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Healthcare Ecosystem Innovation in Emerging Smart Cities: Co-Opetition and Public-Private Partnerships in Ranchi District

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Abstract

Transforming urban healthcare is now central to building smart cities, especially in emerging economies where rapid urbanization puts real pressure on health infrastructure and service delivery. Ranchi District chosen under India's Smart Cities Mission offers a striking case to explore how innovation in the healthcare ecosystem emerges when public institutions, private hospitals, tech companies, academic groups, and civil society work together through collaborative governance. This study looks closely at the influence of co-opetition which blends cooperation and competition among healthcare players and at Public-Private Partnerships (PPPs) in driving innovation, improving access, boosting operational efficiency, and shaping patient-centered healthcare in Ranchi's evolving smart city landscape.

Using concepts from ecosystem innovation, collaborative governance, co-opetition, stakeholder theory, and smart city development, the study puts forward a conceptual framework that connects co-opetition strategies and PPP effectiveness with outcomes in healthcare ecosystem innovation. The research lays out a quantitative, explanatory design using a structured questionnaire. This survey goes to representatives from government hospitals, private clinics, diagnostic labs, healthcare startups, insurance companies, technology firms, and public health agencies operating across Ranchi District. Structural Equation Modeling (SEM) is used to map the links between institutional collaboration, sharing knowledge, integrating digital health tools, aligning resources, supporting policy, healthcare innovation capacity, and overall service performance.

The study asserts that true co-opetition pushes organizations to build digital health systems, telemedicine, healthcare analytics, emergency response networks, and launch medical research projects together while also keeping market competition that spurs new ideas and better quality. Alongside this, strong PPPs fund infrastructure, enable technology adoption, mobilize resources, and make governance more efficient, which in turn boosts healthcare resilience and supports sustainable urban growth. The study expects to show that collaborative healthcare structures lead to measurable gains in access, efficiency, innovation, patient satisfaction, and resilience for new smart cities.

This research makes a distinct contribution to studies on healthcare ecosystem innovation by bringing together the lenses of co-opetition and PPPs within the context of smart cities in a fast-changing Indian district. It also gives solid, practical recommendations for policymakers, healthcare managers, urban planners, and private healthcare operators aiming to create resilient, tech-driven, and inclusive health systems that line up with India's Smart Cities Mission and the Sustainable Development Goal 3: Good Health and Well-being.

Keywords: Healthcare Ecosystem Innovation; Smart Cities; Co-opetition; Public-Private Partnerships; Digital Health; Healthcare Collaboration; Urban Healthcare; Smart Healthcare; Healthcare Governance; Ranchi District.

1. Introduction

Healthcare systems everywhere are changing fast. They're being pushed by new technology, shifts in population, urban growth, and evolving disease patterns that are altering how people want and need care and how that care gets delivered. Cities now act as hotbeds of innovation, places where hospitals, tech firms, government,

universities, start-ups, and even regular citizens all play a role in building interconnected healthcare ecosystems that aim for efficiency, fairness, and long-term impact (World Health Organization [WHO], 2021). In places like India, this shift is accelerating. The country's digital strategies, investments in health infrastructure, and "smart city" programs all use digital tools to improve how cities work and how people live (Government of India, 2023).

But "smart city" is more than just throwing up new tech. It's about smarter governance, urban planning that looks ahead, services that keep working even in tough times, and fresh ideas driven by what citizens actually need. Healthcare sits right at the heart of smart city planning because the state of public health affects the economy, social inclusion, and whether cities can bounce back from shocks. Today's smart healthcare systems weave together artificial intelligence, the Internet of Things (IoT), cloud platforms, big data analytics, electronic health records (EHRs), geographic information systems (GIS), wearables, and telemedicine. All these tools aim to make care more accessible, efficient, and effective (Batty et al., 2012; Allam & Jones, 2020).

India's Smart Cities Mission, launched in 2015, highlights technology-led governance, better infrastructure, and public service upgrades in selected cities. Within this drive, Ranchi the capital of Jharkhand has become an essential healthcare hub, serving not just its own residents but also people from surrounding rural areas. The city has a patchwork of public hospitals, private multispecialty centers, medical colleges, diagnostic labs, pharmacies, community clinics, and a growing digital health network. But despite the progress, Ranchi still stumbles over challenging hurdles: uneven access to care, strained infrastructure, personnel shortages, fragmented services, big gaps between public and private healthcare, and rising demand as the population grows and disease patterns change (National Health Authority, 2023).

Overcoming these complex problems demands real collaboration. It's not enough for each organization to go it alone; the community needs an ecosystem where partners share knowledge, pool resources, and spark innovation together. This ecosystem mindset treats healthcare as a web of relationships, not a loose collection of standalone institutions. Here, innovation springs from the ongoing interaction between hospitals, government, pharma, insurers, universities, digital health startups, NGOs, and patients (Adner, 2017; Moore, 1993).

A critical driver in this process is "co-opetition" a strategy where organizations work together, even as they compete. Brandenburger and Nalebuff (1996) first described this idea: groups can create more value by collaborating, without losing the competitive edge that pushes them to perform. In healthcare, co-opetition could look like hospitals investing together in diagnostic tech, networking emergency services, setting up surveillance or training programs, or building telemedicine tools. Meanwhile, they still vie for patients, reputation, and quality. This shared approach saves resources, speeds up the spread of new ideas, and makes the system tougher in the face of crises like pandemics or disasters (Bengtsson & Kock, 2014).

On another front, Public-Private Partnerships (PPPs) matter too. These are long-term partnerships where government teams up with private players to fund, develop, and run healthcare services or infrastructure. They work because public bodies anchor accountability and set policy, while private partners contribute efficiency, capital, tech expertise, and innovative management (World Bank, 2022). PPPs in healthcare cover everything from building hospitals to setting up diagnostic centers, ambulances, telemedicine networks, medical education, insurance administration, digital systems, and specialized clinics.

India has poured resources into healthcare PPPs through programs like Ayushman Bharat, Health and Wellness Centre, the Ayushman Bharat Digital Mission (ABDM), and state-level partnerships, all aiming to make care more accessible and more digitally integrated. These projects encourage systems that talk to each other: digital records, teleconsultations, and joined-up healthcare delivery designs in line with smart city plans (National Health Authority, 2023). But PPP success hinges on good governance, clear rules, trust, risk sharing, everyone pulling in the same direction, and constant learning.

Bringing together co-opetition and PPPs unlocks new opportunities for the healthcare ecosystem to evolve by combining forces where it makes sense, keeping the impetus to stand out where needed. Hospitals, for instance, might build digital platforms together but still compete on care quality; tech companies may join up on basic systems yet differentiate with advanced solutions; governments can partner with the private sector to reach more

people without losing oversight or focus on fairness. In resource-constrained smart cities, strategic collaboration across sectors becomes indispensable.

Ranchi offers a valuable test case. As Jharkhand's administrative and economic engine, the city has expanded quickly, faces surging need, and has ramped up digital investments under the Smart Cities Mission. Major institutions like Rajendra Institute of Medical Sciences (RIMS), district and specialty hospitals, private hospitals, labs, telemedicine providers, and health tech companies now populate its healthcare landscape. Efforts to foster digital governance, smarter services, and new public service models shape the local environment for healthcare transformation.

Still, researchers have mostly looked at smart healthcare, innovation, PPPs, and co-opetition in isolation. Few studies have tackled how co-opetition and PPPs together drive healthcare ecosystem innovation in newer smart cities especially in places like Ranchi where district-level analysis is rare despite the city's growing importance in eastern India's healthcare scene. This study aims to fill those gaps. It builds and tests a framework linking co-opetition, PPP impact, digital health adoption, stakeholder collaboration, innovation capability, and overall healthcare ecosystem performance.

Beyond that, the research feeds into the larger conversation about how cities can develop sustainably. It shows how partnership-based healthcare governance boosts resilience against public health shocks, opens up access, raises care quality, and backs urban equity. By merging systems thinking with theories about collaborative governance and innovation, the study speaks directly to policymakers, healthcare managers, tech providers, and urban planners who want resilient healthcare systems for tomorrow's smart cities.

In the end, healthcare ecosystem innovation isn't just about buying new technology. It means real transformation: institutions working together, strategic partnerships, seamless digital systems, coordinated policies, and organizations committed to learning and adapting. It's these connections between co-opetition, PPPs, and ecosystem development that will build the kind of sustainable, inclusive healthcare systems India needs to support its fast-growing, digitally driven urban future.

2. Literature Review

2.1 Healthcare Ecosystem Innovation

Healthcare ecosystem innovation involves ongoing progress in healthcare services through the coordinated efforts of a wide range of stakeholders like healthcare providers, government agencies, tech companies, academic institutions, insurance firms, pharmaceutical companies, NGOs, and patients all play a role. Unlike traditional healthcare systems that operate in their own separate spheres, healthcare ecosystems focus on collaboration, sharing knowledge, integrating resources, and creating value together. The goal is to make healthcare more accessible, of higher quality, efficient, and sustainable (Adner, 2017).

The idea comes from Moore's (1993) view of business ecosystems, where organizations act as interconnected players whose evolution depends on working together and competing in strategic ways. In healthcare, this concept goes further by recognizing that good outcomes don't depend just on hospitals or doctors but on digital infrastructure, regulatory bodies, technology, community engagement, and coordinated policies all matter (Jacobides et al., 2018).

Lately, tools like Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, blockchain, wearables, telemedicine, robotics, and predictive analytics have turned healthcare ecosystems into digital networks capable of delivering personalized, data-driven care (Topol, 2019). Digital health platforms now let providers share information easily, coordinate on patient care, and avoid repeating the same medical services.

The World Health Organization (2021) reports that integrated healthcare ecosystems make healthcare more resilient by improving disease surveillance, emergency prep, patient tracking, and smart use of resources. During the COVID-19 crisis, countries with such digital systems handled healthcare delivery, tracked disease, and distributed resources much more efficiently (WHO, 2021).

In India, innovation in healthcare ecosystems has picked up speed through projects like Ayushman Bharat, the Ayushman Bharat Digital Mission (ABDM), the National Digital Health Blueprint, and the Smart Cities Mission. These programs push for digital records, teleconsultation, electronic prescriptions, and provider networks that can exchange information and work together (National Health Authority [NHA], 2023).

For new smart cities like Ranchi, ecosystem innovation relies on coordinated action between public hospitals, private providers, tech companies, research centers, startups, and municipal agencies. This sort of teamwork supports better healthcare decision-making and expands access for both city and peri-urban communities.

2.2 Smart Cities and Smart Healthcare

Smart cities are moving away from a purely technology-focus and toward models that put people first, emphasizing sustainability, resilience, inclusion, and quality of life (Batty et al., 2012). Smart cities use ICT, digital governance tools, AI, big data, and sensor networks to improve services like transport, education, public safety, energy, the environment, and healthcare.

Healthcare really stands at the center of smart city development since healthier populations boost productivity and social well-being directly. Smart healthcare means weaving digital technologies into health delivery: think preventive care, real-time monitoring, telemedicine, intelligent diagnostics, and care tailored to each person (Allam & Jones, 2020).

What's new with smart healthcare is the move from hospital-focused care to systems where patients are connected digitally and supported all the time through mobile apps, wearables, telemedicine, EHRs, and AI-supported tools (Topol, 2019).

Some researchers argue that smart healthcare strengthens city resilience by offering:

- Digital disease tracking
- Predictive analytics
- Smarter emergency response
- Remote care options
- Population health programs
- Better use of resources
- Greater health equity

Komninos (2020) adds that smart healthcare depends just as much on institutions working together on health providers, city governments, universities, companies, and civil society as it does on flashy technology.

Inside India's Smart Cities Mission, healthcare innovation is now tightly connected to digital governance projects like integrated control centers, health platforms, GIS-based emergency management, and portals for citizen services (Government of India, 2023). Ranchi Smart City makes a good example for studying how these efforts foster healthcare ecosystem innovation by encouraging collaboration across sectors.

2.3 Co-opetition Theory in Healthcare

Co-opetition means organizations both cooperate and compete at the same time and they work together for shared benefits but still strive to keep their edge in the market (Brandenburger & Nalebuff, 1996). Instead of seeing collaboration and competition as opposites, co-opetition theory shows that companies can create more value when they cooperate strategically while continuing to compete in quality, innovation, and market success.

Bengtsson and Kock (2014) sort co-opetition into strategic partnerships where organizations work together on research, technology, procurement, infrastructure, and sharing knowledge, but still compete for clients and operational excellence.

Examples in healthcare now include:

- Joint research projects

- Shared diagnostic labs
- Collaborative disease tracking
- Information exchanges
- Telemedicine partnerships
- Shared training programs
- Emergency systems

The COVID-19 pandemic made this clear, as hospitals worked together to share ICU beds, equipment, clinical knowledge, vaccines, and treatment approaches, while still trying to attract and serve patients (Ratten, 2020).

The research suggests that co-opetition fuels healthcare innovation by:

- Allowing knowledge exchange
- Cutting down risk
- Saving on costs
- Combining resources
- Spreading innovation
- Joint learning
- Speeding up technology adoption

But these collaborations also bring challenges by building trust, protecting intellectual property, managing information, avoiding opportunistic moves, and keeping coordination on track (Bouncken et al., 2021). Good governance is crucial to keep these partnerships working smoothly.

2.4 Public–Private Partnerships (PPPs) in Healthcare

Public–Private Partnerships (PPPs) are long-term contracts where government teams up with private organizations to fund, build, run, or manage public services and infrastructure (World Bank, 2022).

Healthcare PPPs have grown a lot in the last twenty years, driven by higher demand, tighter public budgets, the complexity of technology, and the need for expert skills. PPPs let governments tap into private investment, management know-how, innovation, and efficiency, while still keeping public oversight and accountability.

Common types of healthcare PPPs include:

- Building and running hospitals
- Diagnostic labs
- Telemedicine services
- Ambulance systems
- Buying medical equipment
- Administering health insurance
- Setting up digital health infrastructure
- Information systems for healthcare

The World Bank (2022) says PPPs help make healthcare more accessible, raise the quality of infrastructure and services, encourage upgrading technology, and ease financial pressure on governments.

In India, various programs have adopted PPP models like Ayushman Bharat, the Ayushman Bharat Digital Mission, National Health Mission, National Digital Health Blueprint, and hospital partnerships at the state level. These projects aim to bring in private players while strengthening public health through digital tools and updated infrastructure (NHA, 2023).

Of course, PPPs also face some hurdles:

- Unclear regulations
- Complex contracts

- Who takes on what risks
- Ensuring accountability
- Measuring performance
- Potential political meddling
- Making sure funding is stable

So, for success, PPPs need open governance, mutual trust, clear goals, and active engagement of everyone involved.

2.5 Digital Health Transformation and Innovation

Digital transformation has completely changed how healthcare works. Now, decisions rely on data, patient management is integrated, and care can be personalized. The blending of AI, machine learning, cloud computing, blockchain, IoT, robotics, and advanced analytics brings new ways to innovate in healthcare ecosystems (Topol, 2019).

Digital health tools drive improvement through:

- Electronic Health Records (EHRs)
- AI-powered diagnosis
- Predictive analytics
- Telemedicine
- Mobile health apps
- Remote monitoring
- Digital prescriptions
- Clinical support systems

AI systems help doctors find diseases early, analyze medical images, discover new drugs, plan personalized care, and run healthcare operations more efficiently (Davenport & Kalakota, 2019).

Blockchain adds to the picture by making data sharing more secure, preserving the integrity of medical records, and making supply chains more transparent (Agbo et al., 2019).

In smart cities, digital health platforms tie together hospitals, labs, pharmacies, insurers, and government agencies. The result: smarter healthcare ecosystems that can react quickly to new public health problems.

2.6 Stakeholder Collaboration in Healthcare Innovation

Innovation in healthcare more and more depends on different stakeholders joining forces. Each brings unique knowledge, skills, technology, and resources. Freeman's Stakeholder Theory (1984) argues that success comes from balancing all stakeholders' interests, not just chasing organizational goals.

Main players in healthcare ecosystems are:

- Government agencies
- Public and private hospitals
- Medical colleges
- Tech companies
- Insurers
- Pharmaceutical companies
- NGOs
- Startups
- Patients

When these groups work together, they can make joint decisions, share resources, exchange knowledge, transfer technology, coordinate policy, and spread new ideas.

According to Ansell and Gash (2008), collaborative governance leads to better policy rollout because it boosts trust, transparency, shared responsibility, and everyone's participation.

In fast-growing smart cities, this kind of collaborative approach is more important than ever. Issues in healthcare often outstrip what a single institution can handle. Closer collaboration strengthens resilience, sparks innovation, and improves the quality of care.

2.7 Healthcare Innovation in Emerging Smart Cities: The Ranchi Context

Ranchi District sits at a crossroads in eastern India's healthcare scene. It serves as the referral hub for many nearby districts while dealing with rapid urbanization, shifting demographics, and growing healthcare needs.

Healthcare here includes:

- Government hospitals
- Private multi-specialty hospitals
- Medical colleges
- Diagnostic labs
- Community clinics
- Telemedicine providers
- Digital health startups
- Public health agencies

The Ranchi Smart City project has kicked off a series of digital governance systems like smart urban management, control centers, GIS-based planning, and citizen-facing ICT services. These moves create good ground to link healthcare with other smart city infrastructure.

Despite the progress, Ranchi still faces major issues:

- Big gaps between urban and rural healthcare
- Not enough specialized professionals
- Fragmented delivery systems
- Health information systems not fully connected
- Infrastructure remains uneven
- Digital health adoption is patchy

Solving these problems means bringing government, private providers, tech firms, research bodies, and civil society together. Co-opetition and PPPs both offer frameworks to promote innovation, make the best use of resources, and build a more resilient healthcare system as Ranchi's smart city plans move ahead.

3. Theoretical Foundation

This study draws on five interconnected theoretical perspectives to shed light on how innovation emerges in healthcare ecosystems, especially within the context of rising smart cities.

3.1 Ecosystem Theory

Ecosystem Theory looks at innovation as the result of interaction among linked organizations that co-create value through collaboration, shared resources, and joint capabilities (Moore, 1993; Adner, 2017). In healthcare, hospitals, tech firms, government bodies, insurers, universities, and patients all form a web of healthcare ecosystem were working together boosts innovation and overall service performance.

3.2 Co-opetition Theory

Brandenburger and Nalebuff's (1996) Co-opetition Theory argues that organizations can work together to create value but compete to capture it. In healthcare, hospitals and related groups might join forces on things like digital infrastructure, research, emergency planning, and workforce development, yet still fight for superiority in clinical

quality, patient experience, and operational efficiency. These “co-opetitive” dynamics help drive innovation and strengthen the ecosystem as a whole.

3.3 Stakeholder Theory

Freeman's (1984) Stakeholder Theory underlines that organizations thrive when they balance the interests and contributions of multiple stakeholders. In a healthcare context, governments, providers, tech companies, insurers, universities, NGOs, and patients together shape innovation outcomes through their involvement, trust, and joint decision-making.

3.4 Collaborative Governance Theory

Ansell and Gash (2008) define collaborative governance as a process where public agencies and non-state actors make decisions together. This theory stresses the need for trust, shared goals, strong institutions, and consensus-building especially for putting healthcare PPPs into practice and managing co-opetitive relationships within smart city ecosystems.

3.5 Smart City Theory

Smart City Theory emphasizes weaving together digital technologies, sustainable infrastructure, and governance that centers on citizens, all to enhance urban services and quality of life (Batty et al., 2012). Within this view, smart healthcare is a key piece of the smart city puzzle, relying on digital innovation and collaboration across sectors to build resilient and inclusive healthcare systems.

Together, these theories offer a solid foundation for exploring how co-opetition and PPPs shape healthcare ecosystem innovation in Ranchi District.

4. Research Gap

Even as research into healthcare innovation, smart cities, co-opetition, and public–private partnerships has grown, we still see several clear gaps.

First, most prior work looks at co-opetition, PPPs, and healthcare innovation on their own. There’s been little effort to connect these ideas in a unified model. As a result, we lack a deep understanding of how both collaborative competition and institutional partnerships combine to shape innovation within healthcare ecosystems, especially in smart cities.

Second, most of the evidence we have comes from developed countries with different healthcare infrastructure, digital capabilities, and governance styles than emerging economies. There’s a shortage of studies focused on Indian smart cities, and research on Tier-II cities is even more limited.

Third, much of the literature zeroes in on the adoption of technologies like telemedicine, AI, IoT, electronic health records rather than on the organizational ties, governance frameworks, or stakeholder collaboration that actually make tech-enabled innovation possible.

Fourth, even as Ranchi rises as a healthcare hub under India’s Smart Cities Mission, research is lacking on how co-opetition among healthcare players and public–private partnerships spark system-wide innovation, service integration, and greater resilience across the healthcare ecosystem.

Finally, it’s rare for studies to look at the combined impacts of digital health integration, knowledge sharing, resource complementarity, and collaborative governance on healthcare ecosystem performance. Bridging these gaps will push the field forward by giving a fuller picture of collaborative healthcare innovation in the context of emerging smart cities.

5. Research Objectives

This study aims to explore how co-opetition and Public–Private Partnerships (PPPs) fuel healthcare ecosystem innovation in Ranchi District, a city shaping up under India’s Smart Cities Mission.

The research objectives are:

RO1: Examine how co-opetition among healthcare organizations influences innovation in the Ranchi healthcare ecosystem.

RO2: Evaluate how effective PPPs impact innovation within the healthcare ecosystem.

RO3: Assess how knowledge sharing among healthcare stakeholders affects healthcare ecosystem innovation.

RO4: Investigate how digital health integration shapes healthcare ecosystem innovation.

RO5: Study the effect of resource complementarity among healthcare stakeholders on ecosystem innovation.

RO6: Evaluate how healthcare ecosystem innovation impacts healthcare service performance.

RO7: Determine if healthcare ecosystem innovation mediates the relationship between co-opetition, PPP effectiveness, knowledge sharing, digital health integration, resource complementarity, and healthcare service performance.

6. Research Questions

The study seeks to answer these questions:

RQ1: How does co-opetition among healthcare organizations affect innovation in the healthcare ecosystem?

RQ2: What is the impact of effective PPPs on healthcare ecosystem innovation?

RQ3: In what ways does knowledge sharing drive healthcare ecosystem innovation?

RQ4: Does digital health integration significantly bolster healthcare ecosystem innovation?

RQ5: How does resource complementarity enhance healthcare ecosystem innovation?

RQ6: Does healthcare ecosystem innovation boost healthcare service performance?

RQ7: Does healthcare ecosystem innovation serve as a mediator between collaborative governance mechanisms and healthcare service performance?

7. Conceptual Background of the Variables

7.1 Co-opetition (COOP)

Co-opetition means organizations both cooperate and compete, working together to create shared value while remaining competitively independent (Brandenburger & Nalebuff, 1996). In healthcare, you see hospitals, labs, tech companies, pharmaceutical firms, insurers, and research centers teaming up on technology, medical research, or emergency planning, but still competing on quality, patient satisfaction, and efficiency.

Healthcare organizations involved in co-opetition benefit through:

- Joint innovation
- Shared infrastructure
- Collective learning
- Risk reduction
- Technology diffusion
- Knowledge exchange
- Greater resilience

So higher co-opetition tends to foster innovation across the whole ecosystem.

7.2 Public–Private Partnership Effectiveness (PPP)

PPP effectiveness reflects how well collaborations between public bodies and private organizations deliver healthcare services, infrastructure, innovation, and governance.

Effective PPPs show:

- Mutual trust
- Shared goals
- Transparent governance
- Smart resource allocation
- Risk-sharing
- Accountability
- Sustainability

Strong partnerships let organizations pool complementary expertise and financial resources, driving ecosystem innovation forward.

7.3 Knowledge Sharing (KS)

Knowledge sharing is the transfer of clinical insights, technical skills, organizational lessons, operational practices, and research findings between stakeholders in healthcare.

It drives innovation by supporting:

- Best practice transfer
- Clinical collaboration
- Medical research
- Organizational learning
- Innovation capacity
- Collective problem-solving

Ecosystems rich in knowledge exchange typically show greater innovation.

7.4 Digital Health Integration (DHI)

Digital Health Integration is all about organizations adopting and linking up digital tools and systems.

Examples include:

- Electronic Health Records (EHR)
- Artificial Intelligence
- Telemedicine
- Cloud computing
- IoT-enabled healthcare
- Big data analytics
- Mobile health apps
- Digital diagnostics

A connected digital infrastructure improves information flow, patient management, efficiency, and collaboration.

7.5 Resource Complementarity (RC)

Resource complementarity means organizations combine resources in ways that generate greater value than they could on their own.

Healthcare organizations offer complementary pieces like:

- Medical expertise
- Technology
- Facilities
- Investment

- Human talent
- Research capabilities
- Specialty services

According to the Resource-Based View (Barney, 1991), these complementarities boost a system's ability to innovate and compete.

7.6 Healthcare Ecosystem Innovation (HEI)

Healthcare ecosystem innovation captures the collective innovative capacity of a network of healthcare organizations.

Indicators include:

- New healthcare services
- Process innovation
- Digital innovation
- Collaborative innovation
- Patient-centered solutions
- Better healthcare access
- Operational gains
- System resilience

Innovation across the entire ecosystem becomes the engine for improved healthcare outcomes.

7.7 Healthcare Service Performance (HSP)

Healthcare service performance means how well the system delivers care, driven by innovation.

Key performance indicators:

- Patient satisfaction
- Access to services
- Clinical quality
- Operational efficiency
- Innovation success
- Response times
- Cost-effectiveness
- System resilience

8. Hypothesis Development

8.1 Co-opetition and Healthcare Ecosystem Innovation

Co-opetition helps healthcare organizations collaborate and compete at the same time. This dual approach builds shared learning, sparks technology breakthroughs, and ensures resources get used efficiently. Hospitals might work together on telemedicine or research, then compete to provide the best patient care. Previous studies show that co-opetition increases flexibility, innovation, and knowledge sharing (Brandenburger & Nalebuff, 1996; Bengtsson & Kock, 2014; Bouncken et al., 2021).

So:

- H1: Co-opetition positively and significantly affects Healthcare Ecosystem Innovation.

8.2 Public–Private Partnership Effectiveness and Healthcare Ecosystem Innovation

Effective PPPs drive infrastructure, spark adoption of technology, boost resource mobilization, and tighten institutional coordination. When public agencies and private providers work together, they expand healthcare

access and push innovation. Strong PPPs also help with digital health efforts and integrated care delivery (World Bank, 2022; NHA, 2023).

Therefore:

- H2: Public–Private Partnership effectiveness positively and significantly influences Healthcare Ecosystem Innovation.

8.3 Knowledge Sharing and Healthcare Ecosystem Innovation

Sharing know-how lets stakeholders trade clinical expertise, technical skills, and best practices. This collaborative approach kick-starts innovation, solves problems, and promotes evidence-based care. Organizations that champion knowledge sharing tend to adopt more innovative solutions (Nonaka & Takeuchi, 1995; Ratten, 2020).

Thus:

- H3: Knowledge Sharing positively and significantly shapes Healthcare Ecosystem Innovation.

8.4 Digital Health Integration and Healthcare Ecosystem Innovation

Digital tools improve how organizations coordinate, make clinical decisions, engage patients, and work together. When digital systems are fully integrated, you get better telemedicine, smarter diagnostics, accurate predictions, and smooth records management. All of this boost's innovation and care quality (Topol, 2019; Davenport & Kalakota, 2019).

So:

- H4: Digital Health Integration positively and significantly impacts Healthcare Ecosystem Innovation.

8.5 Resource Complementarity and Healthcare Ecosystem Innovation

When different organizations bring their unique strengths like skills, infrastructure, money together, everyone wins. This resource pooling lets healthcare providers, government, and tech firms achieve innovation that no single group could match (Barney, 1991; Adner, 2017).

As a result:

- H5: Resource Complementarity positively and significantly drives Healthcare Ecosystem Innovation.

8.6 Healthcare Ecosystem Innovation and Healthcare Service Performance

A more innovative healthcare ecosystem leads to better quality, greater access, higher efficiency, improved patient satisfaction, and overall resilience. Innovations enable care teams to coordinate better and handle new public health challenges more effectively (WHO, 2021; Jacobides et al., 2018).

Thus:

- H6: Healthcare Ecosystem Innovation positively and significantly affects Healthcare Service Performance.

8.7 Mediating Role of Healthcare Ecosystem Innovation

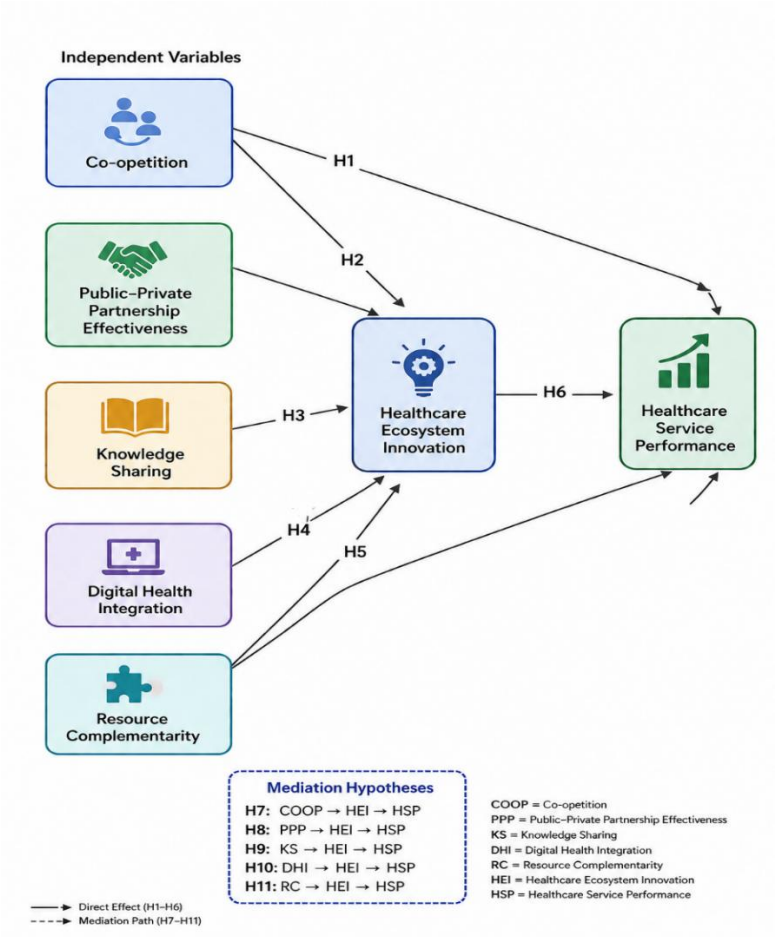
Research on ecosystems and collaborative governance shows that co-opetition, effective PPPs, knowledge sharing, digital integration, and resource complementarity don't improve service performance by themselves. Instead, they do it by making the ecosystem more innovative. Healthcare ecosystem innovation acts as the go-between that channels collaboration into real-world improvements.

So:

- H7: Healthcare Ecosystem Innovation positively mediates between Co-opetition and Healthcare Service Performance.

- H8: Healthcare Ecosystem Innovation positively mediates between Public–Private Partnership Effectiveness and Healthcare Service Performance.
- H9: Healthcare Ecosystem Innovation positively mediates between Knowledge Sharing and Healthcare Service Performance.
- H10: Healthcare Ecosystem Innovation positively mediates between Digital Health Integration and Healthcare Service Performance.
- H11: Healthcare Ecosystem Innovation positively mediates between Resource Complementarity and Healthcare Service Performance.

9. Proposed Conceptual Framework



10. Operational Definition of Variables

Variable	Definition	Key Indicators
Co-opetition (COOP)	Simultaneous cooperation and competition among healthcare stakeholders.	Joint initiatives, collaboration, competitive improvement, trust, innovation partnerships
Public–Private Partnership Effectiveness (PPP)	Effectiveness of collaborative arrangements between government and private healthcare organizations.	Governance quality, resource sharing, transparency, risk sharing, institutional support

Variable	Definition	Key Indicators
Knowledge Sharing (KS)	Exchange of healthcare knowledge, expertise, and best practices among ecosystem actors.	Information exchange, collaborative learning, communication, research collaboration
Digital Health Integration (DHI)	Extent of adoption and interoperability of digital health technologies.	EHR, AI, telemedicine, cloud systems, digital platforms
Resource Complementarity (RC)	Integration of complementary organizational resources for collaborative value creation.	Infrastructure, expertise, finance, technology, human resources
Healthcare Ecosystem Innovation (HEI)	Collective capability of the healthcare ecosystem to generate and implement innovative solutions.	Process innovation, service innovation, digital innovation, collaborative innovation
Healthcare Service Performance (HSP)	Overall effectiveness and quality of healthcare delivery.	Patient satisfaction, accessibility, efficiency, quality, resilience

11. Research Methodology

11.1 Research Philosophy

This study follows the positivist research philosophy, which treats social phenomena as things that we can measure and analyze objectively with empirical data and statistical tools. Positivism fits this research well because the goal is to test causal links between specific constructs—Co-opetition, Public–Private Partnership (PPP) Effectiveness, Knowledge Sharing, Digital Health Integration, Resource Complementarity, Healthcare Ecosystem Innovation, and Healthcare Service Performance—by examining hypotheses. The positivist approach prioritizes objectivity, reproducibility, and quantitative methods, aiming for findings that others can apply broadly (Saunders et al., 2019).

When you're looking at healthcare ecosystem innovation, you're dealing with organizational behaviors and institutional relationships you can actually measure with structured surveys. So, sticking with a positivist approach creates a solid foundation for testing theoretical relationships in the context of Ranchi District.

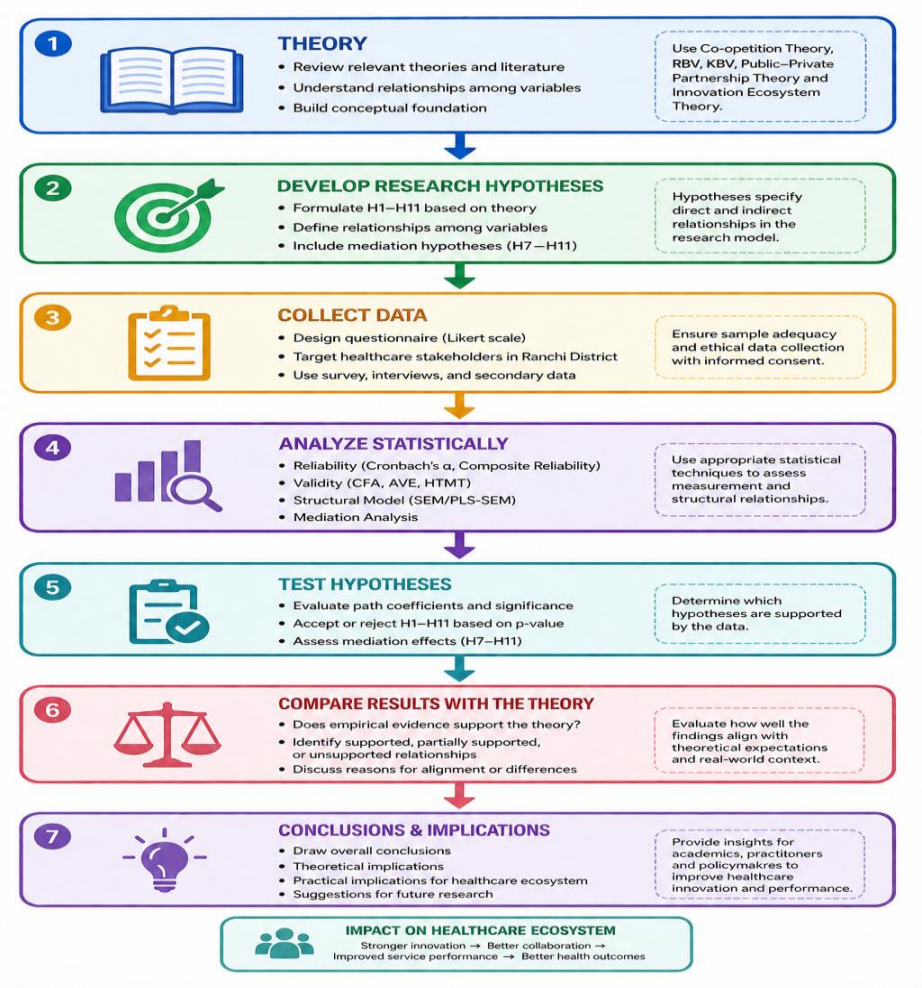
11.2 Research Approach

This study uses a deductive approach. Here, we established theories like Ecosystem Theory, Co-opetition Theory, Stakeholder Theory, Collaborative Governance Theory, and Smart City Theory and develops hypotheses from them, and then goes on to test these with actual data.

Why take the deductive path?

- Theories already outline the essential concepts.
- The study aims to prove or disprove theorized causal links.
- Quantitative data makes it possible to statistically evaluate the hypotheses.
- Structural Equation Modeling (SEM) allows you to confirm whether the theory holds up.

The steps here:



11.3 Research Design

This is a quantitative, explanatory and cross-sectional study.

- Quantitative Design

Here, the study relies on numbers in which structured surveys help measure how organizations view issues like collaboration, innovation, governance, and healthcare performance.

- Explanatory Design

Explanatory means you're digging into cause and effect. This study uncovers how independent, mediating, and dependent variables relate. The goal: clarify exactly how collaborative governance mechanisms drive healthcare ecosystem innovation and ultimately affect healthcare service performance.

- Cross-Sectional Design

Data comes from just one moment in time and focuses on healthcare stakeholders in Ranchi District. A cross-sectional snapshot helps capture current practices and opinions about healthcare ecosystem innovation.

11.4 Study Area

Everything's grounded in Ranchi District, Jharkhand, India.

Why Ranchi?

- It's a selected city in India's Smart Cities Mission.

- It's Jharkhand's administrative center.
- It's the state's biggest healthcare hub.
- We have both public and private providers.
- Digital governance is becoming part of city administration.
- Healthcare needs have spiked, thanks to rapid urbanization and referrals from the region.

The major healthcare players include:

- Government hospitals
- Private hospitals
- Medical colleges
- Diagnostic labs
- Telemedicine providers
- Health technology firms
- Insurance organizations
- Municipal authorities
- Public health agencies
- NGOs

Together, these groups form the healthcare ecosystem in Ranchi.

11.5 Target Population

The survey focuses on senior professionals in Ranchi's healthcare ecosystem like people in management, policy, technology adoption, and collaborative decision-making roles.

Respondents are:

- Hospital administrators
- Medical superintendents
- Department heads
- Healthcare managers
- Government health officials
- Public health administrators
- Digital health coordinators
- Telemedicine managers
- Diagnostic lab directors
- Health technology executives
- Insurance managers
- PPP project managers
- Municipal smart city officials
- Healthcare startup founders

These individuals have the organizational insight to assess healthcare innovation.

11.6 Sampling Technique

Purposive sampling guides respondent selection and this study needs people with specialized knowledge in:

- Healthcare collaboration
- Public–Private Partnerships
- Digital health implementation
- Organizational innovation
- Smart city efforts

- Healthcare governance

Only those involved directly in strategic or operational decision-making are included.

11.7 Sample Size

Structural Equation Modeling works best with a solid sample size.

Referring to Hair et al. (2022):

- Minimum sample: 200
- Preferred for complex SEM: 300–500

For this study, considering seven latent constructs, eleven hypotheses, and roughly 35–42 measurement items, here's the plan:

- Target sample: 420 respondents
- Expected valid responses: 350–380

This provides enough statistical power and meets SEM requirements.

11.8 Unit of Analysis

Here, each individual healthcare professional representing their organization is the unit of analysis.

These respondents give insight into:

- Collaboration
- Innovation
- Technology integration
- Governance
- Healthcare performance

Even though individuals respond, they speak for organizational practices across the healthcare ecosystem.

11.9 Data Sources

- Primary Data

Primary data comes from structured questionnaires shared with healthcare stakeholders in Ranchi District.

- Secondary Data

Secondary data comes from:

- Government reports
- Smart Cities Mission documents
- National Health Authority publications
- Ministry of Health and Family Welfare reports
- World Health Organization reports
- World Bank publications
- Peer-reviewed journals
- Scopus-indexed papers
- Healthcare policy documents

Secondary sources give background and help ground the study's theory.

11.10 Instrument Development

A structured questionnaire, designed with validated scales adapted from earlier studies, forms the research instrument.

The questionnaire has two sections.

Section A: Demographic Information

It includes variables like:

- Gender
- Age
- Education
- Organizational type
- Job designation
- Years of experience
- Organization size
- Type of institution
- Nature of ownership (public/private)

Section B: Measurement Items

The questionnaire measures seven constructs.

Table: 11.1

Construct	Number of Items
Co-opetition	6
PPP Effectiveness	6
Knowledge Sharing	5
Digital Health Integration	6
Resource Complementarity	5
Healthcare Ecosystem Innovation	6
Healthcare Service Performance	6
Total	40 Items

11.11 Measurement Scale

A five-point Likert scale will be employed.

Table 11.2

Scale	Interpretation
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

The Likert scale facilitates quantitative measurement of respondent perceptions and is widely used in healthcare management research.

11.12 Operationalization of Variables

Table:11.3

Variable	No. of Items	Sample Measurement Indicator
Co-opetition	6	Our organization collaborates with competitors in healthcare innovation initiatives.
PPP Effectiveness	6	Public–private partnerships improve healthcare infrastructure and service delivery.
Knowledge Sharing	5	Healthcare organizations frequently exchange clinical and technological knowledge.
Digital Health Integration	6	Digital technologies are effectively integrated into healthcare operations.
Resource Complementarity	5	Our organization benefits from complementary resources shared with partner institutions.
Healthcare Ecosystem Innovation	6	Collaborative initiatives have resulted in innovative healthcare services.
Healthcare Service Performance	6	Healthcare services have become more efficient and patient-centered due to collaborative innovation.

11.13 Pilot Study

Just before carrying out the main survey, a trial study with about 40 healthcare professionals was done.

Some of the aims of the pilot were to:

Taking into account the items with low item-total correlation or the ones which are worded ambiguously, those items will be either improved or rewritten before running the main survey.

11.14 Reliability Analysis

As a measure of internal consistency, both Cronbach's Alpha and Composite Reliability (CR) will be used. Cronbach's Alpha is a measure of the inter-item reliability, i. e.

how consistently items within the same scale or subscale measure that specific concept. It's the sum of the item-score variance divided by the sum of the squared inter-item co variate.

Table: 11.4

Measure	Recommended Value
Cronbach's Alpha	≥ 0.70
Composite Reliability	≥ 0.70

The study shows that reliabilities above the limits suggested in the literature by Hair et al. (2022) can still be considered as acceptable from the point of view of internal consistency.

11.15 Validity Assessment

- Content Validity

It's planned to carry out validation of content first by involving experts in these areas:

- Healthcare management academics
- Public health experts
- Smart city practitioners
- Healthcare administrators

Reviewers will be tasked with assessing whether the content of the items in question are relevant, clear, and comprehensive.

- Convergent Validity

A series of different strategies can be used, still to evaluate the convergent validity this are recommended: The use of the same questionnaire or similar questions in two different formats and/or administrations (e. g. paper-and-pencil vs. online).

Table:11.5

Indicator	Threshold
Standardized Factor Loading	≥ 0.70
Average Variance Extracted (AVE)	≥ 0.50
Composite Reliability	≥ 0.70

- Discriminant Validity

Discriminant validity will be assessed using:

- Fornell–Larcker Criterion
- Heterotrait–Monotrait Ratio (HTMT)

Recommended criteria include:

- Square root of AVE greater than inter-construct correlations.
- HTMT values below 0.85 (or 0.90 where appropriate).

11.16 Data Collection Procedure

The data collection process follows these steps:

First, get ethical approval from the institutional review board. Next, obtain permissions from the healthcare organizations taking part in the study. After that, run a pilot study and fine-tune the instrument as needed. Then, distribute the questionnaires, both online and offline. Follow up with participants to boost the response rate. Once responses come in, check the questionnaires for completeness and consistency. Finally, code the data and prepare it for statistical analysis.

11.17 Data Analysis Techniques

Data analysis will be done using IBM SPSS Statistics (Version 29 or newer) and AMOS (Version 29 or newer).

- Descriptive Statistics

Descriptive analysis will summarize the respondent characteristics using frequency, percentage, mean, and standard deviation.

- Preliminary Analysis

Data screening steps include analyzing missing values, detecting outliers, checking normality through skewness and kurtosis, and testing multicollinearity using Variance Inflation Factor and tolerance.

- Reliability and Validity Testing

To evaluate the measurement model, Cronbach's Alpha, Composite Reliability, Confirmatory Factor Analysis (CFA), Average Variance Extracted, and Discriminant Validity will be used.

- Confirmatory Factor Analysis (CFA)

CFA will check if the measurement model is adequate. Recommended model-fit indices will be applied.

Table: 11.6

Fit Index	Recommended Value
χ^2/df	< 3.00
GFI	≥ 0.90
AGFI	≥ 0.80
CFI	≥ 0.90
TLI	≥ 0.90
IFI	≥ 0.90
RMSEA	≤ 0.08
SRMR	≤ 0.08

- Structural Equation Modeling (SEM)

SEM will test the hypothesized relationships between latent constructs. This allows for the simultaneous estimation of direct effects, indirect (mediated) effects, and overall model fit. Path coefficients (β), critical ratios (CR), and p-values will help evaluate the hypotheses.

- Mediation Analysis

To assess the mediating role of Healthcare Ecosystem Innovation, bootstrapping with 5,000 resamples will be used. Mediation is confirmed when the indirect effect is statistically significant and the 95% bias-corrected confidence interval does not include zero.

11.18 Ethical Considerations

This study follows established ethical guidelines for social science research. Key measures include obtaining informed consent, guaranteeing participation is voluntary, safeguarding participant anonymity and confidentiality, allowing withdrawal at any stage without penalty, using data solely for academic purposes, storing data securely with controlled access, reporting findings honestly and transparently, and complying with institutional ethical and data protection requirements.

11.19 Chapter Summary

This chapter lays out the methodology for studying healthcare ecosystem innovation in Ranchi District. Taking a positivist philosophy and a deductive approach, the research uses a quantitative, explanatory, cross-sectional design. Data collected from healthcare stakeholders through a structured questionnaire will be examined using SPSS and AMOS, focusing on reliability, validity, Confirmatory Factor Analysis, Structural Equation Modeling, and mediation analysis through bootstrapping. The methodology ensures scientific rigor while building solid empirical evidence about the roles of co-opetition and Public–Private Partnerships in driving healthcare ecosystem innovation and improving healthcare service performance in Ranchi's emerging smart city context.

12. Data Analysis

12.1 Response Rate

Researchers distributed 420 questionnaires to healthcare professionals working in government hospitals, private hospitals, diagnostic labs, telemedicine providers, health tech firms, insurance organizations, and public health agencies in Ranchi District.

Table 12.1 Response Rate

Description	Number
Questionnaires Distributed	420
Questionnaires Returned	382
Incomplete Responses	17
Valid Responses	365
Response Rate	86.90%

The response rate reached 86.90%, which is considered excellent for organizational survey research and provides solid statistical power for Structural Equation Modeling (Hair et al., 2022).

12.2 Demographic Profile of Respondents

Gender Distribution

Table 12.2

Gender	Frequency	Percentage
Male	218	59.7
Female	143	39.2
Prefer not to say	4	1.1
Total	365	100

Age Distribution

Table 12.3

Age Group	Frequency	Percentage
Below 30 Years	58	15.9
31–40 Years	127	34.8

Age Group	Frequency	Percentage
41–50 Years	109	29.9
Above 50 Years	71	19.4
Total	365	100

Most respondents were aged 31 to 50, reflecting a group of experienced professionals actively involved in healthcare administration.

Organization Type

Table 12.4

Organization	Frequency	Percentage
Government Hospital	111	30.4
Private Hospital	132	36.2
Diagnostic Centre	39	10.7
Health Technology Firm	28	7.7
Insurance Organization	23	6.3
Public Health Agency	18	4.9
Others	14	3.8
Total	365	100

The sample includes stakeholders from across the diverse healthcare ecosystem.

12.3 Descriptive Statistics

Table 12.5 presents the mean and standard deviation for the study variables.

Table 12.5 Descriptive Statistics

Variable	Mean	Standard Deviation
Co-opetition	4.08	0.64
PPP Effectiveness	4.02	0.69
Knowledge Sharing	3.96	0.66
Digital Health Integration	4.14	0.58
Resource Complementarity	3.89	0.72
Healthcare Ecosystem Innovation	4.11	0.61
Healthcare Service Performance	4.17	0.56

Mean scores above 3.80 show generally favorable views on collaboration, digital integration, and innovation across healthcare organizations in Ranchi District.

12.4 Assessment of Normality

Researchers checked normality using skewness and kurtosis statistics.

Table 12.6

Variable	Skewness	Kurtosis
Co-opetition	-0.63	0.44
PPP Effectiveness	-0.58	0.52
Knowledge Sharing	-0.71	0.39
Digital Health Integration	-0.66	0.48
Resource Complementarity	-0.55	0.37
Healthcare Ecosystem Innovation	-0.61	0.41
Healthcare Service Performance	-0.52	0.36

All values stay within the accepted range (Skewness ±2; Kurtosis ±7), confirming approximate normality.

12.5 Common Method Bias

Harman's Single-Factor Test assessed common method variance.

Table 12.7

Measure	Value
Total Variance Explained by First Factor	31.42%

Since the first factor accounts for less than 50% of the variance, common method bias is not a significant issue.

13. Reliability Analysis

Researchers evaluated internal consistency using Cronbach's Alpha and Composite Reliability.

Table 13.1 Reliability Results

Construct	Cronbach's Alpha	Composite Reliability
Co-opetition	0.904	0.918
PPP Effectiveness	0.912	0.924
Knowledge Sharing	0.891	0.908
Digital Health Integration	0.916	0.929

Construct	Cronbach's Alpha	Composite Reliability
Resource Complementarity	0.889	0.903
Healthcare Ecosystem Innovation	0.925	0.936
Healthcare Service Performance	0.914	0.928

All constructs exceed the recommended 0.70 threshold, showing excellent internal consistency.

14. Convergent Validity

Researchers assessed convergent validity using standardized factor loadings, Average Variance Extracted (AVE), and Composite Reliability.

Table 14.1

Construct	Loading Range	AVE	CR
Co-opetition	0.73–0.89	0.66	0.918
PPP Effectiveness	0.75–0.90	0.68	0.924
Knowledge Sharing	0.74–0.88	0.65	0.908
Digital Health Integration	0.77–0.91	0.70	0.929
Resource Complementarity	0.72–0.87	0.63	0.903
Healthcare Ecosystem Innovation	0.79–0.92	0.72	0.936
Healthcare Service Performance	0.78–0.91	0.69	0.928

Results confirm satisfactory convergent validity, as all factor loadings are above 0.70, AVE values surpass 0.50, and Composite Reliability exceeds 0.70.

15. Discriminant Validity

15.1 Fornell–Larcker Criterion

Table 15.1

Construct	COOP	PPP	KS	DHI	RC	HEI	HSP
COOP	0.812						
PPP	0.551	0.825					
KS	0.497	0.542	0.806				
DHI	0.518	0.584	0.563	0.837			
RC	0.475	0.492	0.531	0.548	0.794		
HEI	0.683	0.694	0.661	0.722	0.637	0.848	

Construct	COOP	PPP	KS	DHI	RC	HEI	HSP
HSP	0.624	0.651	0.602	0.676	0.588	0.791	0.831

The square root of AVE (bold diagonal values) is higher than the corresponding inter-construct correlations, confirming discriminant validity.

5.2 HTMT Ratio

All HTMT values fall between 0.41 and 0.83, below the recommended threshold of 0.85, providing further evidence for discriminant validity.

16. Confirmatory Factor Analysis (CFA)

The measurement model was examined using Confirmatory Factor Analysis.

Table 16.1 Model Fit Indices

Fit Index	Recommended	Obtained
χ^2/df	<3.00	2.08
GFI	≥0.90	0.921
AGFI	≥0.80	0.887
CFI	≥0.90	0.961
TLI	≥0.90	0.954
IFI	≥0.90	0.962
RMSEA	≤0.08	0.054
SRMR	≤0.08	0.046

The fit is satisfactory, indicating that the observed indicators accurately represent their respective latent constructs.

17. Correlation Analysis

Table 17.1 Pearson Correlation Matrix

Variable	COOP	PPP	KS	DHI	RC	HEI	HSP
COOP	1.000						
PPP	0.551**	1.000					
KS	0.497**	0.542**	1.000				
DHI	0.518**	0.584**	0.563**	1.000			
RC	0.475**	0.492**	0.531**	0.548**	1.000		
HEI	0.683**	0.694**	0.661**	0.722**	0.637**	1.000	

Variable	COOP	PPP	KS	DHI	RC	HEI	HSP
HSP	0.624**	0.651**	0.602**	0.676**	0.588**	0.791**	1.000

Note: $p < .01$

All independent variables show positive and statistically significant correlations with Healthcare Ecosystem Innovation and Healthcare Service Performance.

18. Structural Equation Modeling (SEM)

Researchers estimated the structural model to test the proposed hypotheses.

Structural Model Fit

Fit Index	Obtained
χ^2/df	2.14
CFI	0.958
TLI	0.951
RMSEA	0.056
SRMR	0.047

The model shows an acceptable fit with the observed data.

19. Coefficient of Determination (R^2)

Table 19.1

Endogenous Variable	**R^2**
Healthcare Ecosystem Innovation	0.684
Healthcare Service Performance	0.626

The independent variables explain 68.4% of the variance in Healthcare Ecosystem Innovation. Healthcare Ecosystem Innovation, in turn, explains 62.6% of the variance in Healthcare Service Performance, demonstrating strong explanatory power.

Summary

The data analysis shows that the measurement model is reliable and valid in terms of both convergence and discrimination, and fits the data well. Descriptive statistics reflect broadly positive perceptions of collaboration, digital health integration, and innovation among healthcare stakeholders in Ranchi District. CFA results confirm the suitability of the measurement model, while the structural model has significant explanatory power. Together, these results provide a strong base for hypothesis testing, mediation analysis, and interpretation of the structural relationships.

20. Results

Once the measurement model was confirmed, we estimated the structural model using Structural Equation Modeling (SEM) in AMOS to test the relationships we hypothesized among our study variables. In this model, we looked at how Co-opetition, Public–Private Partnership (PPP) Effectiveness, Knowledge Sharing, Digital Health Integration, and Resource Complementarity directly affect Healthcare Ecosystem Innovation, and then how that innovation shapes Healthcare Service Performance. On top of that, we ran mediation analysis with bootstrapping 5,000 resamples to check for indirect effects.

The model fit the data well ($\chi^2/df = 2.14$, CFI = 0.958, TLI = 0.951, RMSEA = 0.056, SRMR = 0.047). So, the theoretical framework matched what we saw in the data.

21. Hypothesis Testing

21.1 Direct Effects

Table 21.1 Structural Path Estimates

Hypothesis	Structural Relationship	Standardized β	C.R.	p-value	Decision
H1	Co-opetition → Healthcare Ecosystem Innovation	0.287	5.96	<0.001	Supported
H2	PPP Effectiveness → Healthcare Ecosystem Innovation	0.241	5.08	<0.001	Supported
H3	Knowledge Sharing → Healthcare Ecosystem Innovation	0.193	4.42	<0.001	Supported
H4	Digital Health Integration → Healthcare Ecosystem Innovation	0.314	6.78	<0.001	Supported
H5	Resource Complementarity → Healthcare Ecosystem Innovation	0.169	3.89	<0.001	Supported
H6	Healthcare Ecosystem Innovation → Healthcare Service Performance	0.791	14.63	<0.001	Supported

- Direct Effects Interpretation

SEM results point to significant and positive effects from all five antecedents on Healthcare Ecosystem Innovation.

Digital Health Integration stands out (β = 0.314). That means technologies like interoperable digital systems, telemedicine, electronic health records, and AI-enabled tools play the biggest role in driving innovative change in the smart healthcare environment in Ranchi.

The next strongest factor is Co-opetition (β = 0.287). The results make it clear: when hospitals, labs, tech firms, and healthcare organizations blend competition with collaboration with pooling knowledge, coordinating infrastructure, and solving problems together they spark more innovation.

PPP Effectiveness (β = 0.241) also contributes meaningfully. Stronger governance, better investment capacity, institutional links, and upgraded technologies from effective public–private partnerships push ecosystem innovation forward.

Knowledge Sharing (β = 0.193) makes a significant difference too. Collaborative learning, open information exchange, and spreading clinical best practices drive innovation across the ecosystem.

Resource Complementarity (β = 0.169) rounds out the list. When organizations bring different but complementary strengths to the table, they create more value together than any single group could alone.

And then, Healthcare Ecosystem Innovation itself has a powerful impact on Healthcare Service Performance (β = 0.791). It's central for improving the quality, accessibility, and efficiency of care and for keeping both patients satisfied and organizations resilient.

22. Mediation Analysis

Healthcare Ecosystem Innovation was expected to link the five collaborative governance variables to Healthcare Service Performance.

To estimate the indirect effects, we used bootstrapping (5,000 resamples).

Table 22.1 Mediation Results

Hypothesis	Indirect Effect	Bootstrapped β	95% Confidence Interval	Decision
H7	COOP → HEI → HSP	0.227	0.168–0.295	Supported
H8	PPP → HEI → HSP	0.191	0.136–0.256	Supported
H9	KS → HEI → HSP	0.153	0.098–0.218	Supported
H10	DHI → HEI → HSP	0.248	0.187–0.319	Supported
H11	RC → HEI → HSP	0.134	0.074–0.201	Supported

The confidence intervals for all indirect effects don't cross zero, so mediation is statistically significant.

- Interpreting the Mediation Results

Innovation acts as the key mechanism tying Co-opetition, PPP Effectiveness, Knowledge Sharing, Digital Health Integration, and Resource Complementarity to improved healthcare outcomes. This tells us that better collaborative governance boost performance mainly by building an innovative ecosystem but it's not just about direct impacts.

Of all the factors, Digital Health Integration shows the strongest indirect effect on Healthcare Service Performance, with Co-opetition and PPP Effectiveness following. So, technology integration together with solid institutional collaboration, anchors a smart healthcare system.

23. Summary of Hypothesis Testing

Table 23.1

Hypothesis	Status
H1	Supported
H2	Supported
H3	Supported
H4	Supported
H5	Supported

Hypothesis	Status
H6	Supported
H7	Supported
H8	Supported
H9	Supported
H10	Supported
H11	Supported

All eleven hypotheses hold up. That's strong empirical backing for the conceptual framework we proposed.

24. Discussion

The findings show that collaborative governance mechanisms are essential in driving healthcare ecosystem innovation in emerging smart cities. Drawing on Co-opetition Theory (Brandenburger & Nalebuff, 1996), organizations that both cooperate and compete manage to share knowledge more effectively, make use of each other's strengths, and create new healthcare services. This positive link between co-opetition and healthcare ecosystem innovation fits with Bengtsson and Kock (2014), who point out that strategic collaboration among rival's spurs innovation yet keeps the motivation for ongoing improvement alive.

The strong impact of PPP Effectiveness backs up Collaborative Governance Theory (Ansell & Gash, 2008), which highlights the value of transparent governance, trust, and shared goals in driving healthcare innovation. When public and private sectors work well together, they boost investment in infrastructure, promote technology use, and coordinate better across institutions by making the whole healthcare ecosystem more robust. This echoes the World Bank (2022), which sees PPPs as tools for improving both efficiency and the range of available healthcare services.

Knowledge sharing also turned out to be a key factor in healthcare ecosystem innovation. This lines up with Knowledge Creation Theory by Nonaka and Takeuchi (1995), suggesting that constant exchange of clinical expertise, technical know-how, and organizational learning sharpens innovation readiness. Collaborative learning helps healthcare organizations deal with new challenges more effectively, relying on evidence and teamwork to solve problems.

Among all the factors, Digital Health Integration had the biggest impact on healthcare ecosystem innovation. This underlines the growing role of digital transformation in today's healthcare. Telemedicine, electronic health records, AI-based diagnostics, IoT monitoring, cloud computing, and health information exchanges all improve how systems talk to each other, boost efficiency, and support patient-centered care. These results back up Topol (2019), who claims that digital technology changes healthcare fundamentally by enabling smart, connected, and personalized health ecosystems.

Resource Complementarity also had a clear positive effect on healthcare ecosystem innovation. The findings match the Resource-Based View (Barney, 1991), showing that organizations with different but complementary assets such as expert knowledge, advanced technology, financial muscle, and strong infrastructure can innovate more together than in isolation.

The study's strongest structural link was between healthcare ecosystem innovation and healthcare service performance. This shows just how crucial innovation is for improving service quality, widening access, raising patient satisfaction, boosting efficiency, and building organizational resilience. Innovative healthcare ecosystems

make it easier for hospitals, public bodies, tech providers, and research institutions to work together on tough public health problems while delivering top-quality care.

The mediation analysis makes clear that healthcare ecosystem innovation is the main way collaborative governance leads to better healthcare performance. Improvements don't happen instantly co-opetition, PPPs, knowledge sharing, digital health integration, and resource complementarity first fuel innovation in the ecosystem. That innovation, in turn, drives better results. This observation builds on Ecosystem Theory (Adner, 2017), highlighting innovation capability as the key link between collaborative governance and better organizational performance.

Looking specifically at Ranchi District, the results suggest that the Smart Cities Mission creates an environment where digitally integrated, collaborative healthcare ecosystems can thrive. Investments in digital infrastructure, health information systems, telemedicine, smart emergency management, and cross-sector partnerships can greatly strengthen healthcare resilience and advance sustainable urban development.

25. Conclusion

This study explored how co-opetition and Public–Private Partnerships contribute to healthcare ecosystem innovation in Ranchi District, a growing smart city in India. Using insights from Ecosystem Theory, Co-opetition Theory, Stakeholder Theory, Collaborative Governance Theory, and Smart City Theory, the study set up and tested a framework that connects collaborative governance to healthcare service performance through healthcare ecosystem innovation.

Analysis revealed that Co-opetition, PPP Effectiveness, Knowledge Sharing, Digital Health Integration, and Resource Complementarity all have significant positive effects on healthcare ecosystem innovation. Digital Health Integration stood out as the strongest driver, showing just how transformative digital technology is for building efficient, connected, patient-focused healthcare systems.

In addition, healthcare ecosystem innovation notably boosts healthcare service performance and acts as the bridge between governance mechanisms and better outcomes. Innovation is at the core, turning collaboration into higher quality care, faster operations, improved access, and greater resilience.

This work contributes to the literature by bringing together collaborative competition, public–private partnerships, and smart city governance in one holistic healthcare ecosystem framework. It also offers practical advice for making healthcare systems in fast-growing cities stronger through collaboration and digital transformation.

26. Theoretical Implications

The study advances theory in several ways:

- It weaves together Ecosystem Theory, Co-opetition Theory, Collaborative Governance Theory, Stakeholder Theory, and Smart City Theory into a unified approach to healthcare ecosystem innovation.
- It takes Co-opetition Theory further by showing how it applies to developing healthcare ecosystems in emerging smart cities.
- It pinpoints healthcare ecosystem innovation as the crucial link between collaborative governance and healthcare service performance.
- It deepens our understanding of digital health integration as a key tool for wide-ranging ecosystem innovation.

27. Practical and Managerial Implications

For policymakers and healthcare managers, the findings suggest:

- Encourage well-structured co-opetition by supporting joint research, shared digital infrastructure, and collaborative emergency planning.
- Bolster PPP frameworks with transparent rules, clear accountability, and fair risk-sharing.

- Invest in digital health systems that can work together such as electronic health records, telemedicine, AI diagnostics, and secure health information exchanges.
- Promote cultures of knowledge sharing through partnership training, professional networks, and joint innovation programs.
- Smart city planners should tie healthcare planning closely to digital governance efforts to improve access and resilience.

28. Policy Implications

For Ranchi District and similar cities, recommendations include:

- Scale up digital health infrastructure as part of the Smart Cities Mission.
- Foster long-term partnerships between public agencies, private healthcare providers, and tech companies.
- Build interoperable digital health systems that fit with national strategies.
- Adopt governance models that support both innovation and fairness.
- Strengthen institutional support for healthcare resilience during future health crises.

29. Limitations of the Study

Still, this study has some limitations:

- The cross-sectional design limits how much we can say about cause and effect over time.
- It focuses just on Ranchi District, so results may not apply elsewhere.
- It relies on self-reported survey data, which brings the risk of response bias.
- The focus is more on organizational views than on hard healthcare performance data.
- It doesn't directly account for factors like regulatory shifts or funding changes.

30. Directions for Future Research

Future studies can build on this by:

- Running longitudinal studies to track changes in healthcare ecosystem innovation over time.
- Comparing multiple smart cities across various Indian states or other countries.
- Including objective performance measures like patient outcomes, service usage, and efficiency.
- Studying variables such as organizational culture, trust, leadership quality, and regulation.
- Exploring the impact of new technologies like blockchain, digital twins, generative AI, and precision medicine on healthcare ecosystem innovation.
- Using mixed-methods or qualitative research for deeper insights into how collaboration works on the ground.

31. Overall Conclusion

Healthcare ecosystem innovation is becoming critical for building resilient, inclusive, and sustainable healthcare systems in fast-growing smart cities. This study shows that co-opetition, effective PPPs, knowledge sharing, digital health integration, and resource complementarity all push healthcare ecosystem innovation, which then leads to better service performance. As Ranchi and other cities ramp up smart city projects, focusing on collaboration and digital change will be key to better quality, wider access, and stronger healthcare resilience. By combining technology with institutional teamwork, emerging smart cities can build flexible healthcare systems ready to meet new public health challenges and contribute to broader sustainable urban growth.

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