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A study on agricultural development through ICT: A case study of e-governance in Janjgir champa district in Chhattisgarh using classification technique

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Abstract

This study evaluation the role of Information and Communication Technology (ICT) in agricultural development with specific reference to e-governance initiatives in Janjgir Champa district, Chhattisgarh. A field survey was conducted during 2025 across five blocks to identify key barriers to effective ICT implementation. Nine constraints were analyzed, including resource limitations, computer illiteracy, lack of citizen awareness, language challenges, resistance to change, shortage of trained personnel, equipment storage issues, difficulty level, and gender-related factors. Data reliability was verified using the Alpha method, while factor analysis was employed to explore variations in responses. To classify ICT-related issues, three machine learning techniques J-48, CART, and Random Forest were applied and compared. Model performance was evaluated using sensitivity, accuracy, specificity, and F1 score. Findings reveal that the Random Forest model achieved superior performance, providing the most reliable classification of policy implementation challenges. The study highlights critical gaps in ICT adoption and offers insights for policymakers to strengthen e-governance strategies for agricultural development in the region.

Keywords: ICT, e-governance, agriculture, reliability test, classification methods

Introduction

E-governance has emerged as a critical dimension of modern governance, enabling the transition from traditional bureaucratic systems to digital and citizen-centric frameworks. The rapid adoption of Information and Communication Technologies (ICT) has facilitated this transformation, strengthening interactions across multiple governance dimensions: Government-to-Citizen (G2C), Government-to-Business (G2B), and Government-to-Government (G2G). These models function within established legal and regulatory frameworks to enhance efficiency, accountability, and transparency (Heeks, 2006; Sharma, 2015) [5].

Globally, governments face increasing demands to provide cost-effective and responsive public services. ICT has emerged as a catalyst in this process by improving both back-end administrative efficiency and front-end service delivery (United Nations, 2020) [11]. In rural India, ICT-enabled e-governance initiatives have contributed to community-level service delivery, enhanced data storage and retrieval, and supported socio-economic development (Bhatnagar, 2004; Singh & Sahu, 2019) [1]. Examples such as Common Service Centres (CSCs) and e-Seva portals have demonstrated measurable improvements in citizen access to services, time savings, and reductions in corruption.

Despite these advances, several constraints continue to hinder widespread adoption. Limited awareness, digital illiteracy, inadequate ICT infrastructure, and linguistic diversity remain major barriers (Prakash, 2022; Rao, 2022) [9, 10]. Studies show that while projects like the Warana Wired Village and Gyandoot initiatives showcased the transformative potential of ICT, sustainability and scalability were often limited

by socio-economic and infrastructural challenges (Maddon, 2009; Bhattacharyya, 2008) ^[2, 6]. More recent research emphasizes the importance of digital literacy campaigns, public-private partnerships, and policy frameworks to bridge the digital divide and ensure inclusivity (Pandey, 2024) ^[8].

Against this backdrop, the present study focuses on evaluating the role of ICT in strengthening e-governance, particularly in rural agricultural settings. By identifying constraints, analyzing variations in citizen perceptions, and applying classification techniques, this research seeks to generate insights that can guide policymakers toward building resilient and inclusive ICT-enabled governance frameworks.

Materials and methods

This study employed a survey-based research design to investigate the challenges encountered in the implementation of ICT-related policies within the agricultural sector of Janjgir Champa District, Chhattisgarh. The survey was conducted during 2025 across five administrative blocks of the district to ensure broad coverage of the study area.

A structured questionnaire was developed to capture data on ICT-related challenges, consisting of 26 questions covering demographic information, ICT usage, and perceived barriers to e-governance adoption. The questionnaire was divided into two parts: (i) general information on respondents' socio-economic background and access to ICT, and (ii) a set of nine ICT-related constraints identified from prior studies and field consultations. These constraints included: (i) resource limitations, (ii) computer illiteracy, (iii) limited citizen awareness, (iv) language-related challenges, (v) resistance to change, (vi) shortage of trained personnel, (vii) equipment storage issues, (viii) perceived difficulty level, and (ix) gender-related barriers.

The survey was administered to a total of 120 local respondents, primarily farmers, rural youth, and community members directly impacted by ICT initiatives in governance

and agriculture. Data were collected through face-to-face interviews and structured questionnaires, ensuring inclusivity of individuals with varying levels of digital literacy.

The internal consistency of the instrument was measured using Cronbach's alpha, with values ranging from 0.871 to 0.953 across constraints, indicating high reliability. According to Nunnally (1978) ^[7], values above 0.70 are considered acceptable, those above 0.80 indicate good reliability, and values above 0.90 reflect excellent reliability.

The collected data were coded by the researcher and analyzed using statistical and machine learning tools, including Jamovi 2.6.44, Python 3.12, and R 4.3.1. These platforms were used for reliability testing, descriptive statistics, and the application of classification algorithms.

For the classification of ICT-related challenges, three machine learning algorithms were applied: J-48 (Quinlan, 1993), CART (Breiman *et al.*, 1984), and Random Forest (Breiman, 2001) ^[3, 4]. These algorithms were chosen for their proven effectiveness in handling categorical survey data and their interpretability in governance-related research. The performance of each model was assessed using sensitivity, accuracy, specificity, and F1-score. Among the three models, Random Forest emerged as the best-performing classifier, demonstrating the highest accuracy and balanced predictive capability across all metrics.

Results Discussion

Accuracy, Sensitivity, Specificity, and F1-Score of ICT based data for Agriculture Department

The CART method achieved an accuracy of 86.11%, sensitivity of 0.92, specificity of 0.96, and an F1-score of 0.81. The J48 method resulted in an accuracy of 88.89%, sensitivity of 0.96, specificity of 0.97, and an F1-score of 0.85. The Random Forest method delivered the highest performance, with an accuracy of 94.44%, sensitivity of 0.95, specificity of 0.97, and an F1-score of 0.89.

Table 1: Accuracy, Sensitivity, Specificity, and F1-Score for Agriculture Department

Models	Accuracy	Sensitivity	Specificity	F1-Score
CART	86.11%	0.92	0.96	0.81
J48	88.89%	0.96	0.97	0.85
Random Forest	94.44%	0.95	0.97	0.89

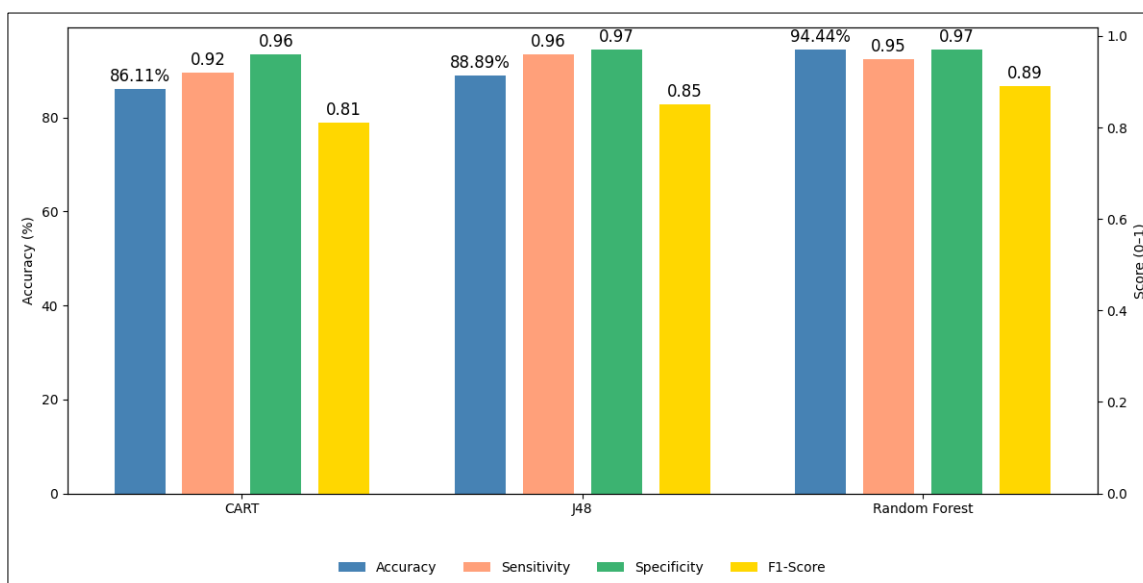


Fig 1: Accuracy, Sensitivity, Specificity, and F1-Score of Agriculture Department

Conclusion

This study highlights the key ICT-related challenges in the agricultural sector of Janjgir Champa District, Chhattisgarh. The survey of 120 local respondents revealed that while ICT-enabled governance has the potential to improve accessibility, transparency, and efficiency of public services, its implementation continues to face multiple barriers. Key constraints identified include limited resources, digital illiteracy, inadequate awareness, language-related challenges, and resistance to change.

The research demonstrated that the structured questionnaire used was highly reliable, as evidenced by Cronbach's alpha values ranging from 0.871 to 0.953, ensuring consistency of responses across ICT-related variables. The collected data were analyzed using Jamovi 2.6.44, Python 3.12, and R 4.3.1, which enabled both statistical and machine learning analyses. Among the classification models applied, Random Forest achieved the highest performance with an accuracy of 94.44%, sensitivity of 0.95, specificity of 0.97, and F1-score of 0.89, outperforming CART (86.11% accuracy, F1-score 0.81) and J48 (88.89% accuracy, F1-score 0.85). These results confirm that Random Forest provides the most balanced and robust predictions for classifying ICT-related challenges.

Overall, the study underscores that while ICT offers transformative opportunities for rural governance, addressing challenges such as infrastructure gaps, digital literacy, and citizen awareness remains essential. Policymakers should prioritize capacity-building programs, localized digital literacy initiatives, and context-specific ICT interventions to strengthen e-governance frameworks. Future studies could expand the scope by including larger samples, longitudinal assessments, and advanced AI-based models to further enhance rural governance outcomes.

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