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Assessment of Employability-Oriented Technical and Communication Skills among Rural and Urban Students in SPSR Nellore District, Andhra Pradesh

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Abstract: This study was undertaken with the descriptive-cum-diagnostic aim of assessing the level of employability-oriented technical and communication skills among rural and urban college students in SPSR Nellore District, Andhra Pradesh, and examining how these skill dimensions relate to one another and to students' perceived employability. The employability framework considered in the study comprises eight constructs: technical skills, communication skills, digital literacy skills, soft skills and teamwork, career guidance and counselling, industry exposure/internship, employability self-efficacy, and perceived employability. The findings revealed that all eight constructs were positively and significantly inter-correlated ($p < 0.01$), with employability self-efficacy exhibiting the strongest association with perceived employability ($r = 0.750$, $p < 0.01$). Principal Component Analysis with Varimax rotation extracted eight components. The PLS-SEM measurement-model assessment showed composite reliability values ranging from 0.864 to 0.893 and average variance extracted values ranging from 0.561 to 0.626 across the eight constructs. The structural model indicated a strong positive relationship between Employability Self-Efficacy and Perceived Employability ($\beta = 0.832$, $p < 0.001$). The six antecedent constructs also showed positive and significant relationships with Employability Self-Efficacy, with path coefficients ranging from 0.168 to 0.241 (all $p < 0.001$). The age-group analysis showed a nominally significant difference in Digital Literacy Skills ($p = 0.046$), although this finding was not statistically significant after Bonferroni adjustment. The study adopted a descriptive-cum-diagnostic research design using a structured questionnaire based on a five-point Likert scale. The study collected 454 valid responses from rural and urban undergraduate and postgraduate students in SPSR Nellore District. The 40-item instrument showed high reliability (Cronbach's Alpha = 0.944). The findings may offer insights into the employability-related skill readiness of college students in rural and urban district contexts.

Keywords: Employability skills, technical skills, communication skills, digital literacy, soft skills, employability self-efficacy, perceived employability.

1 Introduction

The employability of college-going youth has emerged as a pressing concern for higher education institutions, industry, and policymakers in contemporary India. Employability is no longer restricted to the mere possession of a degree certificate; it is increasingly understood as a combination of technical competencies, communication proficiency, digital literacy, soft skills, career readiness, and self-belief that together enable a graduate to secure, sustain, and progress in gainful employment [1], [2]. In a rapidly digitalising and competitive labour market, employers consistently report a gap between the skills fresh graduates possess and those industry demands, particularly in communication, problem-solving, and other non-technical competencies [3], [4]. This gap may be more pronounced among students from rural and semi-urban backgrounds, where access to digital infrastructure and opportunities to develop technology-related skills may be comparatively limited [5], [6].

SPSR Nellore District of Andhra Pradesh, with its mixed rural and urban setting, offers a relevant context for examining the employability-skill profiles of students from diverse socio-economic and geographic backgrounds. The present study, therefore, was undertaken to assess the level of employability-oriented technical and communication skills among rural and urban students in the district and to examine the reliability and underlying component structure of the employability-skills instrument through reliability analysis, Principal Component Analysis, correlation analysis, and analysis of variance across age groups. Such an assessment is valuable to career-guidance cells, training and placement officers, curriculum planners, and policy makers entrusted with bridging the skill gap and enhancing the employability of the student community.

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The employability framework considered in the present investigation comprises eight constructs: technical skills, communication skills, digital literacy skills, soft skills and teamwork, career guidance and counselling, industry exposure/internship, employability self-efficacy and perceived employability. Informed by the employability literature, these constructs collectively cover both the technical and interpersonal competencies associated with readiness for the world of work and the psychological and perceptual aspects of employability. In particular, employability self-efficacy reflects students' confidence in their ability to apply their skills, while perceived employability represents their assessment of their prospects in the labour market [7], [8].

2 Review of Literature

Employability has been defined as a set of achievements, including skills, understandings, and personal attributes, that make an individual more likely to gain employment and succeed in their chosen occupation, benefiting themselves, the workforce, the community, and the economy [9]. The CareerEDGE model of graduate employability conceptualises employability in terms of career development learning, work experience, degree subject knowledge, generic skills, emotional intelligence, and reflective practice. These elements are proposed to contribute to the development of a student's self-efficacy, self-confidence and self-esteem [10]. Further research by Dacre Pool and Qualter [11] examined the relationship between emotional self-efficacy, graduate employability and career satisfaction, highlighting the importance of psychological resources in students' and graduates' career development.

A considerable body of research distinguishes between subject-specific technical skills and generic or transferable skills. While technical competence remains important, generic skills such as communication, teamwork, problem-solving and self-management are also widely recognised as important attributes of graduate employability [12]. Employers across sectors place considerable importance on oral and written communication skills, although the skill gap may vary by occupation and sector. Research on newly graduated engineers in India has also highlighted the importance employers place on soft skills, communication, and professional competencies [13]. Graduate employability has also been conceptualised as a form of identity and career capital that students actively develop through a combination of human capital, social capital, and psychological resources accumulated during their course of study [14].

Digital literacy has increasingly been recognised as an important employability skill, particularly amid technological developments and changing workplace requirements. It encompasses the ability to use digital tools for communication, information retrieval, collaboration, and problem-solving in academic and workplace settings [15]. Differences in access to computers, internet connectivity, and digitally enabled learning opportunities may influence students' opportunities to develop these competencies. Career guidance and counselling services within higher education institutions are also relevant to students' career development, as they can support career decision-making, goal setting, and employment preparation [16].

Industry exposure through internships, industrial visits, and live projects provides students with opportunities to connect classroom learning with practical work situations. These experiences can help students understand workplace expectations and apply their knowledge and skills [17]. Employability self-efficacy, which refers to a student's confidence in their ability to undertake career-related tasks and navigate the employment process, is another important dimension of graduate employability. Research has examined its relationship with self-perceived employability and other career-related outcomes [11]. At the national level, employability surveys among Indian engineering and degree graduates have also highlighted gaps between graduate capabilities and employer expectations, particularly in technical and other workplace competencies.

The rural–urban context is also relevant to studying employability skills in India. Research on newly graduated engineers in India has identified differences in employer expectations and skill requirements across sectors, company sizes and regions [13]. However, employability skill development should not be viewed solely as an individual student's responsibility. Curriculum design, teaching practices and the extent of industry–academia interaction available to an institution also influence students' opportunities to develop workplace-related competencies [18]. Taken together, the literature suggests that employability is a multidimensional construct in which technical skills, communication skills, digital literacy, soft skills, career guidance, industry exposure and psychological resources are inter-related and associated with students' perceived employability [14], [19]. The present research study aimed at answering the following research questions (RQs):

- RQ1: What is the level of technical, communication, digital literacy, and allied employability skills among the students in SPSR Nellore District?
- RQ2: How are the various dimensions of employability skills inter-related with one another and with perceived employability?
- RQ3: Do the employability-skill dimensions of the respondents differ significantly across age cohorts of the students?
- RQ4: Does the employability-skills instrument demonstrate acceptable internal consistency and an identifiable component structure?

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This study makes two contributions to the literature on graduate employability. First, it examines the inter-relationships among technical skills, communication skills, digital literacy, soft skills and teamwork, career guidance and counselling, industry exposure, employability self-efficacy and perceived employability among a mixed rural–urban student sample. It thereby provides evidence from SPSR Nellore District, an area that has received comparatively limited attention in research on graduate employability in Andhra Pradesh. Second, it examines the reliability and underlying component structure of the employability-skills instrument through reliability analysis, correlation analysis, and Principal Component Analysis. The findings may provide a useful basis for further assessment of employability-related skills by training and placement cells and other higher education stakeholders.

2.1. Factors in the Present Study

The factors considered in the present study can be broadly categorised into two groups: skill-based antecedent factors and outcome/perceptual factors. The skill-based antecedent factors comprise technical skills, communication skills, digital literacy skills, soft skills and teamwork, career guidance and counselling, and industry exposure/internship. These factors represent the competencies and developmental opportunities that may contribute to students' employability-related preparedness during their course of study. The outcome/perceptual factors comprise employability self-efficacy and perceived employability, which represent students' confidence in their ability to undertake career-related tasks and their assessment of their prospects in the labour market, respectively. Students must be viewed as active stakeholders in their own skill development, while institutions have an important role in providing structured opportunities through training, mentoring, internships and counselling [20]. From this perspective, employability is neither a purely individual attribute nor a purely institutional outcome; it is shaped by the interaction between students' capabilities and the opportunities provided by educational institutions and the wider employment environment [14].

3 HYPOTHESIS DEVELOPMENT

This study explores the levels and interrelationships of employability-oriented technical, communication, and allied skills among rural and urban students. It also examines the instrument's reliability and component structure. The employability-related constructs considered in the study include technical skills, communication skills, digital literacy skills, soft skills and teamwork, career guidance and counselling, industry exposure/internship, employability self-efficacy, and perceived employability. Based on the relevant literature, these dimensions are important for understanding students' preparedness to enter the competitive job market. The following hypotheses are proposed for the present study.

- H1: The various dimensions of employability skills, employability self-efficacy, and perceived employability are significantly and positively correlated.
- H2: Employability self-efficacy is significantly and positively associated with students' perceived employability.
- H3: Employability-skill dimensions differ significantly across age groups.
- H4: The antecedent employability-skill constructs (Technical Skills, Communication Skills, Digital Literacy Skills, Soft Skills and Teamwork, Career Guidance and Counselling, and Industry Exposure/Internship) have significant positive direct relationships with Employability Self-Efficacy.

H1 focuses on the various dimensions of employability skills, which are expected to be positively inter-related and positively associated with employability self-efficacy and perceived employability. The literature suggests that technical, communication, digital, and soft skills, together with career guidance and industry exposure, are important aspects of a student's employability profile. Therefore, examining the relationships among these dimensions helps clarify how the different aspects of employability relate to one another.

H2 focuses on the employability self-efficacy being significantly and positively associated with perceived employability. Self-efficacy reflects a student's belief in their capability to undertake career-related tasks and navigate the employment process. The CareerEDGE model identifies self-efficacy as an important psychological resource in graduate employability [10]. Therefore, students with higher employability self-efficacy are expected to report higher levels of perceived employability.

H3 examines whether the employability-skill dimensions differ across age groups. Students belonging to different age groups may have varying levels of exposure to academic activities, skill-development opportunities, internships, and career-guidance services. Therefore, the present study examines whether significant differences exist in the employability-skill dimensions across respondents' age groups.

H4 focuses on the antecedent employability-skill constructs, which are expected to have significant positive direct relationships with Employability Self-Efficacy. In line with the CareerEDGE framework, technical, communication, digital, and interpersonal competencies, together with career guidance and industry exposure, are considered important aspects of students' career development. The study therefore examines whether these six constructs are positively associated with students' confidence in their ability to compete for and secure employment.

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In addition to the above hypotheses, Principal Component Analysis is used as an exploratory technique to examine the underlying component structure of the employability-skills instrument. The analysis considers whether a smaller set of components can represent the observed items.

4 Research Methodology

4.1. Research Design

The present study adopts a descriptive-cum-diagnostic research design to assess the prevailing level of employability-oriented technical, communication, and allied skills among rural and urban students and to examine inter-relationships among the different dimensions of employability and the instrument's underlying component structure.

4.2. Area and Population of the Study

The study was confined to SPSR Nellore District, Andhra Pradesh, covering undergraduate and postgraduate students enrolled in engineering, degree, and management colleges in both rural and urban areas of the district.

4.3. Sample Size and Sampling Technique

A total of 454 valid and usable responses were collected from students in SPSR Nellore District. A stratified random sampling technique was applied, with age cohort (below 18 years, 18–20 years, 21–23 years, and above 23 years) and locality (rural/urban) as stratifying variables, to ensure representation across these categories.

4.4. Instrument and Measurement

Data were collected through a structured questionnaire comprising 40 items measured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with five items each devoted to the eight constructs of the study: Technical Skills (TSK), Communication Skills (COM), Digital Literacy Skills (DGL), Soft Skills and Teamwork (SFT), Career Guidance and Counselling (CGD), Industry Exposure/Internship (IND), Employability Self-Efficacy (ESE), and Perceived Employability (PEM). The items were designed to capture students' perceptions across these eight dimensions of employability.

4.5. Statistical Tools Applied

The collected data were analysed using the Statistical Package for Social Sciences (SPSS) and SmartPLS. The statistical techniques applied include descriptive statistics (mean and standard deviation), Cronbach's Alpha for assessing internal-consistency reliability, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity, Pearson Product-Moment Correlation to examine the relationships among the constructs, and Principal Component Analysis with Varimax rotation to explore the underlying component structure of the instrument. One-way Analysis of Variance (ANOVA) was used to examine differences in the employability-skill dimensions across age cohorts. In addition, PLS-SEM was used to assess the measurement and structural models and examine the relationships among the study constructs.

5 Data Analysis and Results

5.1. Demographic Profile of the Respondents

Table 1 presents the demographic distribution of the 454 respondents. The sample reflects a fairly balanced distribution of rural and urban students, with 52.4% from rural areas and 47.6% from urban areas. By age, the largest proportion of respondents (36.3%) belonged to the 18–20 age group. Most respondents (68.7%) were undergraduate students.

Table 1. Demographic profile of respondents.

Demographic Variable	Category	Frequency (N)	Percentage (%)
Locality	Rural	238	52.4
	Urban	216	47.6
Gender	Male	251	55.3
	Female	203	44.7
Age Group	Below 18 years	129	28.4
	18-20 years	165	36.3
	21-23 years	113	24.9
	Above 23 years	47	10.4
Level of Study	Undergraduate	312	68.7
	Postgraduate	142	31.3
Total		**454**	**100.0**

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5.2. Reliability and Sampling Adequacy

Before proceeding to the substantive analysis, the instrument's internal consistency and the data's suitability for component analysis were examined. As shown in Table 2, the overall 40-item scale returned a Cronbach's alpha of 0.944, while the alpha values for the eight individual constructs ranged from 0.831 to 0.869. All values exceeded the conventionally accepted threshold of 0.70 [21], indicating satisfactory internal consistency for the present sample.

Table 2. Construct-wise reliability statistics.

Construct	No. of Items	Mean Score	Cronbach's Alpha
TSK	5	3.2894	0.861
COM	5	3.3035	0.866
DGL	5	3.3070	0.869
SFT	5	3.2868	0.867
CGD	5	3.3075	0.858
IND	5	3.3079	0.862
ESE	5	3.2907	0.831
PEM	5	3.3115	0.857
Overall Scale	**40**	**3.2999**	**0.944**

The KMO Measure of Sampling Adequacy was 0.898, indicating high sampling adequacy. Bartlett's Test of Sphericity was also statistically significant ($\chi^2(780) = 9846.32$, $p < 0.001$), indicating that the correlation matrix was not an identity matrix. These results suggest the data were suitable for examining the instrument's underlying component structure (Table 3).

Table 3. KMO and Bartlett's test.

Sampling Adequacy Test	Value
KMO Measure of Sampling Adequacy	0.898
Bartlett's Test of Sphericity - Approx. Chi-Square	9846.32
Bartlett's Test of Sphericity – df	780
Bartlett's Test of Sphericity – Sig.	$p < 0.001$

5.3. Correlation Analysis

Table 4 presents the Pearson correlation matrix among the eight study variables. All the inter-construct correlations were positive and statistically significant at the 0.01 level (two-tailed), supporting Hypothesis H1. Employability self-efficacy showed the strongest correlation with Perceived employability ($r = 0.750$, $p < 0.01$), supporting Hypothesis H2 and indicating a strong positive association between students' confidence in their career-related capabilities and their perceived employability. Industry exposure/internship also showed a comparatively strong association with Employability self-efficacy ($r = 0.502$, $p < 0.01$), suggesting that students reporting greater industry exposure also tended to report higher employability self-efficacy.

Table 4. Pearson correlation matrix among study variables.

Construct	TSK	COM	DGL	SFT	CGD	IND	ESE	PEM
TSK	1							
COM	0.290	1						
DGL	0.235	0.260	1					
SFT	0.220	0.321	0.269	1				
CGD	0.201	0.328	0.246	0.273	1			
IND	0.290	0.291	0.283	0.282	0.319	1		
ESE	0.429	0.496	0.450	0.484	0.466	0.502	1	
PEM	0.293	0.431	0.348	0.370	0.360	0.431	0.750	1

Note: Correlation is significant at the 0.01 level (two-tailed).

Communication skills showed a stronger correlation with Employability Self-Efficacy ($r = 0.496$, $p < 0.01$) and perceived employability ($r = 0.431$, $p < 0.01$) than technical skills, which recorded correlations of 0.429 and 0.293, respectively. These results indicate that, in the present sample, communication skills were more strongly associated with students' employability self-efficacy and perceived employability than technical skills. Career guidance and counselling and Soft Skills and Teamwork also showed positive and statistically significant correlations with both self-efficacy and perceived employability, highlighting their relevance to students' employability-related perceptions.

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5.4. Principal Component Analysis

A Principal Component Analysis (PCA) was performed using Varimax rotation with Kaiser Normalisation to examine the underlying component structure of the 40-item employability-skills instrument. The rotation converged in six iterations and yielded eight components, broadly corresponding to the eight constructs considered in the study. Most items showed strong primary loadings on their respective components. However, the Employability Self-Efficacy items showed comparatively lower primary loadings and noticeable cross-loadings on the Perceived Employability component. This pattern indicates some overlap between the two constructs and should be considered when interpreting the component structure. Table 5 presents the rotated component matrix, with the highest loading for each item highlighted for ease of interpretation.

Table 5. Rotated component matrix – Principal component analysis.

Item	1 (PEM)	2 (SFT)	3 (IND)	4 (DGL)	5 (CGD)	6 (TSK)	7 (COM)	8 (ESE)
PEM1	**0.799**	0.119	0.161	0.159	0.093	0.061	0.139	0.036
PEM5	**0.770**	0.107	0.149	0.076	0.168	0.066	0.159	0.104
PEM2	**0.769**	0.147	0.132	0.163	0.074	0.147	0.163	0.030
PEM3	**0.765**	0.144	0.160	0.114	0.127	0.096	0.163	0.166
PEM4	**0.733**	0.097	0.154	0.071	0.123	0.078	0.134	0.170
SFT4	0.169	**0.816**	0.038	0.099	0.114	0.098	0.150	0.013
SFT2	0.078	**0.809**	0.104	0.017	0.022	0.079	0.077	0.149
SFT5	0.112	**0.793**	0.093	0.081	0.109	0.036	0.113	0.060
SFT3	0.128	**0.758**	0.147	0.128	0.069	0.106	0.077	0.041
SFT1	0.135	**0.750**	0.041	0.112	0.109	0.016	0.097	0.091
IND3	0.175	0.073	**0.800**	0.108	0.079	0.110	0.104	0.059
IND5	0.107	0.092	**0.797**	0.062	0.121	0.141	0.057	0.192
IND4	0.144	0.059	**0.771**	0.085	0.085	0.068	0.109	0.100
IND1	0.129	0.118	**0.771**	0.096	0.128	0.086	0.143	0.051
IND2	0.205	0.099	**0.754**	0.104	0.114	0.091	0.010	-0.031
DGL3	0.096	0.049	0.035	**0.819**	0.078	0.023	0.061	0.029
DGL4	0.111	0.131	0.102	**0.812**	0.068	0.063	0.087	0.080
DGL5	0.105	0.095	0.109	**0.795**	0.037	0.089	0.070	0.061
DGL1	0.100	0.068	0.096	**0.761**	0.073	0.142	0.084	0.135
DGL2	0.159	0.084	0.093	**0.754**	0.114	0.062	0.075	0.025
CGD3	0.085	0.112	0.027	0.044	**0.800**	0.105	0.067	0.153
CGD2	0.087	0.061	0.125	0.053	**0.784**	0.104	0.141	0.042
CGD5	0.145	0.146	0.103	0.111	**0.776**	0.026	0.132	-0.028
CGD1	0.084	0.042	0.148	0.096	**0.770**	0.069	0.107	0.181
CGD4	0.187	0.064	0.110	0.078	**0.757**	0.020	0.087	0.001
TSK3	0.145	0.059	0.106	0.126	0.040	**0.805**	0.090	-0.036
TSK4	0.149	0.080	0.073	0.012	0.103	**0.785**	0.093	0.091
TSK5	0.058	0.075	0.112	0.110	0.011	**0.772**	0.041	-0.002
TSK2	0.016	0.049	0.065	0.096	0.085	**0.770**	0.136	0.081
TSK1	0.094	0.053	0.097	0.020	0.034	**0.758**	0.097	0.190
COM5	0.148	0.108	0.121	0.075	0.137	0.070	**0.793**	0.017
COM3	0.092	0.159	0.077	0.053	0.102	0.147	**0.759**	0.089
COM2	0.164	0.113	0.102	0.119	0.030	0.102	**0.755**	0.138
COM1	0.171	0.072	0.063	0.072	0.132	0.116	**0.750**	0.048
COM4	0.158	0.070	0.051	0.074	0.131	0.049	**0.741**	0.059
ESE5	0.411	0.196	0.160	0.166	0.169	0.150	0.224	**0.555**
ESE3	0.418	0.235	0.204	0.193	0.168	0.218	0.196	**0.521**
ESE1	0.439	0.211	0.203	0.191	0.242	0.159	0.133	**0.513**
ESE2	0.419	0.191	0.226	0.193	0.230	0.144	0.221	**0.512**
ESE4	0.465	0.186	0.168	0.197	0.127	0.235	0.157	**0.484**

As shown in Table 5, all five Perceived Employability items (PEM1–PEM5) loaded most strongly on Component 1, with loadings ranging from 0.733 to 0.799. The five Soft Skills and Teamwork items (SFT1–SFT5) loaded on Component 2, with loadings ranging from 0.750 to 0.816.

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Similarly, the Industry Exposure items (IND1–IND5) loaded on Component 3 (0.754 to 0.800), the Digital Literacy items (DGL1–DGL5) on Component 4 (0.754 to 0.819), the Career Guidance items (CGD1–CGD5) on Component 5 (0.757 to 0.800), the Technical Skills items (TSK1–TSK5) on Component 6 (0.758 to 0.805), and the Communication Skills items (COM1–COM5) on Component 7 (0.741 to 0.793).

The five Employability Self-Efficacy items (ESE1–ESE5) loaded most strongly on Component 8, with primary loadings ranging from 0.484 to 0.555. However, these items also showed cross-loadings on Component 1, ranging from 0.411 to 0.465. The difference between the primary and secondary loadings was particularly small for ESE4 (0.484 and 0.465), indicating a considerable overlap with Perceived Employability. Although the results broadly reflect the intended grouping of the items, the comparatively lower primary loadings and cross-loadings of the ESE items warrant caution in interpreting the distinction between these two constructs. Overall, the PCA results provide an exploratory indication of the instrument's component structure, but they do not, by themselves, establish its construct validity.

5.5. PLS-SEM Measurement Model Assessment

Following the exploratory component analysis, the measurement model was assessed within the PLS-SEM framework to examine the reliability, convergent validity, and discriminant validity of the eight employability constructs. Fig. 1 presents the measurement model, showing the eight latent constructs, their observed indicators, the standardized outer loadings, and the composite reliability (CR) values. As shown in Fig. 1, the standardized outer loadings of all 40 indicators ranged from 0.704 (COM4) to 0.833 (SFT4), exceeding the commonly recommended threshold of approximately 0.70 for reflective measurement models [21]. Composite reliability ranged from 0.864 (Technical Skills) to 0.893 (Perceived Employability), while Average Variance Extracted (AVE) ranged from 0.561 to 0.626 across the eight constructs. All AVE values exceeded the recommended minimum of 0.50, indicating satisfactory convergent validity [22]. Table 6 presents the convergent-validity statistics, and Table 7 provides the complete set of standardized outer loadings.

Table 6. Convergent validity - composite reliability and average variance extracted.

Construct	Items	Loading Range	Composite Reliability (CR)	AVE	√AVE
TSK	5	0.713 - 0.788	**0.864**	0.561	0.749
COM	5	0.704 - 0.795	**0.865**	0.562	0.750
DGL	5	0.734 - 0.814	**0.878**	0.591	0.769
SFT	5	0.722 - 0.833	**0.880**	0.596	0.772
CGD	5	0.724 - 0.776	**0.873**	0.580	0.761
IND	5	0.729 - 0.814	**0.882**	0.601	0.776
ESE	5	0.749 - 0.803	**0.883**	0.604	0.777
PEM	5	0.749 - 0.832	**0.893**	0.626	0.791



Fig. 1. PLS-SEM measurement model of the eight employability constructs.

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The square root of the AVE for each construct ranged from 0.749 to 0.791 (Table 6). These values exceeded the corresponding inter-construct correlations reported in Table 4, satisfying the Fornell–Larcker criterion for discriminant validity [22]. However, the correlation between Employability Self-Efficacy and Perceived Employability was 0.750, which is relatively close to the square roots of their respective AVEs (0.777 and 0.791). This suggests that, although the Fornell–Larcker criterion was met, the distinction between these two constructs should be interpreted with some caution. Taken together, the results indicate satisfactory composite reliability and convergent validity, with supporting evidence of discriminant validity based on the Fornell–Larcker criterion. The measurement model was therefore considered suitable for proceeding to structural model assessment.

5.6. Structural Model – Direct Relationships

Following the measurement model assessment, the structural model was examined to assess the relationships between the six antecedent employability-skill constructs, Employability Self-Efficacy, and Perceived Employability. Fig. 2 presents the structural model, showing the relationships between Technical Skills, Communication Skills, Digital Literacy Skills, Soft Skills and Teamwork, Career Guidance and Counselling, and Industry Exposure/Internship and Employability Self-Efficacy, as well as the relationship between Employability Self-Efficacy and Perceived Employability. The structural model results indicate a strong positive relationship between Employability Self-Efficacy and Perceived Employability ($\beta = 0.832$, $t = 34.667$, $p < 0.001$). This suggests that students with higher confidence in their ability to apply their skills also tend to report higher perceived employability. The six antecedent constructs—Technical Skills, Communication Skills, Digital Literacy Skills, Soft Skills and Teamwork, Career Guidance and Counselling, and Industry Exposure/Internship—also showed positive and statistically significant relationships with Employability Self-Efficacy. Their path coefficients ranged from 0.168 to 0.241, with all relationships significant at $p < 0.001$.

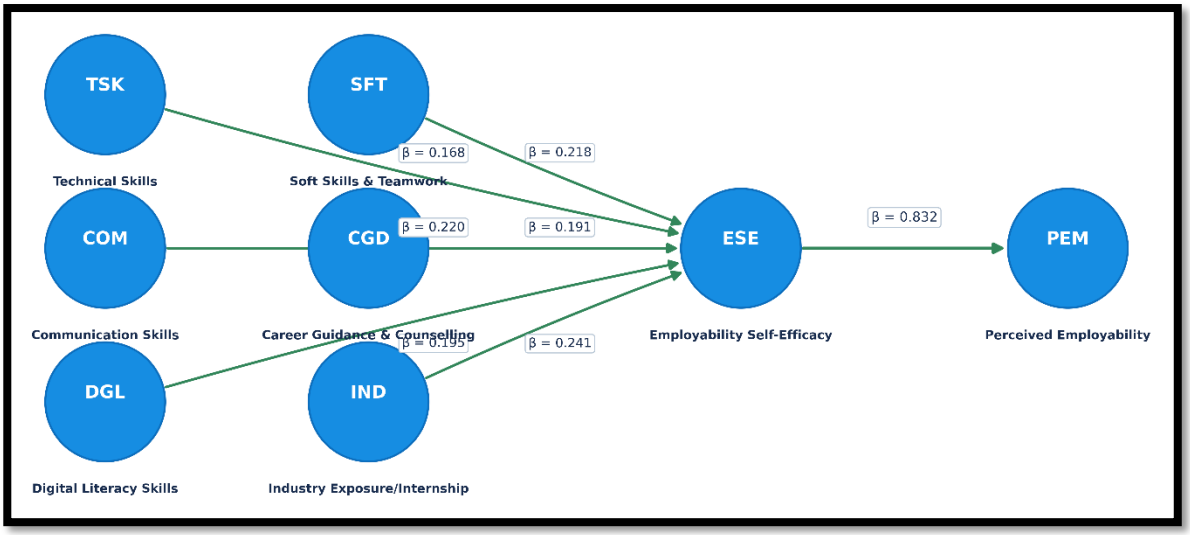


Fig. 2. PLS-SEM structural model showing the direct relationships among employability-related constructs.

These findings indicate that the six employability-related constructs are positively associated with students' employability self-efficacy, while self-efficacy is positively associated with perceived employability. However, the results reflect relationships within the specified structural model and do not establish causal effects or indirect mediation effects. Since the study is based on cross-sectional, self-reported data, the findings should be interpreted with appropriate caution.

5.7. Hypothesis Testing

The structural model results presented in Section 5.6 were examined to assess the proposed relationships among the employability constructs. The results indicated a positive and statistically significant relationship between Employability Self-Efficacy and Perceived Employability ($\beta = 0.832$, $p < 0.001$), supporting H2. The six antecedent constructs also showed positive and statistically significant relationships with Employability Self-Efficacy ($p < 0.001$). Among these, Industry Exposure/Internship recorded the highest path coefficient ($\beta = 0.241$), followed by Communication Skills ($\beta = 0.220$), Soft Skills and Teamwork ($\beta = 0.218$), Digital Literacy Skills ($\beta = 0.195$), Career guidance and counselling ($\beta = 0.191$), and Technical Skills ($\beta = 0.168$). These findings support H4, indicating that all six employability-related constructs are positively associated with Employability Self-Efficacy. Table 8 summarises the hypothesis-testing results.

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Table 7. Standardized outer loadings of the measurement model.

Construct	Indicator	Standardized Outer Loading
Technical Skills	TSK1	0.734
	TSK2	0.735
	TSK3	0.788
	TSK4	0.773
	TSK5	0.713
Communication Skills	COM1	0.738
	COM2	0.760
	COM3	0.750
	COM4	0.704
	COM5	0.795
Digital Literacy Skills	DGL1	0.756
	DGL2	0.734
	DGL3	0.763
	DGL4	0.814
	DGL5	0.775
Soft Skills & Teamwork	SFT1	0.722
	SFT2	0.775
	SFT3	0.744
	SFT4	0.833
	SFT5	0.780
Career Guidance & Counselling	CGD1	0.773
	CGD2	0.764
	CGD3	0.776
	CGD4	0.724
	CGD5	0.769
Industry Exposure/Internship	IND1	0.766
	IND2	0.729
	IND3	0.811
	IND4	0.754
	IND5	0.814
Employability Self-Efficacy	ESE1	0.782
	ESE2	0.793
	ESE3	0.803
	ESE4	0.759
	ESE5	0.749
Perceived Employability	PEM1	0.802
	PEM2	0.784
	PEM3	0.832
	PEM4	0.749
	PEM5	0.788

Table 8. Summary of structural relationships and hypothesis testing results.

Hypothesis	Structural relationship	β	p-value	Result
H2	Employability Self-Efficacy → Perceived Employability	0.832	< 0.001	Supported
H4	Technical Skills → Employability Self-Efficacy	0.168	< 0.001	Supported
H4	Communication Skills → Employability Self-Efficacy	0.220	< 0.001	Supported
H4	Digital Literacy Skills → Employability Self-Efficacy	0.195	< 0.001	Supported
H4	Soft Skills and Teamwork → Employability Self-Efficacy	0.218	< 0.001	Supported
H4	Career Guidance and Counselling → Employability Self-Efficacy	0.191	< 0.001	Supported
H4	Industry Exposure/Internship → Employability Self-Efficacy	0.241	< 0.001	Supported

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Overall, the findings support the proposed positive relationships between the six antecedent constructs and Employability Self-Efficacy, as well as the positive relationship between Employability Self-Efficacy and Perceived Employability. These relationships should be interpreted as associations within the specified structural model, not as evidence of causal or indirect effects.

5.8. Model Fit and Predictive Relevance

The overall fit and predictive relevance of the structural model were examined using selected model-fit and predictive-relevance indices, as summarised in Table 9. The Standardized Root Mean Square Residual (SRMR) was 0.048, which is below the commonly recommended threshold of 0.08 [23]. The Normed Fit Index (NFI) was 0.912, exceeding the reference value of 0.90 [24]. These values provide supportive evidence regarding the fit of the specified model. The Q^2 values for Employability Self-Efficacy (0.612) and Perceived Employability (0.647) were both greater than zero, indicating predictive relevance for the two endogenous constructs under the blindfolding procedure [21]. These results further support the model's ability to account for the endogenous constructs in the study sample.

Table 9. Model fit and predictive relevance indices.

Fit / Predictive Relevance Index	Value	Reference Criterion
Standardized Root Mean Square Residual (SRMR)	0.048	Below 0.08
Normed Fit Index (NFI)	0.912	Above 0.90
Q^2 – Employability Self-Efficacy	0.612	Greater than 0
Q^2 – Perceived Employability	0.647	Greater than 0

5.9. One-Way ANOVA by Age Group

A one-way ANOVA was conducted to examine whether the eight employability dimensions differed across the four age groups of respondents (Below 18 years, 18–20 years, 21–23 years, and Above 23 years). Table 10 presents the descriptive statistics and ANOVA results.

Table 10. Descriptive statistics and one-way ANOVA results by age group.

Employability Dimension	Below 18 yrs M (SD)	18–20 yrs M (SD)	21–23 yrs M (SD)	Above 23 yrs M (SD)	Total M (SD)	F	Sig.
TSK	3.296 (0.936)	3.276 (0.910)	3.285 (0.912)	3.327 (0.898)	**3.289 (0.914)**	0.042	0.989
COM	3.255 (0.997)	3.335 (0.873)	3.309 (0.969)	3.3064 (0.809)	**3.303 (0.925)**	0.182	0.909
DGL	3.165 (0.949)	3.463 (0.908)	3.244 (1.002)	3.297 (0.814)	**3.307 (0.940)**	2.680	0.046
SFT	3.303 (0.944)	3.293 (0.921)	3.2584 (0.951)	3.285 (1.021)	**3.286 (0.943)**	0.051	0.985
CGD	3.189 (0.892)	3.288 (0.939)	3.4336 (0.913)	3.3957 (0.925)	**3.307 (0.920)**	1.593	0.190
IND	3.241 (0.944)	3.323 (0.919)	3.348 (1.000)	3.336 (0.896)	**3.307 (0.942)**	0.309	0.819
ESE	3.260 (1.009)	3.351 (0.911)	3.231 (0.951)	3.302 (0.860)	**3.290 (0.943)**	0.420	0.739
PEM	3.262 (0.940)	3.306 (0.984)	3.3823 (0.975)	3.293 (0.868)	**3.311 (0.956)**	0.327	0.806

Note: The nominal significance level is 0.05. After Bonferroni adjustment for eight comparisons, the significance threshold is 0.00625.

As shown in Table 10, seven of the eight employability dimensions did not differ significantly across the four age groups. These included Technical Skills ($F = 0.042$, $p = 0.989$), Communication Skills ($F = 0.182$, $p = 0.909$), Soft Skills and Teamwork ($F = 0.051$, $p = 0.985$), Career Guidance and Counselling ($F = 1.593$, $p = 0.190$), Industry Exposure/Internship ($F = 0.309$, $p = 0.819$), Employability Self-Efficacy ($F = 0.420$, $p = 0.739$) and Perceived Employability ($F = 0.327$, $p = 0.806$). Digital Literacy Skills showed a nominally significant difference across the age groups ($F(3, 450) = 2.680$, $p = 0.046$). However, this result was no longer statistically significant after Bonferroni adjustment for the eight comparisons. The group means were 3.1659, 3.4630, 3.2442, and 3.2979 for the Below 18, 18–20, 21–23, and Above 23 age groups, respectively. These values do not indicate a consistent increasing or decreasing pattern across age groups.

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Accordingly, the Digital Literacy finding should be interpreted as an exploratory observation rather than conclusive evidence of an age-related difference. Overall, the analysis did not establish statistically significant age-group differences across the eight employability dimensions after adjustment for multiple comparisons.

6 Discussion

The overall findings highlight the multidimensional and interconnected nature of graduate employability. The positive, statistically significant correlations among all eight constructs indicate that technical skills, communication skills, digital literacy, soft skills and teamwork, career guidance and counselling, industry exposure, employability self-efficacy, and perceived employability are closely associated rather than functioning as entirely separate dimensions. The particularly strong relationship between Employability Self-Efficacy and Perceived Employability ($r = 0.750$) highlights the importance of students' confidence in their ability to apply their skills when assessing their own employability. This finding is consistent with the broader understanding of employability as involving both individual competencies and psychological attributes [10], [11]. Communication Skills showed numerically stronger correlations with Employability Self-Efficacy and Perceived Employability than Technical Skills. This observation aligns with the wider employability literature, which recognizes the importance of generic and communication competencies alongside subject-specific knowledge [12], [20].

In the context of SPSR Nellore District, this finding highlights the importance of developing communication skills as part of institutional employability initiatives. However, the observed differences between the correlations should be interpreted descriptively, as no statistical test comparing these correlations was reported. Therefore, the results do not establish that communication skills have a statistically greater influence than technical skills. The PLS-SEM results also indicate positive, statistically significant relationships between all six antecedent constructs and Employability Self-Efficacy.

Industry Exposure/Internship recorded the highest path coefficient ($\beta = 0.241$), followed by Communication Skills ($\beta = 0.220$) and Soft Skills and Teamwork ($\beta = 0.218$). Digital Literacy Skills ($\beta = 0.195$), Career Guidance and Counselling ($\beta = 0.191$), and Technical Skills ($\beta = 0.168$) also showed positive and significant relationships with Employability Self-Efficacy. In addition, Employability Self-Efficacy showed a strong positive relationship with Perceived Employability ($\beta = 0.832$). These findings highlight the relevance of both skill-related and experiential dimensions in understanding students' confidence in their employability and their perceptions of labor-market readiness. Since the study is cross-sectional, these relationships should not be interpreted as evidence of causal influence or mediation.

The Principal Component Analysis broadly reflected the intended grouping of the eight constructs, with the items relating to the first seven constructs showing comparatively strong primary loadings on their respective components. However, the Employability Self-Efficacy items showed lower primary loadings and noticeable cross-loadings on the Perceived Employability component. This overlap suggests that the distinction between these two constructs requires cautious interpretation. The PLS-SEM measurement-model results further supported satisfactory composite reliability and convergent validity, and the Fornell–Larcker criterion was met for discriminant validity. Nevertheless, the overlap observed in the component analysis should be acknowledged when interpreting the relationship between Employability Self-Efficacy and Perceived Employability.

The age-group analysis did not establish statistically significant differences across the eight employability dimensions after adjustment for multiple comparisons. Although Digital Literacy Skills showed a nominally significant result before adjustment ($p = 0.046$), it did not remain significant under the Bonferroni-adjusted threshold. The mean scores also did not increase consistently across the age groups. Therefore, the findings do not provide sufficient evidence to conclude that digital literacy develops progressively with age or that age or academic seniority explains differences in employability perceptions. Further investigation involving institutional, geographical and educational factors may help explain variations in students' employability-related skills and perceptions.

6.1. Theoretical and Practical Implications

The present study has theoretical and practical implications for understanding employability among students in a mixed rural and urban district context. Theoretically, it brings together technical, communication, digital, interpersonal, institutional-support, and psychological dimensions within a single framework for examining student employability. By examining these constructs in SPSR Nellore District, the study adds district-level evidence to the broader literature on graduate employability. The findings also highlight the relationship between employability self-efficacy and perceived employability, while underscoring the need to examine the distinction between these closely related constructs. Practically, the findings offer useful considerations for training and placement cells, career-guidance counselors, and curriculum planners. First, the strong relationship between Employability Self-Efficacy and Perceived Employability highlights the value of including confidence-building activities, such as mock interviews, mentoring, peer-learning activities, and interaction with successful graduates, in placement-preparation programs.

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Second, the positive relationship between Communication skills and Employability self-efficacy suggests that institutions should give adequate attention to spoken communication, presentation skills, group discussions, and professional communication alongside technical training. Third, the positive relationships involving Career guidance and counselling and Industry exposure/internship highlight the potential value of strengthening career-guidance services and providing students with structured opportunities for internships and industry interaction. Finally, the findings on Digital Literacy underline the importance of giving students opportunities to develop and apply digital skills throughout their academic programs, rather than limiting such training to a particular stage of study. These suggestions may help institutions design more comprehensive employability-development initiatives.

6.2. Limitations and Scope for Future Research

While offering useful insights into employability-related skills and perceptions, the present study has certain limitations. First, the sample was confined to SPSR Nellore District, and the findings should be generalized to other geographical contexts with caution. Replication in other districts and states would help assess whether the observed relationships apply across different institutional and regional settings. Second, the cross-sectional research design captures students' responses at a single point in time and does not permit causal or longitudinal conclusions about the development of employability skills during their academic careers. Third, the study relies on self-reported responses to a Likert-scale questionnaire rather than objectively assessed competencies.

Future research could therefore combine self-reported measures with placement outcomes, employer assessments and task-based evaluations of students' skills. Further studies could employ longitudinal structural equation modeling to examine how the relationships among employability-related constructs change over time. Multi-group analysis could also investigate whether these relationships differ across relevant student subgroups. Although the present study included both rural and urban students, it did not undertake a dedicated rural–urban comparison of the constructs or their structural relationships. Future research could therefore conduct rural–urban multi-group comparisons to examine whether locality is associated with differences in employability-related skills and perceptions. Independent-sample replication and further assessment of the measurement properties, particularly the distinction between Employability Self-Efficacy and Perceived Employability, would also strengthen the evidence for the proposed framework.

7 Conclusion

This study assessed employability-oriented technical and communication skills among rural and urban students in SPSR Nellore District and examined the relationships among the eight employability-related constructs. The findings indicate that technical skills, communication skills, digital literacy, soft skills and teamwork, career guidance and counselling, industry exposure/internship, employability self-efficacy, and perceived employability are positively and significantly inter-correlated. Among these relationships, the association between Employability Self-Efficacy and Perceived Employability was particularly strong ($r = 0.750$). The PLS-SEM results also showed positive, statistically significant relationships between the six antecedent constructs and Employability Self-Efficacy, as well as a strong positive relationship between Employability Self-Efficacy and Perceived Employability ($\beta = 0.832$).

The Principal Component Analysis broadly reflected the intended grouping of the eight constructs, although the comparatively lower primary loadings and cross-loadings of the Employability Self-Efficacy items indicated some overlap with Perceived Employability. The measurement-model assessment provided evidence of satisfactory composite reliability and convergent validity, along with support for discriminant validity under the Fornell–Larcker criterion. The age-group analysis did not establish statistically significant differences across the eight dimensions after adjustment for multiple comparisons, although Digital Literacy showed a nominally significant result before adjustment. Taken together, the findings highlight the importance of addressing multiple dimensions of employability in higher education.

Institutions may therefore give balanced attention to technical competence, communication proficiency, digital literacy, soft skills, career guidance and industry exposure, while also creating opportunities to strengthen students' confidence in applying their abilities. This integrated approach may improve students' preparedness for the world of work and their perceptions of employability. Further research using independent samples, longitudinal assessment, and dedicated rural–urban comparisons would strengthen understanding of these relationships and their applicability across different educational settings.

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STATEMENT OF CONFLICT OF INTERESTS
The authors declare no conflicts of interest related to this study.

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ETHICS STATEMENT

This study involved human participants and was conducted using a structured questionnaire. Informed consent was obtained from all respondents aged 18 years and above. For participants below 18 years of age, informed consent was obtained from their parents or legal guardians, and assent was also obtained from the participants themselves before data collection. Participation in the study was voluntary.

LICENSING

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