



Impact of AI-Enabled Techno-Pedagogical special education competency (AI-TPSEC) in Indian MSME: The Mediating role of inclusive skill development and Employee Productivity

Mr. Subash Chandra Patra¹, Dr. Ashok Kumar Sar²

¹Research Scholar, Mail id: KIIT School of Management, KIIT University, Patia, Bhubaneswar, Odisha, India, Pin:751024, ORCID ID:0009-0009-5649-9940

²Professor, KIIT School of Management, KIIT University, India, Mail id: KIIT School of Management, KIIT University, Patia, Bhubaneswar, Odisha, India, Pin:751024, ORCID ID:0000-0002-7861-9060

ABSTRACT

MSME is a crucial segment that contributes 30.10% of GDP, 36% to manufacturing output, 45% to export & 2nd largest employer after Agriculture by employing 24.40 crore people in Indian Economy. The study develops an integrated framework linking entrepreneurial AI-Enabled Techno-Pedagogical special educational competency (AI-TPSEC) to MSME economic performance, focusing on disability-inclusive employment; it uses a mixed-methods design with questionnaires from 320 MSME entrepreneurs in Maharashtra and Odisha with SEM (AMOS) analysis. Results show a positive relationship between TPSEC and firm performance, supported by strong reliability and validity metrics (Cronbach's $\alpha = 0.907$, AVE = 0.788, CR = 0.888), and indicate that workplace skill development and employee productivity mediate this effect. The findings extend special-education research into post-education employment and suggest policy and training interventions to strengthen inclusive HR practices, entrepreneurial training, and MSME competitiveness. The study further highlights the relevance of techno-pedagogical competence for emerging AI-enabled workplace learning and inclusive human-AI interaction in MSMEs.

Keywords: AI-Enabled Techno-pedagogical special education competence; MSMEs; Inclusive skill development; Employee productivity; AI-enabled workplace learning; Human-AI interaction.

1. INTRODUCTION

MSME segment is the DNA of Indian Economy, contributing to industrial employment, value addition, and regional dispersal of industries. MSMEs are those entities whose investment in plant & machinery/equipment range is up to Rs.50 crores and turnover range is up to Rs.250 crores. MSMEs in India suffers from three main problems-Technology, Capital and Talent (Singh and Chakraborty, 2016).

Micro, Small and Medium Enterprises (MSMEs) constitute a critical pillar of India's economic architecture, contributing significantly to employment generation, industrial output, and export performance. The academic literature consistently identifies MSMEs as engines of inclusive growth due to their low capital intensity and high labour absorption capacity (Ministry of MSME, 2024). Studies emphasize that MSMEs facilitate balanced regional development by promoting entrepreneurship and social inclusion of special educated entrepreneurs, thereby reducing income disparities and migration pressures to help in achieving social and economic performance of MSMEs.

More than ever before, the policy and research agenda on inclusion of persons with disabilities in education, employment and in the wider social and economic life have become significant issues of global importance. The United Nations Convention on the Rights of Persons with Disabilities affirms persons with disability's right to equal access to education, vocational training and employment (United Nations, 2006). Yet, many persons with disabilities are struggling to move from school to work. While education inclusion is not a panacea for employment inclusion, there must be continuity between the provision of education, skill development, employability and labour market participation at the work place to achieve an inclusive society. Technological change has introduced new opportunities to tackle some of these challenges. Technology such as digital learning platforms, assistive technologies, adaptive technologies, artificial intelligence, accessible communication technologies, and flexible working arrangements may offer greater opportunities to persons with disabilities. Meanwhile, technology can also pose new obstacles if they are not accessible or if people do not have the skills to utilize them properly (UNESCO,

2023, 2024). The recent advances of AI have also opened up new possibilities for technology-enhanced learning in the workplace. Individualized skill learning and enhanced accessibility for employees with varying learning needs can be achieved through AI-powered learning platforms and platforms that support learning through individuality, as well as through adaptive training systems and intelligent assistive technologies, and personalized digital tools. These technologies can help facilitate human-AI interaction in disability-inclusive workplaces, allowing for flexible learning, personalized support, and participation that is more accessible for everyone. The effective use of them however, relies a great deal on the technological and pedagogical skills of those involved in the workplace learning and training process.

The role of educators and organizational leaders will become more important in this context. Traditionally, special educators have been at the forefront of designing individual learning opportunities and preparing persons with disabilities for independent living and participation. But the shift from education to job demands the involvement of the employers and entrepreneurs as well. Entrepreneurs and owner-managers of MSMEs influence organizational culture, recruitment, training, technology adoption, and workplace practices. Their ability to facilitate technology-enabled learning with special emphasis on AI and skill development may therefore affect the inclusion and productivity of employees with disabilities.

The concept of techno-pedagogical competence has traditionally been associated with educators and the integration of technology with pedagogical knowledge. The TPACK framework developed by Mishra and Koehler (2006) emphasizes the interaction of technological knowledge, pedagogical knowledge, and content knowledge. While the original framework was developed for teachers, its underlying logic may be extended conceptually to entrepreneurs who facilitate learning and knowledge development within organizations.

An entrepreneur's techno-pedagogical competence may include the ability to understand technological developments, facilitate employee learning, integrate digital tools into workplace training, identify appropriate technologies, and create an environment in which employees can continuously develop technology-related skills. In contemporary workplaces, this competence may also involve the ability to evaluate and appropriately integrate emerging AI-enabled learning, assistive, and decision-support technologies into employee training and skill-development practices.

This competence may be particularly relevant to disability-inclusive employment. Persons with disabilities may require individualized workplace training, accessible digital resources, assistive technologies, flexible learning methods, and continuous support. Entrepreneurs who are capable of integrating technology with workplace learning may therefore be better positioned to create inclusive organizational environments.

India's MSME sector provides an important context for examining this relationship. MSMEs represent a major component of India's economic and employment ecosystem. Their relatively flexible organizational structures may provide opportunities for inclusive employment, but their ability to adopt inclusive practices can depend heavily on the capabilities and attitudes of entrepreneurs and owner-managers.

In Indian MSMEs, AI-generated contents and customer segmentation is deployed to improve the marketing of various products. The use of AI-Chatbots helps to improve customer service, AI enabled automated book keeping and fraud detection enhances the financial management competencies of entrepreneurs, AI -supported demand and sales forecasting with proper inventory maintenance improves the profitability. AI enabled recruitment and employee analytics improve retention at work space.

The present study therefore proposes a conceptual framework examining the following relationship:

Entrepreneurs' AI-enabled Techno-Pedagogical special education Competence → Workplace Skill Development → Disability-Inclusive Employment → Employee Productivity → MSME Performance

The relationship between entrepreneurial AI-enabled TPCSE (AI-TPCSE) and the economic performance of MSMEs has attracted considerable attention in entrepreneurship and management research. Restated, research on entrepreneurial education conducted internationally consistently shows that a higher level of educational attainment, technical expertise, digital skills, and innovation skills lead to higher productivity, profitability, growth, and competitiveness of entrepreneurs. The skills these enable entrepreneurs to identify opportunities, use new technologies, make operations more efficient and effectively manage fluctuating market conditions (Shane, 2003; Lazear, 2005). There is another line of literature related to digitalization and technological adoption. As MSMEs become part of the global value chain, they are compelled to improve productivity and competitiveness. ICRIER (2021) shows that digital adoption, such as ecommerce participation and digital payments, has had a positive impact on market access and revenue growth for small business. But it is also pointed out that digital divides exist on the low availability of infrastructure, a lack of skills and security issues. Technological capability is therefore perceived as a chance and a structural problem. With the increasing availability of AI-based business and learning technologies, this challenge is increasingly gaining importance. In addition to the technological access, the ability of entrepreneurs to understand the technology, communicate it and apply it to workplace learning will be crucial for successful adoption by the MSMEs. Techno-pedagogical competence can thus be

considered as being an important human competence for responsible and inclusive interaction with emerging intelligent technologies. The OECD's 2025 survey of more than 5000 MSMEs across 7 countries in globally reveal that about 31% MSMEs are already using Gen AI. Among MSMEs using Gen AI, 65% reported improved employee performance, while 35% reported that it helped them to scale up (OECD publishing, 2025). Day by day various AI enabled technologies are playing important role in MSME work space like Gen AI in the place of content marketing, Agent AI in field of Autonomous customer service, AI Chatbots & Conversational AI for order enquiries and customer support, Predictive AI/Machine learning for sales forecasting, AI-powered CRM for customer segmentation, Computer Vision for quality inspection, AI-powered Automation invoice processing and accounting, Multimodal AI processing texts & images, AI coding assistants, AI cyber security fraud detection, Personalized recommendation AI in digital marketing/E-commerce, AI+IoT/Edge AI in smart manufacturing field..

According to Human Capital Theory, education increases the knowledge, analytical skill and decision-making capabilities of an entrepreneur, which leads to better performance of a business (Becker, 1993). Higher education levels help entrepreneurs to acquire information, get a better grasp of investment opportunities and make more strategic decisions to help their firms perform better.

Davidsson and Honig (2003) studied the contribution of human capital to entrepreneurial success and concluded that these differences in education were correlated with better business growth and business survival rates by the entrepreneurs. Their research found that formal education boosts an entrepreneur's capacity to spot opportunities and to effectively marshal resources. Likewise, Bosma et al. (2004) indicated that education positively affects the performance of ventures by enhancing their managerial skills, strategic planning and innovation. Educated entrepreneurs were more likely to introduce new products, access financial resources, and expand into new markets.

Artificial Intelligence (AI) is the ability of computer systems or machines to perform tasks that normally require human intelligence, such as learning (Russell & Norvig, 2021), reasoning & problem solving (Russell & Norvig, 2021), understanding language (Miao & Cukurova, 2024), recognizing images, solving problems, and making decisions. The main features of AI are learning from data and improving performance of MSME, analysing information and identify patterns, finding solution to complex problems, understanding and generating human language, identifying objects/texts/faces/texts/other visual information (UNESCO, 2023), using data to forecast likely outcomes, performing repetitive tasks with limited human interventions (OECD, 2025). Ex. AI Chatbot, Generative AI, ChatGPT, Google-Gemini, AI-powered translations, AI-assistive technologies (UNESCO, 2024).

AI-enabled Techno-Pedagogical special educational competency (AI-TPSEC) is defined as the special educator's integrated ability to use Artificial intelligence (AI), assistive technology, engage in digital professional learning, and apply evidence-based special education pedagogy (Mishra & Koehler, 2006).

Technical competence refers to entrepreneurs' ability to understand production processes, quality management, technological systems, and operational efficiency. Research consistently shows that technical expertise enhances productivity and reduces production costs. AI knowledge competency refers to understanding AI concepts, applications, limitations and accessibility -related AI Tools.

AI can support personalized learning, adaptive instruction, assessment, communication, and accessibility for learners with disabilities. The integration of AI with technological and pedagogical knowledge is increasingly being explored in special-education teacher preparation (Goldman et al., 2024).

Baum, Locke, and Smith (2001) found that entrepreneurs with strong technical and industry-specific knowledge achieved significantly higher business growth than those with limited technical capabilities. Technical competence enabled entrepreneurs to improve operational efficiency, optimize production processes, and enhance product quality.

Similarly, Colombo and Grilli (2005) concluded that technical knowledge is a critical determinant of growth in technology-based firms. Entrepreneurs possessing engineering and scientific backgrounds were better able to commercialize innovations and manage technological change.

As per MSME annual report-2024-25, registered MSMEs in India in FY25 are 57.77 million comprising of Small Enterprises 7.32 lakh units (1.30%), Medium Enterprises 0.69 lakh units (0.1%) and Micro Enterprises 569.01 lakh units (98.61%). As per MSME annual report-2023-24, During FY-2024, the registered number of MSME enterprises as per Udyam registration portal was 63 million. The disability inclusion in MSME organization work space and impact of TPCSE on economic & social performance among MSME will create a holistic employment opportunity.

Hence the various AI-TPCSEs has to be analysed and addressed. Also, how much the AI-TPCSE of the entrepreneurs impact the profitability and viability of the MSMEs needs to studied (Panigrahi, 2016). The MSME in India constitute about 80% of the total number of industries and produces about 8000 value added products.

W.e.f. April-01,2025, MSME definition has been revised based upon investment Plant & machinery/Equipment and Turnover (Composite criteria).

Type of MSME	Investment (Rs. Crore)		Turnover (Rs Crore)	
	w.e.f. Jult-01,2020	w.e.f. April-01,2025	w.e.f. July-01,2020	w.e.f. April-01,2025
Micro	1	2.5	5	10
Small	10	25	50	100
Medium	50	125	250	500

(Source: MSME Annual Report 2024-25) & Gazette of India notification, Mar.25,2025.

As on December-2024, almost 57.77 million MSME are registered in Udyami portal, 56.90 million micro enterprises were registered on Indian Govt's Udyam registration portal accounting more than 98.60 % of MSME sector. Gender wise URC female is 16.60 million (28.88 %) and male is 40.87 million (70.80%), others 0.20 million (0.40%). Indian Govt. has launched various MSME schemes like PMEGP scheme, NULM, NRLM, MUDRA, PM Svanidhi scheme, Stand up India scheme, PM Vishwakarma scheme etc. Still the disability employee inclusion in MSME workspace has challenges like special educator pedagogical content inclusion in work space to improve productivity of disable employees, access to various technology, adapt to intrategic competencies, access to market knowledge, access to technology, promoting digitalization, infrastructure bottle necks, Inadequate skilling/reskilling (MSME annual report-2024-25).

2. Research objectives

The study empathizes that the relationship between entrepreneurs' AI-Enabled Techno-pedagogical special education competence and MSME performance is primarily indirect. The entrepreneur's competence may first influence workplace learning and skill development, which may facilitate disability-inclusive employment and employee productivity, ultimately contributing to organizational performance. This relationship is particularly relevant in increasingly digital and AI-enabled work environments, where techno-pedagogical competence may support the effective and inclusive adoption of emerging technologies for workplace learning and skill development.

The main objective of the study is

- i.How does entrepreneurs' techno-pedagogical competence w.r.t digital competencies/AI/Machine learning influence workplace skill development in Indian MSMEs?
- ii.Does workplace skill development in the field of AI enabled technologies facilitate disability-inclusive employment?
- iii.Does disability-inclusive employment contribute to employee productivity?
- iv.Does employee productivity influence MSME performance?
- v.Do workplace skill development and employee productivity mediate the relationship between entrepreneurs' techno-pedagogical competence and MSME performance?

3. Significance of the study

The study is important because it clarifies how AI-Enabled entrepreneurial techno-pedagogical special education competence (TPCSE) drives MSME profitability and growth, informing academic scholarship and policy interventions to strengthen the sector. It will help practitioners, policymakers, and educators design targeted skill-development and financial-management programs for special-educator entrepreneurs, thereby supporting job creation, disability-inclusive employment, holistic social inclusion, and greater MSME resilience and competitiveness. The study also has relevance for emerging AI-enabled workplace environments, as techno-pedagogical competence may help MSME entrepreneurs and special educators integrate intelligent learning, assistive, and digital technologies into inclusive skill-development practices. This provides practical implications for human-AI interaction and technology-supported workforce development without changing the study's primary focus on AI-TPCSE and MSME performance.

4. Research questions

The main research questions to be addressed here are-

- 1)What is the role of the various AI-TPCSE impacting the economic performance of MSMEs?
- 2)Is it important for entrepreneurs to have certain level of AI-TPCSE to handle the day-to-day performance of the MSMEs?

5. Literature reviews

5.1 Techno-Pedagogical Competence

The increasing use of technology in education has led to growing interest in teachers' digital and techno-pedagogical competencies. The TPACK framework proposed by Mishra and Koehler (2006) represents one of the most influential approaches to understanding technology integration in teaching.

The framework builds on Shulman's (1986) concept of pedagogical content knowledge and proposes that effective technology integration requires teachers to combine technological, pedagogical, and content knowledge.

The seven knowledge domains of the framework comprise Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge, Technological Pedagogical Content Knowledge.

The core principle is that technology is most effective when integrated appropriately with pedagogical objectives and contextual requirements (Mishra & Koehler, 2006).

Although the TPACK framework was developed in the educational context, its underlying logic may be relevant to entrepreneurial environments where entrepreneurs act as facilitators of workplace learning. In knowledge-intensive and technology-driven business environments, entrepreneurs frequently perform functions that extend beyond resource allocation and strategic decision-making. They may also facilitate employee learning, introduce new technologies, encourage knowledge sharing, and support skill development.

Therefore, this study conceptualizes entrepreneurial techno-pedagogical competence as the entrepreneur's ability to understand, integrate, facilitate, and disseminate technology-enabled knowledge and learning within the MSME organizational workplace.

This adaptation represents a conceptual extension of the traditional TPACK perspective. In contemporary workplaces, this extension may also encompass the ability to understand and appropriately integrate AI-enabled learning platforms, intelligent assistive technologies, and adaptive digital tools. Such capabilities can strengthen technology-supported learning while enabling more inclusive human-AI interaction in workplace training environments.

5.2 AI-Enabled Techno-Pedagogical special education Competence and MSME organizational Workplace Skill Development

Workplace learning is increasingly important in digitally transforming organizations. Employees must continuously develop new skills to respond to technological changes, changing customer expectations, and evolving work processes.

Entrepreneurs play an important role in shaping organizational learning environments. In MSMEs, owner-managers often have considerable influence over employee training, technology adoption, and organizational practices.

An entrepreneur with strong techno-pedagogical competence may be more likely to encourage digital learning, provide technology-enabled training, facilitate knowledge sharing, introduce accessible learning tools, support individualized skill development, promote continuous learning. These practices may be particularly beneficial for employees with disabilities, who may require differentiated learning strategies and accessible technologies. The growing use of AI-supported learning systems may further extend these practices through personalized training, automated feedback, adaptive learning pathways, and accessibility-oriented support. In MSMEs, the effective use of such technologies may depend on entrepreneurs' ability to align intelligent digital tools with employees' learning needs and workplace contexts.

5.3 Workplace Skill Development and Disability-Inclusive Employment

Skill development is an important determinant of employability. Persons with disabilities may face additional barriers in accessing education, vocational training, and employment. Inclusive skill-development systems can help reduce these barriers by providing accessible and individualized training.

Technology-enabled workplace learning can potentially improve the accessibility and flexibility of training. For example, digital platforms can provide self-paced learning, while assistive technologies can facilitate communication and task performance. AI-enabled adaptive learning and assistive systems may further improve this flexibility by tailoring learning content, support, and accessibility features to individual employee requirements. AI can help the special educator to shift from one-size-fits all training to personalized and inclusive workplace training.

Inclusive skill development may therefore increase the ability of persons with disabilities to participate effectively in organizational environments.

5.4 Disability-Inclusive Employment

Disability-inclusive employment involves more than hiring persons with disabilities. It includes meaningful participation, equal opportunity, accessibility, workplace accommodation, career development, and organizational belonging.

The United Nations Convention on the Rights of Persons with Disabilities emphasizes the right of persons with disabilities to work on an equal basis with others (United Nations, 2006).

Inclusive employment practices may include accessible recruitment, reasonable accommodation, assistive technologies, inclusive training, flexible work arrangements, accessible communication, career development opportunities. The special educator can use AI to convert complicated work instructions in to simple step-by-step instructions, generate pictures or visuals demonstration, provide an AI assistant that reminds the employee about each task, adjust training according to the employee's learning progress,

monitor performance and identify where additional support is required.”

Entrepreneurs are particularly important actors because they influence organizational policies and workplace culture by deploying AI enabled digital skills the goal of inclusive employment can be achieved towards social performance goal of MSME.

5.5 Disability-Inclusive Employment and Employee Productivity

The relationship between inclusion and productivity can be explained through Human Capital Theory (Becker, 1964). Employees who possess relevant skills and receive appropriate organizational support can contribute to productivity and organizational outcomes.

Persons with disabilities may experience productivity barriers when workplaces are inaccessible or when they do not receive appropriate training and accommodations. Conversely, when employees have appropriate skills, technology, and organizational support, their productivity may improve.

Therefore, inclusive employment should be understood not merely as a social responsibility but also as a potential organizational capability.

5.6 Employee Productivity and MSME Performance

Employee productivity is a critical determinant of organizational performance. This relationship may be particularly important for MSMEs because they often operate with limited financial and human resources. Productive employees can contribute to improved operational efficiency, higher quality, lower costs, improved customer satisfaction, innovation, business growth.

From a Resource-Based View perspective, skilled human resources can represent valuable organizational resources that contribute to competitive advantage (Barney, 1991). Hence Employee productivity has a positive and significant effect on MSME performance.

5.7 Mediating Role of Workplace Skill Development

The relationship between entrepreneurs' techno-pedagogical competence and disability-inclusive employment may not be direct.

Entrepreneurs' competence may first create better workplace learning environments. These environments may improve the skills and capabilities of employees with disabilities, which may then facilitate inclusion.

Thus: AI-Enabled Techno-Pedagogical special education Competence → Workplace Skill Development → Disability-Inclusive Employment

Hence Workplace skill development mediates the relationship between entrepreneurs' techno-pedagogical competence and disability-inclusive employment.

5.8 Sequential Mediation

The proposed model further suggests a sequential pathway:

Techno-Pedagogical AI Competence → Workplace AI enabled Skill Development → Disability-Inclusive Employment → Employee Productivity → MSME Performance

This represents the central theoretical contribution of the study.

The model proposes that entrepreneurs' techno-pedagogical competence contributes to organizational performance by developing an inclusive human capital pathway. Hence Workplace skill development and disability-inclusive employment sequentially mediate the relationship between entrepreneurs' techno-pedagogical competence and employee productivity. Further, Workplace skill development, disability-inclusive employment, and employee productivity sequentially mediate the relationship between entrepreneurs' techno-pedagogical competence and MSME performance.

5.9. Theoretical Framework

5.9.1 TPACK Framework (Technological Pedagogical content knowledge)

The TPACK framework provides the foundation for conceptualizing techno-pedagogical competence (Mishra & Koehler, 2006). In the present study, the framework is adapted to the entrepreneurial context. The adapted dimensions include; Technological knowledge (Knowledge of digital technology, software, Hardware, platforms and technology tools), Workplace pedagogical knowledge (Knowledge of teaching, learning, Instructional methods assessment and classroom management), Technology integration, Digital knowledge sharing, Technology-enabled employee learning, Pedagogical content knowledge (Understanding how to teach particular content effectively to different learners), Techno pedagogical content knowledge i.e. TPACK; is the integrated knowledge of technology, pedagogy and content to create effective technology-enables learning.

5.9.2 Human Capital Theory

Human Capital Theory proposes that investments in education, training, and skills increase individual productivity and economic outcomes (Becker, 1964). In the present study: Entrepreneur competence → Employee skill development → Productivity. This theoretical pathway explains how techno-pedagogical competence may ultimately contribute to organizational performance.

5.9.3 Resource-Based Theory

The Resource-Based View argues that valuable and difficult-to-imitate organizational resources can generate competitive advantage (Barney, 1991).

From this perspective, disability-inclusive human capital may represent an underutilized organizational

resource. Entrepreneurs who develop inclusive workplace capabilities may strengthen their organizations' human capital and innovation potential.

5.9.4 Social Inclusion Perspective

Social inclusion emphasizes equal participation and access to opportunities for individuals who experience social and economic barriers. Within this framework, disability-inclusive employment represents an extension of inclusive education. The proposed continuum is: Inclusive Education → Inclusive Skill Development → Inclusive Employment → Economic Participation. This provides a strong conceptual connection between special education and MSME research.

5.9.5. Conceptual Framework

The proposed conceptual framework is:

Entrepreneurs' AI-Enabled Techno-Pedagogical special education Competence-----Workplace Skill Development ----Disability-Inclusive Employment ----Employee Productivity -----MSME Performance

The model can be empirically examined using SEM.

6. Research Gap

Although prior studies have examined special education, disability inclusion, entrepreneurial competence, digital transformation, and MSME performance separately, few have integrated these areas to explain how entrepreneurs with disabilities succeed and boost MSME outcomes in India. The application of the TPACK or an adapted techno-pedagogical competence framework to disability entrepreneurship, and the pathways by which entrepreneurial competence affects performance via digital and innovation capabilities—moderated by inclusive ecosystem support—remain underexplored. Developing an integrated framework linking these constructs offers a valuable research opportunity to clarify mechanisms and inform policy and practice. Additionally, limited attention has been given to how techno-pedagogical competence may support the responsible and inclusive adoption of emerging AI-enabled learning and assistive technologies within MSME workplaces. Examining techno-pedagogical competence in this evolving digital context can therefore provide insights into the human capabilities required for effective and inclusive human-AI interaction in workplace learning and skill development.

7. Research methodology:

7.2.1 Research Design: A quantitative, Cross sectional research design proposed to examine the hypothesized relationship.

7.2.2 Research Approach and Scope

To perform the research study quantitative research method would be considered to establish the empirical relationship between the variables (Watson, 2015). The research population is MSME units in and around of Nagpur city of Maharashtra state. A sample size of 320 MSMEs would be considered for data collection. The scope of the research is limited to analyzing the impact of AI-Enabled Entrepreneurial techno-pedagogical competence of special education on economic performance of MSME enterprises. Qualitative aspects have also been considered during the time of data collection as several other factors were analyzed.

7.2.3 Research Population, Sample size and Sampling Method

The study population comprised MSMEs in Maharashtra and Odisha, with a purposive cluster sample of 320 owner-managers and senior managers from enterprises experienced in disability-inclusive employment. Respondents were identified using purposive sampling to target firms with workplace training and skill-development participation, and primary data were collected via questionnaires administered to MSME entrepreneurs in and around Nagpur, Maharashtra.

7.2.4 Research Variables

In the research study one independent variable including entrepreneurial techno-pedagogical competence of special educator i.e. AI-TPCSE (X) and one dependent variable Economic performance of MSME (Y) are considered. By considering these research variables the research hypothesis formation is done.

7.2.5 Research Hypothesis

Relationship between entrepreneurial AI-TPCSE and Economic performance of the MSMEs.

● Null Hypothesis (H₀): There is a positive relationship lies between entrepreneurial AI-TPCSE and Economic performance of the MSMEs.

● Alternative Hypothesis (H₁): There is a negative relationship lies between entrepreneurial AI-TPCSE and Economic performance of the MSMEs.

7.2.6 Research Analysis Design

Quantitative research method has been adopted by taking the data from the 320 samples of MSME units located in and around Nagpur city of Maharashtra state & Odisha state by using 7 points Likert's scale. For the purposes of analysis part of the present research study, AMOS software was used.

Respondents would indicate their level of agreement with statements measuring: Techno-Pedagogical

Competence like Our entrepreneur/owner-manager understands emerging digital technologies, our entrepreneur encourages technology-enabled learning, our entrepreneur facilitates digital knowledge sharing, our entrepreneur supports technology-based employee training, our entrepreneur promotes continuous technology-related learning. In the Workplace Skill Development; Employees receive regular technology-related training, Training is adapted to employees' individual needs, Employees with disabilities receive appropriate skill-development support, Digital technologies are used to facilitate workplace learning. In the dimension of Disability-Inclusive Employment; Our organization provides equal employment opportunities to persons with disabilities, Employees with disabilities receive appropriate workplace accommodations, our organization provides accessible technology, Employees with disabilities participate fully in organizational activities.

In the dimension of Employee Productivity, Employees with disabilities perform their tasks efficiently, Employees with disabilities contribute positively to organizational productivity.

In the dimension of Workplace training improves employee performance; Employees effectively use technology in their work.

In the various dimension of Economics Performance of MSME; Sales growth, Profitability, Revenue growth, Productivity, Employment generation, Employee well-being, Workforce inclusion, Innovation performance, Product innovation, Process innovation, Digital innovation

Descriptive statistics

Descriptive statistics summarized respondent characteristics and study variables using frequency, percentage, mean, and standard deviation: frequencies and percentages described the demographic profile, while means and standard deviations summarized respondents' perceptions of the constructs. A higher mean indicates stronger agreement with a statement, and a lower standard deviation indicates greater consistency in responses, together providing a clear overview of central tendency and dispersion.

Frequency Analysis

Strongly Disagree (SD)=1, Disagree (D)=2, Somewhat Disagree (SWD)=3, Neither Agree nor Disagree (NAD)=4, Somewhat Agree (SWA)=5, Agree (A)=6, Strongly Agree (SA)=7, Total (T) & Mean (M).

Assessment of AI-TPCSE among MSME Entrepreneur.

Table 1 Assessment of AI-Enabled Techno-pedagogical competence of special educator MSME Entrepreneurs.

Statements		SD	D	SWD	NAD	SWA	A	SA	T	M
My business and employees with disabilities have a strong understanding of the AI enabled technical aspects of my product /services as compared to peers in the fraternity.	Frequency	0	0	14	64	117	91	34	320	5.21
	Percentage	0.0	0.0	4.4	20	36.6	28.4	10.6	100	
My business and employees with disabilities stay updated with new AI enabled technologies in field.	Frequency	0	1	16	61	115	81	46	320	5.24
	Percentage	0.0	0.3	5	19.1	35.9	25.3	14.4	100	
My business and employees with disabilities have implemented at least one AI enabled technology upgrade in the past year and the benefit of which has positively impacted efficiency.	Frequency	0	0	18	67	115	89	31	320	5.15
	Percentage	0.0	0.0	5.6	20.9	35.9	27.8	9.7	100	
My business and employees with disabilities regularly attend AI enabled workshops,	Frequency	0	1	9	60	116	106	28	320	5.25
	Percentage	0.0	0.3	2.8	18.8	36.3	33.1	8.8	100	

webinars, or read materials to improve AI enabled technical knowledge.										
My business and employees with disabilities adapt AI enabled technical approach based on customer needs or feedback.	Frequency	0	1	12	71	109	98	29	320	5.18
	Percentage	0.0	0.3	3.8	22.2	34.1	30.6	9.1	100	
My business and employees with disabilities use AI enabled IT tools like AI Chatbots, Generative AI, spreadsheets, email, or mobile apps, WhatsApp's, digital payment methods or AI accounting tools regularly.	Frequency	0	4	9	61	127	84	35	320	5.20
	Percentage	0.0	1.3	2.8	19.1	39.7	26.3	10.9	100	

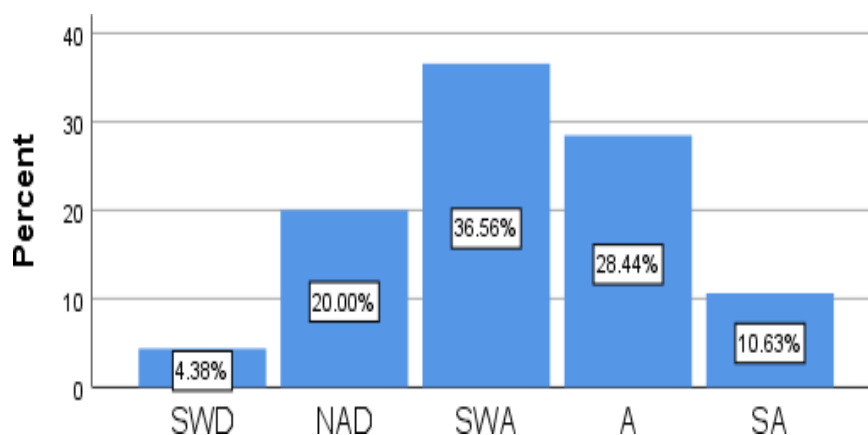


Figure 1 My business and employees with disabilities have a strong understanding of the AI-enabled technical aspects in marketing of my product /services as compared to peers in the fraternity.

The survey (n = 320) indicates strong AI enabled technical competence: 36.6% somewhat agreed, 28.4% agreed, and 10.6% strongly agreed they understand the AI enabled technical aspects of their products/services in MSME better than peers; 20.0% were neutral and 4.4% somewhat disagreed. The mean of 5.21 reflects a generally high level of AI enabled technical knowledge among the sampled MSME entrepreneurs.

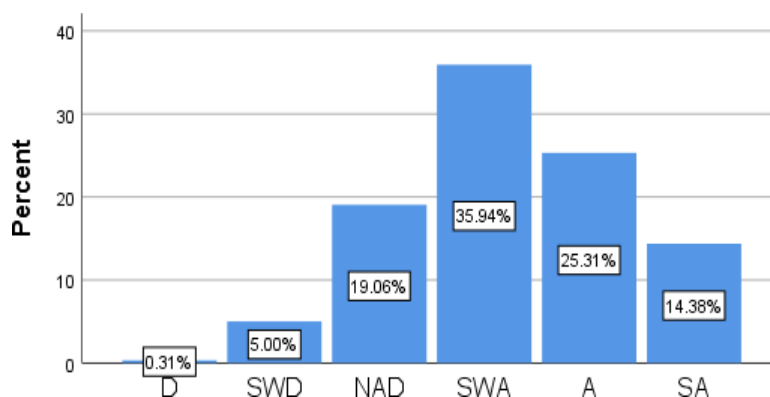


Figure 2 My business and employees with disabilities stay updated with AI-enabled new technologies in their field.

The assessment of AI-TPCSE among MSME entrepreneurs reveals that a majority of respondents actively stay updated with new AI enabled technologies in their field. Out of 320 respondents, 115 respondents (35.9%) somewhat agreed and 81 respondents (25.3%) agreed with the statement, while 46 respondents

(14.4%) strongly agreed. In contrast, only 16 respondents (5%) somewhat disagreed, 1 respondent (0.3%) disagreed, and none strongly disagreed. Additionally, 61 respondents (19.1%) remained neutral in their opinion. The mean score of 5.24 indicates that most MSME entrepreneurs possess a positive attitude toward adopting and keeping themselves informed about AI-TPCSE in their respective fields.

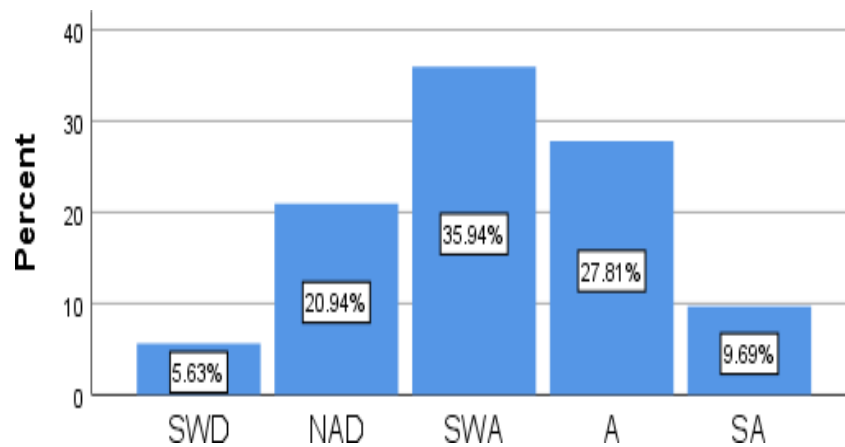


Figure 3 My business and employees with disabilities have implemented at least one AI enabled technology upgrade in the past year and the benefit of which has positively impacted their efficiency.

The survey (n = 320) shows most MSME entrepreneurs reported AI enabled technology upgrades improving efficiency: 35.9% somewhat agreed, 27.8% agreed, and 9.7% strongly agreed; 20.9% were neutral and 5.6% somewhat disagreed. The mean of 5.15 indicates a generally positive impact of recent AI enabled technology implementations on operational efficiency.

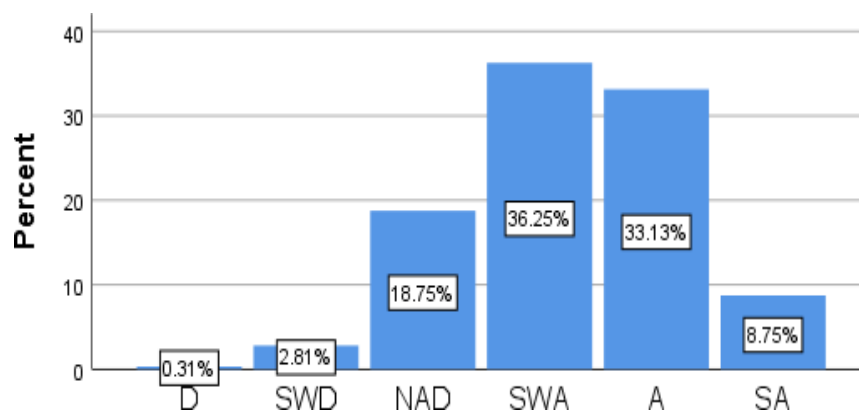


Figure 4 My business and employees with disabilities regularly attend AI enabled technological workshops, webinars, or read materials to improve their AI enabled technical knowledge.

The survey (n = 320) shows active AI enabled technical learning among MSME entrepreneurs: 36.3% somewhat agreed, 33.1% agreed, and 8.8% strongly agreed they attend workshops, webinars, or read materials to improve AI enabled technical knowledge; 18.8% were neutral and 3.1% disagreed. The mean of 5.25 indicates a high level of engagement in continuous AI enabled technical learning to strengthen competence and business performance.

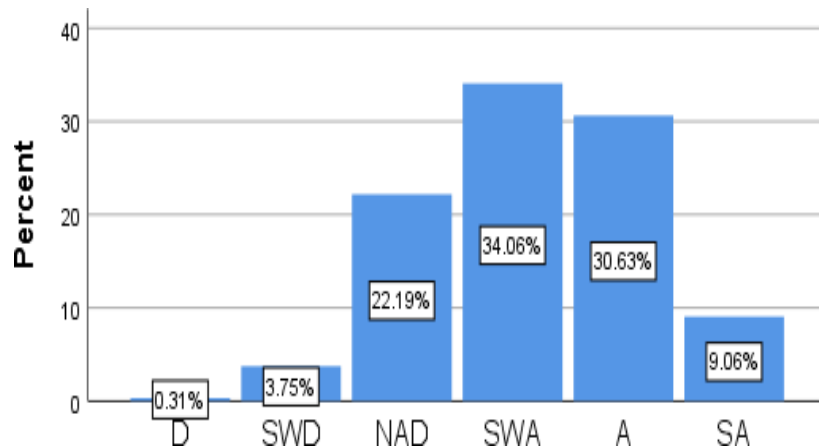


Figure 5 My business and employees with disabilities can adapt their AI enabled technical approach based on customer needs or feedback (CRM).

The survey (n = 320) shows that most MSME entrepreneurs adapt AE enabled CRM technical approaches to customer needs: 34.1% somewhat agreed, 30.6% agreed, and 9.1% strongly agreed; 22.2% were neutral and only 4.1% disagreed. The mean of 5.18 indicates generally good AI-TPCSE and flexibility in responding to market and customer feedback.

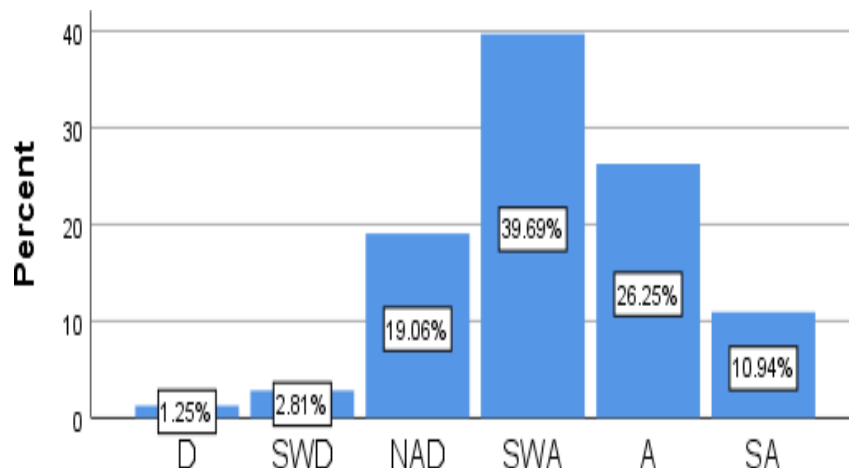


Figure 6 My business and employees with disabilities use IT tools like AI-Chatbots, Gen AI, AI-CRM tools, AI Automation tools, spreadsheets, email, or mobile apps, WhatsApp's, digital payment methods or AI enabled accounting tools regularly.

The survey (n = 320) shows regular IT use among MSME entrepreneurs: 39.7% somewhat agreed, 26.3% agreed, and 10.9% strongly agreed they regularly use AI Chatbots, AI enabled CRM tools, spreadsheets, email, mobile apps, WhatsApp, digital payments, and AI enabled accounting tools; 19.1% were neutral and 4.1% disagreed. The mean of 5.20 indicates generally good AI-TPCSE and routine digital tool adoption.

Assessment of Economic performance of MSME

Table 2 Assessment of Economic performance of MSME

Statements		SD	D	SWD	NAD	SWA	A	SA	T	M
My business has experienced consistent increase in business turnover for past 3 years.	Frequency	0	0	13	62	123	94	28	320	5.19
	Percentage	0.0	0.0	4.1	19.4	38.4	29.4	8.8	100.0	
My business has maintained consistent profit margin over past 3 years.	Frequency	0	1	13	60	121	95	30	320	5.21
	Percentage	0.0	0.3	4.1	18.8	37.8	29.7	9.4	100.0	
My business has	Frequency	0	0	12	64	122	93	29	320	

experienced consistent increase in customer bases for past 3 years and high retention rate.	Percentage	0.0	0.0	3.8	20.0	38.1	29.1	9.1	100.0	5.20
	Frequency	0	1	14	72	107	90	36	320	5.18
My business has maintained consistent increase in business capital for past 3 years.	Percentage	0.0	0.3	4.4	22.5	33.4	28.1	11.3	100.0	
	Frequency	0	0	11	55	134	85	35	320	
My business has maintained consistent increase in return on capital for past 3 years.	Frequency	0	0	11	55	134	85	35	320	5.24
	Percentage	0.0	0.0	3.4	17.2	41.9	26.6	10.9	100.0	
My business has hired more employees recently and supports livelihood for society. My business provides equal employment opportunities to persons with disabilities.	Frequency	0	1	15	55	110	103	36	320	5.27
	Percentage	0.0	0.3	4.7	17.2	34.4	32.2	11.3	100.0	

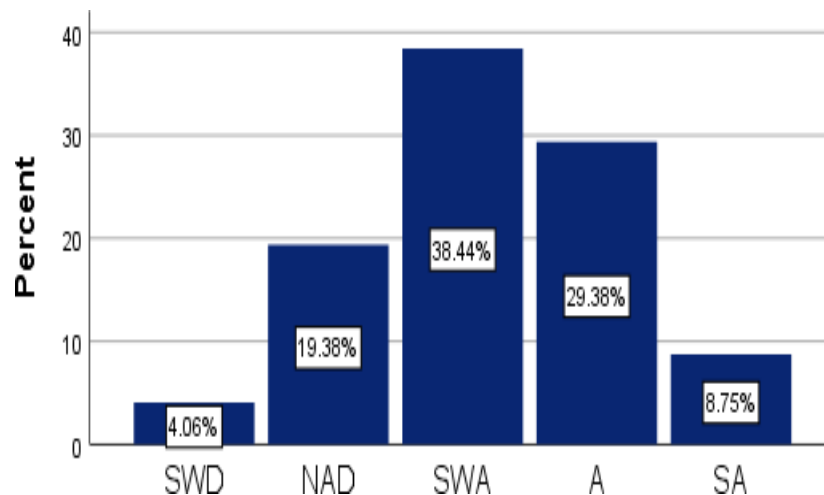


Figure 7 My business has experienced consistent increase in business turnover for past 3 years.

The survey (n = 320) shows positive turnover growth: 38.4% somewhat agreed, 29.4% agreed, and 8.8% strongly agreed their turnover consistently increased over three years; 19.4% were neutral and 4.1% somewhat disagreed. The mean of 5.19 indicates an overall perception of steady financial improvement.

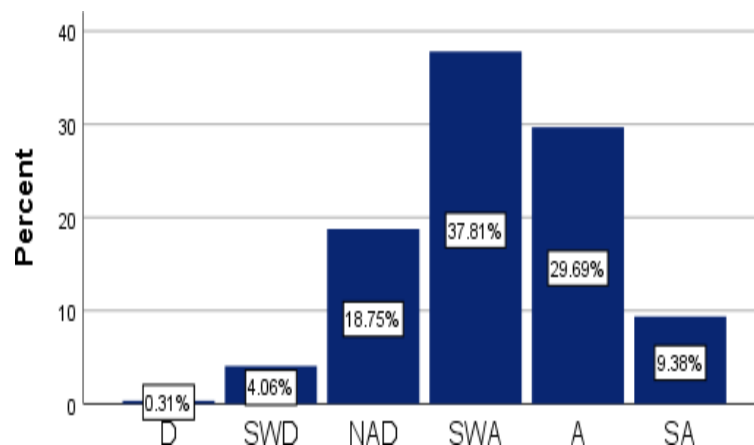


Figure 8 My business has maintained consistent profit margin over past 3 years.

The survey (n = 320) shows generally stable profit margins over three years: 37.8% somewhat agreed, 29.7% agreed, and 9.4% strongly agreed they maintained consistent profit margins; 18.8% were neutral

and 4.4% expressed disagreement. The overall mean of 5.21 indicates broadly favorable and steady profitability among the sampled MSMEs.

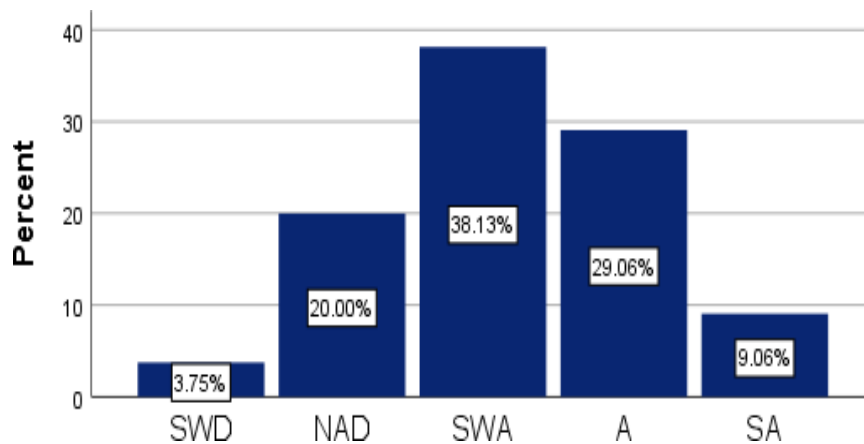


Figure 9 My business has experienced consistent increase in customer bases for past 3 years and high retention rate.

The survey (n = 320) shows a positive trend in customer growth and retention: 38.1% somewhat agreed, 29.1% agreed, and 9.1% strongly agreed that their customer base and retention improved over three years; 20.0% were neutral and 3.8% somewhat disagreed. The overall mean of 5.20 indicates generally favorable market stability and customer loyalty among the sampled MSMEs.

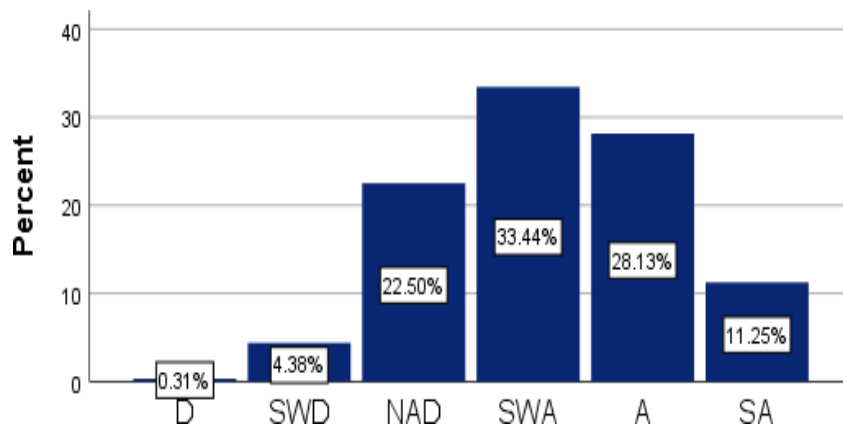


Figure 10 My business has maintained consistent increase in business capital for past 3 years.

The assessment of economic performance (n = 320) shows generally positive capital growth: 33.4% somewhat agreed, 28.1% agreed, and 11.3% strongly agreed that their business capital consistently increased over three years, while 22.5% were neutral and only 4.7% expressed any disagreement. The overall mean of 5.18 indicates a clear, favorable perception of financial growth and satisfactory economic performance among the sampled MSME entrepreneurs.

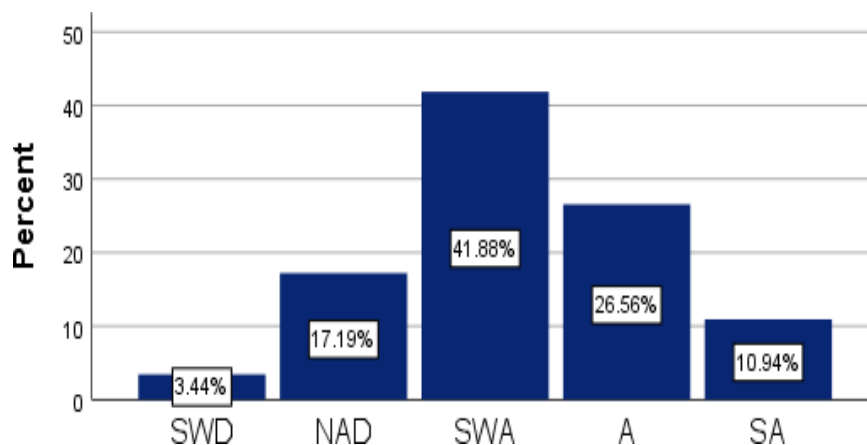


Figure 11 My business has maintained consistent increase in return on capital for past 3 years.

The survey of 320 MSME entrepreneurs shows a strong positive perception of returns on capital: 79.4% (134 somewhat agree; 85 agree; 35 strongly agree) reported consistent increases over three years, 17.2% were neutral, and 3.4% somewhat disagreed. The overall mean of 5.24 indicates generally favourable and stable financial performance among the sampled firms.

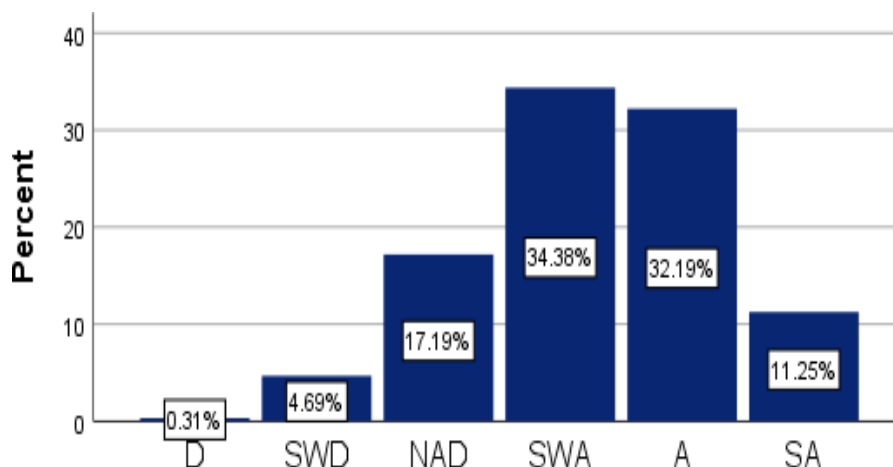


Figure 12 My business has hired more employees with disability inclusion recently and supported livelihood for society.

The survey (n = 320) indicates strong agreement that MSMEs have recently increased hiring of persons with disabilities and supported livelihoods: 34.4% somewhat agreed, 32.2% agreed, and 11.3% strongly agreed; 17.2% were neutral and only 5.0% expressed any disagreement. The overall mean of 5.27 reflects a high perceived contribution to inclusive employment and social livelihood support.

8. Research Analysis and Findings

8.1 Descriptive statistics

Table 3 Descriptive statistics of AI-TPCSE and Economic performance

Variables	N	Minimum	Maximum	Mean	Std. Deviation
AI-TPCSE	320	2.67	7.00	5.205	0.852
Economic performance	320	2.83	7.00	5.216	0.847
Valid N (listwise)	320				

The descriptive statistics of the study variables indicate that all constructs have relatively high mean values, suggesting a generally strong presence of AI-TPCSE and performance outcomes among the sampled MSMEs. AI-TPCSE recorded a mean score of 5.205 (SD = 0.852), indicating that respondents possess a considerable level of AI-TPCSE. In terms of performance dimensions, Economic performance (Mean = 5.216, SD = 0.847). These results suggest that MSMEs are performing relatively well across economic performance dimension of MSME. The standard deviation values for all variables are below 1, indicating low variability and a high level of consistency in responses. Overall, the findings imply that both AI-TPCSE and performance indicators are positively skewed towards higher levels, providing a strong foundation for further inferential analysis.

8.2 SEM (structural equation modelling)

Structural Equation Modelling (SEM), a flexible statistical approach, to describe complex interactions between variables, whether latent or observable. Its ability to analyse intricate causal pathways, integrate latent components, test several hypotheses at once, account for measurement error, evaluate model fit, and combine aspects of factor analysis and regression are just a few of its special features.

Assessment of TPCSE of MSMEs

Table 3 Assessment of TPCSE of MSMEs

Path			Standardized Estimate	S.E.	C.R.	P
AI-TPCSE1	<-----	Assessment of AI-enabled Technopedagogical competence of special educators	0.83			

AI-TPCSE2	<-----		0.812	0.065	16.087	***
AI-TPCSE3	<-----		0.763	0.068	13.804	***
AI-TPCSE4	<-----		0.78	0.063	14.135	***
AI-TPCSE5	<-----		0.771	0.063	14.76	***
AI-TPCSE6	<-----		0.774	0.068	14.048	***

Table 4 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	KMO value	0.952
Bartlett's Test of Sphericity	Approx. Chi-Square	9794.923
	df	861
	Sig.	0.000

KMO and Bartlett's tests to assess the suitability for factor analysis. The obtained KMO value was 0.952, indicating high sampling adequacy, and the Bartlett's test was highly significant ($P = 0.00$), supporting the factor analysis.

Table 5 Reliability and validity Test

Variables	Cronbach's Alpha	AVE	CR
Assessment of AI-TPCSE	0.907	0.788	0.888
Assessment of Economic performance of MSME	0.916	0.808	0.893

Confirmatory Factor Analysis (CFA) employed to rigorously examine the validity of our instrument. The factor loadings for each individual question exceeded the 0.5 threshold, underscoring the instrument's strong capability to accurately measure the intended constructs. This outcome underscores the robustness of our measurement tool. Some items are removed from further analysis as the factor loading value is below 0.5. The model fit values are as exhibited in Table. To assess the internal consistency of the scale, Average Variance Extracted (AVE) and Composite Reliability (CR) is evaluated. Table presents the post-Confirmatory Factor Analysis (CFA) results, including Cronbach's alpha, AVE, and CR values. Discriminant validity is established if the square root of the AVE for a variable is greater than its correlation values when compared with other variables. The findings that were collected are shown in Table, and they contribute to the determination of the discriminant validity.

Discriminant Validity:

Discriminant validity is not a specific test performed in SPSS or any other statistical software but a concept within the context of validating measurement instruments and assessing the relationships between variables. Discriminant validity is crucial to ensure that different constructs or variables in a study are truly distinct and not measuring the same underlying concept. Researchers use various techniques such as confirmatory factor analysis (CFA) or correlation analysis to demonstrate that the measures intended to assess different constructs are, indeed, different and not highly correlated. Discriminant validity helps ensure that the measurement instruments accurately represent the unique concepts they are meant to measure, preventing construct overlap or redundancy and allowing for more robust and accurate data analysis and interpretation.

Table 6 Discriminant Validity Test

Constructs	Assessment of AI-enabled Techno-pedagogical competence of special educator	Assessment of Economic performance of MSME
Assessment of AI-enabled Techno-pedagogical competence of special educator	0.888	
Assessment of Economic performance of MSME	0.309**	0.899

The discriminant validity of the constructs was evaluated through the inter-construct correlation matrix, with the square roots of Average Variance Extracted (AVE) displayed along the diagonal. The table indicates that the diagonal values for all constructs Assessment of AI-enabled Techno pedagogical competence of special educators among MSME Entrepreneurs (0.888), Assessment of Economic performance of MSME (0.899). This signifies that each construct exhibits greater variance with its respective indicators than with other constructs within the model. Despite the positive and statistically significant correlations among constructs at the 0.01 level, none of the off-diagonal values surpass the corresponding square root of the Average Variance Extracted (AVE). The results affirm sufficient discriminant validity among all constructs, indicating that each dimension is empirically distinct and assesses a distinctive facet of the MSP-related outcomes.

Table 7 Model fit summary

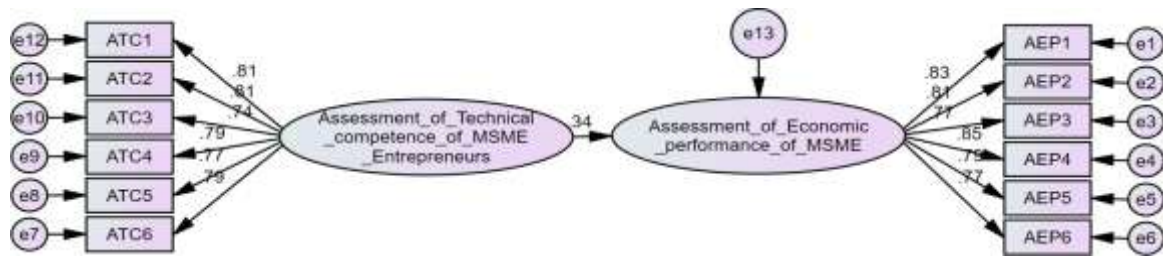
Variable	Value
Chi-square value(χ^2)	769.458
Degrees of freedom (df)	739
CMIN/DF	1.041
P value	0.212
GFI	0.900
RFI	0.913
NFI	0.925
IFI	0.997
CFI	0.997
RMR	0.035
RMSEA	0.011

The results indicate a satisfactory model fit based on key fit indices: $\chi^2 = 769.458$, GFI = 0.900, RFI = 0.913, NFI = 0.925, IFI = 0.997, and CFI = 0.997, all exceeding the recommended threshold of 0.90. The root Mean square residual (RMR) = 0.035 and the root mean square error of approximation (RMSEA) = 0.011 fall within acceptable limits. The CMIN/DF ratio =1.041 suggests a good model fit. The p-value (0.000) indicates that the model is not statistically significant at the conventional 0.05 level, but it remains within an acceptable range. Overall, these results support the model's validity and its ability to represent the sample data effectively

8.2.1 Relationship between MSME entrepreneur's AI-enabled techno-pedagogical competencies of special educator on Economic performance of MSMEs SEM-AMOS analysis result.

H01a: There is no significant relationship between MSME entrepreneurial AI-enabled techno-pedagogical competence of special educator and economic performance of MSMEs.

H1a: There is positive relationship between MSME entrepreneurial AI-enabled techno-pedagogical competence of special educator on economic performance of MSMEs.



SEM-AMOS Analysis Path diagram

Figure 13 Regression Weights: (Group number 1 - Default model)

Assessment of AI-enabled Techno Pedagogical competence of special educator (AI-TPCSE) on Economic Performance of MSME

Table 8 Assessment of AI-TPCSE on Economic performance of MSMEs

Path			Standardize d Estimate	S.E.	C.R.	P
Assessment of Economic performance of MSME	<---	Assessment of AE enabled Techno-pedagogical competence of special educator	0.34	0.061	5.55	***
AEP1	<---	Assessment of Economic performance of MSME	0.831			
AEP2	<---	Assessment of Economic performance of MSME	0.809	0.059	16.97 4	***
AEP3	<---	Assessment of Economic performance of MSME	0.775	0.058	15.94 3	***
AEP4	<---	Assessment of Economic performance of MSME	0.853	0.06	18.37 9	***
AEP5	<---	Assessment of Economic performance of MSME	0.787	0.058	16.31 2	***
AEP6	<---	Assessment of Economic performance of MSME	0.766	0.062	15.70 1	***
AITC6	<---	Assessment of AI enabled Techno-pedagogical competence of special educator	0.794			
AITPCSE 5	<---	Assessment of AI enabled Techno-pedagogical competence of special educator	0.772	0.064	14.83 1	***
AITPCSE4	<---	Assessment of AI-enabled Techno-pedagogical competence of special educator	0.791	0.061	15.30 8	***
AITPCSE3	<---	Assessment of AI-enabled Techno-pedagogical competence of special educator	0.742	0.066	14.12 2	***
AITPCSE2	<---	Assessment of AI-enabled Techno-pedagogical competence of special educator	0.811	0.068	15.78 5	***

AITPCSE1	<---	Assessment of AI-enabled Techno-pedagogical competence of special educator	0.815	0.064	15.885	***
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Table depicts a hypothetical structural equation model that shows cases the interdependence between Two variables, namely the Assessment of AI-Enabled Techno-pedagogical competence of special educator (TPCSE) and Assessment of Economic performance of MSME. In the present model, the independent variable is the Assessment of AI-Enabled Technical competence of MSME Entrepreneurs, whereas the dependent variable is the Assessment of Economic performance of MSME. The findings of the investigation indicate a positive and statistically significant relationship between AI-TPCSE of MSME Entrepreneurs and Assessment of Economic performance of MSME ($\beta=0.340$, $P<0.05$).

The standardized coefficient of 0.340, a positive association between Assessment of AI-TPCSE of MSME Entrepreneurs and Assessment of Economic performance of MSME, as shown in the route connecting these two variables. The correlation coefficient values (C.R. values) show large magnitudes, suggesting that the observed associations are statistically significant. The fit indices indicate that the model has a good fit, since the factors exhibit statistical significance with p-values over 0.05 (as shown in Table). Therefore, the total model fit was evaluated by using seven distinct fit indices, which together demonstrated a statistically significant positive association between Assessment of AI-TPCSE of MSME Entrepreneurs and Assessment of Economic performance of MSME.

8.3 Research Findings

The present study explores the influence of entrepreneurs' AI-Enabled Techno Pedagogical competence of special educators (AI-TPCSE) on the economic performance of MSMEs in India and the findings show high empirical evidence for the proposed hypothesis that AI-Enabled Techno pedagogical competence of special educators (TPCSE) has a significant positive impact on the economic performance of MSMEs in India. Descriptive Statistics reveal that mean scores exceed the scale mid-point and that dispersion is low, as well as the results of the measurement diagnostics, which have high factor loadings, Cronbach's α , CR, and AVE values, and reveal a significant Bartlett's test (KMO = 0.952, Bartlett's test $p < 0.001$). SEM fit indices confirm the robustness of the model. The structural results prove that between the variable AI-TPCSE and economic performance there is a positive relationship with a statistically significant value ($\beta = 0.340$) which implies that domain specific AI Enabled -technical and pedagogical expertise helps the entrepreneur to enhance the processes of production, improve the quality of the product, facilitate the use of innovations and to use the resources optimally, improving economic performance, profitability and cost effectiveness. The results suggest that ongoing development of AI-TPCSE integrated in policy and training programs is crucial for establishing competitiveness and long-term sustainability of MSMEs.

8.4 Discussion

The results indicate that the competence of AI-Enabled Techno-Pedagogical is one of the organizational abilities that is needed for MSMEs that are increasingly involved in a technological context. Entrepreneurs who are better able to understand, communicate, and integrate digital technologies into workplace learning are likely to be more successful in enhancing the organizational efficiency, innovation, and capability of their employees. As MSMEs are exposed to new technologies in the workplace, such as AI learning platforms, intelligent assistive technology, adaptive digital systems, and more, this interpretation becomes more relevant. In these settings, the ability of human beings to relate to AI in a way that is effective and inclusive could be enhanced by the use of techno-pedagogical competence to ensure that the techno-operational skills available to the entrepreneur are matched with the learning needs of employees and the surrounding workplace. The current study does not directly assess the level of adoption of AI or the performance of AI systems, but rather has identified human and organizational competence which could aid in the effective integration of these technologies. The current framework can be extended for future research by directly investigating the preparedness of MSMEs to adopt AI, human-AI interaction and the application of AI assisted learning or assistive technologies. Future research could also explore how AI-Enabled Techno-pedagogical competence impacts on the adoption, responsible use, and effectiveness of intelligent workplace technologies for inclusive skill development and employee productivity.

9. Conclusion

The present study provides a comprehensive examination of the impact of AI-TPCSE on the economic performance of MSMEs in India. The findings of the study strongly support the theoretical premise that AI-TPCSE are critical drivers of MSME success and sustainability."

- Main result: AI-TPCSE positively and significantly improves MSME economic performance (standardized effect $\beta = 0.340$).
- Construct validity: Measurement model is robust (high loadings, Cronbach's α , CR, AVE; KMO = 0.952;

- Bartlett's test significant).
- Descriptive trend: Mean scores for AI-TPCSE and economic performance are above midpoint with low SDs → consistent, high competence levels in sample.
- Practical implication: Prioritize continuous AI-TPCSE training (technical + pedagogical + digital) for entrepreneurs to boost efficiency and innovation.
- Emerging technology implication: As MSMEs increasingly adopt AI-enabled learning, assistive, and digital workplace technologies, stronger techno-pedagogical competence may help entrepreneurs integrate these tools more effectively into employee training and inclusive skill-development practices. This highlights the growing relevance of AI-TPCSE for technology-supported and human-AI workplace environments.
- Policy suggestion: Link MSME support (subsidies/credit) to documented AI-TPCSE capacity-building and measurable economic outcomes.
- Contribution: Empirically validates AI-TPCSE as a multidimensional, actionable lever for MSME growth in India.

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