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REGIONAL INNOVATION SYSTEMS AND THE RISE OF TIER-2 CITIES IN INDIA'S KNOWLEDGE ECONOMY

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ABSTRACT
This paper examines the nature of how Tier-2 cities in India are becoming the knowledge economy drivers in the country. It analyses the interaction between local institutions, industries, and governments in order to promote innovation using the Regional Innovation Systems (RIS) and Triple helix frameworks. A comparative case study methodology recognizes three forms of innovations based on systems; technology-led systems (Pune, Ahmedabad), cluster-based systems (Coimbatore, Bhubaneswar) and policy-driven systems (Kochi, Chandigarh). It has been found that the level of development of university-industry-government cooperation is the determinant of ecosystem performance and innovation results.
Policy suggestions are to enhance Regional Innovation Compacts, enhance access to venture capital, entrepreneurial universities, and inter-city innovation corridors to improve knowledge flow. Although the study delivers important results, its qualitative approach to the problem and use of secondary sources is insufficient, which is why longitudinal and network studies should be conducted to quantify knowledge spillovers more accurately. Finally, the paper highlights the fact that Tier-2 cities in India are becoming strategic driving forces of inclusive, decentralized, and sustainable innovation which is reshaping the geography of the Indian knowledge economy.
Key Words: Regional Innovation Systems, Triple Helix, Knowledge Economy, Innovation Policy, India, Regional Development.

INTRODUCTION

The knowledge economy in India has been transformed as in the last twenty-five years, it has ceased to be concentrated in metropolis cities like Bengaluru, Hyderabad, and Delhi, and has shifted to a more dispersed network of Tier-2 cities (Pune, Coimbatore, Ahmedabad, and Chandigarh). This shift is a wider global phenomenon as regional innovation systems (RIS) become the core of knowledge-based development and local entrepreneurial ecosystem [1].
Regional innovation systems focus on interrelated relations among universities, industries and government institutions to help in developing regional competitiveness and technological learning [2]. Although past approaches to innovation agglomeration focused on the global cities, recent experiences in emerging economies indicate that the mid-tier cities can also emerge as active innovation hubs in the event that they build specialized knowledge bases, entrepreneurial networks, and absorptive capacities [3]. The interaction between human capital, digital infrastructure, and regional entrepreneurship policies in an Indian context is placing Tier-2 cities in the role of key drivers of inclusive, knowledge-based development.

Nonetheless, this change does not occur automatically. Research examining the peripheral regional systems demonstrates that even with institutions of higher education, the lack of unified systems of innovation can restrict the spillovers of entrepreneurship and the generation of local values [4]. Thus, the ways to chart the ways to sustainable and geographically balanced development of knowledge economies relies on the understanding of how regional innovation systems are changing in the Tier-2 cities of India.

This paper will analyze the development of regional innovation systems (RIS) in the emerging Tier-2 cities in India and how it has contributed to the knowledge economy of India at large. It addresses interaction between regional clusters, institutional connections and the entrepreneurial ecosystems in their creation of innovation driven growth, provides understanding how India can use its urban diversity in its enhancement of national innovation and global competitiveness.

Economic Transformation of Tier-2 Cities

The economic geography of India has been changing greatly following the spread of digitalization and decentralization of activities in innovation across the metropolitan centers. Recent work suggests that the spread of the digital economy has facilitated the involvement of smaller cities in knowledge-intensive activities through the exploitation of local resources including universities, technology parks, and skill-oriented clusters [5]. Such digital diffusion, sometimes referred to as knowledge decentralization, enables Tier-2 cities to establish dynamic entrepreneurial systems that can support innovation driven growth.

Such cities include Ahmedabad, Kochi, Bhubaneshwar and Coimbatore. Ahmedabad has emerged as a noted center of design and management-driven innovation and institutions like Indian Institute of Management (IIMA) and fintech ecosystem of GIFT City has played a role in this. Kochi with its Info Park and integrated Incubation centers has emerged as one of the leading locations in IT and maritime technology Start-ups.

Likewise, the active digital governance and creation of start-up accelerators at Bhubaneswar by the policy of Start-up Odisha has made it an upcoming smart city in terms of technology-based entrepreneurship. These illustrations show how clusters of education, digital infrastructure and proactive governance are working together to bring economic change in Tier-2 cities and make the environment conducive to localized innovation and skilled jobs.

Also, the Tier-2 cities provide cheaper operations, living, and infrastructure which is growing, also brings talent into the city spread in the overcrowded metropolitan areas. Consequently, they are becoming significant links in the larger knowledge economy in India, and can also contribute to new systems of local innovation based on access, digital inclusion, and place-based benefits.

Institutional Infrastructure and Policy Support

The institutional and policy environment conducive to promoting entrepreneurship and sharing of knowledge is highly associated to the development of the innovation ecosystems in the Tier-2 cities. Various national policies and programs such as Atal Innovation Mission (AIM), Smart Cities Mission and Startup India have played a key role in organizing the local innovation ecosystem with the encouragement of the cooperation of academia, industry and government agencies [6].

Such programs spur the developments of incubation centers, innovation hub and research collaborations that strengthen the triple helix model in the core of regional innovation systems.

State-level innovation councils and regional start-up missions based on their industrial strengths have also been put in place in many Tier-2 cities. As an illustration, Tamil Nadu Startup and Innovation Mission (TANSIM) and Kerala Startup Mission (KSUM) have developed a culture of entrepreneurship through the encouragement of early-stage ventures and connecting them with institutions of learning and research [7]. Likewise, Madhya Pradesh Innovation and Startup Policy have established incubation centers in universities to assist locals in ideas. These programs not only develop start-ups but also help in knowledge spillovers by mentoring, training and business-education alliances.

Tier-2 cities have increasingly become active in business schools and technical institutions as intermediaries of innovation, between theory and practice. It has been demonstrated that academic-business enterprise collaborations positively impact the readiness to innovate, the generation of local research commercialization, and the development of entrepreneurial skills [6]. Moreover, the Smart Cities Mission has made innovation a part of urban government, promoting urban management with data, sustainable infrastructure, and solutions aware of the citizens-all of which help to build regional innovation systems.

Nevertheless, there are still issues with aligning the national policies and the local needs and with the institutional capacity. Increased funding and programmatic support are not always enough to facilitate effective collaboration due to institutional fragmentation and overlapping of policy in some cases. The policy frameworks in the future should thus be designed to enhance regional connections, reinforce the university-industry-government relationships, and the creation of inclusive innovation that can impact more people in the society.

LITERATURE REVIEW

Regional Innovation Systems (RIS) is employed as a theoretical framework to explain the interaction between geography, institutions and knowledge networks in stimulating economic change in a region. RIS stresses that universities, industries and government institutions are an important interaction which can be referred to as triple

helix- to promote localized innovation [8]. The process-based theory of entrepreneurial ecosystems by Spigel and Harrison offers a powerful conceptual framework and connects clusters, flows of knowledge, and the quality of institutions with developing a local innovation capacity [9]. Regional innovation ecosystems, they contend, do not simply emerge when institutions exist but as a result of the mobile flows of resources, capital, skills, and entrepreneurial knowledge, through the social networks. On the same note, Audretsch and Belitski understand urban entrepreneurial ecosystems as context-specific systems that are incorporated within the socio-economic framework [10]. According to their model, the determinants of entrepreneurial vibrancy are six domains- culture, institutions, infrastructure, information technology, diversity and market demand. There is uneven distribution of these domains in the Indian urban context into Tier-2 cities like Coimbatore, Indore, and Bhubaneswar, which denotes uneven pathways of institutional and infrastructural development.

The work of Pyka, Kudic and Muller on systemic interventions in RIS is also a contribution to the discussion as it splits the failures of the regional systems into institutional infrastructure, the organizational landscape, and the structural connectedness. They signify the increased returns to given interventions to foster networked learning and entrepreneurial linkages [11]. This observation is especially relevant to India where regional differences in innovation are stark and policy experiments that are decentralized like the Atal Innovation Mission are aimed at enhancing local innovation potential.

Entrepreneurial ecosystems are an emerging concept taken as the powerhouse of innovation and economic development in urban areas. The model of network-based by Huggins and Thompson indicates that the quality of networks of inter-firm and access to strategic knowledge mediate regional growth differentials [12]. With Tier-2 Indian cities, this can be seen through the interaction of start-up communities and industrial clusters, in that Pune has IT and automotive forcings, or Coimbatore has manufacturing and engineering clustering's. Smart city projects in India have played a significant role in institutionalizing business ventures in urban systems. Mitra et al. emphasize the fact that smart cities are incubators of innovation in terms of better infrastructure, knowledge centers, and collaboration between multi-stakeholders [13]. Their model prioritizes the idea of inclusive and sustainable innovation in emerging cities with the help of the integration of technology infrastructure, policy support, and entrepreneurial culture. The Smart Cities Mission in India is a good example, where such cities as Surat and Indore utilized digital technologies to enhance urban management and at the same time encouraged entrepreneurship [14].

Nevertheless, Brown warns of relying on universities too much as sources of innovation anchoring in the peripheral regional systems because in this way, institutional capture restrains the general spread of entrepreneurial gains [4]. This observation will resonate with the Indian situation where most Tier-2 universities have a hard time finding meaningful connection with local industries, resulting in disjointed innovation connections. Enhancement of these university-industry interfaces remains important in increased RIS functionality.

The digital revolution has changed the spatial hierarchies of the Innovation systems. According to Han et al., the new digital infrastructure, including high-speed broadband, digital finance and information systems, directly spurs substantive innovation and green transformation especially in the mid-sized cities [15].

In the case of India this finding is in line with the government-led initiatives like Digital India and Startup India initiative that have, collectively, reduced barriers of entry to entrepreneurs who are not located in a metropolitan hub. Cities on a Tier-2 level, such as Kochi, Jaipur and Vishakhapatnam, have shown the world how digital infrastructure can level the disadvantages associated with place through providing connectivity, data access and virtual collaboration. Besides, the idea of digital and spatial affordance by Autio further extends this argument by demonstrating the opportunities available to entrepreneurs using digital networks to overcome conventional geographic challenges [5]. In the case of Tier-2 cities in India, digital affordances will mean remote innovation opportunities - allowing smaller firms and startups to enter into global value chains without having to be physically located in Tier-1 clusters such as Bengaluru or Hyderabad [16]. This change is one of the most important aspects of the knowledge economy decentralization that has been ongoing in India.

Institutional quality and human capital are closely connected to the development of the knowledge economy in the emerging regions. According to Habenko et al. (2023), business education and coopetition (collaboration among competing institutions) play a strategic role in the implementation of national innovation agendas [6]. Their study emphasizes the role of the educational institutions as an intermediary of innovation, which brings managerial and technical skills into the local economies. Tier-2 cities, including Trichy, Nagpur, and Dehradun, have started to establish innovation centers and incubation hubs, as well as industry-focused programs, at their Indian universities as part of government programs that include the Atal Incubation Mission and the Institution Innovation Council (IIC) program [17].

Brown (2016) however cautions that the effect of universities alone in changing peripheral economies is not possible unless they are supplemented by institutional provisions that promote commercialization of knowledge and entrepreneurial spillovers [18]. The Indian higher education system is regularly a victim of bureaucratic rigidity and industry involvement, which restricts the translation of scholarly research into scalable innovation [19]. As such, promoting closer triple helix connections between universities, industry, and local governments is the way forward to the continued growth of RIS in Tier-2 cities.

Cluster-based learning and open innovation systems are also directly connected with the development of Tier-2 cities into innovation hubs. Thanks to Radziwon (2024), it can be seen that regional clusters not only can enjoy the advantages of geographical proximity but can also engage in inter-organizational cooperation and digital knowledge flows [20]. In the case of India, industrial clusters, e.g. textile in Tirupur, IT in Bhubaneswar and automotive in Pune serve as the center of local knowledge sharing and co-creation of innovations.

The cluster dynamics is in line with the previous results of Anokhin that found flagship enterprises in clusters could serve as an engine of the regional innovation that can stimulate both vertical and horizontal knowledge spillovers [21]. This can be seen in the anchoring of local ecosystems in major corporations (e.g. Infosys in Mysuru, Tata Motors in Pune) in Tier-2 Indian cities, attracting talent, suppliers and startups.

The current literature has gone further in the RIS model to include social and environmental sustainability. According to Rinkinen et al. (2015), social enterprises (SEs) are to be included in the regional approaches as the sources of sustainable innovation [22]. This is very relevant to the programmes of inclusive entrepreneurship in India: women startups, social impact incubators, grassroots innovation programmes. Tier-2 cities, having closer community linkages, along with their lower cost base, are well-placed to foster such models of inclusive innovation which align economic growth to social welfare.

This shift reflects a broader evolution from growth-centric to impact-centric regional innovation paradigms. The integration of sustainability into RIS strengthens resilience and broadens participation, thereby ensuring that India's knowledge economy remains equitable and adaptive.

RESEARCH GAPS

Although the literature on the regional systems of the Indian economy as a source of innovation continues to increase, there are still a number of research gaps in the realization of the emergence of Tier-2 cities in the knowledge economy. Although the concept of digital infrastructure is considered a major leveler allowing the small cities to compete in the knowledge-based economy, there is a lack of empiric material on how digitalization of such infrastructure changes the capacity of innovations and entrepreneurial processes. The combination of university-industry firms and policy consistency is vital but under-researched, and little is known of ways in which the institutional connections determine the regional competitiveness. Additionally, despite the fact that cluster-led learning remains dominant, the shift towards more open and digitally networked innovation systems has been analyzed very little. The opportunities of social and sustainable innovation as sources of inclusive growth are also almost unexploited. Lastly, how knowledge spillovers are measured numerically or whether national initiatives such as Startup India or the National Innovation Index can be converted into measurable regional impacts is a major methodological and policy research gap because there is little available data on this area.

RESEARCH METHODOLOGY

The proposed study is a qualitative, multiple case study research to determine how Regional Innovation Systems (RIS) are transforming in the Tier-2 cities of India and how it is being used to further the knowledge economy. In her case study approach, she is able to conduct a context-specific, in-depth analysis of institutional processes, policy structures, and innovation connections that cannot be sufficiently understood with quantitative measures chosen on their own [23].

In line with the interpretivist paradigm, the research is aimed at explaining how and why regional actors-universities, firms, and governments-relate and produce outcomes of innovation [24]. The presence of diversity and imbalanced development of the regional innovation ecosystems in India makes this exploratory design especially suitable.

Research Objectives

The methodological framework is guided by the following objectives:

1. Examine the institutional and infrastructural foundations of regional innovation systems in selected Tier-2 Indian cities.
2. Explore how local governance, entrepreneurship policies, and educational institutions influence innovation capacity.
3. Identify the mechanisms through which knowledge creation, diffusion, and collaboration occur across regional actors.

The research uses mostly secondary sources of data which are the Government reports and indices such as India Innovation Index, (NITI Aayog), Startup India data portal and the reports on Smart Cities Mission. It will also use academic literature and policy documents related to the development of regional systems of innovation and entrepreneurship as well as the development of the knowledge economy [9]; [6].

The data and information will be incorporated into economic and innovation indicators that are provided through other databases such as Department for Promotion of Industry and Internal Trade (DPIIT), CMIE and World Bank Enterprise Surveys. The qualitative inputs provide depth and down-to-earth perspectives of the operation of innovation ecosystems in new circumstances.

The study uses the purposive sampling method to choose six representative Tier-2 cities, that is, Pune, Coimbatore, Bhubaneswar, Ahmedabad, Kochi, and Chandigarh, according to their rising importance in the Indian innovation environment and their specific economic priorities.

- Pune represents a technology- and education-led innovation ecosystem.
- Coimbatore illustrates a manufacturing and engineering cluster.
- Bhubaneswar showcases a policy- and digital governance-driven model.
- Ahmedabad reflects design, management, and financial innovation.
- Kochi demonstrates maritime and IT convergence.
- Chandigarh highlights government-supported and service-oriented innovation.

These instances were selected so that it has geographical diversity, sector diversification, and institutional heterogeneity, which gives an all-inclusive view of how regional innovation systems operate in the mid-sized cities of India.

Thematic and comparative analytical framework is employed to analyze data. Within-case analysis Each of the cities has analyzed it separately and defined its institutional structure, drivers of innovation and policy enablers. Under Cross-case comparison themes in cases have been compared in order to determine patterns and contrasts. Results will be synthesis of results to a set of combined information to develop a typology of Tier-2 regional innovation systems in India. The conceptual framework used in analysis is the Regional Innovation Systems (RIS) and Triple Helix models which concentrate on the relationship between academia, industry and government as the main actors of innovation. Data triangulation is applied to secure the research validity and reliability by cross-validating the results of various sources- academic papers, policy reports, and the views of the stakeholders. Credibility is increased by the utilization of well-documented and transparent sources of data.

In any interview held, ethics are upheld by proper referencing of information and professional handling of data as well as upholding the confidentiality of the participants.

ANALYSIS AND RESULT

The qualitative study used both open and axial codes to identify the important patterns that defined the regional system of innovation in the Tier-2 cities in India. Using open coding, more than 120 documents were identified such as NITI Aayog India Innovation Index (2023) [25], DPIIT Startup India Portal (2024), MSME Annual Report (2023), and the state level policy documents and report. These sources of data proved to be a broad base of studying the institutional, industrial, and policy aspects of local innovation ecosystems. These themes were subsequently coded in the axis and then aggregated into five analytical themes, including institutional infrastructure, innovation drivers, policy enablers, collaboration networks, and ecosystem outcomes, which created a structured data matrix compiled using NVivo 14 and validated by cross-checking.

TABLE 1: DATA ORGANIZATION AND CODING

City	Coding focus	Key Institutions	Dominant Innovation Driver	State-Level Policies	Outcomes	Challenges	Supporting Data
Pune	IISER–Tata Motors joint R&D on materials engineering.	IISER Pune, Symbiosis Innovation Centre, Venture Center (CSIR-NCL)	Automotive & IT clusters (Hinjewadi Phase III SEZ), strong STEM graduate output	Maharashtra Innovation Society Policy (2023) – Pune	Highest Tier-2 start-up density (3,200+), high patent filings (72 in 2023)	Infrastructure strain, talent competition	DPIIT Startup India Database 2024; NASSCOM Report 2023
Coimbatore	Coimbatore: PSG Tech–L&T automation training MoU (2022).	PSG College of Technology Innovation Cell, TIDEL Park Coimbatore	Textile & machinery clusters, 4000+ SMEs adopting automation	TANSIM Startup Policy (2023) – Coimbatore	Rising SME innovation adoption (25% growth 2020-24)	Limited venture capital access	MSME Cluster Atlas 2023; SIDBI Cluster Study 2024
Bhubaneswar	Bhubaneswar: KIIT TBI–	IIT Bhubaneswar Research	Digital governance, smart	Startup Odisha (2023) –	Ranked 9th in India Innovation	Dependence on	Smart Cities Mission

	MSME Technology Centre joint incubation (2023).	Park, KIIT TBI Incubator	city ICT infrastructure	Bhubaneswar	Index (2023)	public funding	Progress Report 2023
Ahmedabad	Ahmedabad: IIMA–GIFT City collaboration on fintech policy labs (2024).	IIMA Centre for Innovation Incubation & Entrepreneurship (CIIE.CO), NID Design Innovation Hub	Fintech and design innovation at GIFT City	Startup Gujarat (2023) – Ahmedabad	Strong design innovation ecosystem (NID projects ↑ 30%)	Early-stage funding gaps	GIFT IFSC Annual Review 2024
Kochi	Kochi: KSUM–Cochin Port Trust partnership on marine tech innovation (2023).	Kerala Startup Mission (KSUM), Maker Village, Cochin Infopark	Blue-economy and IT convergence (maritime logistics, Infopark exports)	Kerala Startup Mission (2024) – Kochi	Kerala Startup Mission hosts 4,000+ start-ups (2024)	Fragmented sectoral coordination	Kerala Maritime Board Report 2023
Chandigarh	Chandigarh: PEC–Chandigarh Administration Smart City Innovation Hub (2023).	Punjab Engineering College Innovation Hub, IEDC Chandigarh Administration	Knowledge services and e-governance platforms	Chandigarh Innovation Policy (2022) – Chandigarh	High e-governance readiness score (0.82 index)	Weak industrial base for R&D	Chandigarh Smart City Limited (2024)

The coded data were interpreted to obtain some patterns that were consistent. Tier-2 cities are characterized by high rates of academic-incubator connections, which emphasizes the development of university-based ecosystems of innovation according to Triple Helix. The innovation path of each city embodies the evolution of each city, which is a path-dependent process of integrating the traditional industrial advantages with the digital. Also, non-centralized yet consistent policy structures, including state startup missions and local innovation councils, are also instrumental in making regional innovation and enhancing government-industry cooperation. It is also indicated by the findings that cross-sectoral linkages are on the rise, which is an indication of the maturity and integration of these urban innovation systems.

Regardless of these improvements, a systematic review of the literature found that there were still structural problems unique to the ecosystems, such as the lack of funding, poor network connectivity, and an uneven participation of the private sector. In general, this systematic coding procedure will provide the comparative analysis of the Tier-2 cities in India with empirical foundations and theoretically sound in relation to the Regional Innovation Systems (RIS) framework.

Case Analysis

Every city is examined as an independent case provides institutional structure, driving forces of innovations, and policy engines based on Triple Helix model. The review is centered on the mapping of its institutional structure, the sources of innovation peculiar to it, and the evaluation of the efficiency of local and state policies.

Each city is prepared as narrative summaries and thematic charts to emphasize the interaction between academia, industry, and government - the three components of the Triple Helix model. This procedure will provide the stability of contextual grounding of every case to be passed to cross-case synthesis.

Pune: Institutional setup: There are more than 200 higher-education institutions in Pune, such as IISER, Symbiosis international university, and the Venture Center by CSIR-NCL, one of the top deep-tech incubators in India [26]. It is located in the Hinjewadi IT Park (Rajiv Gandhi Infotech Park) where 300+ IT and R&D companies are based including

Infosys, TCS, and Cognizant. The Tata Motors/Mahindra automotive and EV cluster is growing according to Maharashtra EV Policy 2023. Backed by Maharashtra Innovation Society (MIS) and Pune Smart City Mission (2024) that encourage data-driven urban innovation. Close university-industry collaboration in research and development and government support via MIS grants have made Pune the leading Tier-2 innovation hub in India [27].

Coimbatore: PSG College of Technology, Amrita Vishwa Vidyapeetham, and TIDEL Park Coimbatore are anchored, and 120 more start-ups are hosted (TANSIM, 2024). It is the parts of textile machinery and engineering, and it has contributed 6% of the MSME production in India [28]. The study of SIDBI Cluster Study, 2024, states that the increased use of Industry 4.0 technologies by local SMEs. Start-ups in technology and manufacturing Tech-manufacturing seed funding of up to Rs.15 lakh is provided by Tamil Nadu Startup and Innovation Mission (TANSIM, 2023). All of these give PSG Tech and L&T good connections when it comes to automation R&D; the state government is the facilitator with innovation vouchers and cluster modernization.

Bhubaneswar: IIT Bhubaneswar, KIIT University and KIIT-TBI are considered core institutions; there is an incubator, the Atal Innovation Mission, which gives the knowledge economy considerable institutional strength. City was also the 2nd Smart City in e-governance preparedness with emerging GovTech and digital governance hub (MoHUA, 2023). Startup Odisha Policy 2023 is one of the policy mechanisms that supports up to 1,500 start-ups; Odisha Skill Vision 2030 aims at ICTs and biotech [29]. The IIT-Bhubaneswar works with the state IT Department regarding the technologies of IoT to manage the city. Academia-industry participation in the development of digital infrastructure is motivated by government incentives.

Ahmedabad: The knowledge economy of Ahmedabad has a good institutional base that is offered by innovation network headed by IIM Ahmedabad (CIIE.CO), National Institute of Design (NID) and Gujarat University Start-up and Entrepreneurship Council (GUSEC). The city of Ahmedabad is a design-management-fintech innovation center, where GIFT City IFSC is home to 400+ fintech and regulatory-tech companies [30].

There are policy mechanisms such as Startup Gujarat Policy 2023 that offers up to Rs. 30 lakh innovation grants; Gujarat Industrial Policy 2020 that deals with digital manufacturing. CIIE.CO collaborates with IIMA and the Government of Gujarat on start-up finances; NID with industry on design innovation in production.

Kochi: 4,000+ registered start-ups are managed by the Kerala Startup Mission (KSUM Dashboard, 2024). The other anchors are Maker Village and Cochin University of Science and Technology (CUSAT) provides an institutional base. Kochi is an innovation hub based on the blue-economy, which combines maritime logistics, fisheries, and IT. Cochin Infopark is home to 450+ technology companies that produce Rs. 8,000+ crore per year of exports [31].

Policy tools Kerala Startup Policy (2024) focuses on sustainable technologies and circular innovation; with the backing of K-DISC and Smart City Kochi. One example of such academia-industry-policy synergy is the Ocean Tech Accelerator run by KSUM and CUSAT with the government.

Chandigarh: The city has a foundation of institutional hub in Chandigarh which is equipped by the Punjab Engineering College (PEC), Post Graduate Institute of Medical Education and Research (PGIMER) and the Innovation and Entrepreneurship Development Centre (IEDC). Dedicated to e-governance, health-tech, and databased services, and with Chandigarh Smart City Limited (2024) as the digital urban project leader. Chandigarh Innovation and Start-up Policy (2022) provide start-up grants and mentoring services to local entrepreneurs. PEC has been working on smart traffic systems and solar energy systems with the administration, and research and governance have been integrated effectively.

The comparative case study found similar and differences patterns in their regional innovation systems (RIS). This discussion discusses the interactions between institutional structures, the drivers of innovations, policy frameworks and inter-sectoral partnerships within the knowledge economy of each city to correlate with a Triple Helix model of medications between academia-industry-governmental synergy.

TABLE 2: CROSS-CASE COMPARATIVE MATRIX

Analytical Dimension	**Pune**	**Coimbatore**	**Bhubaneswar**	**Ahmedabad**	**Kochi**	**Chandigarh**
Dominant Innovation Type	Technology-led, diversified	Cluster-based manufacturing	Cluster-based digital governance	Technology-led design & fintech	Policy-driven sustainability & blue economy	Policy-driven governance & e-services
Institutional Anchors	IISER, Symbiosis, CSIR-NCL Venture Center	PSG Tech, Amrita, TIDEL Park	IIT Bhubaneswar, KIIT-TBI	IIM Ahmedabad, NID, GUSEC	CUSAT, KSUM, Maker Village	PEC, PGIMER, IEDC

Industrial Base / Innovation Drivers	Automotive, IT, EV, R&D	Textile, engineering, automation	ICT, e-governance, smart infrastructure	Design, fintech, manufacturing 4.0	Maritime, ICT, sustainability tech	Governance, health-tech, digital services
Key Government Policies	Maharashtra Innovation Society, Smart City Mission	TANSIM Startup Policy, TN Industrial Policy	Startup Odisha 2023, Skill Vision 2030	Startup Gujarat 2023, Industrial Policy 2020	Kerala Startup Policy 2024, K-DISC	Chandigarh Startup & Innovation Policy 2022
Start-up Density (2024)	~3,200+ (DPIIT)	~1,200+ (TANSIM)	~1,500+ (Startup Odisha)	~2,800+ (Startup Gujarat)	~4,000+ (KSUM)	~600+ (Chandigarh Admin)
R&D / University–Industry Collaboration	High (Tata Motors–IISER, NCL–BASF)	Moderate (PSG Tech–L&T)	Moderate (IIT–Odisha IT Dept)	High (IIMA–GIFT City–Govt partnerships)	Emerging (CUSAT–Port Trust–KSUM)	Emerging (PEC–Smart City Projects)
Triple Helix Maturity	High (balanced academia–industry–policy integration)	Medium (industry and academia strong; policy catching up)	Medium (policy-driven; industry engagement rising)	High (strong academic and policy synergy)	Moderate (government-led; industry engagement developing)	Low–Moderate (government-dominated model)
Policy Enablers	Grants, incubation networks, R&D tax support	Cluster modernization, industrial R&D incentives	Digital infrastructure, skill and ICT training	Startup financing, design innovation labs	Sustainability incubation, ocean-tech funding	Smart City funding, civic innovation labs
Ecosystem Outcomes (2023–24)	72 patents filed; ₹1,500+ Cr startup funding	25% SME innovation growth	Ranked 9th in India Innovation Index	400+ fintech start-ups; 30% design innovation growth	4,000+ start-ups; 40+ social innovation projects	Top 10 in e-governance index; 120+ smart tech projects
Challenges	Talent competition, sustainability issues	Limited VC access, R&D funding	Dependence on public programs	Early-stage funding gaps	Fragmented coordination, scale-up constraints	Weak industrial base, low private R&D
Innovation Ecosystem Typology	Technology-led System	Cluster-based System	Cluster-based System	Technology-led System	Policy-driven System	Policy-driven System

Institutions are the most important pillars of the Triple Helix model because academic institutions remain the main bases of innovation systems in all six cities. Pune and Ahmedabad are knowledge-intensive innovation ecosystems that are globalized in their linkages whereas Coimbatore and Bhubaneswar are the ecosystems associated with capacity-building that is concerned with local industrial modernization. Kochi and Chandigarh are new policy-oriented ecosystems, in which the weak depth of industrialization is paid by the public institutions.

Each city has its own sectoral trajectories that are individual to RIS. The drivers of innovation in Sterling and Washington cities are still path-dependent, i.e. they are based on the old industries, and they selectively adopt digital and sustainability-related technologies. Pune and Ahmedabad are highly diversified in terms of their sectors, whereas Coimbatore and Bhubaneswar are shifting their focus towards traditional industry to a knowledge-based industry.

All six cities also have a multi-level policy alignment that involves combining national schemes like Startup India, Atal Innovation Mission, Smart Cities Mission with state schemes. Maharashtra and Gujarat portray institutional maturity and good inter-agency coordination whereas Odisha and Kerala demonstrate government-led innovation, but lacked the scaling of the same by the private sector. The ecosystem in Chandigarh is government-contained and needs more involvement of venture capital.

The trends in cooperation between academia, industry and the government promote differences in the level of Triple Helix maturity. Collaboration network density is associated with ecosystem performance. More innovation resilient cities (Pune, Ahmedabad) have more industrial and academic actors and government-focused ecosystems (Chandigarh, Kochi) need more integration of the private sector. Quantitative results indicate good developments but ecosystem-related limitations. Every city experience funding shortage, network gaps and brain drain to metros. Specifically, Coimbatore and Bhubaneswar should consider deepening venture capital; Kochi and Chandigarh have to consider trying to make the institutions more aligned with each other, whereas Pune and Ahmedabad must tackle the issue of urban infrastructure and sustainability in connection with the rapid rise of innovation.

Thematic Synthesis and Typology Construction

Based on the within-case and cross-case studies of six Tier-2 cities this synthesis recognizes three thematic axes of the major themes influencing regional innovation in the emerging knowledge economy in India. They are (1) Dominant Innovation Drivers that consists of sectoral and technological specializations that drive regional competitiveness; (2) Institutional Maturity that consists of the depth and strength of the academic -industry-government relationships (Triple Helix); and (3) Network Density that is the level of interaction among actors, cluster, and policy platforms of the innovation system. Through these systematic blending the synthesis creates a comparative typology by classifying Tier-2 cities into Technology-led Systems, Cluster-based Systems and Policy-driven Systems.

TABLE 3: COMPARATIVE TYPOLOGY OF TIER-2 INNOVATION SYSTEMS

Typology	**Representative Cities**	**Dominant Innovation Drivers**	**Institutional Maturity**	**Network Density**	**RIS/Triple Helix Configuration**
Technology-Led Innovation Systems	Pune, Ahmedabad	Advanced technology, R&D, fintech, design innovation	High - well-integrated academia–industry–government linkages	Dense, multi-sectoral	Balanced Triple Helix; strong private R&D and academic anchors
Cluster-Based Innovation Systems	Coimbatore, Bhubaneswar	Industrial modernization, digital governance, automation	Medium - institutional growth with selective collaboration	Moderate; cluster-specific	Evolving Triple Helix; strong industrial heritage with emerging policy support
Policy-Driven Innovation Systems	Kochi, Chandigarh	Social innovation, sustainability, governance-led entrepreneurship	Emerging - government-dominant ecosystems	Fragmented but expanding	Policy-led Triple Helix; state-driven coordination with limited private-sector participation

The cities of Tier-2 have different innovation patterns due to historical inclinations to industry and new digital capabilities. The typology indicates that Tier-2 cities in India are not homogenous systems of innovation but they are instead differentiated ecosystems that represent diverse phases of institutional and technological development. The systems dominated by technology are the sources of innovation possessing international competitiveness and developed infrastructure of knowledge. The transition of ecosystems to modernization by means of policy reform and digitalization is happening via cluster-based systems. Systems that are policy-led are inclusive innovation systems which focus on sustainability, civic technology and social entrepreneurship.

Hypothetically, such arrangements show that RIS has had a localized development in the context of the multi-scalar governance of India. The Triple Helix model, which was initially designed with innovative economies that are mature, is adapted in Triple Helix in the Tier-2 cities in India, where the role of universities and state agencies tends to replace the weaker market forces.

The thematic synthesis offers additional information to the insights of mediation by regional contexts in innovation processes in emerging economies. It has provided a comparative typology, which may be borrowed by policy makers and scholars for the purpose of benchmarking and improving innovation capacity. It provides an empirical support to situational adaptability of RIS theory to decentralized systems of governance like federal innovation system in India.

It focuses on the triumvirate of institutional maturity, network connectivity, and technological specialization as the hallmark of Tier-2 innovation ecosystems.

The synthesis is corroborated by the fact that Tier-2 cities in India are turning in to vibrant innovation hubs that, in one way, form transitional zones between metropolitan and peripheral innovation environments. Their success largely relies not only on investment in technology but also on institutional coherence, connection cross-sectoral and adaptable policy frameworks.

By so doing, these cities help to exemplify how RIS develop along differentiated routes -technological, industrial, and policy-based-within the general framework of the knowledge economy in India

Validation and Triangulation

The methodological integrity of the study requires the assurance of the credibility and strength of findings. Multi-source validation approach is required due to the heterogeneity of Tier-2 innovation ecosystems - which encompasses the technology, policy and institutional networks. Thus, the present study takes a multi-layered triangulation scheme that has three main validation elements. It collected and triangulated data based on four categories of sources that were different but related:

Source Type	Examples and Datasets Used	Validation Purpose
Academic Literature	Peer-reviewed papers on Regional Innovation Systems (RIS) and Triple Helix models	Establishes theoretical foundation and comparative benchmarks
Policy Documents	Startup India (DPIIT, 2024), NITI Aayog India Innovation Index (2023), Atal Innovation Mission Reports (2023)	Validates policy environment, regional program design, and governance models
Government & Institutional Databases	KSUM Dashboard (2024), Startup Odisha Portal (2024), Maharashtra Innovation Society Reports (2023), GIFT IFSC Review (2024)	Provides verified data on start-up density, investment flow, and sectoral specialization
Stakeholder Perspectives	Semi-structured interviews and secondary case documentation from incubator heads, government officers, and entrepreneurs (via published proceedings and reports)	Offers qualitative insight on ecosystem functionality and policy effectiveness

With the multi-source triangulation, overlaps of finding were verified (convergent validity), and some form of conflicting data points were closely examined to evaluate contextual, time interval of data collection, and variability in definition. Thematic coding guaranteed internal consistency as it used similar measures of analysis.

The emerging patterns were cross-validated by cross-case synthesis based on contrastive analysis to ensure that emerging typologies (technology-led, cluster-based, policy-driven) were not based on ad hoc empirical evidence. Thematic findings were cross-checked using comparable data on policy and institutional reports, which enhances construct validity. In order to grasp dynamics in policies and innovations, data and reports of 2020-2024 were analyzed. This sequential overlay will guarantee that discoveries will capture the current policy changes, including the recent 2023 revision of the India Innovation Index that places sustainability measurements. Creativity in the 2024 Startup India data on Tier-2 city start-up density.

The addition of gender and social inclusion indicators in the KSUM and the Startup Gujarat dashboard. The cross-temporal verification of these minimizes time bias and makes the results of the study consistent with the latest status of the knowledge economy of India.

Triangulation process strengthened three major findings with high confidence. The strength of the three-level typology - technology-led, cluster-based, and policy-driven systems were validated through convergent validation. These relationships were centralized around university-industry linkages and state policy regimes and substantiated the centrality of these factors as the most important facilitators of innovation in Tier-2 cities. The observation of the variation between cities was confirmed by contextual validation that did not indicate that these variations are a result of data inconsistency effects.

By conducting systematic data triangulation, cross-source validation, and documenting in an open way, this study has high empirical reliability and interpretive validity. The agreement in the findings of scholarly, policy, and institutional spheres not only improves the validity of the typology but also makes it more significant in the work of the policy maker.

DISCUSSION AND POLICY IMPLICATIONS

The six Tier-2 city analysis of Pune, Coimbatore, Bhubaneswar, Ahmedabad, Kochi, Chandigarh shows that the regional innovation systems (RIS) are developing in different but parallel ways in India. The results indicate that these cities cease to be marginal economic entities, but they turn out to be important centers of the Indian knowledge economy. The institutional reform, digitalization, and the innovation of policies are the factors that lead to their

transformation and being the basis of the appearance of the new urban innovation networks. The developmental processes of every city are characterized by its associated historical industrialization, maturity of the institutions and the ability to merge with the larger national system of innovation.

The discussion identifies three major types of regional innovation strategies, namely technology-based, cluster-based, and policy-based systems. Pune and Ahmedabad are the mature, technology-based ecosystems with diversified R&D, and good academic affiliations and international relations with the industry. Coimbatore and Bhubaneswar are in the form of cluster-based systems that are transforming the old areas like manufacturing and textiles with digitalization and industrial automation. Kochi and Chandigarh, however, have policy-based systems in which innovation is organized mainly through state-based efforts that target social entrepreneurship, governance and sustainability. These divergent ways of moving insist on the idea of path dependency in the history of RIS theory- where regional history and current competencies influence the direction and character of innovation.

In these eco systems, the Triple Helix model, which focuses on the partnership of academia, industry and government, is an efficient analytical tool. The research concludes that in such cities where Triple Helix relationships are balanced and institutionalized, i.e., Pune and Ahmedabad, the extent of innovation, patenting, and start-up growth are higher. Conversely, municipalities in which the government has continued to be the major force in innovation, including Kochi and Chandigarh, have the slower involvement of the private sector and lower commercialization of R&D. The intermediate position is held by Coimbatore and Bhubaneswar, which have both an increasing network of academic and industry, but asymmetrical policy support. These differences highlight the importance of the maturity and density of collaboration networks as important factors of RIS performance and innovation results.

Nevertheless, the research report indicates that some challenges remain prevalent throughout Tier-2 ecosystems. Some of the most crucial ones are funding gaps since venture capital is still clustered in the metropolitan centers leaving other cities with no alternative but to rely on public funding or grant based mechanisms. The Tier-1 cities also reduce the ability to retain talent and entrepreneurs when they are migrating to firms based in those cities. Moreover, fragmentation and network structure creates barriers to knowledge spillovers between clusters, and asymmetry in the policies across the states creates unequal capacities to innovate. To overcome such gaps, special interventions need to be taken beyond national policies in place and instead, place-based, and context-sensitive approaches must be taken based on regional capability and institutional willingness.

Policymaking On the policy side, a number of policy recommendations can be drawn out of this study. In the first place, one should focus on the development of Regional Innovation Compacts (RICs) in order to formalize the cooperation between universities, industries, and governments at the city level. These multi-stakeholder organizations would work as coordination platforms aligning local innovation priorities with national missions like Start up India and Atal Innovation Mission. Second, to mitigate funding inequity, the innovation funding should be established at Tier-2 by setting up Tier-2 Innovation Funds- jointly funded by both government and non-government organizations to scale-up early-stage start-ups and eliminate regional inequities in investment. Tax subsidies and co-investment plan of the incentive programs to venture capital firms to invest in Tier-2 ecosystems would further enhance regional financial ecosystems.

Third, universities need to change into entrepreneurial universities that are actively involved in applied research, incubation, and technology transfer as opposed to being teaching institutions. Academic-industry partnership can be fostered further through the development of industry advisory boards, innovation fellowships and joint IP frameworks. Fourth, innovative principles should be made a priority in the policy. Cities like Kochi and Chandigarh can be the pioneers of sustainability-driven innovation laboratories concerning climate technology, solutions centered on the circular economy, and civic technology. By aligning the local innovation strategies with the UN Sustainable Development Goals (SDGs), there would be improved international collaboration and boost impact-oriented investment.

Lastly, policymakers are advisable to facilitate inter-city innovation corridors between complementary Tier-2 ecosystems. An example of this would be a Pune-Ahmedabad-Coimbatore network specializing in advanced manufacturing and design innovation, and Bhubaneswar-Kochi-Chandigarh network specializing in digital governance and sustainability innovation. These partnerships would help in the flow of knowledge across the region, talent pool, and joint ventures, which would enhance the distributed innovation of India. In addition, instituting a standardized system of monitoring through the India Innovation Index to determine the density of collaboration, start-up survival, and patent activity would institutionalize accountability and promote evidence-based policymaking.

In principle, the research applies the RIS and Triple Helix models to the Indian experience and demonstrates the mediating role of the governance system and institutional flexibility in the process of innovation of regions rather than the technological capability itself. As a matter of fact, it provides policymakers with a differentiated typology to formulate specific interventions. The ecosystems involving technology demand the need to incorporate technology globally and incentive to research and development; cluster-based systems demand the establishment of digital

infrastructure and the modernization of SME; policy-driven systems should concentrate on increasing the involvement of the privates and the freedom of the entrepreneurs.

To conclude, the Tier-2 cities in India are at the beginning of the transformation era where the innovations in the region are becoming more decentralized, all-encompassing, and participative. These cities can fill the gap between national innovation ambitions and realities in the region by utilizing institutional synergies, promoting inter-city linkages, and investing in localized innovation capacity. They should be reinforced by adopting adaptive evidence-based policy architecture, in order to make the process of India embracing a knowledge-based economy equitable and sustainable.

CONCLUSION

This paper addressed the development of the Tier-2 cities in India as emerging centers of the knowledge economy in the country using the concepts of the Regional Innovation Systems (RIS) and the Triple Helix concepts. The results show that although every city has a specific developmental path, they are all in the process of transforming an industrial society into a knowledge economy, which is institutional capacity, policy consistency, and digital inclusion. Ecosystems that are technology intensive like Pune and Ahmedabad have high levels of academic-industry connectivity and global connection, whereas cluster-based systems such as Coimbatore and Bhubaneswar are modernizing conventional industries. Kochi and Chandigarh are policy-oriented ecosystems that are based on extensive coordination by the state and social innovation.

The research points out that the maturity of Triple Helix interactions- the institution, industry, government balance is a critical driver on the performance of innovation. The policy implications focus on the importance of regional innovation compacts, enhanced access to venture capital and fostering entrepreneurial universities in improving institutional collaboration. There are however limitations to the research. The qualitative, case-based design that is rich in the contextual depth does not allow generalizability in the diverse regions of India. The analysis is also based on secondary data and policy documents which are potentially underrepresenting informal innovation, or current dynamics in the private sector. The future studies ought to use longitudinal and network-based approaches to quantify knowledge flows and inter-city connections in a more accurate manner.

In general, the Tier-2 cities in India are becoming the main drivers of inclusive and sustainable development. The formation of their innovation ecosystems by making place-based policies and collaborative governance will be the key to the further development of the transition of India to the distributed and resilient knowledge economy.

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