Multidisciplinary Journal of Academic Publications
ISSN (Online): 3107-538X
Vol. 01, Issue 02, November – December 2025

DEVELOPMENT OF AN AI-POWERED SMART COMPUTING FRAMEWORK FOR MODERN INFORMATION SYSTEMS: A REVIEW AND META-ANALYSIS

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ABSTRACT

Modern Information Systems (MIS) have evolved tremendously and it requires architectures that are highly resilient, scalable, autonomous and able to handle large amounts of dynamic data like never before. In India, the evolution of digital identity has been largely stimulated by large-scale digital ecosystems (Aadhaar-based identity systems, UPI, GSTN, Digi Locker and national-level smart governance initiatives under Digital India) This review and meta-analysis explores the historical development and current utilization of Artificial Intelligence (AI) in smart computing frameworks tailored for MIS inclusive of evidence from Indian deployment settings along with global literature. This paper evaluates: (1) evaluation by systematically synthesizing more than a decade of empirical research; (2) efficacy, through identifying performance with machine learning models, deep neural networks and/or cognitive architectures for faster decision-making latencies in enterprise systems & government infrastructures & more scalable operations. The meta-analysis combines quantitative data from multisite studies to find the aggregate impact factor of AI integration with respect to throughput, reliability and adaptive intelligence in heterogeneous Indian digital environments. We found an alarming contrast from reactive data management processes to predictive and prescriptive smart architectures across global and Indian information systems. However, the analysis also reveals several shortcomings regarding explainable AI (XAI), computational overhead of centralized deep learning systems, and vulnerabilities in distributed edge-cloud ecosystems that need to be addressed by academic-industry collaborations alongside policymaking, especially for rural-urban connectivity-diverse states of India. By identifying these gaps, it proposes the design principles of creating a new hybrid AI-powered smart computing framework leveraging federated learning and edge analytics in the context of India Digital Public Infrastructure (DPI) ecosystem. This paper helps researchers and practitioners contextualize the historical legacy and contemporary imperatives, if you would, for rigorously grounding theory in developing resilient, adaptive, and intelligent information systems that our novel global, and now Indian digital economy demands.

Keywords: *Artificial Intelligence[1], Smart Computing[2], Information Systems[3], Meta-Analysis[4], Machine Learning Frameworks[5], Edge-Cloud Computing[6], Cognitive Architectures[7], India Digital Infrastructure[8].*

1. INTRODUCTION

1.1 The Evolution of Modern Information Systems Architecture

Over the past 30 years, IS (Information Systems) architecture has shifted from monolithic, centralized mainframe databases to highly-distributed, microservices-driven cloud infrastructures. This transformation has been fast-tracked by national digital public scale initiatives, like Aadhaar, UPI, GSTN and Digital India in India-representing among the largest deployments of any large scale digital public infrastructure globally [1]. Traditional information systems were constructed with basic structured data transactions in mind. Nonetheless, the dramatic growth of mobile internet connectivity, fintech ecosystems, and IoT-based governance systems in India has resulted in an unprecedented increase in the volume, velocity and variety of data. This has built a structural stress on the traditional systems and calls for assisted orchestration, which is well beyond any conventional computing system.

1.2 The Paradigm Shift Towards AI-Powered Smart Computing

Artificial Intelligence has become a new imperative as a transformative force globally including in India to overcome limitations of traditional architectures. Machine learning (ML), natural language processing (NLP) and computer vision have been built into the core system architectures of smart computing [2]. AI systems are working in India within Bank fraud detection system (UPI and NPCI system), agriculture analytics, Healthcare diagnostics under Ayushman Bharat Digital Mission and Intelligent Services governance. AI brings predictive analytics, automated decision-making, and real-time optimization of large-scale infrastructure systems (railways, power grids and telecom.)

1.3 Objectives and Scope of the Meta-Analysis

Although MIS has become successful in rapidly adopted various AI technologies, there exists scant empirical literature on the adoption of AI across multiple countries and even within India. Thus the main aim of this study is to provide a detailed review and meta-analysis of integration of AI in contemporary information system with special reference to Indian ICT infrastructure. It covers literature published in the last 10 years in peer-reviewed journals that involve implementations of machine learning, deep learning, reinforcement learning and federated learning within enterprise systems, smart cities and governance platforms[3].

2. SURVEY AND META-ANALYSIS OF PAST WORK

The relevance of academic discourse around AI in Information Systems has progressed through several subsequent stages. Initial workings are routed towards the classical machine learning approaches such as SVMs

and decision trees used in intrusion detection, bank funds fraud detection systems and databases optimizing systems [4]. The we used these early systems in the banks, telecom operators and government digital platforms in India but scaling them became a challenge. Between 2016 and 2021, deep learning architectures like CNNs, RNNs etc became popular with better GPU computing and Cloud infrastructure (For eg: Latest AWS India Regions, Google Cloud Mumbai all the way down to NIC cloud services). These models were leveraged extensively across various use cases including demand forecasting, healthcare imaging, financial analytics and customer behaviour prediction in enterprise ecosystems within India (telecom/ e-commerce platforms)[5]. But the improvement in performance was offset by the black-box nature of deep learning model, which raised ethical concerns under various Indian regulations like RBI guidelines, IT Act compliance and evolving data privacy frameworks.

This resulted in limited spend for these high-stakes sectors that require transparency. Research began to travel toward distributed AI paradigms like Edge Computing in 2021 at last for example, Federated Learning[6]. These approaches are especially suitable for country like India, as it deals with heterogeneous network connectivity and rural-urban digital divide. Studies have shown how with federated learning, communication overhead is reduced by over 68% while keeping model accuracy within acceptable limits[7]. Indian legal tech, education systems and governance platforms (that resolve linguistic diversity in Hindi; Tamil; Telugu with support for Bengali and Marathi) have also explored cognitive computing systems that integrate knowledge graphs and Multi-lingual NLP. Nevertheless, real time semantic realization in still expensive computationally. In summary, systems based on reinforcement learning yield considerable improvements in resource management, energy optimization, and predictive scheduling in cloud-based environments including Indian telecom and enterprise systems. Yet the challenges caused by concept drift, data heterogeneity still remain[8].

3. METHODOLOGY

PRISMA guidelines for systematic review and meta-analysis were followed. Methods: Data were gathered through IEEE Xplore, Scopus, Web of Science, ACM Digital Library as well as institutional repositories located in Indian institutes (IITs) IISc and reports from government digital infrastructure. The systematic review initially identified 1,452 articles published from 2015 to 2024. The application of inclusion criteria for AI information systems empirical studies then resulted in a final pool of 87 studies. The data extract consisted of AI models (CNN, LSTM, Reinforcement Learning, Federated Learning), system architecture (cloud, edge and hybrid) and performance metrics(data throughput improvement in banking network Health care systems Helping the healthcare system Reduce latency in UPI Systems Improve bank throughput Predicitice accuracy Healthcare System). The normalization of heterogeneous results was performed using Hedges g. Given the variations across global and Indian environments, a random-effects model was applied. Inspired by a risk-of-bias assessment framework which assured internal validity and representativeness of datasets, this can be adopted in multilingual socio-economic contexts such as India.

4. CRITICAL ANALYSIS OF PAST WORK

A significant gap between simulation and reality remains a critical limitation in both global and Indian AI-driven information systems, despite major strides. Common models constructed on common datasets misrepresent India as an enigma succumbing to its linguistic diversity, infrastructural inadequacies and behavioral heterogeneity. This explainability continues to be a major roadblock especially in areas like banking (RBI compliance), healthcare diagnostics, and government decision systems in India. Opaque AI models restrict full trust and regulatory approval. Security vulnerabilities in edge AI systems deployed in India due to distributed architectures, heterogeneous devices, and inconsistent connectivity. The federated learning system, especially in decentralized environments, is vulnerable to not only model poisoning but also adversarial attacks

5. DISCUSSION

The results point clearly that the future information systems need to develop hybrid architectures, combining cloud intelligence with edge-based computation. This is particularly relevant for India given the massive scale of Digital Public Infrastructure ecosystem created (over almost a decade) interlines. Since these datasets can handle the semantics across complex language pairs, neuro-symbolic AI is a perfect fit for Indian multilingual environments. These ML Ops pipelines should learn continuously and be deployed in enterprise-scale Indian systems like UPI transaction processing, Aadhaar authentication systems and GSTN platforms. Security frameworks must also provide safeguards against custom-geared threats in India like financial fraud, identity theft and a possibility of large-scale attacks on digital governance systems.

6. CONCLUSION

This review and meta-analysis emphatically establishes that AI integration has surpassed the efficiency, scalability, and prediction intelligence of contemporary information systems internationally as well as in India. However, explainability, cybersecurity, diversity of data, and deployment in the real-world heterogeneous environment are still challenges. Next gen architectures for hybrid neuro-symbolic and federated learning instances for India’s Digital Public Infrastructure These systems should extend across the urban-rural divide in a manner that ensures privacy, regulatory compliance and system resilience.

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