

AI-driven digital transformation in MSMEs : Modeling adoption, readiness, and implementation challenges

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Abstract

Artificial Intelligence (AI) can improve MSME efficiency, productivity, and decision-making. However, AI adoption among Indian MSMEs remains limited due to low awareness and implementation challenges. This study examines AI adoption in Gujarat's MSMEs, focusing on AI awareness, perceived benefits, and adoption challenges. Using a quantitative approach, data were collected from MSME owners and managers through structured questionnaires and analysed using descriptive statistics and Structural Equation Modeling (SEM). The study provides empirical insights into AI adoption factors and offers implications for policymakers, business leaders, and technology providers to support effective AI integration and overcome adoption barriers.

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Keywords: Artificial intelligence, MSMEs, Awareness, Perceived benefits, Adoption challenges.

1. Introduction

AI is transforming global business by improving efficiency, driving innovation, and enabling growth, particularly in resource-constrained countries [1], [2], [3]. AI can address infrastructure and labour challenges, but SMEs face resource and expertise constraints [4], [5]. AI adoption aligns with India's Digital India initiative, which promotes technology-driven economic inclusion [6], [7]. MSMEs drive exports, innovation, and regional development, employing over 110 million people [8], [9], [10]. Limited AI awareness and perceived complexity hinder MSME adoption, despite benefits in efficiency, cost reduction, innovation, and optimization [7], [9]. Key barriers include high costs, skill shortages, data privacy, and

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inadequate infrastructure [6], [11], [1]. Gujarat's strong industrial base makes it a key context for studying AI adoption in MSMEs [10], [12], [13].

2. Literature Review

The TOE framework provides a structured approach to understanding AI adoption in MSMEs [14], [15], [16]. TOE considers technology, organizational, and environmental factors, while TAM focuses mainly on individual usability and usefulness [6], [17]. Likewise, the Diffusion of Innovation (DOI) theory [18], It examines relative advantage and complexity, but may overlook AI's dynamic adoption [19], [11], [20] we address the problem of observer design for time-delay systems with delays in both the state and the input, under the global Lipschitz condition on the system nonlinearity, using a Linear Matrix Inequality (LMI. Developed countries have higher AI readiness due to stronger education and government support [21], [7]. In India, 65% of MSMEs cite inadequate data infrastructure as a key AI-readiness challenge [22], [6]. AI benefits are strategic in developed economies but more tactical and limited in developing economies [3], [23], [24]. Specifically Computer Engineering education faces the challenge of engaging digital-native learners who require interactivity and personalized feedback, as traditional teaching methods often lack these elements. This study aims to empirically quantify the impact of Artificial Intelligence (AI). AI-powered systems enhance operational efficiency and personalization [25], [26], [27]. Information systems improve organizational responsiveness and operational effectiveness [28], [29], [30], [31]. AI-driven FinTech adoption enhances financial management, operational performance, resilience, and sustainability among Indian MSMEs [32].

3. Research Methodology

The study uses a cross-sectional quantitative design to examine AI awareness, benefits, challenges, and adoption in Indian MSMEs [7], [6]. Gujarat's diverse industrial base makes it a major MSME hub [10], [1], [12].

Purposive sampling targeted MSME owners, managers, and IT decision-makers knowledgeable about AI, addressing the lack of a complete sampling frame [7], [11]. The study achieved 80% statistical power at 5% significance, with 305 usable responses (87%) from 350

questionnaires [33]. Respondents comprised 62% owners, 28% managers, and 10% IT heads, representing diverse MSME sizes and sectors [7]. AI Awareness items included understanding AI's role in automating repetitive tasks [9], [11]. AI Adoption Challenges covered cost, skills, and infrastructure, while AI Adoption Intention measured plans to integrate AI into operations within one year [6]. PLS-SEM was used for exploratory-confirmatory models with non-normal data and smaller samples [34], [33], [7], [9].

4. Results

4.1 Measurement Model Evaluation

Discriminant validity was confirmed using HTMT, with all values below 0.85 (0.033–0.141), indicating that the constructs were distinct [35]. The structural model tested the effects of AWA, BEN, and CHA on ADI, including CHA as a negative moderator. VIF values (1.12–1.89) were below

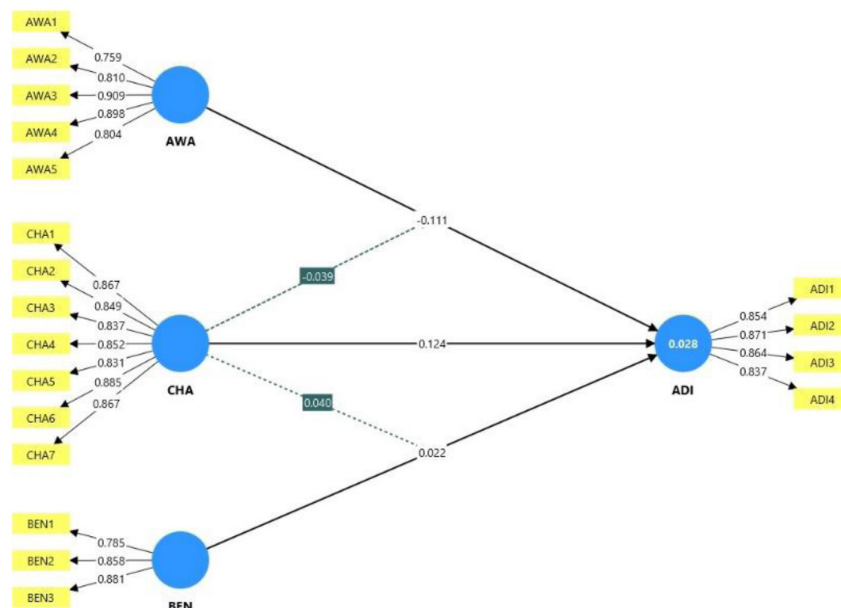


Figure 1
Structural Model with Path Coefficients

5, confirming no multicollinearity [33], [6]. Effect sizes (f^2) were negligible to small (0.02–0.15) threshold; [36], [33], [37].

4.2 The structural model.

The structural model examined the relationships between AWA, BEN, and CHA and ADI, including the moderating effects of CHA on the AWA–ADI and BEN–ADI relationships.

Figure 1 shows the structural model, while Table 1 reports the key path results.

Table 1
Structural Model Results

Path	β	t-value	p-value	f^2	95% CI
AWA $\rightarrow$ ADI	-0.111	0.999	0.318	0.012	[-0.176, 0.299]
BEN $\rightarrow$ ADI	0.022	0.265	0.791	0.000	[-0.178, 0.112]
CHA $\rightarrow$ ADI	0.124	1.859	0.063	0.016	[-0.215, 0.197]
CHA $\times$ AWA $\rightarrow$ ADI	-0.039	0.631	0.528	0.002	[-0.161, 0.088]
CHA $\times$ BEN $\rightarrow$ ADI	0.040	0.649	0.516	0.002	[-0.088, 0.159]

4.3 Hypothesis Testing

H1–H5 was not supported. AWA and BEN had non-significant effects on ADI, CHA showed a marginal positive effect, and both moderation effects were non-significant.

5. Discussion and Theoretical Contributions

AI awareness alone may not drive adoption, possibly due to complexity or limited relevance to MSMEs [7], [2], [18].

Perceived AI benefits may not be strong enough to drive MSME adoption, unlike findings from Indian manufacturing studies [38], [4], [3]. Theoretically, this finding questions the predictive role of perceived usefulness in TAM within the MSME context [39]. It extends TAM by showing that contextual barriers can weaken perceived usefulness in AI adoption.

Overall, AI adoption shows weak effects of enablers and ambiguous effects of challenges, indicating limited interaction among adoption factors [15], [10]. The findings show that contextual and resource constraints can weaken common AI adoption drivers, supporting more context-specific

UTAUT and TOE models. MSMEs should focus on practical AI knowledge and simple tools, as awareness alone may not drive adoption [7], [6], suggesting the use of modular tools without too much expectation for service MSMEs.

6. Conclusion and Future Research

AI factors showed limited effects on MSME adoption intention. AI adoption research highlights null MSME effects and challenges conventional perceptual drivers [7]. It highlights context-specific limits of traditional AI adoption factors in emerging-economy MSMEs [9]. Gujarat-specific evidence reveals state-level differences often missed in national studies [10]. Future research includes Longitudinal, mixed-method, cross-regional studies using regulatory factors and advanced SEM/ML methods are recommended.

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