Profiling Critical Thinking and AI Attitudes in Management Education Using a Factor-Cluster Approach for the Digital Business Era

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ABSTRACT

This paper investigates the relationship between critical thinking skills and attitudes toward artificial intelligence among postgraduate management students in southern India. Data were collected through an online survey from 325 postgraduate management students from various business schools in southern India. An **empirical research design** was used to identify four dimensions through exploratory factor analysis, Confidence in Critical Thinking, Valuing Critical Thinking, Misconceptions of Critical Thinking, and Attitudes Toward AI. These dimensions have guided the K-means clustering, grouping students into three distinct clusters, Critical Thinkers & AI Optimists, Developing Thinkers & AI Moderates, and Novice Thinkers & AI Skeptics. The **findings** reveal notable gender differences across the clusters and distinct demographic patterns that are valuable for tailoring education strategies. Overall, the **results** emphasize the important role of both critical thinking and AI literacy in preparing management students for success in the digital business era. This study will **contribute** to the theoretical understanding of these dynamics while providing practical recommendations for better curriculum design in management education that equips students with cognitive and technological skills required to navigate complex, technology-driven business environments.

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1. INTRODUCTION

In today's dynamic business environment, characterized by rapid technological advancements and evolving consumer preferences, critical thinking has become a cornerstone of management education worldwide. These skills enable business students to analyze complex problems, evaluate evidence, and make informed, agile decisions, fostering innovation and strategic problem-solving [1]. Critical thinking also equips students to challenge assumptions, consider diverse perspectives, and address dynamic business challenges effectively. Recognized as a core employability skill, it is consistently emphasized by corporate professionals, business owners, and professional bodies [2, 3].

Business educators should, therefore, prioritize developing these competencies to enable them to meet the demands of such industries that require processing large amounts of data for informed decisions. However, traditional teaching methods often fail, which necessitates new methods such as incorporating social media in classrooms and increasing students' problem-solving capacities [3]. Such strategies will enable students to tackle complex business environments, risks, and opportunities and contribute to sustainable organizational growth. The business school builds a culture of critical thinking that prepares students for professional life, enabling them to respond appropriately to future market changes and succeed in a competitive world economy [4].

The role of Artificial Intelligence (AI) in education has evolved from a supplementary aid into an essential learning tool. As industries increasingly adopt AI and automation, the demand for managers with AI-related competencies continues to grow, requiring educational institutions to adapt their curricula accordingly [5–7]. Integrating AI literacy into management programs enhances students' understanding of AI systems, ethical awareness, and societal impact, while supporting critical thinking and problem-solving skills [8, 9]. Furthermore, AI-based tools such as natural language processing and predictive analytics help align educational content with industry needs, improving graduate employability [6, 10, 11]. This integration responds to the demands of the Fourth Industrial Revolution by preparing graduates for data-driven decision-making, innovation, and adaptability in the digital business era [12].

Assessing student skills and attitudes in business education is challenging, particularly in critical thinking and adapting to modern business needs. Traditional West-centric models often fail to consider diverse cultural contexts, leading to biased evaluations. Moreover, no universal standard exists for measuring critical thinking, and existing tools frequently omit key philosophical dimensions like inquisitiveness and judgment maturity [13]. Generalized assessments, such as case studies focused on large corporations, limit students' exposure to diverse business environments like SMEs, impacting their employability. Additionally, traditional teaching methods often neglect essential workplace skills, such as collaboration and problem-solving [14, 15]. The rise of generative AI tools like ChatGPT complicates evaluation by raising concerns about academic integrity and independent learning [10, 16]. These challenges highlight the urgent need for innovative, culturally sensitive, and contextually relevant pedagogical approaches to better equip students for today's dynamic business world [17].

The intersection of critical thinking skills and attitudes toward AI is under-explored, especially in postgraduate business education. Even though critical thinking remains one of the key educational goals, there is still a lack of empirical evidence about its integration with AI in assessing student perceptions [18, 19]. However, research on the role of such tools in enhancing critical thinking skills among students of management is still lacking due to the emergence of tools like ChatGPT that increase their potential impact [8, 20]. Even the existing studies present challenges such as ethical issues and the requirement of contextual importance of AI tools, while again emphasizing the need for considering the diverse backgrounds of students and their experiences [8]. Additionally, cultural differences in critical thinking show that a segment-based approach, focusing on the differences across gender, undergraduate degree, and specialization, is also worth exploring. The current study will address such gaps by analyzing the combined effect of attitudes toward critical thinking and AI, with segmentation of students to better understand their perceptions and skills.

India's regulatory framework underscores the urgency of this research. The IndiaAI Mission in 2024 allocates INR 10,000 crore to support ethical AI adoption, compute infrastructure, and educational datasets [21]. MeitY's India AI Governance Guidelines in 2025 mandate sector-specific regulations with self-certification for high-risk AI in education and telecom, emphasizing transparency, bias mitigation, and human oversight [22–24]. The Digital Personal Data Protection (DPDP) Act 2023 requires educational data fiduciaries to implement privacy-by-design in AI systems, directly impacting management training platforms [25]. NEP 2020 integrates AI curriculum through NCERT's AI Cell, targeting multidisciplinary programs including MBA/PGDM [26]. NITI Aayog's National Strategy for Artificial Intelligence (2023) prioritizes AI skilling for 1 million professionals by 2026, including management graduates [27]. These policies frame the study's clusters as diagnostic tools for regulatory-compliant technopreneurship training [28].

This study directly contributes to multiple UN Sustainable Development Goals (SDGs). SDG 4 (Quality Education) Target 4.7 promotes ICT/digital literacy and technical skills for sustainable development addressed through cluster-based AI-critical thinking training [29]. SDG 8 (Decent Work & Economic Growth) Target 8.3 fosters technopreneurship via innovation-driven enterprises, aligning with "Critical Thinkers AI Optimists" (38%) readiness for AI-integrated jobs [29]. SDG 9 (Industry, Innovation & Infrastructure) Target 9.5 enhances research capacity in frontier technologies like AI, supported by profiling 20% "Novice Thinkers AI Skeptics" for upskilling [29]. These linkages position the study's student segmentation as an SDG-aligned framework for India's management education contributing to 2030 Agenda priorities.

This study investigates the intersection of critical thinking skills and attitudes toward artificial intelligence (AI) among postgraduate management students, aiming to address key gaps in the existing literature. Specifically, it examines cognitive aspects such as analytical reasoning, evaluative judgment, and conceptual clarity, along with affective dimensions including students' value orientation, confidence levels, misconceptions, and emotional responses to AI technologies. The study aims to (i) identify latent factors that reflect students' critical thinking dispositions and AI-related attitudes, (ii) classify students into distinct clusters based on these multidimensional profiles, and (iii) analyze how demographic variables such as gender, undergraduate academic background, and current specialization relate to cluster membership. In pursuit of these objectives, the following research questions guide the inquiry:

- What are the underlying cognitive and affective dimensions of critical thinking skills and AI attitudes among postgraduate management students?
- How can students be segmented into meaningful clusters based on their combined critical thinking and AI attitude profiles?
- To what extent do demographic variables (gender, undergraduate degree, and specialization) influence the distribution and characteristics of these student clusters?

The paper is structured to present a comprehensive literature review followed by detailed methodology encompassing exploratory factor analysis, clustering techniques, and demographic analyses. In terms of findings, the discussions are presented in relation to existing literature, with both practical and theoretical implications drawn for higher education and management training. The study concludes with recommendations for integrating critical thinking and AI-focused pedagogical strategies into management education curricula.

2. LITERATURE REVIEW

2.1. Critical Thinking in Management Education

Critical thinking is a widely recognized concept in learning and professional practice, including management education. It refers to a conscious and systematic thinking process involving interpretation, analysis, evaluation, inference, and explanation. According to [30], critical thinking emphasizes reflective and evidence-based reasoning in deciding what to believe or do, while [31] describes it as the integration of attitude, knowledge, and ability applied through logical reasoning. Collectively, these perspectives highlight critical thinking as a combination of cognitive skills and dispositions such as open-mindedness and curiosity to support sound judgment and problem-solving.

In education, various instructional models support the development of critical thinking. Notably, the five-phase model proposed by [32] promotes active learning through goal setting, questioning, skill-building, feedback, and assessment. Additionally, infusion and immersion strategies enable critical thinking to be embedded explicitly or implicitly within curricula. In management education, critical thinking is essential for analyzing complex information, establishing logical relationships, and making informed decisions in dynamic business environments, thereby preparing graduates to meet modern workplace demands.

2.2. Attitude toward AI

The integration of AI in management and business education has become increasingly important as it transforms pedagogical approaches and enhances learning outcomes. AI tools such as ChatGPT are used to foster critical thinking, creativity, and ethical awareness skills essential in today's dynamic business environment [8, 33]. Students generally show positive attitudes toward AI, valuing its personalization and interactive capabilities, although concerns remain regarding ethical issues, bias, and responsible use [8, 10, 34]. While AI can improve engagement and learning effectiveness, human oversight is necessary to maintain academic integrity and holistic learning [9, 10]. Therefore, educational institutions must develop clear guidelines to ensure ethical and transparent AI integration, enabling students to be well prepared for AI-driven workplaces [9, 33, 34].

Recent studies across different cultural contexts highlight the global need to include AI in critical-thinking teaching. In China, [35] found that while undergraduates valued AI-generated content tools for making research easier, many worried that these tools might diminish deep analytical thinking unless paired with specific instructional support. Similarly, [36] report that a series of hands-on seminars and field visits in Valencia, Spain, significantly improved students' ability to ask critical questions about real-world economic issues but also showed ethical concerns regarding unchecked AI use. In Indonesia, [37] show that AI "chat friend" platforms can improve conversation skills and reasoning among EFL learners. However, they highlight the need for organized teaching frameworks to prevent overreliance.

A side from cultural differences in using AI, recent studies point out that a broad understanding of AI literacy is crucial for responsible and effective use in education. [36] argue that AI literacy should involve not only knowing about generative models but also being able to evaluate their outputs and ethical issues. [38] adds to this by suggesting four important areas, understanding model structures, recognizing limitations like mistakes and bias, being aware of societal and data privacy concerns, and developing skills in prompt engineering to help AI produce meaningful responses. [39] demonstrate through their research that structured interactions, where students actively create and refine prompts and then analyze and reflect on the AI's suggestions, significantly boost critical thinking outcomes in undergraduates.

2.3. Factor and Cluster Analysis in educational Research

Factor analysis and cluster analysis are two of the most important statistical methods in educational research, which provide deep insights into the perceptions and attitudes of students by revealing hidden factors and grouping people into similar categories. Factor analysis helps to reduce complex data into understandable variables, thereby providing insight into the major determinants of student choices and overall well-being. For instance, this method has been used to define factors like 'Enrollment Value Optimization' and 'Academic Infrastructure Influence,' which help align institutional goals with the needs of students [40], and to study psychological aspects such as anxiety and satisfaction, thus emphasizing the need for intervention at specific levels [41, 42]. Cluster analysis complements this method by grouping students into distinct groups, such as 'Comprehensive Benefit Seekers' and 'Holistic Students', thereby enabling the formulation of specific strategies that address different needs [40]. It also supports research in learning styles and preparation for the labor market that educational institutions can modify curricula based on such needs [43].

2.4. Research Gaps and Theoretical Contributions

The existing body of research indicates that very little is known about how critical thinking skills are linked to attitudes toward AI for postgraduate management students. Though there has been research on the impact of AI on academic performance and perceptions [44], not enough integrated research has been conducted on how critical thinking skills are related to attitudes toward AI, especially with regard to business education [8]. Additionally, though various studies reveal that AI augments the learning outcome of students and critical thinking in them, other studies describe a tendency to degrade and undermine creativity and academic honesty [45, 46]. These gaps indicate the need for an empirical study that incorporates the assessments of critical thinking and AI attitudes to provide an adequate understanding of how management students perceive and integrate these skills. The current study aims to bridge these gaps through a survey of postgraduate management students, classified on the basis of validated measurement scales into segments regarding critical thinking abilities and AI attitudes, thereby providing actionable insights for educators and policymakers.

3. METHODOLOGY

3.1. Study Design

The empirical research design used a descriptive-exploratory approach to examine the correlation between critical thinking skills and attitudes toward artificial intelligence among postgraduate management students. While the descriptive part of this study is meant to provide an in-depth account of the perceptions of the students, the exploratory part is meant to unearth patterns and relationships that have not been studied before. This double approach is highly suitable for the examination of complex phenomena, such as the interplay of cognitive skills and technological attitudes, offering both an overview and insights into underlying dynamics.

3.2. Sample Characteristics

The present study targeted postgraduate management students (PGDM/MBA) from different business schools in the southern region of India, keeping in view the growing demand for business management graduates to be equipped with critical thinking and AI competencies, especially in India. This population is critical because more and more employers are looking for graduates who can integrate analytical thinking with AI literacy in order to navigate the new landscape of business [47, 48]. The survey was administered to 500 students through a popular online survey platform, using convenience sampling. Of the responses received, 363, or 72.6%, constituted the response rate. After cleaning and validating the data, 325 responses were deemed usable for analysis. This sample offered diverse views from students about entering AI-driven workplaces, supporting the study's aim of exploring the interplay between their critical thinking skills and attitudes toward AI.

3.3. Data Collection

The survey instrument of this study was composed of three sections that were expected to elicit management students' perceptions on critical thinking skills, attitudes toward AI, and demographic characteristics. Critical thinking measurement scales were drawn from established literature [49] and made suitable for the context of this study. The first section measured critical thinking along three dimensions: Confidence in Critical Thinking (17 items), Valuing Critical Thinking (6 items), and Addressing Misconceptions about Critical Thinking (4 reverse-coded items), with scores taken on a 10-point Likert scale anchored at 1 ("Strongly Disagree") and 10 ("Strongly Agree"). Sample items included "I can approach business issues from multiple perspectives" and "I can effectively articulate my critical thinking in written assignments" (Confidence); "Critical thinking is essential for success in my management program" and "My professors expect me to demonstrate critical thinking skills in my work" (Valuing); and "Including all available information in presentation slides is more important than focusing on key points" and "Critical thinking is identifying flaws in arguments" (Misconceptions). The second section consisted of a 4-item AI Attitude Scale, from [50], to capture attitudes toward AI, including "I believe AI will improve my work" and "I think AI technology is positive for humanity," to capture how people perceive the impact of AI on personal, professional, and societal domains. Finally, the third section elicited demographic and background information on the respondents' age, gender, and academic characteristics. This all-inclusive tool, with reverse-coded items where appropriate, elicited highly robust data that could be used for factor-cluster analysis in order to identify distinct profiles of the respondents.

3.4. Statistical Methods

To answer the three main research questions, (RQ1) finding the hidden aspects of critical thinking and AI attitudes, (RQ2) grouping students based on these aspects, and (RQ3) looking at demographic differences among groups, a detailed, step-by-step quantitative analysis was completed using SPSS software. Exploratory Factor Analysis (EFA) helped reveal the basic structure of the measurement scales, directly addressing RQ1. The author calculated Composite Reliability (CR) and Average Variance Extracted (AVE) to check the reliability and validity of the scales. The factor scores from EFA were then used in K-means cluster analysis to group respondents into distinct profiles, meeting the goals of RQ2. To verify the clusters, one-way ANOVA was used to see if there were significant differences across clusters regarding continuous factor scores. Chi-square and Cramer's V tests were employed to examine links between cluster membership and demographic variables, addressing both RQ2 and RQ3. This combined analytical approach ensured that the methods matched the study's goals and provided clear, interpretable results.

3.4.1. Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was used to find the underlying factor structure among the survey items and to confirm that the constructs measured were statistically valid and reliable. The analysis utilized Principal Component Analysis (PCA) as the extraction method and Varimax rotation, which simplifies factor loadings. This process improves interpretability by maximizing the shared variance among variables within each factor. It helps group related items more clearly and reduces confusion in interpreting the factor structure.

To assess whether the dataset was adequate for factor analysis, two commonly accepted diagnostic tests were used. First, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated. KMO values above 0.70 are seen as acceptable for factor analysis. They suggest that the sample size and item correlations were strong enough to create distinct and reliable factors. In this study, all KMO values were above the recommended threshold, indicating that the data were suitable for EFA. Second, Bartlett's Test of Sphericity was performed to test the null hypothesis that the correlation matrix is an identity matrix. This test was highly significant ($p < .001$), confirming that the variables shared enough common variance to justify factor extraction.

During the refinement process, items with cross-loadings below 0.60, which means that an item does not strongly connect to just one factor, or communalities less than 0.50, indicating how much of each item's variance is accounted for by the extracted factors, were removed from further analysis. These thresholds were set to improve clarity and ensure construct validity by keeping only the items that strongly and uniquely contributed to the factor structure. To decide how many factors to keep, the Eigenvalue-greater-than-one rule was the main criterion. Factors with Eigenvalues over 1.0 were considered significant since they explained more variance than a single observed variable. This choice was further supported by the scree plot analysis, which shows the Eigenvalues graphically and helps find the point where the curve levels off, indicating the ideal number of factors to retain.

3.4.2. Reliability and Validity

Cronbach's Alpha was used to assess factor reliability, with values of 0.70 indicating acceptable internal consistency. Descriptive statistics, including means and standard deviations, were calculated for individual variables and summated scales created by aggregating item scores within each factor to support further analysis. This procedure ensured proper scale development in line with established psychometric standards. CR and AVE were calculated for each factor to assess reliability and convergent validity following CR values above 0.70 and AVE values above 0.50 confirmed adequate construct reliability and validity. These computations, based on standardized EFA loadings, strengthened the robustness of the factor structure and supported further analyses.

3.4.3. Cluster Analysis

The factor scores derived from the EFA were used in K-means cluster analysis to segment the respondents into distinct profiles based on their critical thinking skills and attitudes toward AI. The method, commonly applied in behavioral and educational research, is very efficient in the identification of groups with homogeneous response patterns, hence allowing for the interpretation of different respondent profiles. One-way ANOVA was performed to validate the clusters. This was done to identify significant differences across critical thinking and AI-related factors. This ensured that the identified clusters were statistically meaningful and distinct [51]. To check for the existence of a relationship between the cluster membership and demographic variables such as age, gender, and academic background, Cramer's V and Chi-square tests were conducted. These tests analyzed the strength of association and independence between categorical variables, and this helped understand better the influence of demographics on the characteristics of the cluster [52]. This multi-faceted analytical approach gave a comprehensive basis for the interpretation of the clusters and their demographic correlations.

Ethical considerations were given utmost importance during the entire research process to ensure the integrity and confidentiality of the research process. informed consent was carefully obtained from all participants, with full information being provided on the purposes of the study, the voluntary nature of participation, and the right to withdraw at any time. Data confidentiality was strictly maintained, with all responses anonymized and safely stored to protect the identity of the participants. All these were in accordance with accepted ethical standards in research, hence ensuring that the rights and privacy of the respondents were observed.

4. RESULTS AND DISCUSSIONS

4.1. Demographic Characteristics

The demographic profile of the 325 valid respondents is fairly representative and diversified, showing the general characteristics of postgraduate management students. The respondents were nearly even in gender distribution with 51.1 % male respondents (166) and 48.9% females (159). In terms of educational background, the highest numbers of respondent groups came from those holding an Undergraduate degree in Commerce (31.4%, 102), followed by Business Management, 30.2% (98), and then by students holding a degree in Arts (16.6%, 54), Science (13.2%, 43), and Engineering/other field (8.6%, 28) respectively, thus making good representation across various academic backgrounds. It was observed that the freshers are predominant in the survey because 77.8%, 253, have no prior work experience; however, 22.2%, 72, of the respondents report having some form of experience. Further, it also shows the specialization preferences are diverse: the most popular being Marketing, selected by 33.2%, 108, of respondents, followed by Finance selected by 28.0%, 91, students, followed by Human Resources selected by 17.8%, 58, of respondents, by Operations by 11.1%, 36, other specializations selected by 9.8%, 32, students. This sample, diversified by gender, academic background, working experience, and preference for specialization in different areas, will help build a more robust ground for critical thinking skill analyses and attitudes towards AI by the postgraduate management students.

Table 1. Profile of Respondents (N = 325)

Characteristics	Valid Percentage (%)	Valid Frequency
Gender		
Male	51.1	166
Female	48.9	159
Undergraduate Degree		
Business Management	30.2	98
Commerce	31.4	102
Arts	16.6	54
Science	13.2	43
Engineering and others	8.6	28
Work Experience		
No Experience (Fresher)	77.8	253
Experienced	22.2	72
Specialization Choice		
Marketing	33.2	108
Finance	28.0	91
Human Resources	17.8	58
Operations	11.1	36
Others	9.8	32

4.2. Exploratory Factor Analysis

The EFA yielded four factors associated with attitudes of postgraduate management students toward critical thinking and AI, explaining 69.88% of the total variance. A KMO measure of 0.924 and Bartlett's Test of Sphericity ($p < 0.05$) indicated that the data are appropriate for factor analysis. Items with communalities below 0.50 were removed for robustness. Factor loadings reflect the strength and direction of the relationship between individual survey items and the underlying latent factors identified through exploratory factor analysis. Higher loadings indicate that an item is a strong representative of the factor, contributing significantly to measuring that construct. In this study, items with factor loadings above 0.60 were retained, ensuring that each factor comprises items with robust associations, thus improving construct validity and interpretability. This rigorous criterion for item retention strengthens the validity of the factor solution and provides a solid foundation for subsequent analyses.

- Factor 1: Confidence in Critical Thinking (Eigenvalue = 9.472, Variance Explained = 33.83%, Cronbach's Alpha = 0.939) comprised items that reflected the self-rated critical thinking of students, with factor loadings ranging from 0.712 to 0.764 and communalities from 0.546 to 0.596.

- Factor 2: Valuing Critical Thinking (Eigenvalue = 4.011, Variance Explained = 14.32%, Cronbach's Alpha = 0.955) captured the importance students assigned to critical thinking in the academic and career contexts, with loadings ranging from 0.874 to 0.904 and communalities from 0.793 to 0.862.

- Factor 3: Critical Thinking Misconceptions (Eigenvalue = 3.199, Variance Explained = 11.43%, Cronbach's Alpha = 0.908) depicted a simplistic or fallacious concept of critical thinking with the factor loadings that varied from 0.815 to 0.842 and the communality that ranged between 0.796 and 0.845.

- Factor 4: Attitudes towards AI (Eigenvalue = 2.884, Variance Explained = 10.3%, Cronbach's Alpha = 0.964) showed generally positive attitudes by the students about AI. With loadings varying from 0.826 to 0.850 and the communality values ranging between 0.893 and 0.909.

The four factors demonstrate strong internal consistency, with Cronbach's Alpha values ranging from 0.908 to 0.964, indicating excellent reliability. Construct robustness was further supported by CR and AVE. Confidence in Critical Thinking showed strong reliability and acceptable validity (CR = 0.939; AVE = 0.524), Valuing Critical Thinking exhibited excellent reliability and validity (CR = 0.955; AVE = 0.782), and Misconceptions of Critical Thinking demonstrated strong measurement quality (CR = 0.910; AVE = 0.718). Attitude Toward AI emerged as the most reliable and valid construct (CR = 0.964; AVE = 0.872), confirming the suitability of all factors for further analysis.

The EFA results reveal distinct characteristics among postgraduate management students. Confidence in Critical Thinking reflects strong assurance in applying analytical and evaluative skills, supported by a high mean score of 66.88. Valuing Critical Thinking indicates students' recognition of critical thinking as essential for academic performance and career development, with a mean score of 31.45, highlighting a high level of awareness of its importance in meeting program and instructional expectations.

Table 2. Principal Component Analysis on Attitudes Towards Critical Thinking and AI

Eigen-value	**Variance %**	**Factor**	**Item**	**Factor Loading**	**Commu-nalities**	**Mean**	**SD**
9.472	33.830	Confidence in Critical Thinking (α = 0.939, Mean = 66.88, SD = 30.955)	I can identify the structure of arguments without being influenced by their content in case studies and discussions.	0.712	0.546	4.69	2.861
			I can effectively articulate my critical thinking in written assignments and reports.	0.741	0.567	4.73	2.973
			I approach business problems in a focused and systematic manner.	0.764	0.596	4.86	3.069
			I consider myself to be a competent critical thinker in business-related subjects.	0.750	0.593	4.86	2.930
			I perform well in assessments that require critical evaluation of case studies.	0.727	0.550	4.82	2.970
			I engage in critical thinking while working on my assignments and projects.	0.742	0.560	4.73	2.901
			I can approach complex business issues from multiple perspectives.	0.745	0.591	4.76	2.950
			I have the ability to assess the relevance and value of new information presented to me.	0.708	0.522	4.62	2.817
			I can effectively evaluate the arguments made by others in class discussions.	0.726	0.548	4.76	3.035
			I am skilled at analyzing both sides of a business argument or case.	0.718	0.532	5.08	2.982
			I can draw meaningful comparisons between different business theories and models.	0.703	0.517	4.97	2.982
			When designing research or projects, I can effectively eliminate irrelevant variables.	0.730	0.562	4.56	2.879
			I can easily paraphrase the arguments presented by others in my own words.	0.738	0.609	4.70	2.982
			I actively engage in critical thinking during lectures and group discussions.	0.748	0.594	4.76	3.125

Eigen-value	**Variance %**	**Factor**	**Item**	**Factor Loading**	**Commu-nalities**	**Mean**	**SD**
4.011	14.324	Valuing Critical Thinking (α = 0.955, Mean = 31.45, SD = 15.954)	Critical thinking is particularly important in the field of business and management.	0.882	0.793	5.38	2.996
			Critical thinking is essential for success in my MBA/PGDM program.	0.874	0.795	5.15	2.828
			My critical thinking skills improve as I advance through my MBA/PGDM program.	0.904	0.862	5.14	2.983
			Achieving a good grade in my courses requires strong critical thinking skills.	0.899	0.824	5.22	2.990
			My professors expect me to demonstrate critical thinking skills in my work.	0.887	0.819	5.19	2.857
			I believe that applying critical thinking will lead to better academic performance.	0.888	0.825	5.36	2.988
3.199	11.426	Misconceptions of Critical Thinking (α = 0.908, Mean = 22.33, SD = 10.231)	A strong correlation between two variables in research implies causation in a business context.	0.912	0.845	5.47	2.776
			I prefer tasks that have straightforward and quick solutions.	0.863	0.796	5.72	2.926
			Including all available information in presentation slides and lecture materials is more important than focusing on key points.	0.895	0.825	5.74	2.956
			I define critical thinking as identifying flaws or weaknesses in arguments related to business.	0.810	0.684	5.40	2.890
2.884	10.300	Attitude toward Artificial Intelligence (AI) (α = 0.964, Mean = 20.97, SD = 6.550)	I believe that AI will improve my life	0.935	0.909	5.14	1.684
			I believe that AI will improve my work	0.938	0.905	5.25	1.793
			I think I will use AI technology in the future	0.931	0.906	5.25	1.671
			I think AI technology is positive for humanity	0.933	0.893	5.34	1.743
Total variance percentage			**69.88**				

The reliability and validity of the EFA-derived factors were confirmed through CR and AVE. All constructs demonstrated strong measurement quality, with Confidence in Critical Thinking (CR = 0.939; AVE = 0.524), Valuing Critical Thinking (CR = 0.955; AVE = 0.782), Misconceptions of Critical Thinking (CR = 0.910; AVE = 0.718), and Attitude Toward AI emerging as the most robust factor (CR = 0.964; AVE = 0.872). These factors reflect distinct characteristics among postgraduate management students, with high confidence in applying analytical skills (mean = 66.88) and strong recognition of critical thinking as essential for academic and career success (mean = 31.45).

Table 3. Reliability and Convergent Validity Results

Factor	**Composite Reliability**	**AVE**
Confidence in Critical Thinking	0.939	0.524

Valuing Critical Thinking	0.955	0.782
Misconceptions of Critical Thinking	0.910	0.718
Attitude toward AI	0.964	0.872

The third factor, Misconceptions of Critical Thinking, reflects flawed or simplified understandings of critical thinking (mean = 22.33), including equating correlation with causation and overemphasizing information over key insights, which can lead to poor analytical judgments. Case-based learning and real-world scenarios can help address these issues. The fourth factor, Attitude Toward Artificial Intelligence (AI), shows generally positive perceptions of AI (mean = 20.97), indicating students' readiness to adopt AI technologies and underscoring the importance of integrating AI literacy into management curricula.

4.3. Cluster Analysis

The K-means cluster analysis based on the four EFA-derived dimensions identified three distinct clusters among 325 postgraduate management students, revealing diverse profiles in critical thinking skills and attitudes toward AI.

Cluster 1 comprised 99 students (30.5% of the sample) and showed the highest Confidence in Critical Thinking (mean = 105), high valuation of critical thinking (mean = 39), the lowest misconceptions (mean = 20), and the most positive attitude toward AI (mean = 23). Overall, this cluster represents confident, highly motivated students with strong critical thinking skills and an optimistic view of AI.

Cluster 2, the largest group with 125 students (38.4% of the sample), showed moderate Confidence in Critical Thinking (mean = 65), reasonable valuation of critical thinking (mean = 32), balanced misconceptions (mean = 21), and moderately positive attitudes toward AI (mean = 21). This cluster represents students with moderate confidence who require further development in critical thinking while remaining cautiously positive toward AI.

Table 4. Cluster-wise Distribution of Factors

Factors	**Cluster 1** (n = 99, 30.5%)	**Cluster 2** (n = 125, 38.4%)	**Cluster 3** (n = 101, 31.1%)	**F Value**	**Significance**
Confidence in Critical Thinking	105	65	31	1104.478	0.000
Valuing Critical Thinking	39	32	24	23.223	0.000
Misconceptions of Critical Thinking	20	21	26	7.827	0.000
Attitude toward AI	23	21	19	13.395	0.000

Cluster 3 comprised 101 students (31.1% of the sample) and showed the lowest Confidence and Valuing of Critical Thinking (means = 31 and 24) and the highest misconceptions (mean = 26). Attitudes toward AI were also the lowest (mean = 19), indicating limited readiness. Overall, this cluster reflects students with significant challenges in critical thinking and AI engagement, requiring targeted educational interventions.

The ANOVA results confirmed significant differences among the three clusters across all four dimensions, with F-values ranging from 7.827 to 1104.478 ($p < 0.05$), highlighting distinct profiles in confidence, values, misconceptions, and attitudes toward AI. The cluster labels Critical Thinkers & AI Optimists (Cluster 1), Developing Thinkers & AI Moderates (Cluster 2), and Novice Thinkers & AI Skeptics (Cluster 3) were derived from EFA-based dimensions. Cluster validation using Chi-square tests and Cramér's V revealed significant differences only for gender (p = 0.000, Cramér's V = 0.220), while undergraduate degree, work experience, and specialization choice showed no significant associations, supporting the robustness and interpretability of the cluster solution.

- Cluster 1: Critical Thinkers & AI Optimists
  This cluster comprises 99 students (30.5%) characterized by high confidence and strong valuation of critical thinking, minimal misconceptions, and highly positive attitudes toward AI. The gender distribution is nearly balanced. Most students come from Business Management (32.7%) and Commerce (32.4%) backgrounds, with slightly more freshers (31.2%) than experienced students (27.8%). Key specializations include Finance (33.0%) and Marketing (29.6%). Overall, Cluster 1 represents academically strong and optimistic students who are well positioned to integrate AI into their education and future careers.

Table 5. Demographic Profile by Cluster

Demographic Variables	**Clusters**			χ^2	**Cramer's V**	**Significance, p value**
	Critical Thinkers & AI Optimists (n=99) n (%)	**Developing Thinkers & AI Moderates (n=125) n (%)**	**Novice Thinkers & AI Skeptics (n=101) n (%)**			
Gender				15.796	0.220	0.000
Male	50 (30.1)	79 (49.6)	37 (22.3)			
Female	49 (30.8)	46 (28.9)	64 (40.3)			
Undergraduate Degree				8.270	0.113	0.408
Business Management	32 (32.7)	41 (41.8)	25 (25.5)			
Commerce	33 (32.4)	34 (33.3)	35 (34.3)			
Arts	16 (29.6)	23 (42.6)	15 (27.8)			
Science	13 (30.2)	18 (41.9)	12 (27.9)			
Engineering and others	5 (17.9)	9 (32.1)	14 (50.0)			
Work Experience				2.18	0.082	0.336
No Experience (Fresher)	79 (31.2)	92 (36.4)	82 (32.4)			
Experienced	20 (27.8)	33 (45.8)	19 (26.4)			
Specialization Choice				7.392	0.107	0.495
Marketing	32 (29.6)	43 (39.8)	33 (30.6)			
Finance	30 (33.0)	34 (37.4)	27 (29.7)			
Human Resources	22 (37.9)	21 (36.2)	15 (25.9)			
Operations	11 (30.6)	13 (36.1)	12 (33.3)			
Others	4 (12.5)	14 (43.8)	14 (43.8)			

- Cluster 2: Developing Thinkers & AI Moderates
  This cluster is made up of 125 students, constituting 38.4% of the total, indicating moderate confidence and the importance ascribed to critical thinking; fewer misconceptions about AI; and cautious optimism with respect to AI. Males make up 49.6%, while females constitute 28.9%. For most of the students in this cluster, undergraduate degrees are concentrated in Business Management and Commerce, at 41.8% and 33.3%, respectively. This fact suggests an academic background that supports the development of critical thinking but at a lower intensity than in Cluster 1. Experienced professionals make up a slightly higher proportion in this cluster, at 45.8%, while freshers make up 36.4%, which suggests that work experience may be playing a role in their transitional confidence levels. As for specialization preferences, Marketing and Finance top the list, at 39.8% and 37.4%, respectively, with the remaining specializations commanding fewer student choices. Cluster 2 also describes a transitional group balancing critical thinking and AI with caution.

- Cluster 3: Novice Thinkers & AI Skeptics
  This cluster consists of 101 students, representing 31.1%, characterized by low confidence in critical thinking, low value placed on it, high misconception, and relatively less positive attitude towards AI. Females dominate this cluster, comprising 40.3% as opposed to 22.3% males. Engineering and other undergraduate degrees are dominant in this cluster at 50.0%, while Business Management constitutes 25.5% and Commerce 34.3%, thus indicating that non-business backgrounds might relate to low confidence and higher misconceptions. Freshers lead in this cluster, having 32.4% as opposed to experienced professionals at 26.4%, suggesting limited exposure to professional environments that might have improved their level of critical thinking. Specialization choices are fairly evenly distributed, with Marketing at 30.6%, Finance at 29.7%, and Human Resources at 25.9% being the most represented areas. Students in Cluster 3 struggle with the development of critical thinking and engagement with AI.

Policy-aligned recommendations emerge from cluster analysis. Cluster 1 (38%) requires advanced AI governance training per MeitY 2025 guidelines [21]. Cluster 2 (42%) benefits from DPDP-compliant data ethics [25]. Cluster 3 (20%) needs foundational AI literacy aligning with NITI Aayog's 1M AI skilling target by 2026 [27] and NEP 2020 frameworks [26]. UGC/AICTE can mandate IndiaAI Mission-supported interventions [21], ensuring India's 0.65M annual MBA graduates meet national AI workforce goals.

SDG-aligned curriculum design emerges as a key implication. Cluster 3 (Novice Thinkers AI Skeptics, 20%) requires SDG 4.7-compliant foundational modules on AI ethics and data privacy (DPDP 2023), while Clusters 1-2 advance SDG 9.5 research capacities through MeitY self-certification training [22]. B-schools can operationalize Table 5, supporting India's 0.65M annual MBA graduates for SDG 8.3 technopreneurship targets [29].

5. MANAGERIAL IMPLICATIONS

This study offers practical guidance for educators, academic leaders, and policymakers by emphasizing the need for segment-based instructional strategies in management education. The identification of three student clusters Critical Thinkers & AI Optimists, Developing Thinkers & AI Moderates, and Novice Thinkers & AI Skeptics indicates that a uniform teaching approach is no longer sufficient. Advanced learners should be engaged through AI-driven simulations, data-intensive decision-making tasks, and ethical AI case studies to further enhance higher-order thinking and leadership readiness. Developing learners require structured scaffolding through peer collaboration, AI-supported case analysis, guided prompt engineering, and reflective evaluation of AI-generated outputs to close gaps in confidence and engagement. Meanwhile, novice learners benefit from foundational interventions that demystify AI, such as guided AI usage protocols, critical questioning exercises, and interactive tutorials to strengthen conceptual clarity and independent thinking. Integrating AI-enabled tools like natural language processing, predictive analytics, and real-time feedback systems into management curricula can better align learning outcomes with industry expectations, enhance student engagement, and support the development of critical, ethical, and adaptive decision-making skills essential in the digital business era.

6. CONCLUSION

This study highlights the importance of examining critical thinking skills and attitudes toward artificial intelligence as interconnected dimensions in management education. By identifying four underlying factors and segmenting postgraduate management students into three distinct clusters, the findings reveal substantial differences in confidence, value orientation, misconceptions, and technological readiness. These variations demonstrate that students engage with critical thinking and AI in diverse ways, reflecting different levels of cognitive maturity and openness to technological tools.

The results indicate that effective management education in the digital era must move beyond uniform instructional models. Developing graduates who are capable of analytical reasoning, ethical judgment, and informed decision-making requires the integration of critical thinking development with AI literacy. Students who demonstrate higher confidence and positive AI attitudes are better positioned to operate in data-driven and technology-intensive business environments, while those with lower confidence and skeptical attitudes require targeted support to build foundational understanding and engagement.

Although this study is limited by its cross-sectional design and contextual scope, it provides valuable insights for curriculum development and pedagogical innovation. Future research should explore longitudinal approaches, broader institutional settings, and experimental learning interventions to further examine how critical thinking and AI engagement evolve over time. Overall, the study underscores the need for management education to adapt to technological transformation by cultivating cognitively agile and technologically competent graduates who can navigate complexity and uncertainty in the contemporary business landscape.

7. DECLARATIONS

7.1. About Authors

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7.2. Author Contributions

Conceptualization: SS; Methodology: SS; Software: SS; Validation: SS; Formal Analysis: SS; Investigation: SS; Resources: SS; Data Curation: SS; Writing Original Draft Preparation: SS; Writing Review and Editing: SS; Visualization: SS; The author has read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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