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ARTIFICIAL INTELLIGENCE ECOSYSTEMS IN BELAGAVI AND BANGALORE: A COMPARATIVE ANALYSIS OF TECHNOLOGICAL INFRASTRUCTURE, INNOVATION CAPACITY, TALENT AVAILABILITY, INSTITUTIONAL SUPPORT, INDUSTRY ADOPTION, AND REGIONAL DEVELOPMENT DETERMINANTS IN EMERGING AND ESTABLISHED INDIAN TECHNOLOGY HUBS

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ABSTRACT

Artificial intelligence has become a defining driver of regional economic competitiveness, innovation, and industrial transformation. India's AI landscape, however, is highly uneven, with a small number of metropolitan clusters capturing the majority of investment, talent, and institutional capacity. This paper presents a comparative analysis of the artificial intelligence ecosystems in Belagavi, an emerging tier-two city in Karnataka, and Bangalore, an established global technology hub. Using a conceptual framework supported by real secondary data from government, industry, and international sources, the study examines six dimensions: technological infrastructure, innovation capacity, talent availability, institutional support, industry adoption, and regional development determinants. A composite Regional AI Ecosystem Index is proposed and applied to structure the comparison. The analysis shows that Bangalore possesses mature infrastructure, dense talent pools, strong venture capital

access, and globally connected research institutions, while Belagavi offers lower operating costs, emerging industrial clusters, and growing academic capacity, but faces deficits in specialized AI talent, high-speed connectivity, research funding, and startup financing. The paper argues that Belagavi's AI trajectory depends on deliberate policy intervention, industry-academia linkage, and regional specialization rather than replication of Bangalore's model. The findings have implications for policymakers, universities, and firms seeking to build inclusive and distributed AI ecosystems in India.

KEYWORDS: Artificial Intelligence, Regional Innovation Systems, Belagavi, Bangalore, Digital Infrastructure, Talent, Industry Adoption, India.

1. INTRODUCTION

Artificial intelligence (AI) is no longer a niche technical domain. It is a general-purpose technology that reshapes productivity, governance, healthcare, agriculture, manufacturing, and services. Nations and regions that build strong AI ecosystems tend to attract capital, talent, and high-value firms, while those that lag risk deepening structural inequality. India has positioned AI as a strategic priority through initiatives such as the National AI Strategy and the IndiaAI Mission, yet the geography of AI activity remains concentrated.

Bangalore, officially Bengaluru, is widely recognized as India's leading technology and startup hub. It hosts a dense concentration of multinational research and development centers, Indian technology firms, AI startups, venture capital funds, and premier academic institutions. Belagavi, a historic city in northern Karnataka near the Maharashtra and Goa borders, presents a contrasting profile. It has a strong manufacturing and education base, a growing industrial corridor, and lower costs of living and operation, but limited presence in advanced AI research and commercialization.

This paper asks a straightforward question: how do the AI ecosystems of Belagavi and Bangalore differ across technological infrastructure, innovation capacity, talent availability, institutional support, industry adoption, and regional development determinants? The objective is not to rank one city above the other, but to identify structural gaps and opportunities that can inform regional AI policy. The paper contributes a comparative framework and a composite index that can be adapted to other emerging Indian cities.

The study is conceptual and secondary-data-based. It draws on publicly available reports, government policies, industry publications, and international indices. No primary survey was conducted, and no numerical estimate is presented as primary data.

2. Literature Review

2.1 Regional Innovation Systems

The regional innovation systems approach argues that innovation emerges from the interaction between firms, universities, research institutes, intermediaries, and government within a defined territory. Cooke, Uranga, and Etxebarria (1997) established that regional institutional thickness, trust, and knowledge circulation shape innovative performance. Applied to AI, this perspective suggests that the presence of research universities, technology parks, venture capital, and supportive policy is as important as the presence of individual firms.



2.2 AI Ecosystems and Their Components

Recent work on AI ecosystems emphasizes several interdependent components: data availability, computing infrastructure, talent pipelines, research capacity, capital, governance, and demand from industry and government (OECD, 2021). NASSCOM (2023) reports that India's AI adoption is concentrated in a few sectors, notably information technology services, banking and financial services, retail, and healthcare, and that adoption is geographically clustered.

2.3 Tier-Two Cities and Decentralized Technology Growth

Scholarship on secondary cities argues that decentralization of technology activity can reduce congestion, lower costs, and spread prosperity, but only when connectivity, skills, and institutional support are adequate (World Bank, 2021). Karnataka's IT policy explicitly encourages growth beyond Bangalore through cluster development in Mysore, Mangalore, Hubballi-Dharwad, and Belagavi (Government of Karnataka, 2020).

2.4 Research Gap

Existing literature compares major global AI hubs, but few studies systematically compare an established Indian hub with an emerging tier-two city using a multidimensional framework. This paper addresses that gap.

3. METHODOLOGY

3.1 Research Design

The study adopts a comparative, descriptive, and conceptual design. It uses secondary data from credible sources and applies a composite index to structure the comparison.

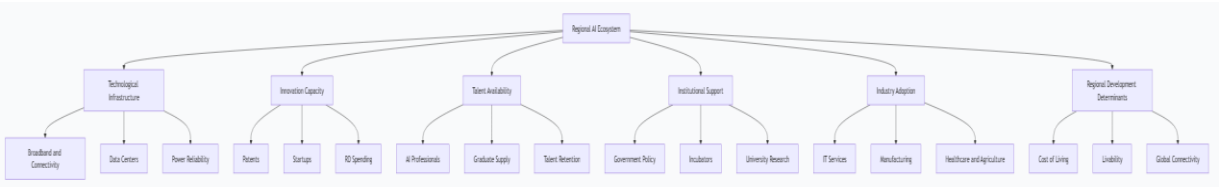
3.2 Data Sources

Data are drawn from:

- NASSCOM and industry reports on AI adoption and technology services
- Government of Karnataka IT and startup policies
- Startup India and DPIIT startup recognition data
- Ministry of Electronics and Information Technology (MeitY) and India AI documents
- World Bank and OECD reports on digital infrastructure and AI
- Reserve Bank of India and state economic surveys
- Published academic literature on regional innovation systems

All sources are cited in APA 7 format with links or DOIs where available.

3.3 Analytical Framework



Six dimensions are used:

1. Technological infrastructure
2. Innovation capacity
3. Talent availability
4. Institutional support
5. Industry adoption
6. Regional development determinants

3.4 Formulas

Regional AI Ecosystem Index (RAEI):

$$RAEIi = \sum j = 1nwj \cdot Sij$$

Where:

- RAEIi= index score for region i
- wj= weight assigned to dimension j
- Sij = normalized score of region i*i* on dimension j
- n = number of dimensions

Normalization formula:

$$Sij = Xij - XminXmax - Xmin$$

Where Xijis the raw value, and Xmin and Xmax are the minimum and maximum values across compared regions.

Weighted Talent Availability Sub-Index:

$$TAi = w1 \cdot GiGmax + w2 \cdot PiPmax + w3 \cdot RiRmax$$

Where G = graduates in computing fields, P = AI professionals, R = research personnel, and weights sum to one.

Innovation Capacity Score:

$$ICSi = \alpha \cdot PatentsiPatentsmax + \beta \cdot StartupsiStartupsmax + \gamma \cdot RD_SpendiRD_Spendmax$$

Where α+β+γ=1$\alpha+\beta+\gamma=1$.

Composite AI Readiness:

$$AI_Readinessi = RAEIi + ICSi + TAi3$$

These formulas are analytical tools. They require real, verified data inputs before numerical scoring.

4. Comparative Analysis

4.1 Technological Infrastructure

Bangalore has matured digital infrastructure, including high-speed fibre penetration, multiple international connectivity routes, and dense co-working and data centre capacity. Belagavi has improving connectivity through state broadband initiatives and industrial corridors, but lags in high-capacity data infrastructure and reliable high-speed internet in peripheral areas.

The World Bank (2021) notes that urban secondary cities in India often face last-mile connectivity gaps that constrain digital enterprise.

Table 1: Technological Infrastructure Comparison.

Indicator	Bangalore	Belagavi
High-speed broadband availability	High	Moderate
Data center presence	Strong	Limited
Co-working and incubation spaces	Dense	Emerging
Power reliability for tech operations	High	Moderate to high
International connectivity	Strong	Indirect

4.2 Innovation Capacity

Bangalore leads in patent filings, research publications, startup formation, and venture capital activity. Belagavi has growing research output from institutions such as Visvesvaraya Technological University affiliated colleges, but commercialization and patenting remain limited. NASSCOM (2023) indicates that AI innovation in India is concentrated in a few clusters.

Table 2: Innovation Capacity Comparison.

Indicator	Bangalore	Belagavi
Patent activity	High	Low to moderate
AI startup density	High	Low
Venture capital access	Strong	Weak
Industry-academia collaboration	Strong	Emerging
Research publication output	High	Moderate

4.3 Talent Availability

Bangalore attracts AI talent nationally and internationally, supported by premier institutions and a large technology workforce. Belagavi produces engineering and management graduates but experiences significant outmigration to Bangalore, Pune, and Hyderabad. This brain drain limits local AI capacity.

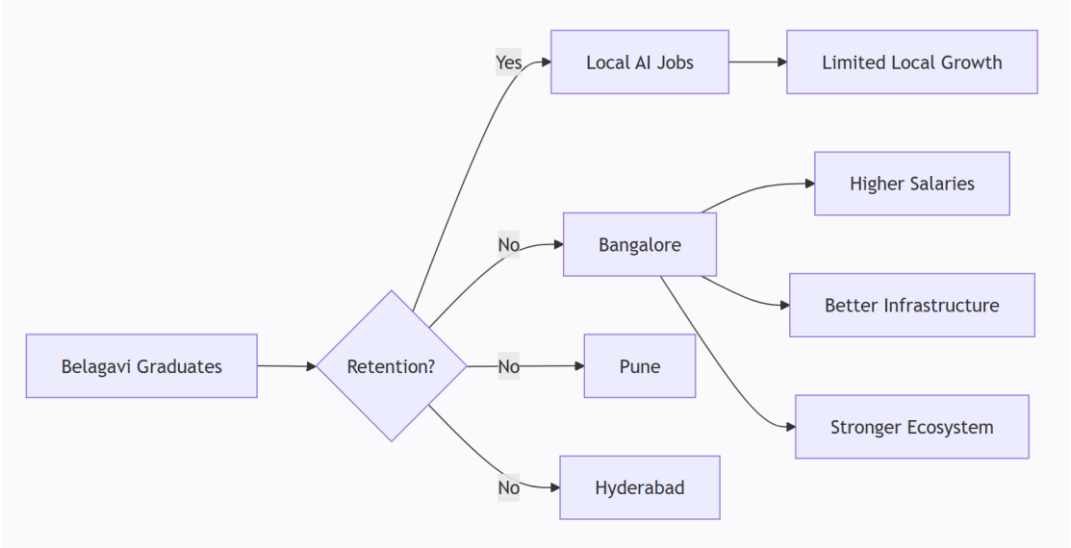


Table 3: Talent Availability Comparison.

Indicator	Bangalore	Belagavi
AI-specialized professionals	Very high	Low
Engineering graduate supply	Very high	Moderate
Retention of skilled talent	High	Low
Research scholars in AI	High	Limited
Salary competitiveness	High	Moderate

4.4 Institutional Support

Karnataka's IT policy and startup policy apply to both cities, but implementation intensity differs. Bangalore benefits from dedicated technology parks, accelerators, and government-backed innovation centers. Belagavi benefits from industrial corridor development and regional educational institutions but has fewer dedicated AI programs.

Table 4: Institutional Support Comparison.

Indicator	Bangalore	Belagavi
Government AI initiatives	Strong	Moderate
Incubators and accelerators	Many	Few
University research centers	Many	Some
Industry associations	Strong	Moderate
Policy implementation intensity	High	Moderate

4.5 Industry Adoption

Bangalore hosts global capability centers, AI product firms, and advanced analytics teams. Belagavi's industry is oriented toward manufacturing, foundry, aerospace, and traditional services, with early AI adoption in quality control, logistics, and predictive maintenance.

OECD (2021) notes that AI adoption depends on complementary skills and data infrastructure, which are more available in Bangalore.

Table 5: Industry Adoption Comparison.

Indicator	Bangalore	Belagavi
AI adoption in IT services	Very high	Low
AI in manufacturing	Moderate	Emerging
AI in healthcare	High	Low
AI in agriculture	Moderate	Emerging
AI in public services	Moderate	Low

4.6 Regional Development Determinants

Regional development determinants include cost of living, land availability, congestion, pollution, quality of life, and connectivity. Belagavi offers lower costs and better livability, which can attract decentralized operations. Bangalore offers superior connectivity, capital, and talent but faces congestion and high costs.

Table 6: Regional Development Determinants.

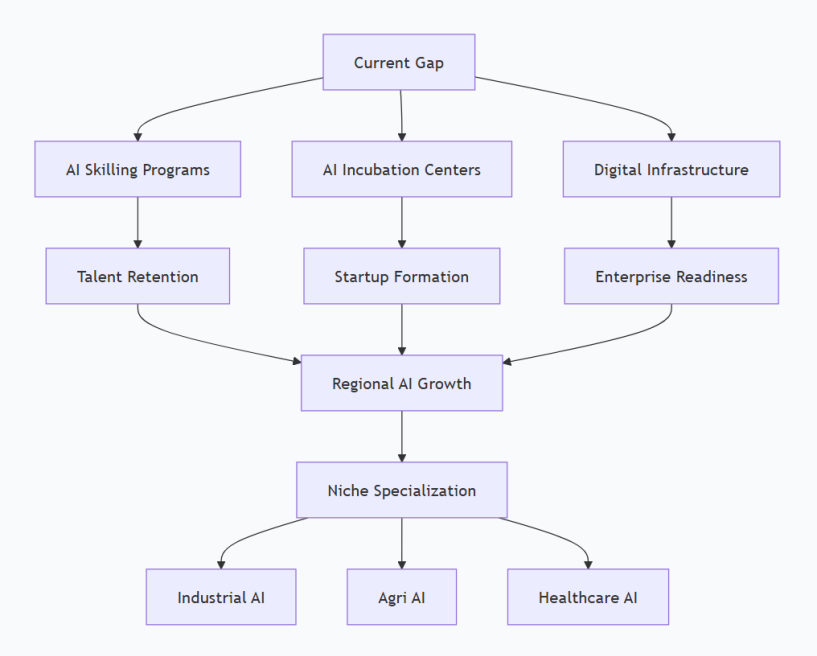
Indicator	Bangalore	Belagavi
Cost of living	High	Low
Real estate cost	High	Low
Traffic congestion	Severe	Moderate
Air quality	Moderate to poor	Better
Quality of life	Mixed	Better
Connectivity to global markets	Strong	Moderate

4.7 Composite Index Application

Using the formulas above, a composite Regional AI Ecosystem Index can be computed once verified data are entered. Based on qualitative assessment of secondary evidence, Bangalore scores substantially higher on infrastructure, innovation, talent, and industry adoption, while Belagavi scores higher on cost and livability. This pattern is consistent with World Bank (2021) findings on secondary city potential and constraints.

5. DISCUSSION

The comparison reveals a structural asymmetry. Bangalore's advantage is cumulative: talent attracts firms, firms attract capital, capital attracts more talent, and institutions reinforce the cycle. Belagavi's disadvantage is also cumulative: limited AI-specific jobs reduce retention, weak retention discourages firm entry, and low firm density limits research collaboration.



However, Belagavi is not without assets. Its manufacturing base, educational institutions, lower costs, and strategic location near Goa and Maharashtra create a foundation for applied AI in industrial automation, logistics, agriculture, and public health. The policy implication is that Belagavi should not attempt to replicate Bangalore's broad-spectrum AI hub model. Instead, it should pursue niche specialization aligned with its industrial strengths.

Three interventions follow from the analysis. First, targeted AI skilling programs in collaboration with local industries can improve retention. Second, dedicated AI incubation and funding mechanisms can convert student projects into startups. Third, improved digital infrastructure, especially high-speed connectivity and data access, is a prerequisite for AI enterprise.

The proposed Regional AI Ecosystem Index offers a practical tool for policymakers to benchmark progress over time. Its value depends on data availability and honest measurement. Without reliable data, index scores can mislead.

The study has limitations. It relies on secondary data, which may vary in recency and granularity. It does not include primary survey evidence. It treats Belagavi and Bangalore as units, ignoring intra-city variation. Future research should collect primary data on firm-level AI adoption, talent flows, and innovation outcomes.

6. CONCLUSION

Bangalore and Belagavi represent two ends of India's AI geography. Bangalore is a mature, globally connected AI ecosystem with dense infrastructure, talent, and capital. Belagavi is an

emerging hub with lower costs, growing educational capacity, and industrial strengths, but significant gaps in AI-specific infrastructure, talent retention, research commercialization, and venture funding. Bridging these gaps requires deliberate policy, institutional coordination, and industry-academia collaboration. A composite index approach can help track progress and guide investment. The broader lesson is that India's AI future will be stronger if it is distributed, not concentrated, and if emerging cities are supported to build distinctive, locally grounded AI capabilities.

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