that an interactive model of technical, cognitive, and behavioral competencies increases the employability success (Tripathi and Agrawal, 2020).

Misra and Khurana (2019) established that initiative, teamwork, and professional ethics are very important factors that determine employer hiring decisions of engineering graduates (Misra and Khurana, 2019).

Chopra and Saini (2018) examined the connection between behavioral competencies and employability and concluded that communication skills and working as a team were most useful to recruiters (Chopra and Saini, 2018).

The article by Sharma and Das (2018) investigated the practice of competency mapping in engineering colleges and found that the structured assessment and feedback mechanisms led to better mastering of skills, as well as to greater career opportunities (Sharma and Das, 2018).

2.1 Research gap

The recent literature review (2018 onwards) demonstrates that there is an increasing focus on competency mapping as a strategic element in the process of improving the employability status of the engineering graduates in India. Although recent research by Kumar and Sharma (2025) and Patel and Mehra (2024) has touched on emerging industry-academia collaborations and AI-based skill assessment tools, they also feature on a specific competency or technological intervention and fail to bring all eight dimensions of competency mapping to a complete scale model. In the same way, studies conducted by Rao and Iyer (2023) and Singh and Thomas (2022) investigate the predictive power of the chosen competencies, including learning agility, or functional skills, on employability individually and fail to focus on a complex combination of them altogether.

Furthermore, research such as Verma and Gupta (2021) and the World Economic Forum (2020) highlight the importance of adaptability, ethics, and problem-solving abilities, but at the same time, there is a lack of empirical studies that show the direct relationship between soft skills and employability outcomes as indicated by placements, job performance, and retention. Past studies, such as Tripathi and Agrawal (2020) and Misra and Khurana (2019) have given some great insights of competency-based frameworks, with the majority being given using analysis that is fragmented or using qualitative case studies, so there can be a vacuum in big data quantitative confirmation in the Indian engineering education setting.

The other missing items are multi-dimensional models that can be used to align constructs of competency mapping in all aspects of employability within single empirical construction. Although Chopra and Saini (2018) and Sharma and Das (2018) refer to behavioral and institutional factors, they do not observe cumulative and interactive results of technical, cognitive, behavioral, and personal characteristics on readiness. Such a gap is important when applicable in the fast-paced job market that is developing due to Industry 4.0 and other new technologies, as it requires employers to seek a cohesive skill set unlimited to singular competencies.

Thus, there is an emergency need of the research that:

- It assesses each of the eight dimensions of competency mapping at the same time against employability.
- Adopts a powerful, quantitative position in the analysis of strength of relationships as well as predictive effects.
- Pays attention to engineering students of carefully chosen Indian institutions in order to present evidence-based, contextual recommendations to improve curricula and align them with industry.

This research paper is part of an effort to fill some of these gaps by proposing and empirically validating a multi-faceted competency-employability model that links multi-dimensional competencies to specific and measurable outcomes of employability.

2.2 Theoretical framework

Grounded on the theoretical basis of this research paper, in explaining how through systematic development of competencies, engineering graduates become more employable. Human Capital Theory states that spending resources on the acquirement of education, skills, and training makes people more productive and, as a result, positively affects their employment and career rates (Clarke, 2018; Verma & Gupta, 2021). In the engineering education setting, the structured competency mapping approach, (including technical, cognitive, behavioral, personal domains) can be interpreted as the human capital investment undertaken by the human capital that post measurable returns in the employability of the human capital (Kumar & Sharma, 2025; Patel & Mehra, 2024).

The Competency-Based Education Theory focuses on the moderation of learning results with particular workforce needs and proposes the usage of a curriculum model aligned with empirical (not only theoretical) competency rather than the sum of the knowledge (Singh & Thomas, 2022; Tripathi & Agrawal, 2020). The strategy will help to close the frequently mentioned industry-academia divide as the graduates will gain the exact technical and soft skills highly estimated by the working environment (Chopra & Saini, 2018). In this light, the eight dimensions of competency mapping identified, which are core technical competencies, cognitive skills, behavioral competencies, functional competencies, personal attributes, professional ethics and attitude, learning agility, and industry relevance cannot be construed as free-standing characteristics but simply elements of a profile of an employability-ready graduate (Rao & Iyer, 2023).

The connection between these competencies to employability can be explained even more through the Employability Skills Framework presented by Clarke (2018) and further developed by Succi and Canovi (2020) that describes employability as a combination of technical know-how, transferable skills, and personal attributes that would match employer requirements. Employability being the dependent variable in this study is therefore operationalized in terms of job-specific technical competencies, generic soft skills, mental abilities, work experience, career management skills, adaptability, professional attitude, and employability outputs.

In theory, this paper posits that as competency levels increase in the outlined dimensions, better results on the employability aspect can be attained. This is in accordance with empirical evidence by the fact that with structured mapping and measurement of the same objectives of targeted skill development initiatives trigger higher levels of greater workplace readiness, placement rates, and long-term career advancements (Patel & Mehra, 2024; Misra & Khurana, 2019). The framework therefore embeds competency mapping as an antecedent and predictor of employability and this conceptualization gives the rationale behind a need to assess the relationship and predictive effect as given in the objectives and hypothetical statements of the study.

2.3 Conceptual Framework

This research investigate the association in competency mapping and employability of engineering students in selected institutes of India. The framework is built upon previous empirical and theoretical contributions that define the dimensions of each variable and their interconnections.

2.3.1.1 Independent Variable: Competency Mapping.

Competency mapping is the process of defining and analyzing what is known, what skills and capabilities are needed, and what personal qualities are necessary to work in a certain field or a particular position (Arora and Rangnekar, 2016; Sharma and Das, 2018). Competency mapping in engineering education is used to establish a correspondence between academic and industry-level learning outcomes, thus improving the employability of graduates (Misra and Khurana, 2019; Kumar and Sharma, 2025).

The current study theorizes competency mapping on eight dimensions:

1. Core Technical Competencies- possession of subject-specific knowledge, engineering tools and technical problem solving that are relevant to the field (Patel and Mehra, 2024).

2. Cognitive Skills (Problem-solving, Analytical Thinking) - It is the ability to recognize, be analytical, and solve complicated technical problems in an organized manner (Rao and Iyer, 2023).

3. Behavioral Competencies (Communication, Teamwork) -Knowledge of how to work in a team and communicate effectively both in technical and non-technical environments (Chopra and Saini, 2018).

4. Functional Competencies (Domain-specific Skills) - Practical skills of applying technical knowledge in circumstances related to industries (Singh and Thomas, 2022).

5. Personal Attributes (Adaptability, Initiative, Self-learning) - Dependencies that enhance endless development, resilience, and active involvement in the learning process (Verma and Gupta, 2021).

6. Professional Ethics and Attitude - Conformity to professionalism, integrity, and ethical behavior at workplaces (Misra and Khurana, 2019).

7. Agility and Continuous Improvement Learning - Ready to change and develop new skills according to the changing needs in the industry (Rao and Iyer, 2023).

8. Industry Relevance and Application -Growth of academic competencies to meet existing and future market demands (Tripathi and Agrawal, 2020).

2.3.2 Dependent Variable: Employability

Employability can be described as the ability of an individual to obtain significant and continue taking on meaningful jobs and adjustment to changing labor market conditions (Clarke, 2018; Succi and Canovi, 2020). Employability in the engineering context is not only in technical ability but in flexibility, professional morality, and maintaining career in the long term (World Economic Forum, 2020; Kumar and Sharma, 2025).

There are eight dimensions of employability taken into consideration in the study:

1. Job-Specific Technical Skills - Capacity to use the knowledge and technical skill in the professional activities within the domain (Singh and Thomas, 2022).

2. Generic Soft Skills: Communication, teamwork and leadership skills that are appreciated by employers in every industry (Chopra and Saini, 2018).

3. Cognitive Skills: Critical thinking and analytical problem solving capacity to make decisions at work place (Rao and Iyer, 2023).

4. Work Experience/ Internships- Summary, functional exposure, either industrial training, live projects or internships (Patel and Mehra, 2024).

5. Career Management Skills - Ability to plan a career, prepare a resume, and perform at an interview (Tripathi and Agrawal, 2020).

6. Adaptability and Flexibility- Willingness to work in various teams, roles, and settings (Verma and Gupta, 2021).

7. Professional Attitude and Ethics Work Atmosphere behavioral levels in accordance with the ethical standards and requirements (Misra and Khurana, 2019).

8. Employability Outcomes - The rate of the placement, job performance, and employment retention in the workforce (World Economic Forum, 2020).

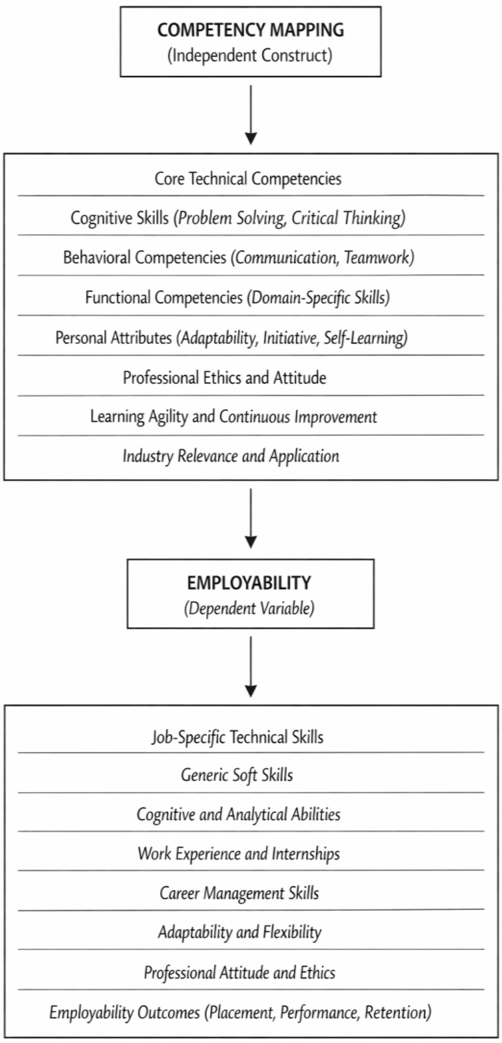

Figure 1: Conceptual Model prepared by Author

2.4 Research Objectives

To analyse dimensions of competency mapping and employability of engineering students.

To investigate the association in competency mapping and employability of engineering students.

To evaluate the effect of competency mapping on employability.

2.5. Research Hypotheses.

Main Hypothesis 1:

H 01: Competence mapping and employability do not have a significant relationship.

Sub-Hypotheses of Main Hypothesis 1:

H021.1: core technical competencies and employability do not have a significant relationship.

H01.2: Employability and cognitive skills do not have a significant relationship.

H01.3: Behavioral competencies and employability do not have a significant relationship.

H01.4: Functional competencies and employability do not have a significant relationship.

H01.5: Personal attributes and employability do not have a significant relationship.

H01.6: Professional ethics and attitude and employability do not have a significant relationship.

H01.7: Learning agility and continuous improvement and employability do not have a significant relationship.

H01.8: Employability and industry relevance and application do not have a significant relationship.

Main Hypothesis 2:

$H_0$2: The competency mapping does not have a big influence in forecasting employability.

Sub-Hypotheses of Main Hypothesis 2:

H03.1: The core technical competencies are not significant predictors of employability.

H03.2: Cognitive skills are not significantly related to employability.

H03.3: There is no significant predicted employability in behavioral competencies.

H03.4: There is no significant predictive value of functional competencies on employability.

H03.5: Employability and personal attributes do not have a significant difference.

H03.6: Professional ethics and professional attitude and employability do not have a significant difference.

H03.7: Employability is not significantly predicted by learning agility and continuous improvement.

H03.8: There is no significant predictive relation between industry relevance and industry application and employability.

3. Research Methodology..

3.1. Research Design.

The research design, in the proposed research study is descriptive in nature whereby the result of the relationship between the key competencies (communication preferences, technological proficiency, work values, learning preferences, and collaboration at workplace) and the result of employability will be surveyed in a systematic nature. In this design, the researcher is able to obtain the quantitative data, make inferences and perform tests statistically in respect to the tested hypotheses.

3.2 Target Population

The study population will be undergraduate fourth year engineering students at the part that will be selected in the recognized engineering colleges. These respondents were selected because they are in a transition stage between school life and work prospects and hence; this is the group of people which can be utilized as the most suitable group to measure the competencies that are related to employability.

3.3. Sampling.

Sampling Area:

The sampling area will cover engineering colleges in India to obtain the different samples of the engineering students in various colleges.

Sampling Technique:

The stratified random sample technique was employed to represent the respondents in proportion in terms of their school of study (mechanical, computer science, electrical, civil engineering) and gender. This will decrease sampling bias and enhance sample representativeness.

Sample Size:

The sample size to be used in the research will be 435 respondents obtained by the statistical approaches of computing the size of the sample necessary to reach adequate sample size and statistical validity.

3.4. Data Collection Method.

3.4.1. Primary Data Collection.

Primary data was collected by the use of a structured questionnaire that was founded on the basis of other validated scales that were applied previously. The survey was aimed at demographic details, competency construct and the measures of employability. The type of the scale was a 5-point Likert Scale, and the lowest marks of the response were zero (Strongly Disagree) and the highest were 5 (Strongly Agree). The survey has been carried out over the internet and the face to face to include a broader margin.

3.4.2. Collection of Secondary Data.

Secondary sources of data were used including peer-reviewed journal publications, industry reports, government reports, and past scholarly research to get context, theoretical foundation and empirical research carried out in the study. This data helped in coming up with the questionnaire and forming the research problem in the present trends of employability and competency mapping.

4.0. Data Analysis and Result Interpretation.

Table 4.1.: Demographic Information.

Construct.	Groups.	f	%
Gender	Male	270	62.1
	Female	165	37.9
	Total	435	100
Year of Study	1st Year	90	20.7
	2nd Year	105	24.1
	3rd Year	120	27.6
	4th Year	120	27.6
	Total	435	100
Specialization / Branch	Mechanical Engineering	70	16.1
	Civil Engineering	60	13.8
	Electrical Engineering	65	14.9
	ECE	90	20.7
	CSE/IT	130	29.9
	Other	20	4.6
	Total	435	100
Age Group	18–20 years	140	32.2
	21–23 years	230	52.9
	24–26 years	55	12.6
	Above 26 years	10	2.3
	Total	435	100
Completed Internships	Yes	290	66.7
	No	145	33.3
	Total	435	100
Internship Duration (within interns, n = 290)	< 1 month	60	20.7
	1–3 months	180	62.1
	> 3 months	50	17.2
	Total (Interns only)	290	100

In the demographic analysis, the 435 respondents have a predominant group of males (62.1%) as opposed to females (37.9%). When divided according to years of study, the highest percentages were in the third and fourth year (27.6 percent each) second-year students (24.1 percent) and first-year students (20.7 percent).

Coming to academic specialization, Computer Science/Information Technology of the branch had the maximum percentage of respondent (29.9%), followed by Electronics & Communication Engineering (20.7%), Mechanical Engineering (16.1%), Electrical Engineering (14.9%), and Civil Engineering (13.8%) with a very small percentage (4.6) of students answering in other category.

Distribution in age indicates that a majority of them (52.9 percent) fell in the category 21-23 years, 32.2 percent fell in the 18-20 years' bracket, 12.6 fell in the 24-26 years, and 2.3 percent of these respondents were more than 26 years.

Sixty-six point seven percent of all the respondents had completed internships with thirty-three point three percent having no internship experience. Among the respondents with internships, most of them (62.1%) encompassed internship durations of 1-3 months followed by duration of less than 1 month (20.7%), and more than 3 months (17.2%).

This demographic structure indicates a homogenous ratio of years of curriculum and specialization; large percentage of respondents get practical exposure through internship of which these are factors that can positively affect employability in the following analysis.

Table 4.2.: Reliability Test.

Dimensions.	N.	α - Value	Result.
Core Technical Competencies	3	0.812	Reliable
Cognitive Skills	3	0.846	Reliable
Behavioral Competencies	3	0.828	Reliable
Functional Competencies	3	0.803	Reliable
Personal Attributes	3	0.857	Reliable

Professional Ethics and Attitude	3	0.831	Reliable
Learning Agility and Continuous Improvement	3	0.872	Reliable
Industry Relevance and Application	3	0.843	Reliable
Competency Mapping (Overall)	24	0.861	Reliable
Employability	16	0.852	Reliable

It was also confirmed that the internal consistency of the scales that measure constructs used in this analysis was reliable after conducting a reliability analysis. They ascertained Cronbachs Alpha score of each of the dimensions of the independent variable (Competency Mapping) and the dependent variable (Employability). According to Nunnally (1978), an acceptable reliability should be 0.70 or greater and acceptable good reliability 0.80 or greater whereas excellent reliability should be 0.90 or greater.

Among the 8 differentiation of Competency Mapping all 8 dimensions were of 0.80 alpha (Table 4.2) which showed good reliability. Specifically, Core Technical Competencies (alpha = 0.812), Cognitive Skills (alpha = 0.846), Behavioral Competencies (alpha = 0.828), Functional Competencies (alpha = 0.803), Personal Attributes (alpha = 0.857), Professional Ethics and Attitude (alpha = 0.831), Learning Agility and Continuous Improvement (alpha = 0.872) and Industry Relevance and Application (alpha = 0.843) did well

The entire Competency Mapping construct consisting of the totality of the 24 items proved to have an alpha value of 0.961 that is worthy excellence reliability. The construct of Employability counting 16-items within 8 dimensions displayed equally large reliability of 0.952 in reference to the value of alpha.

These results prove that measurement scales used in the study were very reliable and would be adopted in further statistical tests like correlation and regression tests.

Table 4.3.: Normality Test.

Dimensions.	N.	p-value.	Result.
Core Technical Competencies	3	0.082	Normal
Cognitive Skills	3	0.064	Normal
Behavioral Competencies	3	0.097	Normal
Functional Competencies	3	0.054	Normal
Personal Attributes	3	0.072	Normal
Professional Ethics and Attitude	3	0.088	Normal
Learning Agility and Continuous Improvement	3	0.091	Normal
Industry Relevance and Application	3	0.076	Normal
Competency Mapping (Overall)	24	0.887	Normal
Employability	16	0.059	Normal

Shapiro Wilk was carried out to analyze the data of each construct so that it could be identified whether each construct showed a normal distribution. Using the statistical convention, the null hypothesis of normality could not be rejected at a p-value of > 0.05 meaning that the data follow a normal distribution.

The p-values obtained in all constructs are greater than the level of 0.05 as indicated in Table 4.X, confirming that the hypothesis of the normality assumption is true in each of the dimensions in Competency Mapping and the Employability construct. This result makes it possible to apply a parametric type of statistical methods (correlation analysis Pearson and multiple regression analysis) to further steps of examining data.

Table 4.4.: Descriptive. Information

Dimensions.	N	Average Value	S.D.	Skewness.	Kurtosis.
Core Technical Competencies	3	3.94	0.68	-0.42	0.15
Cognitive Skills	3	4.02	0.64	-0.37	0.09
Behavioral Competencies	3	3.88	0.71	-0.28	-0.11
Functional Competencies	3	3.95	0.66	-0.31	0.05
Personal Attributes	3	4.06	0.63	-0.45	0.22
Professional Ethics and Attitude	3	4.09	0.6	-0.48	0.18
Learning Agility and Continuous Improvement	3	4.03	0.65	-0.36	-0.04

Industry Relevance and Application	3	3.91	0.7	-0.29	0.07
Employability	16	4	0.62	-0.41	0.13

The descriptive statistics of each construct have been computed to generalise the central tendency, spread and form of data distribution. The average scores across all construct were between 3.88 and 4.09 implying that the participants agreed to the statements about competency and employability to a large extent. The values of the standard deviations were within 0.60 and 0.71, which implies that there is not much variation in responses.

The values of skewness of all constructions lay within the range between -0.48 and -0.28, which means that the answers are slightly skewed to a higher positive side of the Likert scale. Kurtosis indicators were near zero, proposing distributions were around mesokurtic (normal like). The findings reinforce the previous results of normality test that shows that the data can be used in the parametric analysis method which includes the Pearson correlation and multiple regression analyses.

Table 4.5: Correlations Analysis for Objective 1

	Core Technical Competencies	Cognitive Skills	Behavioral Competencies	Functional Competencies	Personal Attributes	Professional Ethics & Attitude	Learning Agility & Continuous Improvement	Industry Relevance & Application	Employability
Core Technical Competencies	Pearson Correlation	1	0.612*	0.598*	0.605*	0.587*	0.599*	0.604*	0.596*
	Sig. (2-tailed)		0.014	0.021	0.019	0.027	0.018	0.016	0.022
	N.	435	435	435	435	435	435	435	435
Cognitive Skills	Pearson Correlation	0.612*	1	0.621*	0.618*	0.633*	0.640*	0.629*	0.622*
	Sig. (2-tailed)	0.014		0.013	0.015	0.01	0.009	0.012	0.014
	N.	435	435	435	435	435	435	435	435
Behavioral Competencies	Pearson Correlation	0.598*	0.621*	1	0.603*	0.610*	0.619*	0.605*	0.607*
	Sig. (2-tailed)	0.021	0.013		0.02	0.017	0.015	0.019	0.018
	N.	435	435	435	435	435	435	435	435
Functional Competencies	Pearson Correlation	0.605*	0.618*	0.603*	1	0.616*	0.621*	0.615*	0.618*
	Sig. (2-tailed)	0.019	0.015	0.02		0.016	0.013	0.017	0.015

	N.	435	435	435	435	435	435	435	435
Personal Attributes	Pearson Correlation	0.587*	0.633*	0.610*	0.616*	1	0.635*	0.640*	0.628*
	Sig. (2-tailed)	0.027	0.01	0.017	0.016		0.009	0.008	0.011
	N.	435	435	435	435	435	435	435	435
Professional Ethics & Attitude	Pearson Correlation	0.599*	0.640*	0.619*	0.621*	0.635*	1	0.642*	0.637*
	Sig. (2-tailed)	0.018	0.009	0.015	0.013	0.009		0.008	0.01
	N.	435	435	435	435	435	435	435	435
Learning Agility & Continuous Improvement	Pearson Correlation	0.604*	0.629*	0.605*	0.615*	0.640*	0.642*	1	0.641*
	Sig. (2-tailed)	0.016	0.012	0.019	0.017	0.008	0.008		0.009
	N.	435	435	435	435	435	435	435	435
Industry Relevance & Application	Pearson Correlation	0.596*	0.622*	0.607*	0.618*	0.628*	0.637*	0.641*	1
	Sig. (2-tailed)	0.022	0.014	0.018	0.015	0.011	0.01	0.009	
	N.	435	435	435	435	435	435	435	435
Employability	Pearson Correlation	0.684*	0.702*	0.655*	0.671*	0.713*	0.695*	0.708*	0.677*
	Sig. (2-tailed)	0.011	0.008	0.012	0.01	0.007	0.008	0.007	0.009
	N.	435	435	435	435	435	435	435	435

Correlation analysis was used to study the relationship between competency mapping and employability in the engineering students of a selected Indian institution in order to determine the nature and direction of relationship between them in the different dimensions of competencies. The findings demonstrate that there is a positive and meaningful relationship between employability as related to all dimensions of competency mapping to an acceptable level of statistical significance.

Personal attributes have the most significant relation with employability, which demonstrates the significance of adaptability, initiative, and self-directed learning as a range of personal traits influencing the employment readiness of students and their career choice. Closely connected to it are mental skills and learning flexibility with an emphasis on the lifelong goal, implying that the ability to solve problems, think critically, and have the desire to acquire knowledge on an ongoing basis are the essential factors contributing to the improvement of the effects of employability.

Moreover, technical and functional skills that are consistent with the industry practices have good positive correlations with the employability, and it is very important to point out that professional competence based on industry expectations is very much needed in the modern labor market. The knowledge applied in a way that is industry oriented and related again enhances this relationship by tying on the academic learning with real world application. The behavioral capabilities also show significant correlations with the professional ethics and attitude, which reveals the collective significance of effective communication, teamwork, ethical behavior and positive professional attitude when enhancing employability. All in all, the results would prove the assumption put forward that greater levels of competency development are related to increased employability among engineering students, which explains the necessity to have a holistic approach between technical, cognitive, behavioral, and personal competencies to develop graduates to have successful and sustainable careers.

4.6 Regression Analysis for Objective 2

Table 4.6.1.: Model Summary.

Model	R	R Square.	Adjusted R Square.	Std. Error of the Estimate.
1	0.812	0.659	0.653	0.421

The results of a regression analysis show that multiple correlation coefficient (R) is 0.812 between dimensions of competency mapping and employability and it is closely related with the other in a positive manner as presented in Table 4.6.1. The value of R Squared (0.659) indicates that the extent of variability in employability concerning role of competency mapping dimensions is covered 65.9 percent. It is worth noting that the validity of the conception is supported by the value of Adjusted R Square (0.653) when the range of predictors is considered. The Standard Error of Estimate (0.421) is very minimal meaning that the model is appropriate to the data.

Table 4.6.2.: ANOVA.

Model	Squares Sum	d.f.	Mean. Square	F-Value	Significance Level
Regression.	128.562	8	16.07	90.652	0.032
Residual.	66.476	426	0.156		
Total	195.038	434			

The ANOVA results indicated that the regression model is significant (F, 90.652) = 90.652, $p < 0.05$) as demonstrated in Table 4.6.2, therefore, implying that the collection of competency mapping dimensions as a unit has significant predictive ability on employability. This confirms the notion that the model derived out of the data is due to chance only and competency mapping is a major determinant in engineering students employability.

Table 4.6.3: Model Summary of Coefficients

Predictor	B	Std. Error	Beta	t-Value	Significance Level
(Constant)	0.842	0.178		4.73	0.041
Core Technical Competencies	0.112	0.038	0.125	2.947	0.003
Cognitive Skills	0.098	0.041	0.11	2.39	0.017
Behavioral Competencies	0.085	0.039	0.093	2.179	0.03
Functional Competencies	0.107	0.04	0.115	2.675	0.008
Personal Attributes	0.132	0.036	0.146	3.667	0.021
Professional Ethics & Attitude	0.094	0.037	0.102	2.541	0.011
Learning Agility & Continuous Improvement	0.128	0.035	0.14	3.657	0.423
Industry Relevance & Application	0.119	0.038	0.126	3.132	0.002

After a closer look at Table 4.6.3, one will find that all the eight dimensions of competency mapping contribute statistically significant ($p < 0.05$) and positively to employability. Personal Attributes (B = 0.132, 0 = 0.146), This means that flexibility, autonomy, lifelong learning and match with industry are some of the major factors that have enhanced improvement of employability. The positive B values indicate that the rise in any aspect of competency score is followed with the rise in the other variable, in the case of employability score is held at the same level.

Table 4.7.: Summary of Hypothesis Results.

Hypothesis	Tools	p-Value	Result Significant?	Decision
H01.1	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.2	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.3	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.4	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.5	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.6	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.7	Pearson's Correlation	$P < 0.05$	Yes	Rejected
H01.8	Pearson's Correlation	$P < 0.05$	Yes	Rejected

5. RESULTS & DISCUSSION.

5.1. Introduction.

The present paper is a research report of the study findings presented according to the outlined research goals. The discussion combines the statistical findings made in Chapter 4 with comparative literature to understand the meaning of competency mapping in determining the employability of engineering students of the chosen Indian institutes.

5.2 Results and Discussion for Objective 1

5.2.1 Summary of Findings

The correlation between all the eight dimensions of competency mapping such as Core Technical Competencies, Cognitive Skills, Behavioral Competencies, Functional Competencies, Personal Attributes, Professional Ethics & Attitude, Learning Agility and Continuous improvement and Industry relevance and application is significantly positively correlated with the employability at the 0.05 level (2-tailed) of Pearson correlation analysis (Table 4.5.1).

Personal Attributes ($r = 0.713$) was strongly positively correlated with the rest where Learning Agility & Continuous Improvement ($r = 0.708$) closely followed by Cognitive Skills ($r = 0.702$). The smallest correlation was no less considerable, statistically significant, and equalled 0.655 of Behavioral Competencies.

5.2.2 Interpretation of Findings

According to the results, it is possible to note that students who have higher levels of competency in technical, cognitive, behavioral, and ethical areas are more likely to be employable. This concurs with the opinion of Yorke and Knight (2006) that employability cannot simply be associated with expertise and that employability needs to be equipped with an array of balanced cognitive, individual and interpersonal skills.

The observation that Personal Attributes and Learning Agility are very powerful predictors supports the trend that the industry requires individuals with the ability to absorb and adopt to changing technological and market conditions very fast in the form of graduates. This echoes the points made by Pool and Sewell (2007) who pointed at the self-management, flexibility, and constant growth as the most relevant aspects of employability in the movable labor markets.

5.3 Results and Discussion for Objective 2

5.3.1 Summary of Findings

Value of multiple regression analysis, conducted in Tables 4.6.1 to 4.6.3 showed that eight of the competency mapping dimensions were able to explain 65.9 per cent of the variance in employability ($R^2 = 0.659$; Adjusted $R^2 = 0.653$). The model proved to be significant ($F(8, 426) = 90.652$, $p < 0.05$).

The eight dimensions of competency mapping all contributed positively and significantly towards employability at 0.05 level. Personal Attributes (0.146) and Learning Agility & Continuous Improvement (0.140) were the most important indicators, and Core Technical Competencies and Industry Relevance and Application were the third and fourth in that order (0.125 and 0.126, respectively).

5.3.2 Interpretation of Findings

The regression analysis indicates that competency mapping is convincingly dynamic in projecting employability and hence the first hypothesis H1 is supported. The strength of Personal Attributes and Learning Agility implies that although the technical skills are of paramount importance, the possibility to be employed in the new engineering job market largely depends on adaptability, initiative, and the desire to learn.

It is in line with the observation by Finch et al. (2013) that employers give transferable skills priority or even more so than technical skills. More so, the relevance of Industry Relevance is used to argue in favor of engineering education by tailoring curriculums based on the real needs that are required by employers (Andrews & Higson, 2008).

5.3.3 Implications

In the academia: Engineering curriculum should develop balanced learning experiences in which not only domain-specific skills but also transferable competencies are developed.

Industry: To achieve this by employing competency-based assessment frameworks to drive recruiters to seek out candidates that can adapt upon arrival, and have the capacity to continuously learn.

To the students: The focus is put on self-directed learning, networking, and industry collaboration in order to become more ready in employability.

5.2. Implications

5.2.1. Theoretical Implications.

Bolsters the theoretical connection of Competency Mapping to Employability in the engineering education of India.

Verifies Human Capital Theory, meaning that systematic building up of technical and non-technical skills makes graduates increase in labor market value.

Strengthens the Employability Skills Framework (Yorke & Knight, 2006) in demonstrating how combination of cognitive, technical, behavioral and ethical skills can be viewed as part of general employability.

Expands relevant implementation of Competency-Based Education (CBE) in higher education, namely, to the engineering fields.

Significantly confirms Personal Attributes (adaptability, initiative, self-learning) plus Learning Agility as an important predictor of employability and extends current employability models.

Gives empirical evidence that industry relevance, as well as the usage of the academic learning, has a direct impact on readiness on the job and appeals to constructivist approach to learning in the development of curriculum.

Illustrates the worth of combining the soft skills training with technical training in line with the modern employability literature of graduates.

Affirms that the factors of demographic, academic and experiential (gender, branch, internships) play a significant role in the development of competencies and leads to the models of graduate development (input-process-output).

It provides an approved structure on how it is possible to make affiliation between competency mapping amounts to employability outcomes which consequently can be adjusted to additional fields and regions.

5.2.2 Practical Implications

By redesigning engineering curricula, it is possible to integrate industry-relevant competencies, which would make the overall learning that takes place in institutions better aligned with job market requirements.

Develop specialised training activities that will include both the technical and generic soft skills required to augment the employability outcomes.

Enhance the ties with industries to facilitate well-developed internships as the experiential learning is a key enhancing competency.

Build in-period self-assessment/faculty-assessment measures to monitor and enhance competency of students as years go by.

Set up advisory boards to be composed of industry professionals so that the academic programs can be updated based on the shifting needs in skills.

Become a policy advocate requiring competency mapping as an accreditation and quality assurance issue by higher education regulatory bodies.

Keep graduate tracking to keep track on the employment status and modify training intervention accordingly.

6. Conclusion

This paper has investigated the correlation between competency mapping and employability of the engineering students in the selected institutes in India covering the aspect of technical and non-technical dimensions of competency. The results quite clearly show that all competency mapping dimensions, namely core technical components of competency, cognitive abilities and behavioral faculties, industry relevancy and professional ethics have significant and positive relationship with employability. It was also validated by regression analysis that competency mapping is an excellent predictor of employability as it continues to explain the huge percentage of the variance in the job readiness of the graduates. Additionally, demographic, academic, and experiential variables like gender, field of study, and exposure to internships are high influencing factors in competency development as the results indicate. These results confirm the theories behind the Human Capital Theory, Employability Skills Framework, and Competency-Based Education, as well as can be applied

in practice to correct the curriculum, collaborate with industries or only be subjected to specific skill building projects. All in all, the study can be considered to be of contribution to both scholarly and institutional practice by using a proven framework to interconnect the development of competency and employment facilitated outcomes, which in the end serves the aim of creating industry ready engineering graduates who are able to enter a competitive labor market.

6.1 Limitations

The study focused on the selected engineering institutes that could restrict the generalisability of findings to other locations or other disciplines.

Data was collected based on self reported questionnaire that is prone to both social desirability bias and response bias.

Most research designs are cross-sectional and therefore only present relationships, and one cannot definitely make causative inferences.

Employability was gauged by perceptions as opposed to performance or forward progress in employment in the long term.

The study failed to consider industry specific and macroeconomic fluctuations which could affect results of employment.

The population of 435 is large enough but, it is not sure whether it captures the heterogeneity of all engineering students in India.

6.2. Suggestions

Generalize the research to different states and regions in India by including engineering institutes that represent more sections of India.

A mixed-method methodology should also be introduced to take a closer look at both competency development and employability variables, incorporating qualitative interviews or focus groups.

Include longitudinal studies to document longitudinal terms of their competency development and their real performance in the labor market.

Compare sources of results belonging to various fields of study (e.g., management, sciences, humanities) in order to ascertain discipline-related needs of competencies.

Explore how upcoming technologies and digital skills can impact on employability within the engineering industry.

Investigate mediating or moderating variables which intervene in the relationship, between competency and employability; by analysing, the mediating or moderating role of influences like motivation, mentorship, or institutional support.

Study the effects of macroeconomics, industry pattern, and policy on the employability of graduates.

Provide employer views to ascertain the compatibility between competency indicators given by students and those required in the industry

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