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"Assessing Organizational Readiness for IoT Adoption in Medium-Scale Manufacturing Industries of Nashik District"

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ABSTRACT

The success of Internet of Things (IoT) implementation depends not only on technology infrastructure but also on organizational preparedness. This study assesses organizational readiness for IoT adoption in medium-scale manufacturing industries of Nashik District, Maharashtra. Using a pilot survey of 96 respondents from 20 manufacturing units, the study evaluates three readiness dimensions: technological preparedness, workforce capability, and management commitment. Reliability analysis using Cronbach's Alpha yielded values of 0.881 for technological preparedness, 0.823 for workforce capability, and 0.833 for management commitment, indicating good internal consistency. The Kaiser-Meyer-Olkin (KMO) measure ranged from 0.661 to 0.751, and Bartlett's Test of Sphericity was significant ($p < 0.001$), confirming sampling adequacy. Findings indicate that while management commitment is relatively strong (mean score 4.12), workforce skill gaps (mean score 2.95) and legacy equipment incompatibility remain significant readiness deficits. The study contributes a validated readiness assessment instrument for manufacturing MSMEs considering IoT adoption.

Keywords: Organizational Readiness, IoT Adoption, Medium-Scale Industries, Manufacturing, Nashik District

INTRODUCTION

The transition to smart manufacturing has accelerated globally under the influence of Industry 4.0 technologies [1]. Among these technologies, the Internet of Things (IoT) enables real-time monitoring, predictive maintenance, and data-driven decision-making in industrial settings [2]. However, successful IoT implementation requires more than technology acquisition; it demands organizational preparedness across technological, human, and managerial dimensions [3].

For medium-scale manufacturing industries, readiness assessment is particularly critical. Unlike large enterprises with dedicated digital transformation teams, medium firms operate with limited resources and cannot afford implementation failures [4]. Assessing readiness before adoption helps identify gaps, prioritize investments, and increase the probability of successful implementation.

Nashik District in Maharashtra hosts over 500 medium-scale manufacturing units across automotive components, engineering, pharmaceuticals, and agro-processing sectors [5]. These industries face increasing pressure from customers and competitors to adopt digital technologies. However, systematic assessment of their organizational readiness for IoT adoption remains absent from the literature.

This study addresses this gap by developing and validating a readiness assessment instrument tailored to medium-scale manufacturing contexts. The specific objectives are: (1) to assess technological preparedness for IoT adoption, (2) to evaluate workforce capability and skill readiness, (3) to examine management commitment levels, and (4) to validate a readiness assessment instrument for manufacturing MSMEs.

LITERATURE REVIEW

2.1 Theoretical Framework

Organizational readiness for change is defined as the extent to which organizational members are psychologically and behaviorally prepared to implement change [6]. Readiness comprises two dimensions: change commitment (shared resolve to implement change) and change efficacy (shared belief in collective capability).

For technology adoption contexts, the Technology-Organization-Environment (TOE) framework provides a useful organizing structure [7]. This framework suggests that adoption decisions are shaped by technological context (technology characteristics), organizational context (firm resources and management support), and environmental context (industry conditions and competitive pressures).

2.2 Readiness Dimensions for IoT Adoption

Three readiness dimensions emerge from the literature as critical for IoT adoption success.

Technological Preparedness: This dimension includes existing IT infrastructure, equipment compatibility, connectivity availability, and data management capabilities. Research consistently identifies legacy equipment incompatibility as a primary barrier for manufacturing MSMEs [8].

Workforce Capability: Digital skills, analytical abilities, and willingness to learn new systems constitute workforce readiness. Skill shortages are consistently reported as major adoption barriers in developing country contexts [9].

Management Commitment: Leadership support, resource allocation, and strategic alignment determine whether readiness translates into action. Top management commitment significantly predicts adoption success in Indian manufacturing SMEs [10].

2.3 Research Gap

While substantial research exists on IoT adoption outcomes, limited attention has been paid to measuring organizational readiness before implementation [4]. Existing readiness assessment models are often designed for large enterprises and may not suit MSME characteristics. This study addresses this gap by developing and validating a readiness assessment instrument for medium-scale manufacturing contexts.

RESEARCH METHODOLOGY

3.0 Research Objectives

This study pursues the following objectives:

Objective 1: To assess the level of technological preparedness for IoT adoption in medium-scale manufacturing industries of Nashik District.

Objective 2: To evaluate workforce capability and skill readiness for IoT adoption in the same industries.

Objective 3: To examine the extent of management commitment toward IoT adoption.

Objective 4: To validate a readiness assessment instrument for manufacturing MSMEs considering IoT implementation.

Objective 5: To identify sectoral variations in readiness across different manufacturing sectors in Nashik District.

Objective 6: To provide recommendations for improving organizational readiness based on empirical findings.

3.1 Research Design

This study employs a cross-sectional survey design to assess organizational readiness for IoT adoption. The research is quantitative in nature and follows a descriptive-cum-analytical approach.

3.2 Population and Sample

The total population of medium-scale manufacturing industries in Nashik District is 368, as per records of the District Industries Centre. Medium-scale enterprises are defined as those with annual turnover between ₹50 crore and ₹250 crore, employing between 100 and 500 workers.

For this pilot study, 20 industries were selected using stratified random sampling, ensuring representation across automotive, engineering, pharmaceutical, and agro-processing sectors. From each industry, five employees were surveyed, including managers, supervisors, and technical staff. Of the 100 questionnaires distributed, 96 were completed and returned, yielding a response rate of 96 percent. According to Krejcie and Morgan [11], a population of approximately 370 requires a sample size of around 186 respondents for full-scale analysis. The present sample of 96 is adequate for pilot validation purposes.

3.3 Instrument Development

A structured questionnaire was developed based on existing readiness assessment literature. The instrument comprised three sections: demographic information (5 items), technological preparedness (12 items), workforce capability (8 items), and management commitment (6 items). Responses were measured on a five-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5).

3.4 Statistical Analysis

The following statistical tools were employed: Cronbach's Alpha to assess internal consistency reliability, Kaiser-Meyer-Olkin (KMO) measure to test sampling adequacy, Bartlett's Test of Sphericity to verify factorability of the correlation matrix, and descriptive statistics (mean, standard deviation) to summarize readiness levels.

3.5 Ethical Considerations

Participation was voluntary, and respondent anonymity was maintained. Informed consent was obtained from all participants and their respective organizations.

RESULTS

4.1 Reliability Analysis

Cronbach's Alpha was computed for each readiness dimension to assess internal consistency. Table 1 presents the results.

Table 1: Reliability Statistics

Dimension	Number of Items	Cronbach's Alpha	Interpretation
Technological Preparedness	12	0.881	Excellent
Workforce Capability	8	0.823	Good
Management Commitment	6	0.833	Good

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The alpha value of 0.881 for technological preparedness indicates excellent internal consistency. Values above 0.80 for all dimensions exceed the commonly accepted threshold of 0.70 for social science research [12]. These results confirm that the questionnaire items consistently measure their respective readiness dimensions.

4.2 Sampling Adequacy and Factor Validity

The Kaiser-Meyer-Olkin (KMO) measure was computed to assess sampling adequacy for each dimension. Table 2 presents the results.

Table 2: KMO and Bartlett's Test Results

Dimension	KMO Value	Bartlett's Test (p-value)	Interpretation
Technological Preparedness	0.751	< 0.001	Meritorious
Workforce Capability	0.661	< 0.001	Acceptable
Management Commitment	0.708	< 0.001	Middling

KMO values above 0.60 are considered acceptable for factor analysis, while values above 0.70 are regarded as middling to meritorious [13]. The obtained values (ranging from 0.661 to 0.751) indicate satisfactory sampling adequacy. Bartlett's Test of Sphericity was statistically significant ($p < 0.001$) for all dimensions, confirming that the correlation matrices are not identity matrices and that factor analysis is appropriate. This supports the construct validity of the instrument.

4.3 Descriptive Statistics of Readiness Dimensions

Table 3 presents the mean scores and standard deviations for each readiness dimension.

Table 3: Descriptive Statistics of Readiness Dimensions

Dimension	Mean Score (out of 5)	Standard Deviation	Readiness Level
Management Commitment	4.12	0.67	High
Technological Preparedness	3.28	0.89	Moderate
Workforce Capability	2.95	0.94	Low-Moderate

Management commitment scored highest (mean 4.12), indicating that leadership support is relatively strong. Technological preparedness scored in the moderate range (mean 3.28), suggesting that while some infrastructure exists, gaps remain. Workforce capability scored lowest (mean 2.95), indicating significant skill gaps that need attention before IoT implementation.

4.4 Item-Level Analysis

Analysis of individual items within each dimension revealed specific patterns.

Technological Preparedness: Approximately 65 percent of respondents indicated that their organizations have basic IT infrastructure in place. However, only 38 percent reported that existing machinery is compatible with IoT sensor integration. Connectivity reliability was rated as adequate by 52 percent of respondents.

Workforce Capability: Only 28 percent of respondents rated their organization's IoT-related technical skills as adequate. Data analytics capability was rated even lower, with only 22 percent indicating sufficient expertise. Employee willingness to learn new systems was relatively higher, with 62 percent expressing positive attitudes toward digital upskilling.

Management Commitment: Seventy-five percent of respondents agreed that top management understands the strategic importance of IoT. Resource allocation for digital transformation was rated as adequate by 68 percent of respondents. However, only 45 percent reported that their organizations have a formal digital transformation roadmap.

4.5 Sectoral Variations

Technological preparedness scores showed variation across manufacturing sectors. Automotive component industries scored highest (mean 3.52), followed by engineering (mean 3.31), pharmaceuticals (mean 3.15), and agro-processing (mean 2.98). This variation likely reflects differing customer requirements and quality standards across sectors.

DISCUSSION

5.1 Interpretation of Findings

Three key findings emerge from this study. First, management commitment is relatively strong, with mean scores above 4.0, indicating that leadership recognizes IoT's strategic importance. This aligns with Sivathanu [10], who found that top management support significantly affects IoT adoption in Indian manufacturing SMEs.

Second, technological preparedness is moderate, with legacy equipment incompatibility being the primary constraint. Only 38 percent of respondents reported that existing machinery is compatible with IoT sensor integration. This finding is consistent with Kumar, Sindhwani, and Singh [8], who identified outdated machinery as a primary barrier for manufacturing MSMEs.

Third, workforce capability shows the lowest readiness level, with significant skill gaps in IoT and data analytics. Only 28 percent rated their organization's IoT-related skills as adequate. However, the finding that 62 percent of workers expressed willingness to learn new systems provides a foundation for targeted training interventions. This aligns with Mukherjee et al. [9], who reported that human factors significantly influence IoT adoption success.

5.2 Comparison with Existing Literature

The readiness levels observed in this study mirror patterns documented in other developing country contexts. Research on Pakistani manufacturing SMEs using the TOE framework found similar barriers related to technological infrastructure and organizational capability [14]. The moderate technological preparedness scores in Nashik (mean 3.28) are comparable to findings from similar industrial clusters in India [10].

The strong management commitment observed (mean 4.12) is encouraging, as leadership support has been identified as a critical success factor for technology adoption in MSMEs [4]. However, the gap between management commitment and formal digital transformation planning (only 45 percent have a formal roadmap) suggests that commitment has not yet translated into structured implementation plans.

5.3 Implications for Practice

For manufacturing MSMEs, the findings suggest that readiness assessment should precede technology investment. Organizations with strong management commitment but weak workforce capability should prioritize training before implementation. Similarly, those with moderate technological preparedness should address legacy equipment compatibility as an early step.

For policymakers, the findings highlight the need for targeted skill development programs focused on IoT and data analytics for manufacturing workers. The sectoral variation in technological preparedness suggests that one-size-fits-all approaches may be ineffective. Agro-processing industries, which scored lowest on technological preparedness, may require additional support compared to automotive component manufacturers.

For industry associations, the findings suggest opportunities to facilitate shared learning and resource pooling among member firms. The positive attitude toward learning (62 percent willingness) indicates that training programs would be well-received if made accessible.

SCOPE OF THE STUDY

This study focuses on assessing organizational readiness for IoT adoption in medium-scale manufacturing industries located in Nashik District, Maharashtra. It examines three readiness dimensions: technological preparedness, workforce capability, and management commitment. The study covers five industrial sectors: automotive components, engineering, pharmaceuticals, agro-processing, and general manufacturing. The geographical scope is limited to industrial areas within Nashik District, including Satpur, Ambad, and Sinnar MIDC zones.

The research considers the perspective of both managerial and operational employees to provide a comprehensive readiness assessment. As a pilot investigation, the study primarily aims to validate a readiness assessment instrument for subsequent large-scale research. The study does not examine actual IoT implementation outcomes, nor does it analyze other Industry 4.0 technologies such as artificial intelligence, cloud computing, or robotics independently. The time frame for data collection was limited to a three-month period, capturing readiness at a single point rather than tracking changes over time.

LIMITATIONS OF THE STUDY

The study has several limitations that must be acknowledged. First, the sample size of 96 respondents from 20 industries, while adequate for pilot validation, does not represent the full population of 368 industries. According to Krejcie and Morgan [11], the recommended sample size for this population is approximately 186 respondents. This limitation affects the generalizability of findings to the entire population of medium-scale industries in Nashik District.

Second, the findings are geographically limited to Nashik District and may not be generalizable to other regions of Maharashtra or India. Different industrial clusters may have varying levels of infrastructure development, skill availability, and management attitudes toward technology adoption.

Third, the study employs a cross-sectional design, capturing readiness at a single point in time. Readiness may change with organizational interventions, training programs, or external pressures. Longitudinal studies are needed to understand how readiness evolves over time.

Fourth, the data are based on self-reported responses, which may involve perceptual bias. Respondents may overstate their organization's readiness due to social desirability bias or understate it due to lack of awareness of their organization's actual capabilities [15]. The study did not independently verify technological infrastructure or skill levels through objective measures.

Fifth, the study focuses solely on readiness assessment and does not examine actual adoption outcomes. The relationship between readiness scores and subsequent implementation success remains unexplored and requires future investigation.

Sixth, the study was conducted during a period of economic recovery following the COVID-19 pandemic, which may have influenced management attitudes toward technology investment. Findings may not fully represent readiness under normal economic conditions.

FUTURE RESEARCH DIRECTIONS

Based on the findings and limitations of this study, several directions for future research emerge. First, a full-scale study with the recommended sample size of 186 respondents should be conducted to validate the findings and enable more robust statistical analysis. This would allow for confirmatory factor analysis and structural equation modeling to test the relationships between readiness dimensions.

Second, longitudinal studies examining how readiness changes following targeted interventions would be valuable. Such studies could track the same organizations over 12 to 24 months, measuring readiness before and after training programs or infrastructure upgrades.

Third, comparative studies across different industrial regions of Maharashtra such as Pune, Aurangabad, and Nagpur could identify region-specific readiness patterns and inform targeted policy interventions.

Fourth, research examining the relationship between readiness scores and actual IoT adoption outcomes would help establish the predictive validity of the assessment instrument. This would involve following organizations that have undergone readiness assessment and subsequently implemented IoT solutions.

Fifth, sector-specific studies focusing on individual manufacturing sectors (e.g., pharmaceuticals, textiles, food processing) could identify unique readiness requirements and barriers that may be masked in aggregate analyses.

CONCLUSION

This study assessed organizational readiness for IoT adoption in medium-scale manufacturing industries of Nashik District across three dimensions: technological preparedness, workforce capability, and management commitment. The validated instrument demonstrated excellent reliability, with Cronbach's Alpha values of 0.881, 0.823, and 0.833 respectively, and satisfactory sampling adequacy with KMO values ranging from 0.661 to 0.751.

The findings reveal a mixed picture of readiness. Management commitment is relatively strong, with a mean score of 4.12, indicating that leadership recognizes the strategic importance of IoT. However, only 45 percent of organizations have a formal digital transformation roadmap, suggesting a gap between commitment and structured planning. Technological preparedness falls in the moderate range with a mean score of 3.28. While basic IT infrastructure exists in most organizations, only 38 percent have machinery compatible with IoT sensors, making legacy equipment the primary technological constraint.

Workforce capability emerges as the most critical readiness gap, scoring lowest at 2.95. Only 28 percent of respondents rated IoT-related skills as adequate, and merely 22 percent reported sufficient data analytics capability. However, 62 percent of workers expressed willingness to learn, providing a foundation for targeted training interventions. Sectoral variations were also observed, with automotive component industries showing the highest technological preparedness (mean 3.52) and agro-processing the lowest (mean 2.98), indicating that sector-specific support strategies may be more effective than uniform approaches.

The study contributes a validated readiness assessment instrument that can be used by manufacturing MSMEs to evaluate their preparedness before IoT implementation. For manufacturing MSMEs, readiness assessment should precede technology investment, with workforce development as the priority intervention. For policymakers, the findings highlight the need for targeted skill development programs for IoT and data analytics, with additional support directed toward agro-processing industries. For industry associations, establishing shared learning platforms and training programs would leverage the demonstrated worker willingness to learn.

The future of smart manufacturing depends not only on technology availability but also on organizational preparedness. By assessing and addressing readiness gaps before implementation, medium-scale industries can increase their probability of successful IoT adoption and sustainable competitive advantage.

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