Integrating Innovation and Collaboration in Indian Construction:

A Mixed-Methods Analysis

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Author's Declaration

I, the undersigned, Kumar Gaurav Thakur, candidate for the PhD degree in Business Administration at Central European University, declare herewith that the present thesis titled "Integrating Innovation and Collaboration in Indian Construction: A Mixed-Methods Analysis" is exclusively my own work, based on my research and only such external information as properly credited in notes and bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person's or institution's copyright.

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Declaration of Generative AI

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Abstract

The construction industry has long struggled to keep pace with innovation compared to other sectors, hindered by fragmentation, short project lifecycles, and limited resources. This dissertation examines how collaborative models can improve the innovation environment in the construction sector, focusing on India, a rapidly developing nation with one of the world's largest construction markets and significant environmental challenges. To explore this, the dissertation introduces the Networked Construction Innovation Alliance Model (NCIAM), a three-tier collaborative framework designed to centralise access to innovation, leverage diverse partnerships, and foster systemic change within the construction sector. A mixed-methods approach is adopted across two interconnected research studies. The second chapter provides philosophical grounding for this dissertation. This chapter has outlined the ontological and epistemological foundations that inform the selection of methods for this dissertation and justify its conceptual approach. The third chapter, guided by systems theory and using semi-structured interviews analysed using the Gioia method, proposes a detailed NCIAM framework, emphasising the roles of SMEs, young innovative firms, and public institutions, as well as the presence of construction contractors and other innovative firms. The fourth chapter employs the extended Resource-Based View of strategy using PLS-SEM analysis to demonstrate how NCIAM participation can yield financial gains and inter-organisational stakeholder trust. Together, these studies make theoretical contributions to open innovation, systems theory, and the extended RBV, and offer practical implications for advancing collaborative innovation in construction. The NCIAM presents a viable foundation for improving innovation ecosystems, with future research needed to test its real-world application, refine governance structures, and explore broader geographic adaptability.

Acknowledgement

In the course of my doctoral journey, I often found quiet resonance in the life of *Karna* — a figure defined not only by adversity, but by unwavering resolve, dignity, and commitment to purpose. While my path has been far less heroic, the spirit of perseverance in the face of uncertainty and limitation felt strikingly familiar. This reflection became a quiet source of strength throughout the process.

Like many long journeys of inquiry, this doctoral work was shaped by moments of doubt, persistence, and growth. It is therefore not a solitary achievement, but one built upon the guidance, support, and encouragement of many individuals who stood beside me throughout this process.

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1 Chapter 1 - General Introduction Chapter

This thesis develops and evaluates a collaboration model designed to enhance the innovation environment within the Indian construction industry. This opening chapter establishes the study's rationale, beginning with the core research motivations that shaped its focus. It provides justifications for the specific industry and geographic context before outlining the aims and objectives that emerged from the preliminary investigative phase. In subsequent sections, the core concepts and guiding backgrounds that shape the entire dissertation are addressed. The conceptual and contextual background is provided by examining the notion of collaboration and collaborative innovation, and by offering pertinent details about the importance of collaboration in improving the innovation environment. Following this, the concept of Open Innovation and the One-Stop-shop (OSS) business model are probed. Lastly, the theoretical, methodological, practical, and broader relevance of this dissertation is emphasised, reinforcing the unified goals of the three essays in a coherent way.

1.1. Thesis Motivation

There are three situations distributed over a period that act as inspiration to investigate the construction industry. One comes from my own construction industry experience while working on a transmission line-related construction project back in 2015-16. These roughly translated excerpts are from my interaction with the project manager of this project. “Sir, the concrete anchor block that is holding the tower is standing at a height of 2 meters above the ground and is just a waste of concrete as its root runs well below the ground for another 11 meters. Can’t we reduce the height of this block? It will save time and cost and reduce the risk of working at height at the next project when we will tension the guy wires.” I asked. My senior replied, “It is not your job to

decide what must be the height of the anchor block. Let the designers take care of that. You focus on your execution work." "But Sir, I have done a bit of calculations myself and what I am proposing might be fruitful for the future projects and the organisation as well", I argued. "Have you prepared a work method statement for the next activity? Go and work on it. We will discuss this later." He spoke in a firm tone, but "later" never came. This was a conversation at most construction project sites I worked at for the first six years of my professional career at one of the top infrastructure companies in India. It was disheartening because if one of the top 30 global construction contractors was unwilling to change its mindset, then who would? Since this industry is one of the riskiest, I was never able to implement anything noteworthy on my own besides some minor positive improvements. Nevertheless, this made my brain think of ways to make a notable impact on the sector.

Next, while pursuing my master's degree in the UK, I came across a quote by John M. Beck, the founder and chairman of Aecon Group Inc., who once (2016) said, "Looking at construction projects today, I do not see much difference in the execution of the work in comparison to 50 years ago." His words made me think even more about this very realistic concern of a lack of solutions that cater to the problem of slow technological adoption by the infrastructure industry. And then a few months later, I came to know about Egan's (1998) report, titled 'Rethinking Construction', in which he indicated that there were factors involved, such as teamwork, the supply chain, training people to fulfil their role and modern methods of construction, that could make the construction industry more efficient. These three situations led me to believe that innovation is the way forward and is urgently needed to improve the construction industry, and that collaboration is required to achieve this. There are limitations in this

sector, such as low profit margins, which can be addressed to some extent through collaboration with other like-minded contractors, partners, and suppliers.

1.2. Why the Construction Industry?

Construction is classified as a top-level industry by the United Nations International Standard Industrial Classification (Whyte, 2003). When related industries (such as manufacturers of building products and systems, designers, and property managers) are included, the industry accounts for about fifteen per cent of the GNP of most nations (Marceau et al., 1999; Seaden & Manseau, 2001). Even though it is one of the most important economic sectors worldwide, in 2020, spending on construction amounted to thirteen percent of the global GDP (Robinson et al., 2021, p. 10), the construction industry is notorious for being slow to accept new technologies. Research has revealed that an industry's choice to adopt or reject innovations depends on how well-informed industry personnel are about an innovation’s potential benefits or drawbacks (Weerapperuma et. al., 2022). A study by the McKinsey Global Institute (2017) found that over the past twenty years, the annual productivity growth of the construction sector has barely improved by one percentage point.

In his report, Moavenzadeh (1978) emphasised that the construction industry is crucial for economic development in less industrialised nations, as it accounts for a substantial portion of both gross national product and employment. The industry also fulfils a variety of physical, economic, and social needs, while playing a vital role in achieving key national objectives. Due to its scale, operational characteristics, and involvement in all developmental activities, the construction sector presents an ideal opportunity for the transfer, adaptation, and advancement of technologies that align with the developmental aspirations of emerging nations (Moavenzadeh, 1978; Ofori, 2016; Alaloul et al., 2021).

Increasingly, sustainability is becoming a requirement rather than just a desirable characteristic, and its pursuit is bound to affect both the construction process and the built asset itself. Currently, sustainability is on the agenda of every government (Agenda, 2016). And only a few firms in the construction industry have the resources or incentives to maintain a formal research and development program (Walker et al., 2003; Meng & Brown, 2018). As a result, the construction sector does not seem to produce innovations at the speed that a modern industry can expect, despite the sustainability opportunity (Kajander, 2016). Construction companies use technologies which are mostly developed outside of the industry (Whyte, 2003). In their systematic analysis of innovation boundaries, Carmona-Lavado et al. (2023) identify construction as a primary ‘target industry’ that relies on the transfer and adaptation of technological solutions from established 'source industries’ such as the automotive industry.

It is evident that challenges surrounding the development and adoption of advanced technologies and innovations have been the subject of research for several decades, yet these issues persist. Within the construction industry, in particular, there are notable limitations related to innovation capacity, a prevailing mindset that favours traditional methods, and restricted funding for innovative initiatives. Moreover, after reviewing numerous research papers in the field of business administration, it has become clear to me that the construction industry has not received as much academic attention as sectors like manufacturing, energy, information technology, or healthcare. Given this disparity, now is an opportune moment to shift focus toward the construction sector and address a pressing issue that demands immediate attention.

1.3. Why the Indian Construction Industry?

Since gaining independence in 1947, the Indian construction sector has served as a vital driver of growth, supporting the development of various industries such as

manufacturing, transportation, and defence, thereby contributing to the nation's overall progress (IBEF, 2019). However, India still faces significant challenges in infrastructure development, which act as barriers to its growth. These challenges include limited and inadequate mechanisation of construction processes, a lack of automation and digitalisation in the sector, a shortage of professionally skilled workers, and low labour productivity (Bajpai & Misra, 2021). An enhanced innovation ecosystem could play a crucial role in addressing these issues.

As per the *Invest India* website, which is the national investment promotion and facilitation agency of the Government of India, the construction sector contributes nine per cent to Indian GDP, and it is the second biggest employer in India. This sector received the second-largest inward FDI for India in 2020-21. The Real Estate Industry alone in India is expected to reach USD 1 trillion by 2030 and will contribute thirteen per cent to India's GDP. As per a newspaper report, India is currently the fourth-largest construction market in the world and is well poised to become the third-largest construction market in the world by 2030 (Dutt, 2023).

India's construction industry is expected to facilitate the growing population and support the need for infrastructure (Cheng, 2017). But it is facing significant challenges in achieving quality and speed in construction. Low quality, delays in completion, high demand and lack of construction project management skills are challenging growth and consistency in the industry (Bendi et al., 2021). Considering the limitations, prospects and the growing market size of the Indian construction industry, which is currently undergoing a significant transition toward becoming an even bigger construction market globally, India presents itself as a highly promising geographical region for this research.

1.4. Collaborative Innovation

Innovation management practices across industries are undergoing significant changes (MacCormack et al., 2007; Spanjol et al., 2024). Collaboration is widely recognised as a crucial factor in fostering the right conditions for innovation. “The basic aim of collaboration is to pursue goals collaboratively that otherwise would be difficult to pursue” (Di Benedetto et al., 2019, p. 1). Collaboration between competing companies, a practice known as coopetition, has emerged as a significant and rising business trend in recent years. (Gernsheimer et al., 2021; Hern & Paul, 2020). This trend has been driven largely by the COVID-19 pandemic, which has had a profound impact on the global economy (Independent, 2020; Hern & Paul, 2020). Within the construction industry, the pandemic severely disrupted supply chains, causing delays and material shortages that hindered project progress (Farooq et al., 2022; Sutterby et al., 2023). These challenges have encouraged greater cooperation between the construction sector, government entities, and local communities, fostering innovative and sustainable solutions for construction organisations and projects (Araya et al., 2024). Although collaboration was already recognised as an important business practice before the COVID-19 pandemic, the crisis intensified the necessity for firms, especially SMEs and start-ups, to engage more extensively with external partners to recover from losses and navigate heightened uncertainty (Wu et al., 2024). Collaboration within innovation ecosystems extends beyond the traditional participants of construction projects, such as contractors, government bodies, and engineering firms, to encompass a broader range of actors, including material suppliers, technology developers, research institutions, and representatives of civil society (Vosman et al., 2022).

The innovation benefits of partnering are well established in the literature. Bresnen and Marshall (2000) note the following advantages over traditional approaches: increased productivity, reduced costs, reduced project times, improved quality, and improved client satisfaction. In fact, it is becoming increasingly common to gather knowledge for new product ideas from a variety of players outside organisational boundaries due to the rising popularity of the open innovation model (Salge et al., 2013). Innovations are increasingly being introduced to the market through networks of firms or an ecosystem, chosen for their distinct capabilities and functioning in a coordinated way. This emerging model requires firms to cultivate diverse, complementary skills, especially the ability to collaborate effectively with partners to achieve exceptional innovation performance. However, despite this necessity, prior research provides limited guidance on how to develop or utilise this capability (MacCormack et al., 2007; Linde et al., 2021). While openness offers significant benefits, it also introduces the risk of opportunistic behaviour.

1.5. Open Innovation

One prominent tactic for fostering collaborative innovation is Open Innovation (Chesbrough, 2020). This tactic emphasises that innovation is an organisation-wide process, involving the exploration and integration of both external and internal knowledge sources. Such efforts can lead to the development of new products, techniques, organisational structures, and markets (Chesbrough, 2003; 2011). Open innovation relies on business models to define the organisational and technological architectures through which external and internal knowledge is integrated. These models facilitate value creation by enabling the combination of internal and external ideas, while also establishing mechanisms through which firms capture a share of that value (Bogers et al., 2018). However, despite this recognition, the literature offers

limited guidance on how firms should design and operationalise collaboration structures that effectively support such innovation processes. This highlights the need for a more explicit and systematic collaboration model to guide innovation activities.

1.6. One-Stop-Shop Business Model

The one-stop-shop (OSS) collaboration model is an operating model in which a single actor works with other players in a specific value chain to provide complete business packages. In some areas of the European Union, this paradigm has begun to take hold (Pardalis, 2021). The OSS model is a collaborative approach that could inspire effective partnerships within the construction sector to address issues related to slow innovation. This model is a collaboration model that appears to cut across sectors and combine the elements of strategic and neighbourhood partnership (ASKIM et al., 2011). OSS clientele comprises both individual consumers and businesses. The latter, in their pursuit of gaining and sustaining a competitive edge, turn to a range of organisations for support, seeking services such as information, consultancy, training, and more specialised offerings like business digitalisation solutions (Rudawska, 2022).

The OSS has become a widely adopted service delivery model in the public sector. At its core, the OSS concept prioritises user needs by consolidating multiple services into a streamlined process, enhancing speed, efficiency, and cost-effectiveness to deliver optimal value to customers (Bridge & O'Neill, 2017; Rudawska, 2022). This model, in varying degrees of sophistication, is also being embraced by private and public-private service providers. Their goal is to meet rising customer expectations, where convenience and time efficiency are key priorities (Rudawska, 2022). For instance, OSSs now play a key role in the European Commission's Smart Financing for Smart Buildings (2018) initiative and are referenced in Directive 2018/844/EU. The creation and growth of OSS is further encouraged through multiple support measures,

including: (a) sharing best practices via ManagEnergy, the EU's network of regional and national energy agencies; (b) direct funding opportunities under the Horizon 2020 program, through targeted calls and agreements; and (c) grant schemes designed to assist project development (Biere-Arenas et al., 2021).

1.7. Structure of the Dissertation and Integration of the Chapters

While the initial conceptual motivation drew on the "one-stop shop" (OSS) idea of simplifying access to innovation, the proposed Networked Construction Innovation Alliance Model (NCIAM) also aligns more closely with collaborative innovation platforms such as the Fraunhofer Building Innovation Alliance, as it focuses on facilitating structured collaboration and knowledge exchange among diverse actors within the construction innovation ecosystem.

This thesis outlines the research undertaken to develop a conceptual Networked Construction Innovation Alliance Model (NCIAM) framework, aimed primarily at enhancing innovation within the Indian construction industry, while also highlighting its additional potential benefits. This doctoral thesis consists of two individual but connected research studies divided across three chapters. The central aim of this research is to contribute a novel theoretical and practical perspective to the field of collaborative innovation, culminating in a robust, actionable framework that empowers the construction sector to systematically implement the NCIAM framework and realise its full strategic and operational benefits. Across these three chapters, a multi-method approach has been adopted, combining structured survey data, secondary data, and semi-structured interviews to obtain a triangulated perspective on the role of collaboration in enhancing the innovation environment within a future-oriented context.

The research draws on insights from real-world participants, primarily from the Indian construction industry, as well as from other sectors with relevant experience in construction-related collaboration. This methodological diversity supports strong internal and external validity, enhancing both the timeliness and practical utility of the findings. Chapter Two, "From Concept to Empirical Exploration," lays the ontological and epistemological groundwork for the dissertation, justifying the research design by aligning it with established scholarly standards. It develops both the methodological and conceptual rationale for the study, explaining why a future-oriented investigation is appropriate within accepted research paradigms. The chapter outlines the philosophical and methodological assumptions guiding the inquiry and articulates the researcher's motivation, positioning this work more clearly within the broader discourse on innovation in the construction industry. Furthermore, it advances the argument for the NCIAM framework as an extension of the One-Stop-Shop and Open Innovation concept by comparing it with existing models of collaboration for innovation. Additionally, the chapter provides a robust rationale for the integration of mixed methods with a design science research approach, positioning them as the optimal methodological choices for the theoretical development of the NCIAM framework. It concludes by defending the legitimacy of perception-based, future-oriented research as a valid mode of scientific inquiry, thereby reinforcing the conceptual and exploratory nature of this doctoral study.

The third chapter, "Designing for Innovation: A Networked Construction Innovation Alliance Model for the Indian Construction Sector ", develops the design of the NCIAM framework, which is a three-tiered framework with a diverse set of industries (like construction and manufacturing), companies (like SMEs and YICs), and organisations (like government and university) having a role to play in this networked collaboration

model. The aim of this NCIAM framework is primarily to improve the innovation environment in the construction sector. In addition to outlining the structure of the collaboration model, this study also proposes the initial steps necessary for initiation of the stakeholder dialogues, along with some preliminary characteristics of the model itself. The methodology integrates Systems Theory to understand stakeholder dynamics, an abductive approach to guide the analytical process, and qualitative interviews as the primary data source. This design allows for an iterative cycle where empirical findings are continuously contextualised and interpreted through critical engagement with the scholarly literature, leading to meaningful conclusions. The fourth chapter, “Assessing the Impact of Networked Construction Innovation Alliance Model on Indian Construction Firms: A Perceptions-Based Study”, explores the predictive relevance of the Networked Construction Innovation Alliance Model and the extent to which it can influence stakeholder trust, new business opportunities, and environmental and financial performances. The Extended Resource-Based View (ERBV) serves as the theoretical framework guiding this investigation. And it is based on respondents' perceptions and does not claim causality but instead seeks associational relationships. The study employed a survey research design and a quantitative approach, utilising the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique for data analysis and interpretation. This method was selected for its ability to model complex relationships among latent constructs with minimal restrictions on data distribution and sample size, aligning with the objectives of this study. The study makes a dual contribution: first, it extends the NCIAM literature by examining its interplay with other firm-level variables; second, it offers actionable insights to inform the strategic decisions of managers, scholars, and innovation partners, thereby bolstering the rationale for their investment in the NCIAM

framework's development and adoption. The results and discussions presented in this dissertation offer not only theoretical and methodological contributions but also possess external relevance for key stakeholders, particularly construction firms, innovation partners, and government institutions, seeking to foster collaborative innovation practices.

2 Chapter 2 - From Concept to Empirical Exploration: Building the NCIAM framework for Innovation Ecosystems in Indian Construction

2.1 Introduction

A recurrent critique within the extant business and management literature is that the construction sector is notably hesitant to embrace emerging technologies, frequently trailing other major industries in the implementation of innovative practices and novel technologies (Herr & Fischer, 2018; Navaratnam et al., 2019). This tendency for delayed adoption extends across new materials, techniques, and technological applications, with reports indicating a systematically slower rate of integration than the industrial average (Barbosa et al., 2017). Resistance to change among individuals has been widely recognised as a major barrier to the adoption and implementation of new technologies within the construction industry (Lawluvy et al., 2022). Thus, although heightened innovation is a known precursor to greater macroeconomic contribution from the construction sector, the industry's widespread reputation for technological conservatism in numerous countries points to a substantial unmet potential for progress (Dulaimi et al., 2002).

Research has consistently shown that the construction industry is among the slowest to create and use new technology, often choosing to stick with traditional methods it finds reliable (Rosenfeld, 1994; Van Tam et al., 2024). To tackle this problem, research points to better collaboration and a more integrated way of working as the solution. For instance, Egan (1998) argues that combining design and construction teams, while also improving how the supply chain is managed, is a key driver for innovation and quality. Because the industry is so fragmented, with many small companies working

on temporary projects, adopting these more unified approaches is seen as a crucial step for encouraging faster innovation (Blayse & Manley, 2004). Collaboration facilitates the successful development and implementation of innovations, while innovation in turn generates new opportunities for collaborative engagement (Koozani et al., 2025).

This chapter provides a robust ontological and epistemological foundation for the dissertation. Ontological and epistemological foundations leading to the choice of the method and philosophy behind that choice. The central aim of this chapter is to build a methodological and conceptual foundation for the dissertation. It outlines why a future-oriented research posture is the appropriate approach for resolving the core research question concerning the Indian construction sector’s innovation ecosystem. Furthermore, it sets the stage for the two-phase empirical study, beginning with the qualitative design of a collaboration model (Chapter 3) and culminating in a quantitative test of its perceived benefits using PLS-SEM (Chapter 4). By articulating this rationale, the chapter integrates the dissertation's components and validates the overarching research framework. This dissertation examines India, one of the largest and fastest-expanding construction markets. While the industry is growing, as with the industry worldwide, the adoption of innovation has historically been slow, with technological conservatism (Luthra et al., 2016) limiting the implementation of new methods and practices. This is not to suggest that the Indian construction sector is not growing; over the past decade, it has been gradually moving toward sustainability, showing notable progress in its green initiatives (Vyas & Jha, 2016). But that progress is slow.

The Delhi Metro project provides an illustrative example of effective project delivery in India. It demonstrates that large, complex projects can adhere to timelines, budgets,

and quality standards. However, this does not necessarily indicate an improvement in innovation within the Indian construction industry *per se*. This project's success is primarily attributable to execution excellence (effective planning and management) rather than innovation itself (Singh & Prakash, 2017). If the successful implementation of the Delhi Metro is regarded as a benchmark for innovative project execution, it is pertinent to question why a comparable level of success has not been achieved in the Bangalore and Mumbai Metro projects, both of which have experienced prolonged timelines and remain partially incomplete (See The Hindu Bureau, 2025; Prasad, 2025; Badgeri, 2025; Konduskar, 2025).

The present research addresses innovation challenges within the Indian construction sector, a pursuit guided by a core methodological principle. As Max Weber stated, an empirical science "cannot tell anyone what he should do—but rather what he can do--and under certain circumstances--what he wishes to do" (Weber, 1949, p. 54). This perspective underscores the lack of a single optimal approach to conducting research. Rather, the strength of this study lies in its adherence to the indicators of robust research: a clearly defined problem and the deliberate selection of a conceptual and methodological framework appropriate for its investigation (Winch, 1990).

This doctoral dissertation defines "Networked Construction Innovation Alliance Model" (NCIAM), a forward-looking, theoretically grounded and empirically informed conceptual framework inspired by the One-Stop-Shop (OSS) business model. The OSS model is a collaborative structure designed to provide value through the integration of fragmented services, saving time and reducing costs for customers, which include both individuals and businesses (Askim et al., 2011). Adopting OSS reduces the administrative burden on enterprises by providing a single point of contact

in complex industries. Implementing this approach also helps bridge coordination gaps among stakeholders (Ongaro, 2004).

Further expanding the point raised in the previous paragraph, it has been said that the OSS can, in a government-led setup, effectively clarify and communicate regulatory requirements, addressing citizens' and businesses' common difficulty in accessing information on administrative procedures. They create "win-win" outcomes by improving service delivery and regulatory compliance, i.e. clients can access forms, submit information once, and complete processes more easily. At the same time, governments gain better-quality data and higher compliance rates with lower enforcement costs (OECD, 2020). Although no universal OSS model fits all contexts, they should be part of broader administrative simplification strategies (OECD, 2020). Evidence, though limited, links OSSs to higher citizen satisfaction, reduced corruption, and greater efficiency (Knox & Janenova, 2019). Privately driven OSSs, leveraging partner networks and standardised processes, enhance service quality and foster customer trust through sustained engagement across key stages of the user journey (Pardalis et al., 2022).

Selecting a specific issue and framework for this research work serves to establish a clear focus for the present investigation, while recognising that other approaches also offer valuable insights (Winch, 1990). Other collaboration models certainly exist, like open innovation or the triple helix model, and this dissertation's aim is not to critique them but to introduce a new model designed to enhance innovation in the Indian construction sector, where such an approach is particularly needed. The contemporary reality highlights the relevance of this dissertation, which states that adhering to outdated rules or methods can lead to obsolescence; succeeding today requires a transformed understanding of competition, growth, and leadership (Adner, 2021).

The NCIAM framework is developed using a design-oriented, theory-building approach, positioning the work within the tradition of exploratory research. Furthermore, the methodology adopts an Exploratory Sequential Mixed Methods (ESMM) approach (Creswell & Creswell, 2018, p. 63). This approach starts with a qualitative phase to design a theoretical artefact, the conceptual collaboration model. The findings from this phase then inform the subsequent quantitative phase, which undertakes an evaluation of the model's performance. This results in a conceptual framework that outlines the key factors under examination and their proposed interconnections (Miles & Huberman, 1994, p. 18).

The research focuses on the design and preliminary validation of the NCIAM framework for enhancing the innovation ecosystem in the Indian construction industry. Unlike purely empirical or purely conceptual studies, this dissertation occupies an intermediate position by proposing a design-oriented conceptual model for innovation collaboration in the construction sector. The research, therefore, combines conceptual model development with empirical engagement, using practitioner perspectives to inform the design of the model and to examine perceived relationships among its key elements. This approach allows the study to develop a future-oriented collaboration framework while strengthening its analytical rigour through empirical insights from industry stakeholders.

An important gap exists in the literature concerning collaboration and innovation within the Indian construction ecosystem, lacking a contextually grounded, system-oriented framework. Extant models such as the Triple Helix, University-Industry Collaboration and Open Innovation are inadequate as they typically focus on narrower partnerships, originate from Western contexts, or don’t sufficiently capture the fragmented, project-based nature of the Indian construction industry. Another known innovation

collaboration model that will be looked into is the Fraunhofer model, which is again Western-centric. Prevailing methodological approaches are often limited to single-method designs or isolated case studies and are insufficient for the development and preliminary testing of transferable theoretical artefacts. This dissertation directly addresses this void by introducing the Networked Construction Innovation Alliance Model (NCIAM), a framework specifically created for the unique demands of the Indian construction sector.

This chapter proceeds as follows. First, it establishes the theoretical gap motivating the Networked Construction Innovation Alliance Model (NCIAM) model. Second, it presents the conceptual logic of NCIAM and positions it relative to existing collaboration frameworks. Third, the chapter articulates the philosophical foundations (ontology and epistemology) that underpin the research. Finally, it explains how these philosophical commitments justify the methodological choices, design science research combined with an exploratory sequential mixed-methods design, which collectively enable the model's development and preliminary validation.

2.2 Conceptual Foundation for the NCIAM Structure Design

As Buerkle et al. (2021) present a collaborative safety framework in human–robot interaction, designed to enhance rather than replace existing models. In a similar vein, this doctoral dissertation does not seek to criticise or supersede previous collaboration models, but rather to complement them through a framework explicitly bounded by its primary goal of improving innovation in the Indian construction sector. This doctoral dissertation aims to demonstrate a strategy that can lead to a broader, positive impact of innovation across the construction industry, rather than limiting it to a select few firms. This perspective supports the adoption of a networked-collaboration approach, which more effectively addresses the nuanced limitations of existing collaboration

models in promoting industry-wide innovation. Drawing inspiration from the literature on open innovation, network-based collaboration, and the One-Stop-Shop (OSS) business model, as well as insights from empirical data, the NCIAM framework is developed and presented in the third chapter.

While models like the Triple Helix, open innovation networks, the Fraunhofer Model and University-Industry collaboration models have contributed significantly to collaborative innovation, they exhibit limitations, such as contextual sensitivity, strategic misalignment, and/or the dilution of expertise. This section briefly examines collaboration models that prioritise innovation as their end goal. The **Triple Helix model** emphasises the contributions of organisations, governments, and universities in fostering a more conducive environment for innovation (Etzkowitz, 2003). Among the three innovation actors, industry consists of firms and organisations that are responsible for producing goods and services, creating economic value, and generating wealth. Universities develop modern technologies and knowledge, while governments ensure legal frameworks and regulations governing interactions and transactions among innovation actors (Etzkowitz, 2003). The model's weaknesses stem from relationship barriers like differing cultures and mistrust, university-specific issues such as low entrepreneurial capacity, and policy failures in several countries that do not support collaboration. These three types of barriers are not mutually exclusive and often overlap, hindering the model's effectiveness in practice (Razak & White, 2015). Several studies have identified rigid institutional structures, cumbersome bureaucratic processes, limited capabilities, inadequate funding, and the persistence of traditional values and philosophies within universities as the primary barriers to developing a hybrid Triple Helix model in developing countries (Razak & White, 2015).

Next is the **Open Innovation model**. Chesbrough proposed the following definition of Open Innovation (OI) based on the concept of business models: “We define open innovation as a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization’s business model” (Chesbrough & Bogers, 2014, p. 17). Based on the core premise that maintaining a competitive edge requires external collaboration, OI posits that organisations cannot innovate effectively in isolation and must instead engage with a diverse network of partners, including suppliers, customers, universities, research centres, and even competitors (Bigliardi & Galati, 2013). However, the implementation of OI faces considerable challenges, such as the organisational complexities of managing numerous external collaborations, an underdeveloped theoretical understanding of novel organisational structures, and the necessity for stringent intellectual property (IP) policies to mitigate the risk of knowledge leakage (Elmquist et al., 2009; Isckia & Lescop, 2011). A lack of trust among partners further intensifies concerns regarding intellectual property protection and the risk of knowledge leakage, underscoring the importance of developing new IP frameworks that are less producer-centric (Isckia & Lescop, 2011; Tanguy, 2016). In addition, the effectiveness of the model is often shaped by firm size and industry, with SMEs facing particular disadvantages due to financial constraints and a lower capacity to absorb external knowledge (Spithoven et al., 2010; Trott & Hartmann, 2009; Tanguy, 2016).

Open innovation can enhance innovation in the construction sector by enabling collaboration with research institutions and organisations from other industries, which facilitates knowledge exchange and the development of new competencies and best practices (Rahman et al., 2019; Greco et al., 2021). Such collaborations also support

the introduction of new technologies and innovative construction processes through access to external expertise and shared resources (Greco et al., 2021). Open innovation (OI) adoption in the construction industry is limited by firms' reluctance to share proprietary knowledge and the sector's fragmented structure, which discourages collaboration across the supply chain (Stichting Innovatie & Arbeid, 2014; Salvalai et al., 2023). In addition, the project-based nature of construction and difficulties in scaling laboratory innovations to real-world applications create coordination and implementation challenges for OI practices (Salvalai et al., 2023). The structure of the construction ecosystem can create several barriers to open innovation. These include the temporary nature of project-based relationships, which limits trust and knowledge sharing among participants (Lau & Rowlinson, 2009); the fragmented nature of construction activities, which makes it difficult to establish long-term partnerships (Miozzo & Dewick, 2004); and low profit margins that restrict firms' capacity to invest in research and development (Love et al., 2017).

Then comes **university-industry collaboration (UIC).** The conventional mission of universities has centred on education and fundamental research, activities historically recognised for generating positive externalities for industry and catalysing regional economic development (Etzkowitz & Leydesdorff, 2000; Trippl, Sinozic, & Lawton Smith, 2015). Within this context, University-Industry Collaborations (UICs) emerge as a key mechanism for interaction. According to Amabile et al. (2001), UICs are fundamentally defined by three constitutive features that determine their character and efficacy: they are composed of individuals from distinct professional backgrounds (namely academics and practitioners); the core relationship is forged between these individuals rather than at an abstract organizational level; and these individuals operate within the frameworks of their separate, and often divergent, institutional

organisations. UIC “allows firms and universities to tap into complementary skills of each other and thus potentially help with saving cost and enhancing research outcomes.” (Hemmert et al., 2014, p. 605). Consequently, it is reasonable to assert that universities and numerous construction firms often share similar fundamental goals regarding the generation and dissemination of knowledge (Jones et al., 2021). Despite this common ground, significant challenges persist within these partnerships. The accelerating proliferation of international and interdisciplinary knowledge presents difficulties for traditionally siloed academic disciplines. Furthermore, the management and organisation of such interdisciplinary innovations impose novel and complex demands (Tolstykh et al., 2021). An additional barrier is the persistent perception among industry actors that academic research is insufficiently attuned to practical, real-world applications and constraints (Locket et al., 2008). Different work routines may also make researchers and firms repel each other. A particularly significant point of contention is the misalignment of time horizons; corporate partners typically operate under a "time-to-market" imperative, which is often fundamentally incompatible with the extended, deliberate timelines characteristic of academic research (Fontana et al., 2006; Locket et al., 2008). This disconnect frequently fuels industry perceptions that scholarly work lacks practical applicability (Lavikka et al., 2020). Within the construction sector specifically, Lavikka et al. (2020) demonstrate that the industry's fragmented, short-term, and risk-averse project cycles frequently conflict with the longitudinal nature of academic inquiry. This underscores that effective collaboration depends on implementing structured governance frameworks and robust knowledge-transfer protocols.

University–industry collaboration in the construction sector can support innovation by providing firms access to advanced research, emerging technologies, and skilled

graduates, while participation in publicly funded research programmes can also reduce the financial risks associated with R&D activities (Jones et al., 2021). However, such collaboration may also face challenges, including differences between academic research objectives and industry needs, mismatches between academic research timelines and the fast-paced nature of construction projects, and difficulties in translating academic knowledge into practical on-site applications (Jones et al., 2021).

Research and Development (R&D) collaborations are examined as a means of accessing innovation. The acceleration of technological advancement, economic volatility, and the rapid pace of innovation have compelled firms to seek new sources of competitive advantage. This environment has catalysed the emergence of alliance capitalism, a response characterised by a rise in cooperative agreements and joint research and development (R&D) initiatives (Hagedoorn, 1993). Specifically, a form of inter-firm collaboration for R&D (Veugelers, 1997). Such R&D collaboration constitutes a distinct form of partnership where firms pool their research activities through various organisational modes (Hagedoorn, 2002), operating within formally structured innovative environments (Fiaz & Naiding, 2012). Within R&D partnerships, significant information asymmetries present considerable obstacles during negotiation and monitoring phases, consequently elevating governance costs and critically influencing a firm's make-or-buy decisions (Kohtamäki et al., 2013). A further impediment to effective collaboration is the inequitable access granted to suppliers regarding the focal firm's internal systems and essential tools. This disparity generates operational inefficiencies and disrupts synergistic efforts in joint R&D ventures (Bäck & Kohtamäki, 2015). R&D alliances are fraught with several other significant pitfalls. A primary challenge is the frequent failure of partners to collectively govern the cooperative endeavour. Furthermore, the very act of collaboration necessitates the exposure and

joint development of valuable proprietary knowledge. Uncontrolled dissemination of this know-how can erode a firm's technological edge, thereby jeopardising its long-term competitive position (Baumol, 1993; Hamel et al., 1989; Veugelers, 1998). Additional complications arise from the inherent difficulty in accurately valuing a partner's technological assets ex ante and in effectively controlling the flow and application of shared knowledge. The intrinsic uncertainty of R&D outcomes further complicates governance, as it is often impossible to distinguish a partner's non-compliance from genuine, exogenous project failures. This ambiguity makes it exceptionally challenging to design contracts that can effectively mitigate opportunism by specifying contingent R&D inputs (Veugelers, 1998).

Supplier–contractor collaboration in innovation and technology development (often interpreted as inter-firm R&D collaboration) can enhance innovation in construction by enabling contractors to utilise suppliers' specialised technological knowledge, thereby improving design solutions, construction processes, and the development of new building systems (Sariola, 2018). Suppliers can also play a central role in driving systemic innovations in areas such as energy-efficient housing through coordinated development across the construction supply chain (Mlecnik, 2012). However, suppliers' innovation potential is often underutilised due to weak collaboration practices and limited integration of suppliers into project development processes (Sariola, 2018). In addition, the fragmented structure of the construction industry and the coordination required among multiple actors can hinder effective collaborative innovation and the scaling of new solutions (Mlecnik, 2012).

The **Fraunhofer model** of innovation is an applied research system that promotes technological development and economic competitiveness through collaboration between research institutes, universities, and industry (Klingner & Behlau, 2012). A

key feature is its performance-based funding model, in which about 30% comes from federal and state governments and over 70% from industry contracts and publicly funded projects. This structure encourages industry involvement while allowing institutes to conduct forward-looking research without immediate commercial application (Klingner & Behlau, 2012). The model also operates through a decentralised network of specialised institutes affiliated with universities, where directors often hold academic positions, enabling institutes to conduct applied research and develop technological solutions for industry (Klingner & Behlau, 2012). The Fraunhofer model faces coordination challenges due to its decentralised structure, as institutes may develop overlapping expertise, making it difficult for customers to identify the most suitable institute for collaboration (Klingner & Behlau, 2012). In addition, the headquarters must balance competition and cooperation among institutes while responding to the expectations of multiple stakeholders within the socio-political framework (Klingner & Behlau, 2012). The model also depends heavily on industry contracts, with more than 70% of research revenue derived from industry funding, and decisions about investing in emerging technologies involve uncertainty regarding the timing of commercial maturity (Klingner & Behlau, 2012). Furthermore, the long-term and multidimensional nature of innovation outcomes makes the overall impact of research activities difficult to measure (Frietsch et al., 2022).

The Fraunhofer Building Innovation Alliance is a collaborative platform that brings together eleven Fraunhofer institutes to address scientific and technological challenges in the construction sector by providing integrated system solutions and serving as a central interface between industry, research, and policy (Fraunhofer Building Innovation Alliance, n.d.). By consolidating the expertise of multiple institutes, the alliance enables interdisciplinary collaboration and the development of innovative

building materials, systems, and processes throughout the building lifecycle, thereby supporting innovation and efficiency in the construction industry (Fraunhofer Building Innovation Alliance, n.d.). However, its research scope is primarily focused on building-related technologies and lifecycle optimisation, which may limit its attention to other construction domains such as large-scale infrastructure projects (Fraunhofer Building Innovation Alliance, n.d.).

Both collaboration models, UIC and R&D partnerships, face a key limitation that this research work seeks to address: innovation outcomes are often confined to a limited group of partners. The benefits of innovation should be distributed more broadly across the construction industry, reaching as many stakeholders as possible. This does not suggest that existing models lack value; rather, each possesses distinct strengths and weaknesses. Building on these insights, this research proposes the development of a collaborative framework tailored to the Indian construction sector, addressing limitations in collaboration models largely developed within Western innovation contexts (See - Nsanzumuhire & Groot, 2020; De Oliveira et al., 2020).

The NCIAM model designed here draws inspiration from both the OI framework and the One-Stop-Shop (OSS) business model. OI is already discussed above. The OSS model is briefly discussed next.

While one-stop shops are frequently perceived simply as mechanisms for integrated service delivery, emphasising physical co-location, shared information and communication technologies (ICTs), and centralised geography, this view is limited. Askim et al. (2011) contend that a comprehensive understanding of a one-stop shop's potential impact requires analysing it as a distinct organisational form in a broader institutional sense. Fundamentally, it can be described as a central hub designed to

provide streamlined services to clients (Wimmer, 2002). The one-stop-shop (OSS) model functions as a collaborative business framework wherein a primary entity coordinates with various stakeholders across a value chain to deliver comprehensive, integrated service packages. This paradigm is gaining traction in certain regions of the European Union (Pardalis, 2021). Essentially, the OSS creates a platform that enables multiple groups to pool their resources for developing synergistic projects, thereby offering multifaceted solutions to complex individual and collective challenges. By adopting this model, firms can facilitate a more extensive and accessible suite of services. The central objective of the OSS is to mitigate the effects of localised fragmentation and a lack of coherence among disparate agencies and programs (Finn, 2000).

The concept of a 'cross-industry ecosystem' has become increasingly relevant in light of the interdisciplinary nature of contemporary innovations and the growing importance of inter-sectoral collaboration (Tolstykh et al., 2021). This perspective is further reinforced by Farhadi (2019) in his book *Cross-Industry Ecosystems*, where he develops the theoretical and methodological underpinnings of the concept and highlights the increasing complexity of intersectoral economic development. At its core, the concept suggests that in a volatile and uncertain environment, economic actors formulate strategies and build competitive advantages through resource sharing, network externalities, and knowledge spillovers. Such dynamics call for the advancement of new theories and approaches that accurately capture these real-world trends (Acs et al., 2016). Building on these ideas, this doctoral research addresses the need to develop a collaboration model that addresses the observed limitations of existing innovation collaboration frameworks, which are limited in accommodating the sector's structural, organisational, and cultural specificities.

According to the coherence theory of concepts, the meaning of a concept is defined by its relationships within a network of other concepts. For instance, one cannot fully grasp object concepts without also understanding related shape concepts (Audi, 2005, p. 195). In this dissertation, the concept of collaboration, i.e. NCIAM, includes dimensions such as trust, knowledge sharing, and inter-organisational coordination. Understanding these interrelated concepts is essential for constructing a functional and theoretically informed NCIAM collaboration structure.

2.3 Philosophical and Methodological Foundations

Despite often operating beneath the surface, philosophical assumptions significantly shape how research is conducted, making their identification a critical part of the process (Slife & Williams, 1995). Establishing the philosophical foundations of this study is crucial, as they inform the conceptualisation of collaboration and influence the methodological choices made in pursuing this goal.

2.3.1 Ontological Stance

This dissertation adopts a stratified realist ontology, which assumes that social reality exists independently of human perception but is organised into multiple layers that may not be directly observable. Stratified realism conceptualises reality as consisting of three domains: the empirical, the actual, and the real (Bhaskar, 1976, 1978, 1989; Fletcher, 2017). The empirical domain refers to experiences and observations accessible to researchers and participants. The actual domain includes events and processes that occur regardless of whether they are observed. The real domain comprises the deeper structures and patterns that produce observable events and experiences (Sayer, 1999; Fletcher, 2017).

Within this layered view of reality, processes operate across different levels and interact with contextual conditions to generate observable outcomes (Outhwaite, 1987; Danermark et al., 2002). Consequently, observable patterns alone cannot fully explain social phenomena, because the same mechanism may produce different outcomes depending on contextual circumstances (Zachariadis et al., 2013). Understanding social phenomena, therefore, requires moving beyond surface-level observations to consider the underlying structures and mechanisms that shape events and experiences (Muselela, 2025).

Stratified realism is particularly suited to the study of complex social and organisational systems, where outcomes emerge through the interaction between structural conditions and human agency (McEvoy & Richards, 2003). Phenomena such as organisational collaboration, networks, and innovation arise from the interplay between institutional arrangements, organisational practices, and individual actions operating across different levels of reality (Danermark et al., 2002; Eastwood et al., 2014). In such contexts, empirical observations, such as practitioners' experiences and perceptions, represent only one layer of reality but can provide valuable insights into the underlying logic shaping observable outcomes (Koopmans & Schiller, 2022).

Adopting a stratified realist ontology, therefore, enables this dissertation to conceptualise complex organisational phenomena as the outcome of interacting mechanisms operating across multiple levels of reality, while recognising that empirical observations provide only partial access to these underlying processes.

2.3.2 Epistemological Positioning

This dissertation is guided by a critical realist (CR) epistemology. Emerging from the positivist–constructivist debates of the 1980s (Denzin & Lincoln, 2011), critical realism

integrates insights from both traditions to provide a balanced framework for scientific inquiry (Brown, Fleetwood, & Roberts, 2002). A central premise of CR is that human knowledge can access only a limited portion of a broader, more complex reality (Fletcher, 2016). Knowledge is therefore understood as theory-laden and provisional, in which explanations may be regarded as more or less “truth-like” rather than as absolute representations of reality (Danermark et al., 2002).

From a critical realist perspective, social phenomena such as collaboration and innovation ecosystems possess real effects, yet their existence and operation are contingent upon human activity and social context. As Bhaskar (1979) explains, social structures “exist and persist only through human activity,” and the mechanisms shaping social behaviour cannot be empirically identified independently of the activities through which they operate (p. 48). This perspective highlights the importance of investigating both observable practices and the deeper conditions that shape patterned behaviour. Within this framework, participants’ lived experiences and interpretations provide an important empirical window into these underlying mechanisms (Bhaskar, 1979).

A key aim of critical realist inquiry is to develop explanations of the mechanisms and conditions through which social phenomena occur (Carlsson, 2003). It therefore encourages the integration of diverse theoretical perspectives, methods, and analytical tools to investigate complex social systems (Mingers, 2004). In this dissertation, Systems Theory is used to conceptualise collaborative structures within the construction ecosystem, while the Extended Resource-Based View is employed to examine the organisational implications of collaborative arrangements. These complementary theoretical lenses illustrate the flexibility of critical realism for analysing applied organisational phenomena.

Within CR, pattern-shaped practices produce outcomes only when they operate within appropriate contextual conditions (Allana & Clark, 2018). In the context of the Indian construction sector, mechanisms associated with collaboration, such as knowledge exchange, stakeholder engagement, and information flow, may shape innovation outcomes when supported by suitable organisational, institutional, and regulatory environments. This perspective, therefore, emphasises explanation rather than the identification of universal laws.

Adopting a critical realist epistemology also supports methodological pluralism, recognising that different methods may provide complementary insights into complex social phenomena (Allana & Clark, 2018). Accordingly, this dissertation employs a sequential mixed-method design in which qualitative and quantitative approaches contribute to theory development and empirical examination. Chapter 3 uses qualitative interviews to explore practitioner perspectives and identify mechanisms associated with collaborative practices, while Chapter 4 employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine relationships among constructs derived from the conceptual model. This combination reflects the critical realist view that empirical observations can provide insights into underlying mechanisms when interpreted within an appropriate theoretical framework (Easton, 2010; Stutchbury, 2021).

The analysis further draws on retroductive reasoning, which seeks to infer the mechanisms that could plausibly generate observed patterns within empirical data (Mukumbang, 2023). While the compatibility of PLS-SEM with CR has been debated (Singleton et al., 2023), its capacity to model complex relational structures within open social systems aligns with the critical realist understanding of context-dependent social phenomena (Bhaskar, 1989). In this study, PLS-SEM is therefore used not to establish

deterministic prediction but to examine the empirical plausibility of relationships derived from the qualitative phase.

In summary, the critical realist epistemology adopted in this dissertation provides a framework for linking empirical observations with theoretically informed explanations of underlying mechanisms. Through the integration of qualitative insights and quantitative analysis, the research seeks to advance understanding of collaborative dynamics within the construction ecosystem while recognising the contextual and provisional nature of knowledge claims.

2.3.3 Methodology

The methodology of this dissertation is grounded in the ontological and epistemological positions outlined above. Consistent with a critical realist perspective, the research adopts a mixed-method design to investigate complex organisational phenomena through complementary forms of empirical inquiry (Teddlie & Tashakkori, 2003; 2009). Mixed methods are particularly appropriate when research seeks both to develop theoretical insights and to examine their empirical plausibility within applied contexts. This dissertation employs the ESMM approach (Edmonds & Kennedy, 2017). It begins with investigating a concept, followed by a validation phase that leverages the strengths of both methods for robustness and validity (Cooper & Schindler, 2014; Heesen et al., 2016). Qualitative interviews are particularly valuable in the first phase for generating rich data to understand complexity and inform hypotheses (Flick, 2018; Breitbart, 2010).

2.3.3.1 Design Science Research Strategy

This dissertation is informed by Design Science Research (DSR), a research approach that focuses on developing artefacts to address practical problems within a specific

domain. In contrast to purely descriptive or explanatory research traditions, design science aims to generate actionable knowledge by designing and evaluating artefacts that contribute to both theoretical understanding and practical problem solving (Van Aken, 2004; Voordijk, 2009). Within the design science framework, research outputs may include constructs, models, methods, and instantiations, which collectively support the development of solutions to complex organisational challenges (March & Smith, 1995).

In this dissertation, the primary artefact is the Networked Construction Innovation Alliance Model (NCIAM), a conceptual collaboration framework developed to enhance innovation within the Indian construction sector. In DSR, models function as structured representations of problem and solution spaces, enabling researchers and practitioners to conceptualise relationships among actors, processes, and resources (March & Smith, 1995).

The artefact must therefore address a clearly identified problem, demonstrate utility for the intended domain, and contribute novel insights that extend existing knowledge (Hevner et al., 2004). In this sense, DSR emphasises innovation and relevance, requiring that artefacts be rigorously defined, internally coherent, and provide useful guidance for practitioners and researchers alike (Hevner et al., 2004; Kuechler & Vaishnavi, 2011).

Importantly, DSR recognises that artefacts may initially be conceptual or prospective rather than immediately implemented in practice. Conceptual artefacts can serve as boundary objects that support theoretical reasoning, guide future implementation, and stimulate discussion among practitioners and researchers (Hevner et al., 2004). This characteristic is particularly relevant for research addressing emerging organisational

challenges, where innovative solutions may need to be conceptualised before they can be fully implemented or tested in practice (Hevner et al., 2004; Zeng et al., 2025).

Design science research has increasingly been adopted in project management and construction research, where complex organisational systems often require solution-oriented approaches that integrate theoretical insight with practical relevance (Gregor & Zwikael, 2024; Zeng et al., 2025). In these contexts, artefacts frequently take the form of conceptual frameworks, collaborative processes, or management models that guide decision making and organisational practice. The growing adoption of DSR in construction research reflects the sector's need for structured solutions to complex challenges, including coordination, knowledge exchange, and innovation management. Frameworks derived from DSR, therefore, play an important role in supporting the development of new organisational practices and innovation strategies within construction ecosystems (Zeng et al., 2025).

In this research, the design science logic is reflected in the study's sequential structure. The qualitative phase contributes to the development of the artefact by exploring practitioners' perspectives and identifying mechanisms shaping collaborative innovation practices. The quantitative phase then examines the empirical plausibility of relationships associated with the proposed collaboration framework. Through this process, the dissertation contributes both a conceptual artefact, supported by empirical investigation (the NCIAM model), and an empirical examination of its potential implications, thereby aligning with the design–evaluation logic that underpins DSR (Hevner et al., 2004; Kuechler & Vaishnavi, 2011).

2.3.3.2 Qualitative Phase: Development of the NCIAM

Semi-structured interviews with twenty-nine experienced professionals across different parts of the construction ecosystem provided rich insights into collaborative practices and innovation challenges. This method is well-suited for exploratory research because it enables in-depth discussion while allowing participants to elaborate on their experiences and perspectives (Adams, 2015; Adeoye-Olatunde & Olenik, 2021).

2.3.3.3 Quantitative Phase: Assessment of the NCIAM

In the second phase, the potential implications of the proposed model are examined through a quantitative survey of construction professionals. Data from 178 respondents were analysed using Partial Least Squares Structural Equation Modeling. This technique is appropriate for exploratory and theory-building research because it enables the examination of relationships among multiple constructs within complex models and is robust with moderate sample sizes (Hair et al., 2018). The purpose of the quantitative analysis is not to establish definitive causal relationships, but to examine the empirical plausibility of associations among constructs within the proposed collaboration framework. In this way, the quantitative phase complements the qualitative findings by providing an additional perspective on how collaborative mechanisms may relate to organisational outcomes such as stakeholder trust, financial performance, and new business opportunities (Magno et al., 2022; Fauzi, 2022).

2.4 Responding to the Critiques of Perceptual and Futuristic Research

2.4.1 Role of Perception in Research

Perception serves as a fundamental source of knowledge. “Seeing is perceiving; and perceiving is a basic source of knowledge” (Audi, 2005, p. XVIII). Both memory and perception function as drivers in the formation of beliefs, justifications, and knowledge, whether propositional or objectual. And these perceptions and memorised experiences of humans (in this case, key informants) form the basis for creating a new stream of knowledge, as could be observed in this dissertation. The role of memory in retaining and structuring knowledge allows these insights to be organised and interpreted systematically (Audi, 2005, p. 70). This, in turn, shaped the development of the NCIAM in Chapter 3 and the model’s effect in Chapter 4. By documenting and interpreting participants’ perceptions, this research connects individual perceptions to broader systemic patterns of collaboration, in line with CR's explanatory reasoning.

Perception-based research is a well-established approach in academic scholarship, as perception is a key abstract factor shaping human and societal behaviour. Defined as the process of sensing, interpreting, and appreciating physical and social phenomena (Young, 1956), perception is more generally understood as “an idea, a belief or an image you have as a result of how you see or understand something” (Oxford Learner’s Dictionaries, n.d.). It is a complex process by which individuals select, organise, and interpret sensory stimulation to create a meaningful and coherent picture of the world (Berelson & Steiner, 1964, p. 88). Anderson and Paine (1975) emphasise that perceptions of environmental uncertainty shape how individuals perceive the need for strategic change, which represents the “strategy as perceived” dimension in broader research. Building on this idea, subsequent studies have investigated related gaps by approaching the issue from various perspectives

(Özleblebici & Çetin, 2015). From a psychological standpoint, individuals' perceptions directly influence their decision-making and, consequently, the outcomes of those decisions. Additionally, organisational researchers agree that many critical decisions within organisations are likely shaped by managers' personal cognitive processes (Beyer et al., 1997).

Snow (1976) highlighted that an organisation's actions in responding to its environment are aligned with managerial perceptions. In one of the early studies on e-commerce, when the field was still emerging, Keeney (1999) conducted interviews to explore individuals' views on the advantages and disadvantages of e-commerce. At that time, an exploratory approach was essential because existing theoretical models offered limited insights into the phenomenon (Venkatesh et al., 2013). Later, Pavlou and Fygenson (2006) employed a mixed-methods design to examine e-commerce adoption. They started with a qualitative exploratory study to identify key adoption factors, which were then integrated into a research model and tested through a confirmatory quantitative study (Venkatesh et al., 2013).

As another example, Albertsen et al. (2020) investigated consumer perceptions and acceptance of food innovations. In addition to examining perceptions, they proposed an integrated framework to explain the acceptance process. Research based on perception is frequently employed to evaluate conceptual models, as demonstrated in empirical studies within the transport and health services sectors (Cruzes et al., 2013; Pevec & Pisnik, 2018). The extant literature demonstrates that this dissertation's methodological approach is well established. Prior research in the field has frequently employed perceptual constructs as the basis for empirical analysis. For example, Pevec and Pisnik (2018) formulate their hypotheses using perceptual measures, such as perceived service quality and perceived service value, to examine relationships

within service contexts. This demonstrates the established use of perception-based constructs in empirical research.

When looking at the construction industry context, perception-based research is also prevalent in construction and project-oriented contexts, where stakeholders' perspectives can significantly shape outcomes. This is evident in studies examining transformational leadership and team-building, gaps between user and developer perceptions, practitioners' value assessments, and perspective-driven evaluations of project success (Aga, 2016; McLeod & MacDonell, 2012; J. Jia & Capretz, 2017; Wandahl, 2015). An example of a perceptual study in the construction sector that explores predictive relationships is the work by Enya et al. (2020), which reviews High Reliability Organisations (HRO) and their characteristics, forming the basis for an integrative model. This paper even presents the hypothesis like H2: Perception of construction workers hazard management **predicts** characteristics of HRO in construction and H4: Perception of construction workers job competence predicts characteristics of HRO in construction (Enya et al., 2020).

2.4.2 Futuristic Research Acceptability

The German futurist Rolf Kreibich defined the futurist research field: "Futures studies are the scientific study of possible, desirable, and probable future developments and scope for design, as well as the conditions for these in the past and in the present. Modern future studies assume that the future is not entirely determinable and that different future developments (futures) are possible, and there is scope for design." (Kreibich et al., 2011, p. 8). The exchange of diverse perspectives within the collaboration process is critical, as it is essential not only for responding to unforeseen challenges but also for proactively identifying and mitigating potential future problems (Bassanino et al., 2009).

It would not be wrong to say that in social science research, future-oriented inquiries are often perceptual in nature, as they rely on people's judgments and expectations about conditions that are yet to materialise. It must be pointed out that there are research in which the hypothesis statements do not state definitive, absolute facts; instead, they predict a perceived relationship. Colquitt (2001) proposes hypotheses such as "Distributive justice will be positively related to outcome satisfaction" and "Informational justice will be positively related to collective esteem," illustrating the conventional use of predictive phrasing in empirical research. Contemporary scientific research has evolved beyond merely investigating existing phenomena to actively identifying and constructing novel pathways (Alvesson & Sandberg, 2023) with diverse stakeholders, often with divergent objectives (Chung, 2024).

Projects addressing current and future challenges often engage stakeholders, target groups, and field experts directly. Participatory approaches facilitate the exchange of images, ideas, and concepts about the future, capturing a broad spectrum of perspectives on potential developments (Hines, 2012; Kreibich et al., 2011). Although from a different research area, contemporary Information Systems development projects similarly involve active participation from diverse internal and external stakeholders, each with distinct motivations, goals, and potentially unique success criteria, many of whose perspectives have not been thoroughly considered in previous research (Cicmil & Hodgson, 2006; Haried & Ramamurthy, 2009).

Similarly, José Ramos' Futures Action Model can be implemented in organisational settings. Its multi-layered design follows a problem-to-solution progression, drawing on the sociological principles of action research by integrating participatory engagement with futures-focused strategic planning. The model starts with challenges of broad or industry-level importance and leads organisations toward a "solution space

where participants can explore the purpose, resource strategy, and governance system of an initiative that can effectively address the issue or problem" (Ramos, 2017, p.837).

Budruk and Feldhaus (2019) developed a framework to facilitate future collaboration across social sciences, humanities, and natural sciences, aiming to advance the understanding of human-nature relationships. Complementing this, Brown et al. (2021) developed a structured process model in their study, which outlines specific stages and strategies for companies to facilitate successful collaborations within circular innovation initiatives. This prior work demonstrates how academic research can integrate forward-looking model design with practical relevance.

2.4.3 The Construction Industry Innovation Context

This dissertation considers any kind of innovation, not limited to technical advancements. Broadly, the notion of innovation is variously understood by stakeholders, and its definition is often vigorously debated (Blayse & Manley, 2004). The definition provided by Slaughter (1998) is broadly accepted by participants and academics within the construction industry. She defines innovation as follows: "Innovation is the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change" (Slaughter, 1998, p.1).

The construction industry is the world's largest consumer of resources and raw materials, accounting for roughly fifty per cent of global steel production and using around three billion tons of raw materials annually for building products (Agenda, 2016). It also generates substantial waste, meaning that even modest improvements in material efficiency and recycling can yield significant benefits (Agenda, 2016). In

response to this high level of waste, resource consumption, and environmental impact, both society and organisations are calling for innovative systems focused on sustainability to promote more rational resource use. Numerous studies emphasise the critical role of innovation in achieving sustainability and advancing sustainable development goals (Barbieri et al., 2010; Christensen, 2019; Kuzma et al., 2020).

Sustainability is increasingly shifting from a preferred attribute to a fundamental prerequisite, a transition that inevitably influences both construction methodologies and the final built structure. This imperative is now a universal priority for governments worldwide (Agenda, 2016). However, the construction sector appears to generate innovations at a pace slower than anticipated for a contemporary industry, even in light of the impetus provided by sustainability objectives (Kajander, 2016). This is significant given the established positive correlation between innovation and sustainability (Kuzma et al., 2020). Innovation itself evolves within increasingly interconnected economies characterised by evolving social norms and mounting environmental concerns (Dearing, 2000).

While some innovation has occurred at the enterprise level, overall sector productivity has remained almost unchanged over the past 50 years (Agenda, 2016). Data from the U.S. Bureau of Economic Analysis indicate that value added per worker in construction was roughly 40 percent lower in 2020 than in 1970 (Goolsbee & Syverson, 2023). As an industry shaped by competitive procurement models, construction has traditionally taken a cautious approach to product design and delivery, contributing to project management silos and a fragmented industry structure (Agenda, 2016).

The Indian construction sector plays a crucial role in national economic growth; however, its historical resistance to innovation has resulted in persistent inefficiencies, elevated expenses, and negative environmental impacts due to a prolonged reliance on conventional techniques and materials (Irani, 2023). This adherence to outdated practices creates sluggish operational processes that ultimately jeopardise project outcomes, underscoring the critical importance of innovation and digitalisation for developing more efficient and high-performing business models (Bajpai & Misra, 2021). Furthermore, the industry's complex and stringent regulatory framework presents a significant obstacle, as compliance is often a cumbersome and lengthy process that stifles the adoption of novel approaches (Singh et al., 2023).

The environmental impacts associated with construction in India point to the relevance of modern and innovative approaches. The literature indicates that such approaches are often linked to collaborative arrangements that extend beyond firm-level practices and toward shared objectives (Mojumder & Singh, 2021). Scholars have also emphasised the necessity of building an ecosystem that nurtures innovation within the Indian construction sector (Dauda et al., 2024).

2.5 Conceptual Research in Construction and Other Management Disciplines

The development of conceptual research in doctoral studies is a well-established and accepted scholarly approach, particularly when theoretical fragmentation or limited empirical foundations exist (Cropanzano, 2009). Within the social sciences, conceptual research plays a foundational role by synthesising existing scholarship, refining theoretical constructs, and developing frameworks that provide a basis for subsequent empirical investigation and validation (Van Der Waldt, 2024). The legitimacy and scholarly value of this approach are well-established in management and marketing disciplines, where conceptual models are frequently published in

leading journals (Jaakkola, 2020; Meredith, 1993). This tradition is similarly evident in supply chain and operations management, which commonly utilises conceptual frameworks to address critical areas like resilience and sustainability, including models designed for risk management and defining performance metrics (Singh et al., 2019; Yun & Ülkü, 2023). These examples demonstrate that conceptual work is both mainstream and impactful across multiple fields.

The industry's fragmented, project-based nature presents significant obstacles to systematically capturing knowledge, fostering collaboration, and driving innovation (Kivrak et al., 2008). To mitigate the persistent problem of knowledge dissipation across projects, a conceptual framework serves as a vital scholarly instrument. It establishes a foundational structure for future empirical validation, aiming to systematise knowledge management practices. The creation and eventual validation of such a framework are considered pivotal for addressing this enduring challenge, offering substantial benefits for all parties involved (Gunasekera & Chong, 2018). Building on this, Ulhaq et al. (2017) developed a conceptual framework designed to enhance knowledge management across construction project supply chains, underscoring the critical role of theoretically grounded models in connecting diverse stakeholders. In a similar vein, research by Kivrak et al. (2008) proposed a conceptual framework to systematise the knowledge-capturing process for construction firms. The study subsequently introduces a web-based application, the Knowledge Platform for Contractors, to illustrate the practical implementation of its conceptual model (Kivrak et al., 2008).

Goel et al. (2019), in their analysis of two decades of scholarship, posit that conceptual research is instrumental in pinpointing critical knowledge gaps within the field of sustainability. They concurrently emphasise that stakeholder engagement is vital for

the collaborative management and execution of sustainable construction initiatives. Complementing this view, Goh and Rowlinson (2013) formulated a conceptual maturity model designed to steer construction firms in the adoption and development of sustainable practices. These works collectively illustrate that conceptual frameworks are not only common but essential for advancing construction theory and practice.

Insights from management research reinforce this direction. Brown et al. (2021) provided a process model for collaboration in circular-oriented innovation, demonstrating how conceptual models structure multi-stakeholder cooperation. Singh et al. (2019) and Yun & Ülkü (2023) similarly proposed conceptual frameworks for resilience and risk management in supply chains, while Van Der Waldt (2024) argued that theoretical framework construction is itself a legitimate scholarly contribution. Adapting these principles allows construction scholarship to draw on well-structured conceptual models to examine collaboration and knowledge management challenges.

Landscapes influenced by human activity are multifunctional, necessitating research and management that integrate multiple disciplines (Fry, 2001). The construction sector is inherently complex, encompassing technical, organisational, economic, and social aspects. As a result, research in Construction Management and Economics (CME) is multidisciplinary, drawing on concepts, methods, and frameworks from various fields to understand, predict, and enhance processes related to the design, production, and operation of the built environment (Voordijk, 2009). Thus, although the construction industry has unique characteristics, research in this area can benefit from theories and literature from other disciplines.

In conclusion, conceptual research is a legitimate and widely accepted approach across management, marketing, supply chain, and related management disciplines.

2.6 Conclusion

The construction industry is often regarded as a distinctive sector that requires its own specialised body of literature. However, if this reasoning were strictly applied, then every industry, whether healthcare, manufacturing, IT, or finance, could be seen as equally unique, each with its own particularities. While this research is situated within the construction sector, its primary focus is not on the technical or technological aspects of construction. Instead, it examines management processes from the standpoint of a management researcher. The central concern, therefore, lies with management practices, principles, and philosophies, which are not confined to a single industry. Although the context is construction, the subject of study is management. The managerial challenges, philosophies, and organisational behaviours explored here are part of the broader field of management studies and remain relevant across industries.

For this reason, the literature underpinning the dissertation is grounded in general management scholarship. Theories and frameworks drawn from this field are transferable to multiple sectors, including construction. This choice is further justified by the inherently interdisciplinary nature of the construction industry itself, which draws upon engineering, architecture, economics, sustainability, human behaviour, and management. Studying construction in isolation from these overlapping disciplines would be limiting. Reliance solely on construction-specific literature risks narrowing the theoretical foundation and overlooking broader insights offered by management research. In short, while construction provides the empirical setting, the dissertation concerns management as a universal discipline, making the use of general management literature both appropriate and essential to the validity and rigour of this research. Having said that, the construction industry literature is integrated wherever

available to substantiate the applicability of the core management framework central to this study.

Innovation is widely acknowledged as a key driver in advancing the Sustainable Development Goals (SDGs). Yet, its full potential, particularly when viewed through systemic approaches, remains underexplored (Zadegan et al., 2025). The third chapter in this dissertation addresses this gap by designing the NCIAM framework through a systems theory lens. Importantly, the NCIAM framework is not conceived merely as an academic abstraction. Rather, it serves as a diagnostic tool that construction practitioners can employ to understand innovation collaboration systems better, identify leverage points for intervention, and adapt the framework in practice. Whereas existing collaboration models typically present only a structural representation of stakeholder interactions, often mapped by directional arrows to illustrate information flow, the NCIAM framework goes further. In addition to structure, it specifies features that can enhance the practical feasibility of real-world implementation, making it more relevant and actionable.

This chapter has also outlined the philosophical and methodological foundations of the dissertation. Ontologically, the research adopts a stratified realist view. Furthermore, this chapter has shown that knowledge can be generated not only by testing hypotheses but also by demonstrating the contextual and practical utility of a forward-looking model. This leads directly to the fourth chapter, which tests hypotheses to further validate the usefulness of the NCIAM structure. These hypotheses are not intended to establish causal relationships, given the hypothetical, futuristic context. Instead, they examine statistically significant associations between constructs in the framework, thereby evaluating the plausibility and predictive potential of the model. In

doing so, the research provides theoretical validation while recognising the limitations of causal inference.

This dissertation adopts Critical Realism as its epistemological stance, recognising the interplay between conceptual structures and human interpretations in knowledge production. Epistemologically, it also relies on abductive reasoning, understanding the iterative interplay between theory and data. Methodologically, the study is situated within the design science tradition: it produces a conceptual artefact (the NCIAM structure) while grounding it empirically through semi-structured interviews and PLS-SEM surveys. By balancing both conceptual and empirical dimensions, the dissertation demonstrates that it is not detached from reality. Instead, it offers a design-oriented, mixed-method contribution to both theory and practice. The NCIAM structure is conceptual yet empirically informed, forward-looking yet rooted in practitioner perspectives, and provisional yet rigorously justified. Taken together, these characteristics establish it as a legitimate scholarly pathway for advancing understanding of innovation ecosystems in the Indian construction industry.

I would like to conclude this chapter by stating that the core focus of this dissertation is on a collaboration strategy tailored to the Indian construction sector context, which has the potential to improve the innovation ecosystem. This dissertation does not focus on the end goal of the model, which is innovation.

3 Chapter 3 - Designing for Innovation: A Networked Construction Innovation Alliance Model for the Indian Construction Sector

Drawing on the philosophical foundations and methodological rationale presented in the previous chapter, this chapter develops the NCIAM framework and examines its potential governance mechanism in the construction industry.

3.1. Introduction

Annually, global construction-related expenditures amount to approximately USD10 trillion, accounting for thirteen percent of the world's GDP. This positions the construction sector as one of the largest in the global economy. The industry employs seven per cent of the global workforce and has a far-reaching impact, as it is responsible for creating the infrastructure where we live and work, producing energy, materials, and goods, and enabling transportation networks. Construction is a vital industry worldwide, yet it has faced challenges in modernising its practices compared to other sectors. Its significance, therefore, cannot be overstated (McKinsey Global Institute, 2017). Innovation is considered essential for the construction industry due to the challenges it will face in the future. However, implementing innovation is difficult in this fragmented and project-driven sector (Lindblad & Guerrero, 2020). Construction markets are highly dynamic and constantly shaped by evolving technologies. Competitors can easily replicate market positions, making competitive advantage a somewhat temporary phenomenon (Porter, 1996).

One important solution that can contribute to resolving the innovation-related issue in the construction sector is collaboration. Collaboration serves as a tool that fosters the growth of individuals, activities, and, reportedly, the organisations they are part of (Reficco et al., 2018). It is regarded as essential for addressing urgent global

challenges, as highlighted by UN Sustainable Development Goal (SDG) 17, which emphasises partnerships to achieve the remaining 16 SDGs (Luthra et al., 2022). Research indicates that external collaborations can enhance innovation performance by providing access to diverse knowledge areas and exposing decision-makers to various technologies (Baker et al., 2016; Martínez Costa et al., 2019). Stuart (2000) examined how alliances influence innovation rates and economic growth. A key finding from this study is that firms benefit from their partners' corporate social capital. According to Leenders and Gabbay (2000), corporate social capital encompasses the resources, both tangible and intangible, that a company gains through its social networks, which help it achieve its objectives.

MacCormack et al. (2007) found that many companies approached collaboration with an “outsourcing” mentality, leading to three key mistakes. First, they prioritised cost reduction alone, overlooking the strategic value of collaboration. Second, they failed to structure their organisations effectively for collaboration, treating innovation as akin to production and viewing partners as distant “suppliers”. Third, they neglected to invest in developing collaborative capabilities, assuming their current personnel and processes were sufficient. In contrast, successful firms established clear collaboration strategies and implemented organisational adjustments to enhance performance in these areas. Ultimately, collaboration has emerged as a vital driver of competitive advantage (MacCormack et al., 2007).

By the late 20th century, several factors converged to weaken the foundations of traditional innovation practices. A key factor was the significant increase in the number and mobility of knowledge workers, making it harder for companies to retain control over their proprietary ideas and expertise. Additionally, the rise of private venture capital played a crucial role, providing funding for new firms to commercialise ideas

that had escaped the confines of corporate research labs. Such factors have challenged traditional innovation activities and processes. When groundbreaking innovations emerge, the scientists and engineers behind them gain access to external opportunities that were previously unavailable. If the company that funded the discovery fails to act on it promptly, the individuals involved may choose to pursue it independently, through a startup backed by external investors. Should this new venture succeed, it could secure further funding via a public stock offering or be acquired at a favourable valuation (Chesbrough, 2003).

Open innovation requires companies to rethink and restructure their conventional approaches to knowledge creation and innovation. In today's highly interconnected markets, much of the knowledge essential for innovation in large, multidivisional firms exists outside individual business units and beyond corporate boundaries. To leverage these external knowledge resources, large firms must facilitate the free flow of information (Wallin & von Krogh, 2010). Consequently, organisations need to make their internal and external boundaries more flexible and establish networks built on trust (van de Vrande et al., 2009).

One type of open innovation is a form called networked innovation (Chesbrough, 2003; Valkokari et al., 2009). This model encourages technology companies to embrace a collaborative approach, where they share ideas and technologies and bring products to market through licensing agreements and other partnership arrangements (Rasmussen, 2007). Varying degrees of openness are central to networked innovation, both in theoretical frameworks and in practical applications. Network-based collaboration emphasises that knowledge and resources are spread across multiple independent yet interconnected actors within the network (Valkokari et al., 2009).

Construction is a complex process, as each project is, to some degree, unique. This uniqueness limits the potential for reusing existing solutions, a practice that is more common in other industries (Patel et al., 2012). The benefits of effective collaboration can vary depending on the type of business or company, but they often include increased profitability by sharing expertise across business units or organisations; cost reduction through the adoption of best practices; enhanced decision-making by pooling insights and knowledge; fostering innovation through the exchange of ideas; and improved capacity to achieve goals that involve multiple units or companies (Hansen & Nohria, 2004).

According to the network management literature (e.g., Johnston and Vitale, 1988; Konsynski & McFarlan, 1990), business ecosystem management involves organising the necessary structures, facilities, and mechanisms to ensure coordinated activities among ecosystem members. This suggests that managing an ecosystem requires creating and maintaining an environment where collaboration among initially loosely connected companies can develop and thrive (Riemer & Klein, 2006). The construction business ecosystem can be understood as a network of interrelated construction firms linked through diverse production systems, collectively forming a cooperative and structured business environment within the industry (Kim et al., 2015). The construction sector operates as a collaborative and systemic industry, as its supply chains involve numerous partners working together (Sanchez & Haas, 2018).

To facilitate effective open innovation, collaboration structures are designed to allow information to flow seamlessly and flexibly to areas where it can create the greatest value (Teece, 2020). Therefore, the design of collaborations fosters a culture that can quickly absorb and utilise external knowledge to adapt to rapidly changing environments (Teece, 2016). Openness comes with a risk of opportunistic behaviour.

To address this risk, effective governance mechanisms are essential, which can be established through formal or informal agreements or by aligning around shared goals (Fey & Birkinshaw, 2005). This study addresses these aspects by developing a collaboration model tailored to meet the innovation needs of the Indian construction industry.

In this study, a network-based collaboration model inspired by the OSS business approach is developed, referred to as the Networked Construction Innovation Alliance Model (NCIAM). This model is designed not only to serve as a framework for collaboration but also to incorporate initial mechanisms that help mitigate opportunistic behaviour among participants. As mentioned in previous chapters, it is worth reiterating that the NCIAM framework is based on the One-Stop-Shop (OSS) business model concept. The essence of an OSS lies in its structure as an integrated system where all collaborating partners are centrally organised and guided (Panakaduwa et al., 2025; D. Brown, 2018). The proposed NCIAM framework follows a three-tier structure, emphasising the importance of diversity among collaborators, including manufacturers, IT firms, universities, contractors, government entities, etc.

Finally, after outlining the key aspects of this network-based collaboration model, some preliminary features are demonstrated to validate its robustness. Semi-structured interviews were conducted to collect relevant data. The collaboration model is then presented and analysed in the context of existing business and management literature and interview insights. While extensive academic research supports the idea that collaboration can enhance innovation, there remains a gap in the literature regarding the specific mechanisms through which this occurs (Paulus et al., 2018; Zhao et al., 2024). This paper addresses this gap. Although differences exist among disciplines, this NCIAM framework is meant to be a generic depiction of the components of

optimum and suitable collaboration between Indian construction contractors and other industry firms.

The NCIAM framework aligns well with systems theory, which emphasises the interconnected nature of various elements within a system (Day & Shea, 2020). Key principles of systems theory include holistic thinking, the interplay between individual components and the overall system, the common flow of input, throughput, and output, and the system's interactions with its environment. The idea of viewing a system, along with the collective impact of its components, is particularly relevant to innovation (Day & Shea, 2020). One of the strengths of systems theory is its multidisciplinary perspective (Teece, 2011). Therefore, using systems theory as a theoretical lens for developing the NCIAM framework is appropriate, as it highlights the intricate and dynamic relationships among diverse actors within large, complex systems. This research investigates how a successful collaboration model is created and identifies the key dimensions that contribute to its effectiveness.

3.2. Literature Review

The following section provides an in-depth discussion of the core insights that the extant literature on collaboration has provided. In the following section, systems theory and the construction sector and its innovation needs are discussed. Based on this discussion, the relevance of inter-organisational collaboration, which follows the networked process in improving the innovation scenario in the construction sector, is pointed towards.

3.2.1. Systems Theory

Von Bertalanffy (1968) describes a system as a complex network of interacting components. According to Ng et al. (2009), a system can be understood as a unified

entity with distinct boundaries that separate its internal and external elements, allowing for the identification of inputs and outputs associated with it. Lundvall (1992, p. 2) provides a more formal definition, stating, “Somewhat more specifically, a system is constituted by a number of elements and by the relationships between these elements”. Similarly, Kuhlmann (2001, p. 955) emphasises the role of knowledge in defining a system, conceptualising it “As a system we understand a conglomeration of actors, institutions and processes all functionally bound together, whereby certain characteristic core functions of each form the demarcation criteria against other societal (sub)systems”.

Systems are typically nested and interconnected, with sub-units functioning as independent systems themselves (Bertalanffy, 1968). For example, a single firm, which can be examined as a system, is embedded within a broader industrial or business ecosystem and is interconnected with other firms in its value chain. Although the holistic perspective is a defining characteristic of systems theory, a systems approach also emphasises the importance of studying individual components. Understanding both the broader system and its individual elements is essential (Teece, 2018). A research cooperation network (or collaboration model), for instance, includes factors such as the number of co-authors who have previously worked with at least one researcher, the frequency of collaborations, identifying new collaborators, and integrating bibliographic data from various sources (Hoang et al., 2018). These components can be selected or developed either collectively or individually. Nonetheless, to ensure their effectiveness and value, they must be harmonised and linked to a well-defined strategic vision.

Systems theory is a theoretical framework that examines phenomena as integrated wholes rather than merely the aggregation of individual components. It emphasises

the interactions and relationships between parts to understand an entity's organisation, functioning, and outcomes. This approach bridges holism and reductionism, fostering a dialogue between the two (Mele et al., 2010). Systems theory is guided by two key principles: emergence and hierarchy, and communication and control (Checkland, 1999). The first principle indicates that systems are structured hierarchically, with each level potentially being more complex than the one beneath it. The second principle suggests that controls can be exerted from any level in the hierarchy onto the level below, limiting the degrees of freedom and influencing its emergent behaviour (Kopeikin et al., 2023). This study invokes emergence and hierarchy in such a way that emergence enables fluid interaction and collective learning among participants. And hierarchy provides the necessary governance to align these efforts. This creates a system that is both dynamically creative and coherently focused on its objectives.

The core idea of systems theory is that organisations are composed of multiple, interdependent components that together create something greater than the sum of their individual parts. Interactions within the system are considered purposeful, boundaries are viewed as permeable, and cause-and-effect relationships are understood as dynamic and nonlinear processes (Suter et al., 2012). Collaborative systems provide a precise framework for describing the nature and structure of collaborative relationships, without being limited by specific content. As such, collaborative systems enhance the field of 'Collaborative Networks' by clarifying the social and organisational dimensions of these networks (Neumann, 2012).

The idea of learning is fundamental to systems. These systems can self-reconfigure, or at least easily reconfigure, to sustain behaviours that satisfy all participants over time (Mele et al., 2010). Senge (1990) explores how systems thinking allows

organisations to evolve into learning entities. He emphasises systems thinking, personal mastery, mental models, shared vision, and team learning as the foundation for developing three key learning capabilities: nurturing aspiration, promoting reflective dialogue, and comprehending complexity to enhance value creation.

When we look at the construction system, including the work processes, production setup, wider industry, and social relationships among the people involved, we can see that it behaves like a complex system (Bertelsen, 2003). Seeing something as a complex system is not about creating a new category of systems; it's simply a different way of understanding them, compared to the traditional, orderly view. From this perspective, studying complexity means examining the system, without oversimplifying it, and paying attention not only to the individual parts but also to how they interact. Most systems, especially those involving people, are naturally nonlinear and full of feedback loops (Bertelsen, 2003; Kauffman, 1995). There is a growing body of academic work that uses systems theory or systems thinking as the theoretical lens for studying construction and construction projects. Researchers use these frameworks to study productivity, risk & stakeholder management, safety, carbon/eco-systems, industry transformation, and more (for example, Fernández-Solís, 2008; Mawdesley & Qambar, 2000; Ghamarimajd et al., 2024; Uusitalo et al., 2024; Muruganandan et al., 2022).

Innovation is a form of learning. To drive faster organic growth, companies must shift their perspective on innovation from one that hinders growth to one that actively enables it. This transformation necessitates rethinking the systems and processes through which innovation is pursued (Day & Shea, 2020). Additionally, innovation clusters and networks are often seen as critical components for fostering innovation. Innovation networks and clusters, along with "networks of innovation networks and

clusters", are knowledge-focused concepts that highlight the significance of networks. This underscores the need to link systems and systems theory with the networks and clusters conceptually. By applying systems theory to innovation, it becomes possible to establish connections between the components of a system and clusters (innovation clusters), as well as between the inherent logic of a system and that of networks (innovation networks) (Carayannis et al., 2016).

Systems theory highlights key considerations such as whose purposes and values are prioritised, how boundaries are defined to both enable and limit the innovation process, how elements within those boundaries are activated to foster the creation of value, how the broader context is interpreted to either support or hinder innovation, and (returning to the question of whose purposes and values matter) how 'value' is interpreted from diverse perspectives (Emerson, 2015; Midgley & Lindhult, 2021). The systems theory approach, therefore, emphasises the synergies among components, their integration, and the outcomes that arise from their interactions (Teece, 2018).

3.2.2. Interdisciplinary Collaboration Systems and Their Advantages

A common benefit of teamwork is that combining expertise and knowledge from various fields enhances creativity, particularly when addressing today's complex challenges (Lonsdale et al., 1980; Webb & Hobdell, 1980). Additionally, the rationale for collaboration is often based on the idea that relying on others for specific tasks and resources enables individuals to focus on their strengths and areas of expertise (Abramson & Rosenthal, 1995).

Kagan (1992) highlighted the creation of new professional activities as a vital element of collaborative efforts, defining collaboration as the process of establishing "an identifiable durable collaborative structure is built" (Kagan, 1992, p. 60). In their

application of systems theory to service integration, Kagan and Neville (1993) underscored how connecting individuals and programs enables the achievement of outcomes that would be unattainable through independent actions. Kagan et al.'s (1995, p. 145) research on service integration across four states revealed that effective collaboration required strategies for “broad-based reform that affects clients, programs, policy, and organisational bureaucracy”. In essence, collaborative reform goes beyond the individual participants and their immediate services to clients. This type of reform can manifest in the creation of new structures, policies, and systems for delivering services.

Collaboration is both a mindset and an interactive process rooted in cooperation and a shared commitment to working together (Lorenz et al., 1999). At its core, it involves professionals from diverse backgrounds operating within a unified framework. It requires moving beyond competition, territorial disputes, and power struggles, allowing professionals to focus on collective goals rather than individual status. Collaboration enables professionals to deliver high-quality, comprehensive, and efficient outcomes by valuing each participant’s presence, expertise, and unique strengths. Importantly, it is not a disorganised, leaderless, or ineffective group activity (Lorenz et al., 1999).

Berg-Weger and Schneider (1998, p. 698) described interdisciplinary collaboration as “an interpersonal process through which members of different disciplines contribute to a common product or goal”. In this research, we take a more positive approach because here mutual goals, collective success, and cooperative problem-solving are highlighted. Interdisciplinary collaboration is viewed as an effective interpersonal process that enables accomplishing goals that would be unattainable if professionals worked independently (Bruner, 1991). Given the complexity of construction projects

and their numerous lifecycle stages, the industry has developed robust mechanisms to integrate the expertise of multidisciplinary stakeholders, including owners, architects, engineers, contractors, and suppliers (W. Shen et al., 2010).

An alternative term for interdisciplinary collaboration is cross-sector collaboration. Cross-sector collaboration is a powerful approach for leveraging resources in a mutually beneficial manner while embedding sustainable practices into the value chain (Luthra et al., 2022). It involves partnerships among organisations, governments, non-profits, philanthropic entities, and other sectors, united by a shared goal of addressing societal challenges by integrating diverse perspectives and resources (Al-Tabbaa et al., 2019). The open innovation model reinforces the idea that collaborative networks are a crucial external element in the innovation process, particularly for overcoming the resource constraints faced by SMEs (Corsten & Felde, 2005). Avermaete et al. (2003) identified four key domains of innovation: product, process, market, and organisational innovation.

The architecture, engineering, and construction (AEC) industry is increasingly adopting integrated project delivery models that foster collaboration and efficiency across all phases of construction projects. Collaborative Project Delivery (CPD) has been conceptualised as a cooperative framework that aligns the goals and interests of all stakeholders while promoting shared risks and rewards throughout the design and construction process (Babalola et al., 2024). In this context, a well-defined capital construction project often aligns with an organisation's broader strategic objectives, emerging from intensive cross-functional collaboration between business and project units (Yin et al., 2023). Moreover, cross-sector collaborations within the construction industry are frequently motivated not only by commercial and institutional imperatives

but also by organisational commitments to achieving broader social value and public-good outcomes (Barraket & Loosemore, 2017).

3.2.3. Why do organisations collaborate?

A firm's decision to enter a partnership is often analysed through a cost-benefit framework, where the advantages and disadvantages of alliances are primarily strategic and technological. Partnerships form when the anticipated benefits outweigh the costs (Harrigan, 1985; Contractor & Lorange, 1988). In today's rapidly evolving, technology-driven landscape, sources of innovation are widely dispersed, constantly shifting (OECD, 2008) and often exceed the capabilities of individual companies (Hagedoorn & Duysters, 2002). Business ecosystems provide companies with an environment that fosters diversity, learning, interconnectedness, and mutually beneficial interactions. A knowledge-based business ecosystem typically involves firms situated in close geographical proximity, creating a hub centred on shared knowledge and innovation (Peltoniemi et al., 2005; Martin & Moodysson, 2011).

Firms operating within a well-managed ecosystem often gain a competitive advantage over those outside such ecosystems, thanks to the synergy effects among individual members and the collective benefits of the ecosystem (van der Borgh et al., 2012). Integration ensures that organisational goals are achieved, and consistency is maintained across the organisation. At the same time, differentiation is essential due to the efficiencies gained through specialisation, as no single individual can possess all the knowledge needed to perform every task required by an organisation (Meyer, 1982). Companies in the construction sector similarly collaborate on construction projects primarily to share and manage knowledge more effectively, thereby improving efficiency and project value (Ren et al., 2018). Contractors collaborate to manage the challenges of complex, uncertain, and resource-limited construction environments,

using knowledge sharing to leverage the expertise of other stakeholders for effective project delivery (Cheng et al., 2023).

3.2.4. Network-Based Collaboration

Collaboration within networks is widely recognised as essential for maintaining a competitive edge in an increasingly unpredictable industrial landscape. In fact, operations researchers argue that industrial firms no longer compete as standalone entities but rather as members of broader industrial collectives (Hwang et al., 2008; Khilwani et al., 2009). From a network perspective, Podolny and Page (1998) distinguish between two forms of learning. First, networks can enable learning by transferring knowledge between firms, essentially serving as channels for processing and disseminating knowledge. Learning from an alliance partner exemplifies this type of knowledge exchange. Second, networks can also serve as platforms for generating new knowledge at the network level. Collaborative efforts among organisations transform conventional management practices and establish fresh inter-organisational frameworks for strategy, coordination, control, and information and knowledge management. Although networks are celebrated as the organisational structures of the future, they are also fragile and unstable arrangements that often face challenges and failures (Klein & Poulymenakou, 2006).

Kale et al. (2000) discovered a positive correlation between the strength of relationships and the level of learning within alliances. Proximity plays a key role in establishing network connections and enhancing interactions between firms and individuals, which are essential for knowledge exchange. The greater the reliance on tacit knowledge, the more critical physical closeness becomes for the parties engaged in the exchange (Maskell & Malmberg, 1999). Research on interorganizational networks related to innovation explores various network types, such as cross-sectoral,

horizontal, and vertical networks, along with their characteristics, the roles of modern actors within them, and potential factors for success. The intricate nature of the design process demands a broader network of participants, spanning vertical, horizontal, and cross-industry collaborations, beyond what is typically seen in conventional innovation networks (Melander & Arvidsson, 2022).

Collaborating in networks for innovation generates value across three levels: for the individual firm (micro level), among participating actors (meso level), and within society (macro level) (Garcia et al., 2019). Research indicates that firms engaged in collaborative networks are more likely to achieve innovation (Zubeltzu-Jaka et al., 2018). Additionally, Zhou et al. (2020) demonstrate that when network participants are more accustomed to embeddedness and knowledge-sharing practices, they are better equipped to take effective steps toward developing innovations.

The reasons for joining networks vary widely; while knowledge exchange is a key motivation, networks also fulfil other roles, such as facilitating industry standards-setting, piloting initiatives, and commercialisation efforts (Kiefer et al., 2017). Audretsch et al. (2011) highlighted that innovation accelerators provide critical opportunities for building social capital, fostering the trust and tacit knowledge essential for launching new ventures. Earlier research has explored the significance of social capital in inter-organisational networks (Inkpen & Tsang, 2005) and the role of social interactions in driving innovation within highly innovative firms (Molina-Morales & Martinez-Fernandez, 2010).

3.2.5. Innovation and Partnering

The advantages of partnering for innovation are widely recognised in academic research. Bresnen and Marshall (2000, p. 231) highlight several benefits over

traditional methods, including higher productivity, lower costs, shorter project timelines, enhanced quality, and greater client satisfaction. The innovation benefits of relationship management in construction projects, whether through partnering or alliancing, stem from improved knowledge sharing between organisations and a greater willingness among firms and individuals to propose and implement unconventional solutions (Barlow, 2000; Kumaraswamy & Dulaimi, 2001). Inter-organisational collaboration among stakeholders is regarded as a fundamental requirement for managing innovation in sustainable construction projects (Zhang et al., 2020). A key approach to fostering such collaboration for innovation is open innovation (Chesbrough, 2003).

Open innovation has emerged as a transformative approach to organising innovation (Chesbrough, 2003). It is based on the principle that companies can and should leverage external ideas alongside internal ones, as well as external pathways to market, to drive their innovation efforts. This approach integrates internal and external ideas into cohesive platforms, architectures, and systems. At its core, open innovation revolves around the capacity to establish a network that enables individuals, organisations, and sectors to collaborate and co-create. It is underpinned by business models, frameworks for creating and capturing value, that fluidly extend beyond organisational boundaries within the broader innovation ecosystem (Holgersson et al., 2018). In the construction sector as well, innovation thrives when stakeholders maintain effective collaboration and strong working relationships. Investigating these collaborative networks provides insight into the internal processes that drive innovative outcomes (Xue et al., 2017).

3.2.6. Construction Sector and Collaboration

The construction sector is a highly interconnected and complex industry, characterised by supply chains that involve numerous partners and relationships (Sanchez & Haas, 2018). According to the Relational View, a firm's critical resources often extend beyond its boundaries and are embedded in interfirm resources and collaborative routines (Dyer & Singh, 1998). In construction, partners depend on each other's resources and capabilities to execute projects, engaging in various forms of collaboration to share information, knowledge, and materials. The Relational View emphasises that these relationships are essential for enabling the development of circular building projects. However, despite the inevitability of cross-sectoral collaboration in construction, silo structures remain prevalent, with firms often interacting primarily with immediate actors in the supply chain and displaying a conservative approach to broader collaboration (Köhler et al., 2022).

Modern construction projects engage a wide range of specialised firms, including those focused on property development, architecture, structural engineering, mechanical and electrical engineering, project management, construction, and the fabrication of building components and materials. As a result, the construction sector's value chain is broadly characterised by a diverse array of firms. This has led many to describe the sector as highly fragmented (Barlow, 2000; Dulaimi et al., 2002; BIS, 2013).

One of the most challenging aspects of construction production is the temporary or one-off nature of construction projects. This characteristic leads to discontinuities in knowledge development and transfer both within and across organisations, as well as limitations in building 'organisational memory' (Dubois & Gadde, 2002). The unique, one-off nature of most building projects restricts the applicability of innovations to other

situations, diminishing the potential benefits of innovation and, consequently, the incentives to innovate. This often leads to the repeated development of different solutions for similar or identical client requirements, which hinders organisational learning (Barlow, 2000). The project-based structure of the construction industry often limits opportunities for sustained innovation, as it constrains the development of long-term relationships and the alignment of incentives beyond individual projects (Vosman et al., 2023).

Greater levels of innovation in the construction industry are likely to enhance its contribution to economic growth. However, in many countries, the industry is often perceived as lacking innovation, with significant potential for improvement (Dulaimi et al., 2002). As one of the most resource-intensive sectors, construction is responsible for more than a third of global energy consumption, material use, and associated waste production (UNEP, 2021). Sustainable construction involves minimising waste during building and demolition phases and promoting design-for-disassembly to close material loops and reduce energy consumption (Adams et al., 2017; Sanchez & Haas, 2018). Transitioning to a Circular Economy (CE) requires a systems-thinking approach, encouraging stakeholders in the construction sector to adopt a holistic perspective and understand the full life cycle of buildings (Zimmann et al., 2016).

A major barrier is the absence of incentives for project partners to invest substantial resources when the benefits, such as recovered materials, may be reaped by others in the distant future. However, the managerial expertise and lessons gained from participating in such projects can position a firm as a preferred partner for future building projects, enhancing its competitiveness. The construction sector, therefore, provides an ideal context for applying a collaboration framework for the circular

economy, enabling an analytical understanding of how cross-sectoral collaboration can advance CE initiatives (Köhler et al., 2022).

In a foundational study, Dubois and Gadde (2002), later expanded by Dorée and Holmen (2004), emphasised that collaboration extending beyond individual construction projects is a critical driver of innovation in the construction sector. Similarly, Miozzo and Dewick (2004) contend that firms in construction "must rely on the capabilities of other firms to produce innovation and that is facilitated by some degree of continuing cooperation between those concerned with the development of products, processes and designs." (Miozzo and Dewick, 2004, p.72).

Economic specialisation leads firms to perform distinct activities within the value chain as described in Figure 3.1. This fragmentation of the value chain significantly impacts innovation in such industries. Greater fragmentation results in a wider distribution of resources, such as knowledge, skills, and technologies, across firms, making inter-firm collaboration crucial for driving innovation. Previous research highlights that in the construction sector, where resources are spread across numerous entities, collaboration extending beyond individual projects is a key pathway to fostering innovation (Rutten, 2016).

Numerous studies and industry reports emphasise the critical role of inter-firm collaboration in driving innovation within the construction sector (Latham, 1994; Egan, 1998; Dulaimi et al., 2002; BIS, 2013). Additionally, the idea that collaboration serves as a vital source of innovation is reflected in construction sector reform initiatives globally. Efforts to foster innovation by encouraging collaboration among firms have been a key component of sector reform programs in various countries (Barlow, 2000; Cable et al., 2013).

Figure 3.1: Construction Value Chain: Actors & Interactions

Figure 3.1 is removed from the publicly accessible version of this thesis due to copyright restrictions.

Original source:

International Finance Corporation (2018*). Construction Industry Value Chain: How Companies Are Using Carbon Pricing to Address Climate Risk and Find New Opportunities*.

Available at:

https://openknowledge.worldbank.org/server/api/core/bitstreams/764fcf0f-bd53-5da3-902a-b463771060fd/content

(Source: World Bank, 2018)

3.2.7. One-Stop-Shop Business Model

The one-stop-shop (OSS) business model integrates the supply chain and customer interface, providing a single point of contact for the client (Brown, 2018). The supplier delivers a holistic design-and-build solution, coordinated by a single company or an integrated network. In construction, this model is applied to housing retrofit, functioning as a digital or physical point of contact (Panakaduwa et al., 2025). It shares similarities with the construction management procurement route (Brook, 2004) and has the potential to address market fragmentation and deliver integrated solutions (Bertoldi et al., 2021).

The OSS model is a widely adopted approach in building redevelopment (Donati & Copiello, 2023). Research highlights its benefits; Swedish construction SMEs view it

as a strategy for business growth and network expansion (Pardalis, Mainali, et al., 2019a). In Sweden, younger, higher-income, and environmentally concerned homeowners are more likely to support OSS (Pardalis et al., 2019). The model shows diverse capabilities across the EU and is supported by targeted initiatives in at least twenty-nine countries (Bagaini et al., 2022). This is crucial as the EU building renovation rate remains low at around one percent, hindering progress towards 2030 climate targets and necessitating new investment strategies that leverage One-Stop-Shops to overcome barriers like financing and end-user support (Gokarakonda et al., 2024).

3.2.8. Advantages of improving innovation in the construction sector

There is growing recognition that construction innovation involves a diverse array of participants within a product system (e.g., Marceau et al., 1999; Blayse & Manley, 2004). The mechanisation of numerous construction tasks has lowered costs by reducing the need for labour hours. Innovations in construction can also create new markets, such as those for high-tech industrial facilities required in semiconductor manufacturing. Additionally, construction-related innovations can deliver substantial social benefits (Seaden, 1996). When the cost of constructed facilities is reduced, the facilities themselves become more affordable and, therefore, more accessible to a greater proportion of the population.

Enhancing the efficiency of residential construction to elevate the quality of life for citizens is a key objective of many national construction initiatives. Similarly, innovations aimed at reducing the environmental impact of construction activities offer social benefits both locally and globally (Slaughter, 1998). Specifically, in construction, innovations frequently expand the technical feasibility of projects. Tasks or facilities

that once seemed beyond the reach of current technology can become achievable through such advancements.

Innovation can deliver substantial benefits that extend beyond direct financial savings or gains yet still enhance a company's competitive edge. For both innovators and early adopters, intangible advantages such as an enhanced reputation, streamlined workflows, and the ability to attract top talent can result from embracing innovation (Slaughter, 1998). These non-monetary benefits often hold greater significance in the early stages of innovation adoption than anticipated cost savings, as seen in implementing new information technologies in construction (Ramcharan, 1997).

3.2.9. Creation of a Successful Collaboration Model

Organisations are increasingly prioritising sharing, coalition-forming and community-driven initiatives. Collaboration has become a unifying concept that enables diverse groups to achieve shared objectives. In modern contexts, collaboration serves to minimise intergroup conflicts by aligning efforts toward common goals (Schlessman-Frost & Saunders, 1993). However, collaboration introduces a range of interpersonal, social, political, cognitive, and technical challenges. Participants from varied backgrounds must develop shared understandings (Weick et al., 2005) and synchronise their actions (Ren et al., 2008). They are often required to think innovatively and act swiftly to address issues (Rudolph et al., 2009) while navigating potential obstacles (Ren et al., 2008) and distractions (Laxmisan et al., 2007). Nevertheless, identifying the formula for creating a successful collaboration remains a central challenge.

Goldstein and Schlessman-Frost (1992) stress the need for clear and consistent communication among all team members to keep everyone well-informed and aligned.

They also recommend organising regular meetings to enhance coordination and keep the project on schedule. Furthermore, Clark (1991) underscores the importance of defining specific roles and responsibilities for each team member, promoting clarity and accountability. When these strategies are applied, they can greatly enhance the effectiveness and success of collaborative initiatives.

Other authors offer insights into the planning and management of collaboration (Clark, 1991; Hord, 1986). Flynn and Harbin (1987) outline distinct developmental stages for interagency coordination: Formation, Conceptualisation, Development, and Implementation. For example, Kagan (1991, p.78) highlights several key elements necessary for fostering collaboration, including shared resources, joint planning, shared authority and power, as well as common goals. Kagan emphasises that the structure matches the mission of the collaboration, meaning that the operational framework should reflect the collaborative objectives. This underscores the idea that collaboration inherently transforms previously independent organisations into a unified, new structure.

A model that comprehensively addresses these concerns is warranted. This new framework should enable a clear definition of goals, categories, variables, responsibilities, and activities, creating a structure that ensures accountability within the collaboration. It promotes effective collaboration by encouraging transparent communication and decision-making. Furthermore, the framework should be flexible and transferable, capable of being applied to other collaborative initiatives. Above all, the model must uphold integrity and ethics, ensuring that information and communication empower all participating agencies to access the data required for making fair and informed decisions (Schlessman-Frost & Saunders, 1993).

3.2.10. This Research Study

Hardy et al. (2005) state that a collaborative identity represents the link binding the parties together in constellations of individuals who belong to different professions. The basis for a successful collaboration appears to be the design of inter-organisational collaborative identities (Hardy et al., 2005; Hesjedal et al., 2015; Sundqvist et al., 2015; Yakhlef et al., 2015). Border alliances are common within different service professions where cooperation among actors is encouraged because it benefits the business (Caplow, 1968, pp. 136–142).

The collaboration model illustrates how individuals in the user's environment communicate and coordinate to accomplish tasks, often leveraging technology. When a project emphasises substantial collaboration, developing a collaboration model is essential. This representation becomes crucial when interactions, information sharing, and activity coordination involve three or more people. However, if the interactions are limited to two individuals with straightforward, point-to-point communication, the Relationship Model (Holtzblatt & Beyer, 2017) alone suffices.

The collaboration model helps uncover the dynamics of coordination when it becomes more intricate, such as when groups of people collaborate to plan or carry out shared activities. If collaboration is a core aspect of the design problem and involves significant complexity, creating a collaboration model is valuable (Holtzblatt & Beyer, 2017). Meanwhile, linear economies face challenges like unsustainable supply chains and pressing issues such as climate change, waste production, disposal, and environmental harm (Nandi et al., 2021). As a result, these economies are increasingly exploring innovative models, frameworks, and strategies to transition toward a sustainable future (Morseletto, 2020; Dutta et al., 2021).

The significance of developing appropriate collaboration models and the need for models tailored to specific projects or challenges have become evident. This research paper aims to address this. I align with those who believe “that models do indeed create and organise all meaning and even make ‘reality’ what it is” (Decker & Saunders, 1976, p. 35).

The construction industry is defined by the formation of temporary partnerships between firms and individual projects. As a result, collaboration beyond a single project often runs counter to the industry's culture (Holmen et al., 2005). Despite the widespread use of the term "collaboration," there is a lack of clear criteria for its practical implementation within or between organisations (Schlessman-Frost & Saunders, 1993). Although interest in the topic has increased in recent years, research specifically addressing business-to-business exchanges is still relatively scarce (Gomes et al., 2022; Matt et al., 2023; Tsytsyna & Valminen, 2024), with many aspects remaining either underexplored or insufficiently studied (Baptista & Nunes, 2025). To ensure effective collaboration, a structured model is necessary to define the key categories and variables involved. In the context of construction and related firms, such a model would ultimately foster a more innovative environment in the sector.

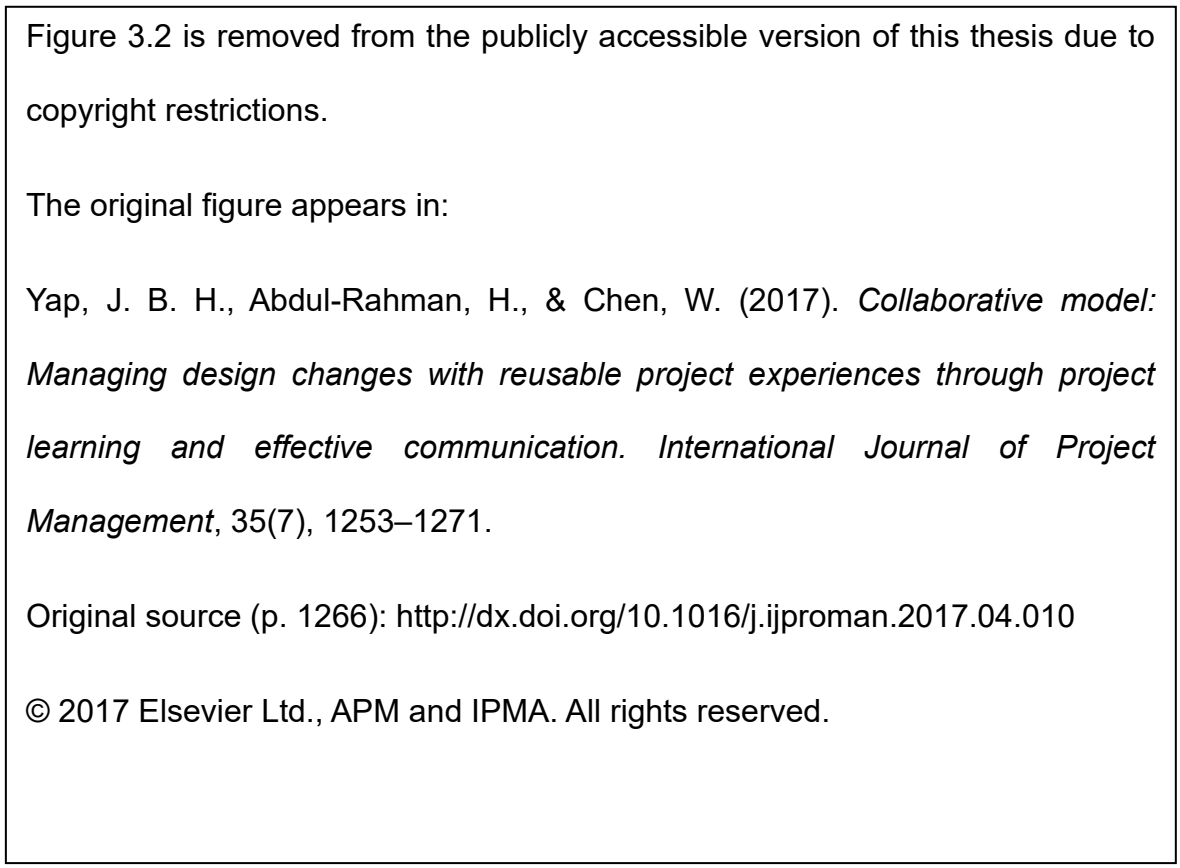
In India, the infrastructure and construction sectors are among the fastest-growing segments of the economy, yet they continue to face major challenges such as low productivity and delays in operational procedures. As a result, the three core project parameters, cost, time, and quality, are frequently compromised (Bajpai & Misra, 2021). Bajpai and Misra (2021) highlight that India’s construction sector urgently needs innovative approaches to achieve excellence in performance. Previous studies have worked on collaboration-oriented frameworks with the intention of improving performance and efficiency in construction-related projects. For example, Yap (2017)

developed and proposed a collaborative model that integrates project learning and effective communication to manage design changes more efficiently, thereby reducing rework and improving coordination among stakeholders (Refer to Figure 3.2). Building on these insights, the present research proposes a collaboration model tailored to the Indian construction context, aiming to promote more efficient and integrated project delivery practices.

This research adopts an exploratory approach to identify and propose a model that outlines the design and implementation of a collaborative NCIAM framework. Rather than testing an established theory, the study focuses on theory development through exploratory interviews, with the expectation that the proposed model may be refined and validated through future empirical research. This work builds on an existing collaboration framework, which serves as the foundation for designing a collaboration model (NCIAM) tailored to the innovation needs of the Indian construction sector. This foundational framework is the OSS business model, where a single entity, often in partnership with others, delivers comprehensive yet customised solutions (Mahapatra et al., 2013).

A collaboration system is a blend of actors, technology, knowledge, and work practices designed to help groups achieve their goals efficiently and effectively. Developing such systems involves addressing numerous interconnected challenges within a socio-technical framework. The sheer volume, complexity, and diversity of these challenges can overwhelm designers, potentially leading to flaws in system design (Briggs et al., 2009). My proposed model aims to alleviate this cognitive burden, enhancing the completeness and coherence of collaboration design, ultimately leading to better outcomes.

Figure 3.2: Collaborative model for design change management



(Source: Yap et al., 2017)

3.3. Research Goal

The key concepts, theories, and debates related to the construction sector in India and collaboration for innovation have been identified as the foundation of this research. This paper focuses on structuring the Networked Construction Innovation Alliance Model (NCIAM) to optimise its implementation and outcomes. To support this aim, the research explores the specific and defining characteristics of the NCIAM framework, examines approaches to address organisational challenges and collaboration barriers during its initiation, and outlines the potential phases involved in implementing the NCIAM framework effectively. This work also highlights the importance of various partners in this NCIAM, including government (initiation support and oversight), construction contractors (customers and investors), suppliers (innovators), etc.

Based on these objectives, a semi-structured interview guide comprising 33 questions, organised into five thematic areas, was developed to capture expert perspectives on collaboration dynamics, governance mechanisms, and implementation processes relevant to the proposed NCIAM framework.

Interview Question Design

To ensure alignment with the research objective of structuring the Networked Construction Innovation Alliance Model (NCIAM), the semi-structured interview protocol was designed to explore practitioners' experiences and perspectives on collaboration and innovation within the construction ecosystem. The questions were specifically developed to identify the first initial steps and then key structural, organisational, and operational elements that could inform the design and implementation of the proposed collaboration model.

The interview questions were organised around five main thematic areas:

First, participants were asked about the role of collaboration in improving innovation within the construction sector, allowing the study to understand current practices and perceived benefits of collaborative innovation.

Second, questions explored the formation and structure of a potential collaboration network, including the types of partners to involve and how such collaborations could be initiated and evolve over time.

Third, the interviews examined governance and organisational arrangements, including decision-making structures, the role of neutral coordinating bodies, and mechanisms for managing stakeholder relationships.

Fourth, participants were asked about operational mechanisms within the collaboration, including knowledge sharing, contractual arrangements, trust-building mechanisms, and ways of managing competition among partners.

Finally, questions explored implementation considerations and potential outcomes, including funding structures, intellectual property management, and the broader benefits participants might gain from such a collaborative framework.

These thematic areas directly reflect the study's research objective of identifying the actors, stages in the formation of collaboration, governance structures, and coordination mechanisms necessary to structure and operationalise the NCIAM framework. By drawing on the experiences and insights of industry experts, the interviews provided the empirical foundation for developing the conceptual collaboration model proposed in this study. The full list of interview questions is provided in Appendix B.

3.4. Methodology

During the data collection phase, the model was referred to as the One-Stop Collaboration (OSC) model. Following feedback from the pre-defence examination panel, the framework has been renamed the Networked Construction Innovation Alliance Model (NCIAM).

3.4.1. Data Collection

Given the limited prior research connecting innovation needs with the Indian construction sector, a qualitative approach is adopted for this study. To explore how structured, multi-stakeholder collaboration for innovation could be designed and implemented within the Indian construction sector, data were collected through semi-structured interviews (primary source), supported by company publications,

documentation of existing long-term collaborations in India, and relevant media reports. Secondary data sources were also valuable, providing a means to triangulate the findings from the interviews. Data triangulation here attempts to provide “a confluence of evidence that breeds credibility” (Eisner, 1991, p. 110). This approach enhances the credibility and depth of the findings by allowing different data sources to corroborate and complement one another.

A total of twenty-nine interviews were conducted with individuals involved in the construction industry in India, consisting of six face-to-face and twenty-three online interviews. The respondent group included three female participants and twenty-six male participants, reflecting the male-dominated nature of the construction industry. The respondents represented three organisational categories: independent bodies, innovating companies, and construction firms. The interviews were transcribed and analysed using the method developed by Savall and Zardet (2005), which involved selecting “witness sentences” to identify key categories and themes. These sentences, taken directly from the participants' own words, were chosen for their significance and representativeness.

The respondents were selected as experienced professionals whose prior involvement in collaborative projects within the construction ecosystem allowed them to provide informed perspectives on collaboration practices, governance structures, and the challenges associated with them. These insights served as a basis for exploring how such experiences could inform the design of the proposed collaboration model. The qualitative data were transcribed, organised, coded, condensed, and categorised using *NVivo* (Saldaña, 2013). To align with the abductive approach and stay open to categories that were not predefined in the theoretical framework, the

coding process also incorporated codes derived inductively from the responses of the participants.

Before the interview questions were discussed, participants were provided with a brief description of the research context and the concept of collaboration being explored. Respondents were informed that the study aimed to investigate whether a new collaborative framework could help address the relatively slow pace of innovation within the construction sector. The concept introduced to participants was initially referred to as the One-Stop Collaboration (OSC) model (now NCIAM). The OSC concept was presented as a hypothetical collaboration platform inspired by the idea of a “one-stop-shop,” in which construction contractors and other relevant ecosystem actors could possibly collaborate under a structured framework to jointly develop and implement innovations in the construction sector. Participants were informed that the purpose of the interview was to gather expert insights that would help define the structure, governance mechanisms, and operational features of this proposed collaboration model. This brief explanation ensured that respondents had a shared understanding of the concept before answering the interview questions.

All participants were informed that the data collected would be used for the purposes of this doctoral research and may contribute to future academic publications. They were also assured that their personal information would be anonymised and treated confidentially. Informed consent was obtained from all participants prior to their involvement in the study.

At the start of our study, purposeful sampling is employed (Lincoln & Guba, 1985) to initially select Indian construction professionals, followed by snowball sampling to reach additional participants. The LinkedIn website was chosen as the platform to

identify and connect with participants during the initial phase. Before proceeding with the main interviews, two pilot interviews were conducted, one with a fellow researcher and the other with a professional from the target sample group. The pilot interviews were conducted to refine my questions and gain interviewing experience. The duration of the interviews varied between twenty minutes and one hour, with an average length of thirty-two minutes for the twenty-nine respondents. The online interviews were held via Google Meet and conducted primarily in English, although some interviewees used a few Hindi phrases when they felt more comfortable, which helped them express their experiences and opinions more freely. The sampling strategy prioritised interviewing the most knowledgeable individuals in the Indian construction industry, covering a range of roles from mid-level to senior positions.

During the interviews, many respondents discussed various collaborations already existing in India involving construction companies. This discussion regarding existing collaborations came up during the interviews, and it was not originally part of the interview guide. As a result, their priorities and characteristics were also examined and included. Additionally, as recommended by the respondents, official publications and news articles were also reviewed to gain a deeper understanding of how collaborations take place in the Indian construction sector. This research prioritises the anonymity of all respondents. The data collection process concluded when theoretical saturation was achieved across all data sources (Lincoln & Guba, 1985). In this paper, numerous quotes from interviews have been incorporated, along with insights from secondary sources. Table 3.1 provides an overview of the data sources used here and how they informed this study.

Table 3.1: Description of Data

Data Type	Amount	Use in Analysis
Primary data **Interviews:** Semi-structured interviews with sixteen Indian construction employees. Five semi-structured interview responses from neutral organisations involved with the Indian construction sector. Eight semi-structured interviews with respondents from innovator companies based in India, such as manufacturing, IT, etc.	Interviews lasted between twenty minutes and sixty minutes 311 single-spaced pages of transcripts in total for interviews lasting between twenty and sixty minutes	Provided insights into individuals' perceptions of collaboration based on their experiences of working in a construction company Brought in their expertise and opinion from a neutral standpoint when dealing with the construction industry Shared their perception of working in collaboration with construction companies in India.
Secondary data based on recommendations by interviewees Publications from the organisations Existing Collaborations Media articles	 Ninety pages Five in number Fifteen single-spaced pages	Provided insights into what companies and the government are thinking about the future of the Indian construction sector and the importance of innovation.

(Source: Author's own)

Table 3.2: Interview Participants

ACTORS	POSITION	EXPERIENCE IN YEARS	GENDER	TYPE OF ORGANISATION	MEDIUM OF PARTICIPATION
GR1	Senior Program Manager	11.5	M	Government Body	ONLINE
GR2	Deputy Director General	13	M	Government Body	Face-to-Face
UR1	Assistant Professor	08	F	University	ONLINE
UR2	Assistant Professor	18	M	University	ONLINE
NR1	National Program Manager	10	M	NGO	ONLINE
CR1	Planning Manager	10.5	M	Construction	ONLINE
CR2	Strategic Project Manager	10	F	Construction	ONLINE
CR3	Manager - Tendering	11	M	Construction	ONLINE
CR4	General Manager	10	M	Construction	ONLINE
CR5	Senior Planning Manager	10	M	Construction	ONLINE
CR6	Assistant General Manager	10	M	Construction	ONLINE
CR7	Deputy General Manager	14.5	M	Construction	Face-to-Face
CR8	Project Manager	13.5	M	Construction	ONLINE
CR9	Project Manager	18	M	Construction	Face-to-Face
CR10	Lead – Steel Structures	30	M	Construction	Face-to-Face

CR11	Quality Engineer	07	M	Construction	Face-to-Face
CR12	Head -EHS	25	M	Construction	Face-to-Face
CR13	Project Controls Manager	16	F	Construction	ONLINE
CR14	Assistant General Manager	15	M	Construction	ONLINE
CR15	Manager	15	M	Construction	ONLINE
CR16	Deputy Manager	14	M	Construction	ONLINE
IR1	General Manager – Business Development	16	M	Manufacturing	ONLINE
IR2	Co-Founder and CEO	15	M	IT (Prop-Tech)	ONLINE
IR3	Reliability Improvement Analyst	14	M	Manufacturing	ONLINE
IR4	Senior Civil and Structural Engineer	19	M	Design Consulting	ONLINE
IR5	Management Consultant	16	M	Infrastructure Consulting	ONLINE
IR6	Co-Founder and Business Head	35	M	IT	ONLINE
IR7	Project Manager	13	M	Manufacturing	ONLINE
IR8	Assistant Project Manager	11	M	Design and Manufacturing	ONLINE

(Source: Author's own)

3.4.2. Data Analysis

Once all the data were gathered, the analysis began by examining the respondents' perspectives on collaboration strategies to enhance innovation in the Indian construction sector. Additionally, five collaborations in India, which involved

construction companies and were suggested by the respondents, were analysed to determine if they primarily focused on innovation and to identify their limitations. The importance and role of government institutions or departments were also considered in promoting innovation within the Indian construction sector. Following this, I proceeded with developing the NCIAM structure based on the respondents' feedback. During the analysis, notable differences were observed in how various stakeholders viewed the same issues, depending on their sector. For example, most interviewees emphasised the importance of including neutral parties, such as the government, universities, and NGOs, in the NCIAM framework, while a few were sceptical about their role and influence.

Recognising the significance of these differences, this research aims to understand the broader evolution of the collaboration model and identify key characteristics of the NCIAM framework based on the interpretation of responses. By systematically examining the perspectives of various respondents on how collaborating members should unite and on the guidelines for becoming an NCIAM partner, a consistent pattern emerges regarding how these relationships can evolve.

Insights from the literature are systematically integrated with empirical observations to explore how the collaboration model can be developed. The data is organised using NVivo, and to maintain rigour in the qualitative analysis, the Gioia approach is applied. Gioia et al. (2012, p.21) emphasised that researchers should balance data and existing theory, combining "knowing" and "not knowing" to facilitate discovery while avoiding unnecessary repetition of established knowledge.

In this phase, I first adhere closely to the information provided by the informants (Gioia et al., 2012; van Maanen, 1979). Key and recurring expressions are then identified

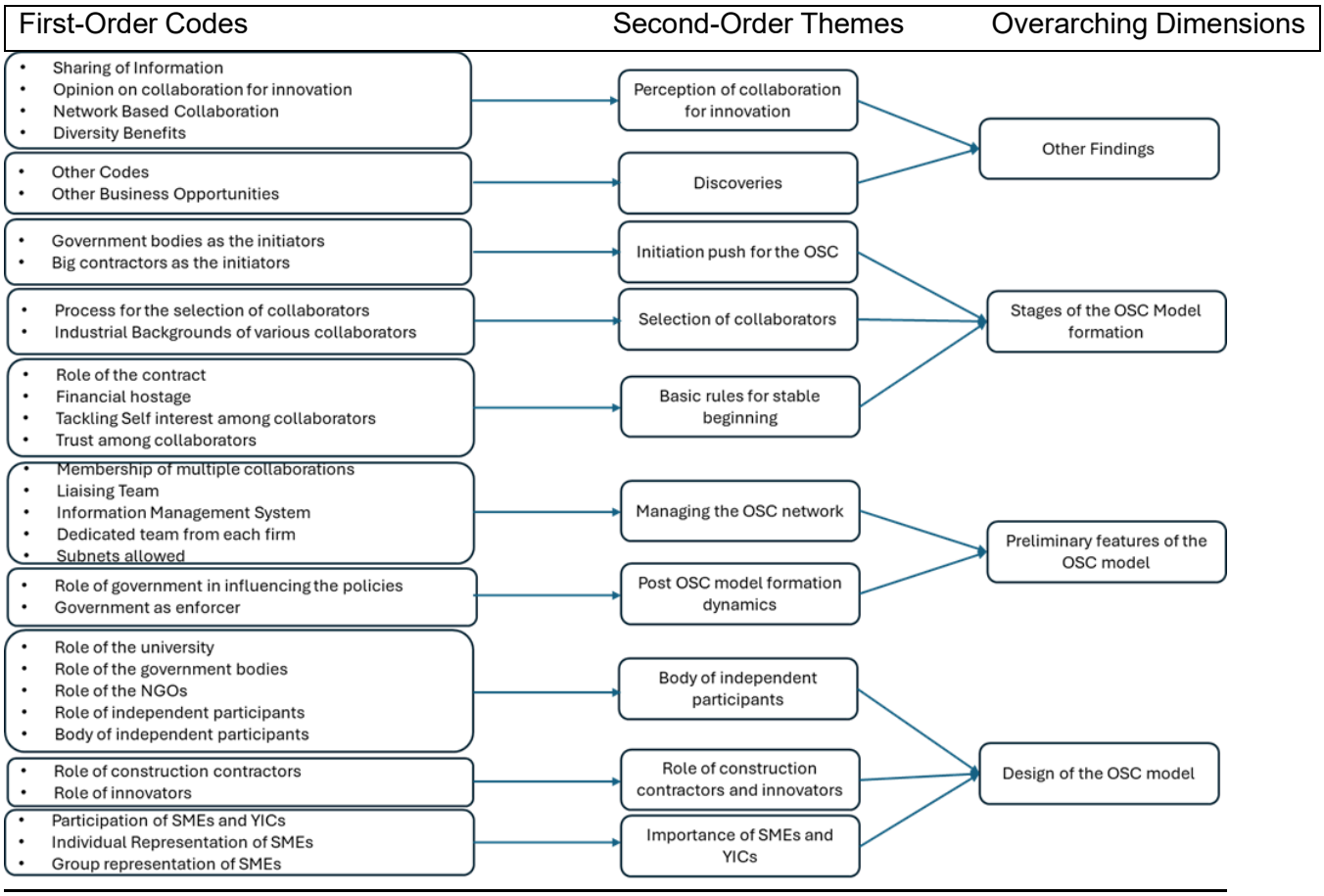
and coded to reflect respondents' past experiences and how they derived their opinions from those experiences. During this initial stage of data analysis, I remain deeply aligned with the interviewees' exact wording, ensuring that my understanding is firmly rooted in the empirical data. Second, I consolidate these codes into broader themes. At this stage, I compare the emerging insights with existing literature. By iteratively moving between theory and data, the codes and concepts are refined throughout the analysis. As a result, prior publications on the topic proved invaluable in interpreting and contextualising the data. In a third and final step, I combine my data-driven first-order codes (refer to Figure 3.3 below) with theoretically grounded second-order themes to form overarching dimensions (Gioia et al., 2012).

Figure 3.3 illustrates the structure of the data. Through analysis, links between the emergent dimensions were identified, a process that involved careful consideration of the participants' diverse backgrounds to capture a range of experiential responses. Theoretical insights and expositions were developed by engaging with extant literature and secondary data, culminating in the creation of the NCIAM framework. Key informants were recruited as the primary source of data for this investigation.

3.4. Findings

This section examines the perspectives of managers and key informants from diverse industries and organisations, with direct quotes incorporated to substantiate and illustrate the key dimensions. Based on this, both the design and features of the NCIAM framework are developed to encapsulate the conclusions and demonstrate the connections between key concepts. The step-by-step process of creating the model is outlined, and an analysis is provided on how respondents from the construction industry perceive the challenge of managing individuals with varying self-interests and knowledge backgrounds within a unified framework. Three main overarching

Figure 3.3: Key Dimensions and their empirical evidence



(Source: Author's own)

dimensions emerged: stages, features, and design of the NCIAM framework. Another aggregate, "Other findings", was also identified, but the analysis is limited to perceptions of collaboration. However, before these overarching dimensions are examined, five specific collaborations suggested by respondents during the interviews are first presented.

3.4.1. Existing Collaborations in India

The respondents recommended exploring several organisational alliances in India that were highlighted during our discussions, which included participants from a wide range of Indian companies. They emphasised that being part of such associations offers

valuable benefits, including access to knowledge, enhanced reputation, and expanded professional networks. Table 3.3 describes these organisations.

Table 3.3: Existing Premier Associations in India

Respondent	Name	Objective(s)	Source link
CR6	Building Materials and Technology Promotion Council (BMTPC)	BMTPC has been dedicated to implementing a holistic and unified strategy to promote affordable, eco-friendly, and energy-efficient innovative building materials and construction technologies for both urban and rural housing, incorporating disaster-resilient practices. BMTPC focuses on fostering a supportive environment for affordable housing and sustainable development. BMTPC, an interministerial organisation, is committed to advancing innovative and affordable building materials and products by evaluating, validating proven technologies, and facilitating the widespread dissemination of information through demonstrations and large-scale outreach. The Council maintains ongoing engagement with R&D and standardisation institutions, industry stakeholders, relevant associations and federations, industrial promotion agencies, financial institutions, public and private sector construction organisations, and NGOs.	https://www.bmtpc.org/
GR1	Builders' Association of India (BAI)	BAI is the sole nationwide apex organisation representing civil engineering and construction companies across India. Their role is to engage with government entities such as State Public Works Departments and the Central Public Works Department, with the aim of modernising work methods and specifications, fostering appropriate work ethics within the industry, and standardising tender processes.	https://www.baionline.in/
GR1	Federation of Indian Chambers of Commerce & Industry (FICCI)	FICCI is India's largest and oldest apex business organisation. FICCI serves as the representative voice of India's business and industry. It influences policy, fosters dialogue,	https://www.ficci.in/api/home

		collaborates with policymakers and civil society, and advocates for the interests and perspectives of the industry. It provides support and representation to its members, which include Indian private and public sector corporations as well as multinational companies.	
IR3	Confederation of Indian Industry (CII)	The Confederation of Indian Industry (CII) aims to foster and maintain an environment that supports India's growth by collaborating with industry, government, and civil society through advisory and consultative initiatives. A core mission of CII is to help its members enhance productivity and efficiency, enabling them to meet global standards and compete effectively on the international stage. CII drives transformation by collaborating with the government on policy matters, engaging with thought leaders, and improving efficiency, competitiveness, and business opportunities for the industry. This is achieved through a variety of specialised services and strategic global partnerships.	https://www.cii.in/
CR6	National Association of Software and Services Companies (NASSCOM),	NASSCOM is dedicated to positioning India as the worldwide centre for innovation and IT services, with a commitment to humanising technology by enhancing and empowering people's lives. NASSCOM is a mission-oriented organisation that collaborates with industry, government, and academia to build India into the most reliable ecosystem for delivering world-class products and services, nurturing digital talent, and creating meaningful impact.	https://www.nasscom.in/

(Source: Author's own)

BMTPC operates under a government department, while the other associations are either directly or indirectly linked to the government and its entities, facilitating networking opportunities. Among them, only BMTPC and BAI specifically focus on the construction sector, whereas NASSCOM serves the IT industry, and FICCI and CII cater to a wide range of industries and organisations. Although all these associations

engage in some level of innovation, it is not their primary objective. BMTPC is the sole organisation actively involved in innovation-related activities, but its primary focus is housing construction, particularly for low-income housing projects. Moreover, it largely operates independently, making it a top-down, government-controlled entity for innovation within the construction sector. However, none of these associations approaches the Indian construction sector with a perspective that could significantly enhance the innovation ecosystem. Most do not even consider innovation explicitly, and only one focuses on construction-sector innovation, albeit with very limited impact.

Professional and trade associations play a significant role in shaping industry behaviours, both directly and through indirect influences. First, these associations establish norms, informal rules, and codes of conduct that help maintain order without relying on legal enforcement. Instead, they use decentralised mechanisms where noncompliance results in social and economic penalties (North, 1990, p. 59). Second, research suggests that professional associations often collaborate with state agencies to safeguard their self-regulatory independence and autonomy (Greenwood & Hinings, 1996). In some cases, the state partners with these associations to streamline and regulate specific areas of activity (Scott, 1992, p. 211). So, it is beneficial for construction firms to be members of some useful professional and trade associations.

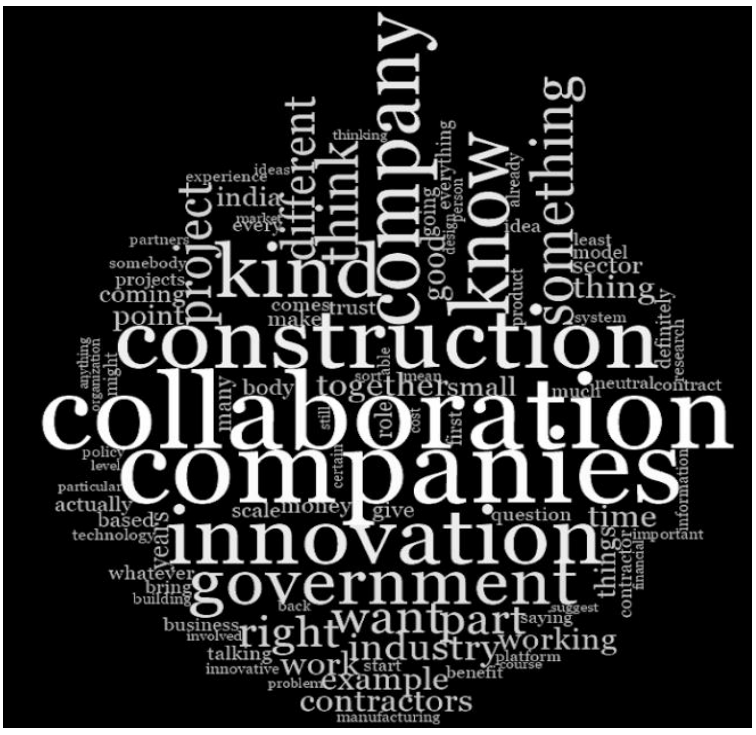
These associations highlight a positive aspect: companies in India have experience working within such networks. This familiarity with various participants enables construction companies to place greater trust in known partners, increasing the likelihood of successful future collaborations.

3.4.2. Perception of Collaboration for Innovation

From a systems theory viewpoint, addressing complex, interconnected challenges in innovation requires recognising the interdependencies within and across stakeholder networks. Systems approaches enable this by facilitating synergistic value creation. Systemic innovation, in this context, emerges as the coordinated evolution of multiple, interacting innovations within an interconnected system of organisations, commonly referred to as an innovation system (Lindhult et al., 2022).

Based on the responses collected for coding, a word cloud was generated using the *NVivo* software. This is done so that the readers can get acquainted with the subject domain that will be dealt with in this and the following segments.

Figure 3.4: Word Cloud based on responses



(Source: Author's own)

The most prominent and frequently recurring terms in the responses, such as collaboration, government, construction, and innovation, are central to this research.

These keywords highlight the core elements of the study, including stakeholder involvement, the value of partnerships, and the need for creative solutions. Their repeated occurrence serves to reinforce their significance and validate the study's central themes.

The innovation advantages of collaborations and alliances are well-documented in the literature (Todeva & Knoke, 2005). Partnerships help strengthen social networks and interpersonal relationships, fostering trust and providing access to diverse skill sets that enhance creative problem-solving (Uzzi & Dunlap, 2005). This is extensively discussed in the research background section above. Informants unanimously expressed positive views on collaboration for innovation, believing that network-based or any form of collaborative innovation benefits not only contractors but also the environment and society.

Table 3.4: Illustration of two categories of organisations working in the construction industry

Construction Contractor Respondents	Other Respondents
CR1: "In terms of innovations, the collaboration is a must to enhance the progress, enhance the situation of the project."	UR2: "We do have many benefits of your collaboration. Maybe we can have an innovation that will, you know, reduce waste, right?"
CR11: "I believe that as we collaborate on a construction project with different partners to complete a project successfully, similar could be said about collaboration for innovation in the construction sector. This will certainly help."	GR1: "Yeah, yeah, yeah. So, actually, in the construction industry, they don't put much focus on R&D - research and development……There are other benefits or strengths of collaboration because everybody could contribute in terms of, suppose they want to do some research, and every company could contribute and create a fund for this innovation"
CR3: "It's required because the things which are going on in India, in the construction, we are lagging so much, and that is the main part of any project's particular domain, and it is lagging in	GR2: "So construction contractors, they're basically subcontracting. But if we are saying that people are sharing their good practices and accordingly that is being utilised in either programs or projects, then I would say that is called

that…. Yes, for innovation, they should come together. 100% .”	collaboration, and that is different from subcontracting because that is already happening”
CR4: “So the collaboration at the industry level is not just helping to get higher productivity but is also good for the overall welfare of the society, also because if a lot of the population is working in this built environment segment, so they should also get a better work-life. So, in that perspective, also this collaboration is helpful”	IR2: “It has helped me a lot - doing collaborations. I also started with the collaboration directly with the developers. While doing so, I got in touch with a lot of the lenders. Once I got in touch with lenders, they connected me with a lot of other developers… So, this network effect matters a lot. It helps you a lot, especially if it is from one sector to another. If you truly want a very holistic approach, then this is a good way.”

(Source: Author’s own)

They believed that tackling a problem with multiple minds could lead to solutions more effectively than working in isolation. Additionally, the construction industry frequently involves subcontracting, indicating that they are already experienced in managing collaborative environments.

CR11: “Like in construction projects, we have various partnerships because not all companies have every skill and knowledge. Similarly, in a network where I think there will be companies with diverse knowledge, it will help in improving innovation conditions. This is true, in my opinion, for any industry. And that's why I feel construction can also get benefits from this.”

Some participants believed that collaboration is beneficial across all industries, particularly in construction, as this sector has seen limited innovation. In some cases, the regulatory framework for approving and adopting new technologies is outdated, preventing advancements made in other countries from being accepted in India. Both construction and manufacturing professionals supported the notion that network-based associations, such as One-Stop-Shop inspired models, could help advocate for faster government approvals and the adoption of new technologies or methods.

One of the respondents, who is a professor at a university (UR2), pointed towards the UN Sustainable Development Goals (SDGs). There are at least three SDGs which resonated with the central idea of this project, which is designing a collaboration network model for innovation.

Table 3.5: Important SDGs

SDG NO.	Details of the SDGs
9	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation
13	Take urgent action to combat climate change and its impacts
17	Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development

(Source: https://sdgs.un.org/goals)

These three goals talk about fostering innovation, reducing the adverse effects of climate change and partnership. At some level, this study is also trying to address these issues so that it can contribute to the achievement of these goals.

Three collaborative reports on the future of the building and construction sector, produced by the National Real Estate Development Council (NAREDCO), India's leading real estate industry association, in partnership with KPMG, ANAROCK, and Knight Frank, highlighted the importance of embracing technology, innovative construction techniques, and sustainable practices. These publications emphasised the need for enhancing efficiency, fostering innovation, and reducing greenhouse gas emissions within the Indian real estate sector.

Table 3.6: Publications by NAREDCO

Sl NO.	Publication Title	In Collaboration With	Year
1	Indian Real Estate Vision 2047	Knight Frank	2023
2	Real Estate Unboxed – The Modi Effect	ANAROCK	2024
3	Navigating the dynamics of real Estate in India	KPMG	2024

Most participants expressed generally positive views about collaboration as a mechanism for supporting innovation within the construction sector. These initial responses were not intended to justify the development of the proposed collaboration model, which is already grounded in the research gap identified in the literature. Rather, these opening questions served to capture respondents' experiences with collaborative practices and to introduce the discussion before moving toward more specific questions about structured network-based collaboration frameworks that would further lead to the development of the proposed NCIAM framework.

The interviewees also expressed their views on knowledge sharing, emphasising that exchanging information is advantageous for all, particularly in the construction industry and for the broader benefit of society.

CR1: "So, irrespective of the fact that our company has created that technology, we are still sharing it with other companies. So, this stops the monopoly of having a good innovation. And once we share an innovation with other companies, the innovation grows. Because if we don't, then our innovation growth or that innovation's further growth and development, will stop."

CR9: "Just the thing is that everyone wants to grow. And everyone wants simplification. So, in here, there will not be any competition. What I feel, my personal opinion, is that there will not be any competitiveness. There is only data sharing and the way we want to execute, and the way further we want to take the construction system or construction execution activities to a higher level and in a simplified way."

Collaboration fosters the exchange and dissemination of knowledge, which in turn helps build lasting partnerships (Guan & Zhao, 2013).

3.4.3. Stages of the NCIAM framework

The systemic approach adopts a bottom-up perspective, emphasising the collaborative system as an evolving entity while examining micro-level interactions, such as those between individual agents, to uncover how its properties arise organically and provide a comprehensive view of its developmental trajectory (Stacey et al., 2000; Batty & Torrens, 2001). This method recognises that the actions of different system participants can collectively alter their evolutionary course. Key characteristics of complex systems within collaboration networks include emergence, self-organisation, path dependence, operational closure, thermodynamic openness, co-evolution, adaptation, and learning (Tani et al., 2018).

Respondents highlighted several aspects regarding the potential initiation of such a collaboration. A commonly expressed view was that the process should begin with a relatively small group of influential stakeholders, particularly leading construction firms, who could initiate discussions and provide credibility to the collaboration. While most respondents suggested that government bodies could play a facilitating role in supporting the early stages of such an initiative, a minority of participants felt that the collaboration should remain industry-led, with no direct government involvement. Respondents further indicated that once these core actors were engaged, additional partners could be gradually invited, and foundational guidelines could be established to support the stable launch of the NCIAM.

Initiation push for the NCIAM: The role of an initiator in encouraging, rather than controlling, collective action is essential (Mattiacci & Zampi, 2004). According to Burt (2002), a capable initiator can enhance enabling factors and mitigate challenges by developing suitable coping mechanisms. Here, the informants suggested that there are two ways in which this NCIAM framework could be initiated. The most effective

approach is for the government to take the lead in this initiative. It can invite key stakeholders, such as manufacturers, IT firms, and large construction contractors, to come together and initiate discussions. Given that the Indian government already holds the responsibility of addressing climate change, it is logical for them to endorse and drive this collaborative effort, ensuring that all involved parties act.

CR11: “Governments these days are involved in pollution control, and that's why they kind of support the idea of, let's say, generating power from solar energy and green hydrogen, etc. And this suggests to me that they can act as initiators for this type of collaboration as well.”

Respondent CR4 even suggested that the government can lure firms by giving tax rebates, or they could use their iron hands and enforce it.

CR13: “See, there are a lot of initiatives being taken by the Government of India……. So, under the Indian Government, there are a lot of ministries. I think they can initiate it. They can take their effort to bring forth all the participants and the private sectors together. And also, they can associate with some research and development institutes that are working in India to give more input and data for that innovation.”

The second option proposed by respondents for initiating the NCIAM framework involved a well-established, large construction contractor taking on the role of a focal firm. This firm would encourage other similar contractors to unite and begin discussions on how to initiate a collaborative framework.

CR9: “Someone who is an industry senior, those people have to come forward, and they have to call all the contacts they are having, and they have to give a platform, like online platforms, so that those who might be interested can join. They must reach out to the organisations who are having that experience. And they must request them if

they are really interested, they will come and they will support. As it is not a business, no one would be a competitor here."

UR2: "I mean, the well-established company, even the small company, can also do this. But if someone already is some kind of figure and if they speak for sure, there will be some influence or some impact, yeah, OK, so that is possible."

Private collaborators have started several successful collaboration initiatives. This paper mentions a couple of examples, such as NASSCOM and FICCI.

The interviews and the historical analysis of such collaborations highlighted the crucial role of government involvement. Respondent CR12 provided an example of the UAE's development, which was driven by a collaborative system known as *'majilis'*. This system brought together the government, experts, and ordinary citizens to work collectively.

Historically, the UAE embraced an informal participatory approach known as the *majlis* (Arabic for council), where citizens engaged directly with rulers and community leaders in public gatherings to address community issues and concerns. Building on the majlis concept, the "UAE brainstorming session" initiative leveraged the nation's robust information and communication technologies (ICT) infrastructure and the widespread social acceptance of ICTs, particularly social media platforms, to crowdsource ideas and solutions for improving public services in two key sectors. This approach successfully identified and addressed challenges in public health and education, resulting in the implementation of new, impactful initiatives (Salem, 2014).

Suominen et al. (2015) explain that public-sector actors often take on the central role of initiators in collaborative innovation processes. Governments can effectively use their authority to drive innovations and implement market reforms (Jepperson & Meyer,

1991). In certain countries, governments may enforce strict innovation policies and implement formal measures that demand close collaboration among network organisations (Mani, 2002). For government policymakers, the findings of Yang et al. (2022) indicate that they should promote collaboration between firms and universities or research institutions (URIs), particularly in industries that depend on knowledge from diverse scientific fields. Additionally, governments should encourage firms to engage with a wide network of multiple URIs, reducing the need to rely on repeated partnerships and better aligning with the evolving demands of dynamic markets.

By fostering university-industry collaboration while also establishing a stable environment, governments can enable firms to maximise the advantages of scientific partnerships (Yang et al., 2022). Developing nations like India must focus on laying the groundwork for innovation by enhancing the ability of economic and social stakeholders to apply new or existing knowledge from other sources. Due to their limited resources, this often involves prioritising skill development and institutional strengthening over direct investments in R&D. However, some public R&D efforts are still essential to establish a baseline level of absorptive capacity. India is a leader in both global and national commitments to the Sustainable Development Goals (SDGs). Prime Minister Narendra Modi's personal dedication to Agenda 2030 and his forward-thinking vision for India have transformed the SDGs into a true national mission (United Nations in India, 2019).

Government support in developing economies is essential for boosting innovation, specifically by moving beyond basic financial incentives to provide non-fiscal measures, like a strong policy focus on human resource development, which is necessary to build the structural capacity for R&D success (Mani, 2004). Across the world, governments are playing a pivotal role in driving innovation within the

construction industry. Through strategic national initiatives, they are actively promoting the digital transformation of the sector. For example, the UK's Digital Charter, Japan's Society 5.0, and Singapore's Smart Nation program all reflect a strong policy commitment to leveraging digital technologies for industrial advancement, including construction. In China, the 14th Five-Year Plan for the Development of the Digital Economy explicitly calls for the integration of digitalisation with construction services, demonstrating the government's determination to inject sustained innovative momentum into the industry (Huateng et al., 2022; Yuan & Zhang, 2025).

When considering the respondents' opinions, the existing literature, and the Indian government's commitment to achieving the UN SDGs by 2030, it is clear that the government, or any government body acting as a catalyst, is likely the most effective and suitable option for initiating the NCIAM. Additionally, the majlis system in the UAE serves as an excellent example of a government-led initiative that has proven successful.

Selection of Collaborators: Choosing the right partner is crucial for generating value in partnerships. A strong alignment with the partner and a well-designed selection process help in managing unforeseen challenges (Duisters et al., 2011). Therefore, selecting the right partners is vital for ensuring the stability of the collaboration. A well-thought-out selection strategy or criteria can result in favourable outcomes, such as innovation in this context.

CR8: "But they should fulfil certain criteria. The first thing is their interest. Then there's definitely a scale. It should not be a petty contractor, those who are doing the painting in the house, for example. And then what kind of structure do they have in their company? Maybe there is a single person who is managing everything in a single

company. Then he will just come, and he will listen, and he will not implement anything because he will not have the bandwidth. So that arch structure should be there. So, we should first make a criterion and then recognise them."

When choosing partners, large organisations evaluate their integrity, reputation, and potential dedication to the collaboration to minimise the risk of opportunistic actions. Specifically, they gather information about the prospective partners' past conduct and performance history, as well as examine the incentives for cooperation that these partners might have (Gulati et al., 2012). The respondents also agreed on similar lines. They understood the seriousness of selecting the right partners.

CR1: "We must check whether this company is capable of doing this (work) or not? We must do a background check - what are their finances and turnovers? Which projects have they done in the past? We cannot just select anyone as a partner."

Respondent CR13 further added that references provided by other members and their past experiences could act as a good selection criterion. This aligns with the criterion proposed by Fusillo et al. (2020), who observed that firms often connect with the 'friends of a friend,' meaning that entities sharing a mutual collaboration partner tend to form a connection.

CR13: "It is more or less the word of mouth that works in this industry. And the kind of projects they have executed in the past."

Based on the responses, other parameters that emerged and were expected from construction professionals included time, quality, safety, and cost. In their opinion, their skills were very important, along with their intent to invent and what they could bring to the table.

The next key topic addressed was the industrial or organisational background of the sectors that must participate in the NCIAM framework. Our discussion highlighted a wide variety of backgrounds. The central idea was that anyone with relevant experience in the sector and the ability to contribute to innovation should be included in this collaborative effort.

CR11: “With a construction contractor and with anyone who can support innovation and has previous experience of working in and with this sector. And yes, it must evolve with time, and it can attract a larger number of participants. This could happen only if the success story of collaboration could come out in an open domain. Other sectors that I would consider could be the manufacturing side, like equipment manufacturers, IITs, universities, consultants, etc.”

GR1: “I would bring academia. I would try to bring in institutes of repute, academic institutes, which would support academics in terms of academic support, and I would also bring in NGOs.”

IR4: “So you can also have collaboration with the design companies. So that can take care of all the documentation needs and the design needs.”

Innovation networks involve collaboration among businesses, research organisations, universities, and government entities to achieve common innovation objectives (Corley et al., 2006). Based on my discussions with informants, the industries and organisations identified included Information Technology, manufacturing, design, and consulting sectors, as well as universities, government agencies, and Non-Governmental Organisations (NGOs). Additionally, construction contractors were naturally integral partners in this new collaborative model.

Past research supports the benefits of diversity on innovation. The respondents' opinions were the same.

IR1: “So everybody needs to have an understanding of the nitty-gritties, even if from their own perspective. So, when we are speaking about the collaboration, people of different expertise need to be there.”

Basic rules for a stable beginning: To maximise the benefits of collaborations with diverse stakeholders, it is recommended that firms integrate relational governance with conventional contractual governance (Hofman et al., 2020). Formal controls and penalties, rooted in legally binding agreements, can help curb opportunistic behaviour among partners (Poppo et al., 2008). Additionally, well-defined contracts can effectively tackle coordination issues (Mellewigt et al., 2007).

In the early stages of creating the NCIAM framework, a significant challenge would be to determine how to align stakeholders, manage the collaboration, and establish agreements to effectively capture value. Participants emphasised the necessity of having formal contractual agreements to define responsibilities and, to some extent, address trust-related concerns among partners. Interviewees highlighted that crafting a contract is crucial for facilitating and advancing collaborative efforts.

GR2: “Yes, because the more boundaries they have, the more agreements they have on certain areas. If the objectives are clear and the goals are clear, then that will be better. So, the contract can establish a clear set of boundaries, goals and mutual areas of work.”

CR3: “100% it is required. ..… If you talk as a company, that will create a sort of trust. And we can say that we can invest our time since we have trust. So that is required.”

Financial and economic hostages serve as formal mechanisms intentionally designed to mitigate and deter opportunistic behaviour among transacting parties (Klein, 1980; Williamson, 1983). Along this line, respondent CR4 talked about financial hostage acting as proof of seriousness from all the participants of the NCIAM framework, which CR8 further elaborated.

CR4: “I believe until and unless you have something to lean on. Until you put something at stake, your seriousness is missing.”

CR8: “Yeah, that should be a good thing to do. Why? Because let's say there's no money, there's nothing binding. Then the people may leave, in between also. …. So, if they have spent something, they definitely will try to carve out something out of that?”

Also, these steps, namely the contractual relationship and financial collaterals, could help minimise self-interests and build trust among collaborators who want to participate in the NCIAM framework.

CR1: “To tackle self-interest, before collaboration, that documentation part should be crisp and clear.”

CR11: “For securing trust, that companies will not leave whenever they want, I think a financial hostage in some form, depending on the capacity of a firm, is not a bad idea. As there is an investment of time and money in any innovation project from partners in this kind of collaboration.”

Trust is a critical factor influencing the readiness of network participants to share knowledge. Without trust, there can be uncertainty and competitive ambiguity about whether a firm within the network is truly an ally (Powell, Koput, & Smith-Doerr, 1996). Numerous sociological and economic studies emphasise that a failure to cooperate among partners often results in the breakdown of such relationships, primarily due to

misaligned incentives among self-interested parties. In the best-case scenario, conflicting interests may lead to reduced commitment, gradually eroding the partnership over time (Doz, 1996). Consequently, the use of contracts and financial safeguards becomes crucial, particularly during the early stages of collaboration, to ensure stability and alignment.

3.4.4. Preliminary features of the NCIAM framework

In this section, key features essential for operating the NCIAM framework are introduced. Successful participation in NCIAM requires seamless teamwork to drive innovation. The significance of these features lies in their interconnectedness, i.e. whether they align, conflict, or reinforce one another can directly influence the model's outcomes. Moreover, these features are not just theoretical; they might play a crucial role in the practical functioning of NCIAM, fostering stronger collaboration among participants. I will explore the essential aspects of managing the NCIAM framework, along with key considerations for its post-formation dynamics.

Managing NCIAM Network: When multiple organisations form a network, the alliance must be managed to ensure mutual benefits for all members. At the outset of any collaboration, there is typically a lack of social capital among the partnering firms. As a result, alliances involving companies from different sectors demand focused management efforts and effective relationship-building strategies (Duysters et al., 1999). Dangelico (2016) highlights in his research that successful green product innovation heavily relies on effective collaboration management. Managing such an ecosystem involves creating and sustaining an environment where collaboration among initially loosely connected businesses can flourish and evolve (Riemer & Klein, 2006). Here, we discuss some essential aspects required for operating the NCIAM network. The roles and responsibilities of participants will be covered in later sections.

Interviewees stated that one important feature that this collaboration must adopt is a dedicated team representing their firms that could connect the parent company with the NCIAM network.

CR11: “Yes, because it could be a full-time job to interact with and understand various points of view in this collaboration. So, each company could send someone completely dedicated to this collaboration.”

Even though the interviewees already agreed upon the importance of the contract, they still felt that a liaison team representing their firms would not be a bad idea.

CR13: “Yeah, a liaison team is always needed; every party should have one representative in that team who, kind of, sorts out issues or whatever arises during the collaboration, initialisation of the collaboration and also during the functioning of that particular group.”

For open innovation to be effective, collaboration structures must facilitate the seamless and flexible flow of information to areas where it can create the greatest value (Teece, 2020). This underscores the critical importance of managing information systems. Such systems primarily operate in key areas, including information security, transaction auditing, reporting, centralised policy enforcement, and application connectivity (Karajeh & Maqableh, 2014; Khwaldeh et al., 2017). Innovation projects are inherently complex and unique. As a result, they require centralised control, strict discipline, and thorough monitoring of project outcomes. This is where an information management system becomes invaluable, particularly in a networked environment where multiple organisations must share data and knowledge.

The interviewees identified two key approaches to integrating an information management system:

1. Adopting an existing system.

2. Developing a new system tailored to the specific collaboration.

CR8: “Maybe the available platforms can be used or maybe we can develop something new.”

GR1: “So obviously there should be a communication channel. So, they should adopt the same communication channel which is successful.”

Open innovation fosters the development of dynamic capabilities, with collaborative learning among partners improving the ability to identify and capitalise on opportunities (Teece, 2020). This process often results in the formation of subnetworks or sub-nets within a larger network, characterised by greater dynamism compared to the broader group. These subnetworks are often described as issue-based or value-driven networks (Rampersad et al., 2009; Brito, 1999). The term "net" refers to a smaller, specialised segment within a broader network. Specifically, an issue-based net consists of select actors from the larger industrial network who come together around a particular focus. Sub-nets emerge as a cluster of relationships among a limited group of participants who share relevant interests and possess the necessary resources to take collective action (De Brito, 1999).

A similar scenario can be anticipated among participants in the NCIAM, where one or a few members of the broader collaboration network may consider adopting a specific innovation, while others may not share the same interest. Respondents emphasised that different companies have varying needs and priorities, so they should have the flexibility to select and implement only what aligns with their requirements.

UR1: “Yes, every company’s requirements are different, so we can't enforce our decisions or our solutions to them.”

CR9: “As I said earlier, when the innovation gives a fruitful result and that has been accepted by a few companies. So, a few companies are accepting because they have a future prospectus. They are having a future clarity and their prospectus. So, they definitely can, and they will be investing. And the people who don't have the prospectus and are not experts in a particular area are not interested. They definitely can come back.”

CR11: “Subnet should also be allowed as not all companies could be interested in the same innovation.”

The central theme of the networked construction innovation alliance model is the exchange of knowledge and ideas and the sharing of innovation among organisations. This led to an obvious question: Are firms that are part of this Networked Construction Innovation Alliance Model allowed to be part of other similar or not-so-similar collaborations? Responses were in favour of allowing collaborating companies to be part of other networks or collaborations.

CR11: “Yes. So that more financial and innovation benefits could be secured, depending upon the type of company you are.”

IR1: “Yes, I think that would also be nice. I mean, that is the whole point of having a business that, besides the forum, there should be others whom I can sell to.”

Post Networked Construction Innovation Alliance Model formation dynamics: In some situations, parent firms may need to adjust the governance structure of an alliance. This could be due to a lack of experience with a specific collaborative task, errors made during the initial design phase, or the emergence of new opportunities (Reuer et al., 2002). In this paper, a couple of anticipated post-formation governance recommendations have been proposed , drawing from both the respondents’

perspective and relevant literature. I have limited these to just two, as the model is still in the design phase and has not yet been implemented. Once the NCIAM becomes operational, additional dynamics may emerge.

Competitors can easily replicate management practices, new technologies, improvements, and effective methods for addressing customer needs (Porter, 1996). For alliances to create relational rents, the inter-organisational resources and capabilities they develop must be difficult for rival networks to imitate (Barney, 1991). Lundvall et al. (2002) have proposed that policymakers should revise legal frameworks to undermine imitators and bolster the position of radical innovators. In developing countries like India, where government intervention is often limited, there is a pressing need for supportive policymaking and regulation to foster innovation (Luthra et al., 2022).

Respondents' opinions were mixed about government intervention in policy adjustments that could inhibit imitators outside of the NCIAM group from copying innovations generated by NCIAM collaborators.

UR1: “So if there is a technology which is patented by a company, that patent takes care of it, it's not getting imitated then. The government need not bring another separate policy to prevent imitation, and if you are doing that, then the whole team is gone.”

CR10: “Yes, policy, like a patented policy. If you copy, it means immediate fines. Like how Apple and Microsoft and all, they are doing... Then they (imitators) will be afraid... Or easily they'll copy very fast.”

CR1: “Yes, this must happen. Then the motive (of collaborators) will be proper.”

Next, the discussion concerns the government's enforcement of an innovation among NCIAM participants and outside sector actors. To effectively implement and enforce decisions, regulators must possess sector-specific expertise, including insights into market conditions, cutting-edge practices and technologies, organisational capabilities, industry dynamics, competitive landscape, and technical infrastructure. Gann et al. (1998) highlighted that overly complex enforcement systems are unlikely to foster innovation, emphasising that clarity and simplicity in regulatory processes are essential to promote the adoption of best practices and stimulate innovation. Encouraging demand for new practices and technologies can lead to positive innovation outcomes (Gann et al., 1998).

When asked if the government should enforce any innovation if it brings greater benefits to all the participants of NCIAM and even outside, the interviewees believed that it should not be enforced. The government should only act as a facilitator.

CR2: “When you are saying that if it is a technological adoption, then you cannot force someone.”

UR1: “Government can show a way. They can show a way in the sense that then people will start to say that even government projects are doing this, so why can’t we do it? So that kind of thing can happen. But enforcing is, again, maybe not the right way to go about it. It can only be recommendations because enforcing… again, the scale comes in, some companies’ competence may not be that high to actually go for something, to go for a green rating system. So, they can give recommendations that this is the way to go forward.”

CR6: “They can say - See, this is what the new product is. This is good for you, good for the environment at large… So let me give you the benefit. If you purchase it here,

I will give you a discount in the registration phase. You cannot say that now you have to; in a way, then you're adding more stress to firms."

The table below presents some of the expected features based on our current discussions.

Table 3.7: Features of the NCIAM

S. No.	Feature Details
1	Adopting the contract is very important, especially during the initial stage of NCIAM formation.
2	Financial or economic hostages should be allowed to build trust among participants.
3	A liaison team is required to settle unique problems.
4	An information management system should either be adopted from a successful organisation or newly developed from scratch.
5	A dedicated team must represent each participating member.
6	Subnets are allowed to develop any innovation.
7	A firm can be a member of another similar or different type of collaboration.
8	Governmental organisations can sway policies to prevent imitators from replicating any innovation created by the NCIAM group.
9	Government authorities should not enforce any innovation on any company inside or outside NCIAM.

(Source: Author's own)

3.4.5. Networked Construction Innovation Alliance Model Design

In systems theory, the design of collaboration models is deeply informed by the understanding of distributed network systems in which no central authority dictates outcomes, and instead, collective behaviour emerges from the simultaneous, locally informed actions of individual agents. Within such a system, each participant (or 'node') can be viewed as an autonomous entity with its own goals, perceptions, and internal states (Klein et al., 2006). These nodes interact and continuously adjust their behaviours in response to the feedback they receive from others in the network, striving to balance individual utility with systemic coherence. In a collaborative setting, this reflects how each actor seeks to fulfil their own interests while remaining aligned

with the evolving dynamics of the broader group. The effectiveness of the collaboration, analogous to the system's utility, arises not from top-down direction but from the mutual alignment, adaptive coordination, and integration of all actors' contributions (Klein et al., 2006).

The NCIAM framework is structured around the roles and functions of various participants in an innovation-driven partnership. These participants include government agencies, NGOs, universities, construction contractors, and innovative firms. This paper specifically explores the involvement of small and medium-sized enterprises (SMEs) and young, innovative companies (YICs) within the NCIAM framework. It examines how SMEs, especially from the perspective of construction contractors, integrate into this framework.

Importance of SMEs and YICs: When asked about the presence of SMEs or young, innovative companies (YICs) as participants of this NCIAM framework, most respondents validated their participation as they believed that innovation or contribution could come from anyone.

CR6: "An idea is an idea. It can also come from a farmer. You should be open. It should be an open platform."

CR11: "Small and micro enterprises are known for their creativity and less bureaucracy in their organisations, which is known by the fact that they compete with big fish in the pond."

One of the informants further highlighted that many small companies specialise in unique innovations, offering valuable expertise at a relatively low cost.

CR7: "Sure. Definitely. I'll give an example of this project. So, they are in this type of project. There are very, very specific works like, you know, 5-byte security systems,

window packages, door packages. There, you can have those small players who don't require that much cash flow. Just the requirement is their innovation and expertise. So, where the labour and the cash flow dependency is minimal, you can introduce these small players, which are like startup companies and all."

Numerous research studies have examined the role of SMEs and young innovative firms in driving innovation (Cavallo et al., 2020; Giraudo et al., 2019). SMEs play an undeniable role in the innovation ecosystem, primarily due to their sheer numbers and dominance in economic activity across most economies. However, they are even more pivotal in Schumpeterian dynamics, as high-tech SMEs are crucial in developing and leveraging new technologies that can shape emerging industries and fuel future economic innovations. Increasingly, large corporations are seeking external sources for new technologies, and high-tech SMEs are among the key providers they target (Veugelers, 2008).

Young Innovative Companies (YICs) are recognised for their strong focus on Research and Development (R&D) (Czarnitzki & Delanote, 2012). These firms represent a unique subset within the SME category, characterised by their youth, small size, and significant potential to create innovations for commercial use (Schneider & Veugelers, 2010). The literature underscores the ability of such companies to make meaningful contributions through their innovative capabilities. As a result, firms that are both young and small in scale should be integrated into the NCIAM framework.

The next question explored how SMEs should engage in the NCIAM. Most respondents agreed that SMEs should participate collectively, with group representation. Given that they compete with large multinational enterprises with

greater resources and influence, this approach could enhance their ability to make their voices heard.

CR10: “Cluster. Go as a cluster always so that they can fight with B (bigger firms). They join together; they become giants. 100 C (small firms) joint, they can easily compete with one A (large firms).”

CR12: “So yes, the small people do hold some value, eventually. But collectively, yes, I think in the beginning, they need to be more collective, where they can raise their voice and get that confidence that there's a forum and not to sell my business. That is the key thing we did in every forum.”

However, there were a few respondents who were in support of SMEs maintaining their individuality.

CR1: “But if they have a good portfolio and their teams put their skilled knowledge and skill power, then they should have separate representation in front of the bigger companies, that this is my procedure, and this is my portfolio, that this is how I proceed to this work and like that.”

There is a danger of larger firms aggressively taking over smaller businesses, as well as the possibility of an open innovation project failing, which can significantly affect SMEs more severely than their larger counterparts (Hagedoorn, 1990). Multinational corporations (MNCs), with their vast resources, technological expertise, and established economies of scale, dominate the market and often push out local SMEs (Masroor & Asim, 2019).

A lack of trust often leads to a lack of closeness between collaborating partners. Consequently, without sufficient visibility, efficiency, and strong relationships within local networks, SMEs find it challenging to engage with larger entities, such as MNC

subsidiaries. In essence, significant obstacles arise due to insufficient information, unclear processes, and a lack of trust. These challenges are especially pronounced in asymmetrical relationships, inter-organisational ties between dissimilar entities, such as small and large firms, despite the potential for mutual benefit (Narula, 2004). Given their size and financial limitations, SMEs are often open to collaborating not only with complementary partners but also with competitors (Ritala & Hurmelinna-Laukkanen, 2009).

Whether in business alliances or innovation project collaborations, SMEs always face the risk of power asymmetry when dealing with multinational enterprises (MNEs). MNEs can shape outcomes in their favour, potentially disadvantaging SMEs. To address this issue within the NCIAM framework, SMEs should engage collectively rather than individually, particularly during the early stages of NCIAM development.

Body of Independent Participants: According to respondents, government bodies, NGOs, and universities are seen as neutral participants in the NCIAM framework. They also believe that these independent agencies can contribute beyond serving as arbiters or overseeing the NCIAM when challenges arise. When discussing this perspective, respondent GR1 expressed support for the idea.

GR1: “Yeah, that is very mandatory. I strongly recommend forming a board…... There would be the involvement of academia, NGOs, and the government. Those should be part of this board or committee or kind of apex body within the collaboration.”

CR11: “There must be a kind of independent body that observes. This type already exists as an independent board of all conglomerates to keep the self-interest of participants in check.”

Even under the most favourable conditions, restrictions on information sharing and a lack of trust hinder collaboration between SMEs and MNC subsidiaries. The involvement of a neutral third party or agency could help address these challenges (Prashantham & McNaughton, 2006). Nidumolu et al. (2014) highlight the complexities of sustainability collaborations, which can be exacerbated by conflicting priorities among participants. As a result, independent project-management experts with proven expertise in fostering trust among diverse stakeholders should be responsible for designing and overseeing these partnerships. Moreover, the project management role must be perceived by all parties as impartial and dedicated to the success of the project rather than favouring any single stakeholder (Nidumolu et al., 2014).

In addition to being part of the independent and neutral body of NCIAM and contributing to policy adjustments, government agencies could also provide funding for NCIAM-driven innovation projects.

GR1: “It is very important that if the government acts as a stakeholder of this collaboration, there is clear and close communication with the government. So, it would help in any policy formulation that is aligned with the interests of the industry.”

CR1: “Government can help in financing projects.”

According to a World Bank report, financing innovation activities poses a significant challenge for many firms. Financial limitations that curb investments in innovation can hinder long-term economic growth. Government funding can be crucial in encouraging firms to participate more actively in collaborative R&D projects. A study in Germany revealed that government funding not only strengthened existing partnerships but also led to the formation of new ones. Similarly, research on the U.S. Advanced Technology Program demonstrated that government funding directly spurred the creation of

numerous consortia and joint projects, with many collaborations continuing even after the government-funded projects ended, often extending to different initiatives (Bravo-Biosca et al., 2012).

Respondents felt that NGOs represent civil society, and that is why it is essential for them to monitor the quality of innovation skills and advocate for particularly valuable innovations.

NR1: “See what an NGO do? So, I'll take you to the construction. I'll put my experience. It's like a bridge between a buyer and a seller. In India, an NGO works with CSR firms for government funding. What they do is they take the money from the CSR companies, and they forward that money to the work contracts. So that whatever the NGO has promised is done. So, when an NGO is in the play, one thing which is very important is the quality of work. NGO is there to check and balance that the contractor is not causing only problems.”

IR1: “Yes, in this, I guess now there are different types of NGOs that are, you know, especially in my sector itself, there are NGOs that work on awareness alone. And then there are NGOs who are working towards collaborating with the industry, you know, the different stakeholders of an industry and trying to influence the change. Yeah, so these NGOs could actually try to influence the governing bodies because they have a certain reach. And sensitising them towards the need for a certain thing. And also, if maybe a forum exists wherein these NGOs can also advocate or, in fact, not even advocate, even introduce and say that - look, there is an innovation that is available. Can you have a look into it? You know, even if that simple word is put in by the NGOs, I think it would be really helpful.”

CR12: “NGOs mostly would help you in getting the grassroots information as well. You can't live just on your ideas. I sometimes need grassroots-level information if I'm planning something”

NGOs are frequently effective in maintaining neutrality during collaborations, provided they are dedicated to developing solutions that benefit all parties involved (Nidumolu et al., 2014). Collaborations between companies and NGOs have been shown to generate social innovations, as the two sectors bring complementary resources to the table (Austin & Seitanidi, 2012).

In addition to maintaining neutrality among collaborators in the NCIAM framework, universities can leverage their strong research capabilities to significantly contribute to innovation efforts. Their expertise in research can play a vital role in driving creative and impactful solutions.

IR5: “In a lot of different industries, top universities in India especially collaborate with relevant PSUs along with inputs from consultants and other private companies to research…. So, all of those work together to find a common solution in an innovative sphere, so that is something that is already happening.”

CR13: “See if the innovation companies are being associated. Obviously, universities should also collaborate because they also have a lot of research and development which goes on inside them.”

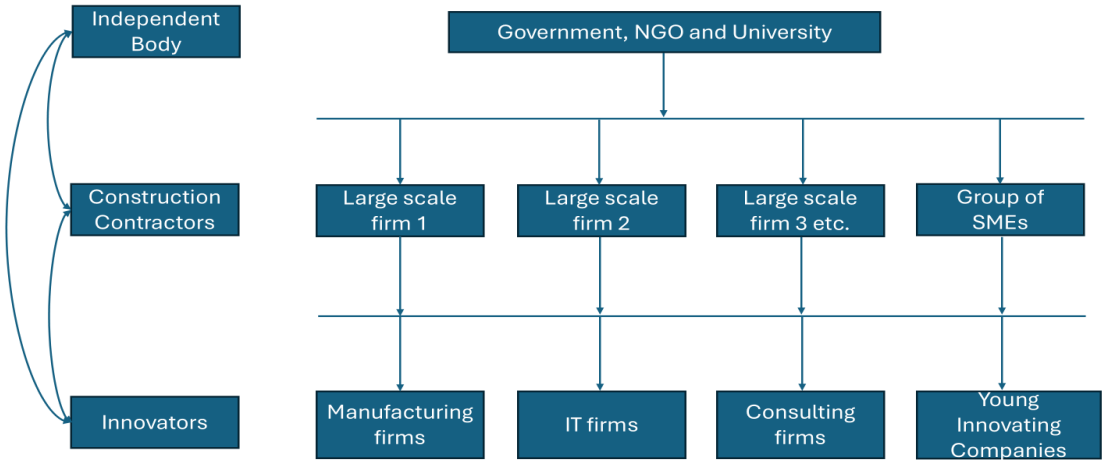
In today’s fast-paced and technologically complex environment, companies struggle to sustain a competitive edge (Dagnino et al., 2020). As a result, they increasingly partner with universities and research institutions to create cutting-edge industrial technologies (Lin, 2019; Petruzzelli & Murgia, 2020)

Role of construction contractors and innovators: This is straightforward. Contractors seek innovation while participating in this NCIAM, and innovative firms supply innovation.

CR11: “It is construction companies who are investing money and adopting innovations.”

UR1: “Innovation is also a business. Innovation is generally not something that is done just to solve a problem. Innovation is also done to create a business. So, if a company is looking to sell their product. For them, the effort they're putting in is being paid by people”

Figure 3.5: Networked Construction Innovation Alliance Model



(Source: Author’s own)

Based on previous discussions, the NCIAM framework has been developed and presented. By integrating insights from the reviewed literature and our interviews, I introduce the framework of the NCIAM framework, as illustrated in Figure 3.5 above.

NCIAM is a three-tiered collaboration model in which the independent body, comprised of government, university and NGO, sits at the top. The second level is occupied by the construction contractors, who are not just limited to three in number, as shown in Figure 3.2. It is just there for representation purposes. The last level in this model is occupied by innovative firms, which are again not limited to just four categories. The number will depend on the needs of construction contractors.

3.4.6. Expert Review and Validation of the Networked Construction Innovation Alliance Model

Conceptual Evaluation of the NCIAM framework (Face Validity): Because the proposed three-tier collaboration model is in the conceptual phase, a qualitative face-validity assessment is conducted to ensure its conceptual soundness and relevance to experts. Face validity, or expert validation, is a central element of this qualitative evaluation (Ling & Leng, 2018). Professionals are most frequently chosen for this task based on their relevant work experience (Lecours, 2020; Ford, 2002). Five subject-matter experts with substantial construction industry experience were purposively selected. Each was presented with the model diagram and descriptions and invited to discuss their perceptions of its clarity, logical changes, and completeness. The interview questions were intentionally open-ended (e.g., "Do you agree with the model's design?", "Would you recommend any changes to make it more effective in practice?", "Are there aspects that seem unclear, unnecessary, or missing?") to elicit naturalistic feedback

Respondents mostly agreed with the NCIAM framework design, with some recommending that other participants be included. Respondent CR15 mentioned that "I agree with the design of the model". Respondent CR14 echoed the same sentiment, but he thought that bringing them under one roof could be challenging.

CR14: “Model design looks promising, but also looks quite challenging to implement, considering bringing competitors into the same forum. We should bring all the companies/stakeholders involved in the construction supply chain. Would like to add design companies which are primarily involved in the construction equipment/tools/material, etc.”

Respondent CR16 suggested bringing in clients as part of the collaboration. IR8 suggested that extra protection be provided for participating members against IP theft.

This form of qualitative face validation, in which domain experts provide evaluative feedback on a conceptual framework, has been widely applied in model development research (Mårtensson et al., 2019; Lecours et al., 2020; Zarghani et al., 2024; Ling & Leng, 2018) and is considered appropriate at the theoretical stage before empirical testing. All experts confirmed that the proposed collaboration model is conceptually sound, supporting its face validity and suitability for further development.

Practical and Contextual Insights: This study also examines additional practical aspects critical to facilitating effective participation in collaborative innovation projects after the model is designed. As Midgley and Lindhult (2021) note, systemic innovation depends on “policies and governance… to create an enabling environment for innovation systems,” and is driven by “the interdependency of actors… leading to a need to cocreate value and innovate in concert.” This system's framing supports an analytical focus on elements such as funding mechanisms, IP and governance rules, business models, and the defined scope of collaboration, as each contributes to the enabling structures and interactions that shape innovation outcomes. Key elements, including funding mechanisms, intellectual property (IP) protections, the business model, and the scope of innovation for this NCIAM framework, are discussed below,

based on feedback from this new set of five respondents consulted after the model design. Considering these factors can help address the multifaceted challenges commonly encountered in collaborative initiatives.

When asked about the suitable funding mechanism, respondents felt that only the team that participates in the innovation project while being part of the NCIAM framework should be responsible for the funding of the project.

CR14: “Transparency in fund allocation would be key to build trust within the partners and, hence securing fund. Funding mechanism should be in sync with the allocation to the projects, i.e. to which OSC (now NCIAM) team would be taking to work upon, and which may have an impact only on limited partners in this OSC (now NCIAM) value chain.”

Respondents CR16 also felt that the contribution should be proportionate to the size of the firm, meaning that smaller firms should pay less if they are involved in an innovation collaboration project when in NCIAM. Respondent IR7 talked about a hybrid approach to funding. He said:

IR7: “As a project manager, I can say that a hybrid funding approach is the most effective way to fund innovation projects and collaborations. Relying on a single source creates vulnerabilities. The combination of different funding mechanisms ensures stability, flexibility, and shared risk. Contribution from members and support from the Government or donors will be helpful”

Along the same line, respondent IR8 also stressed the government's role here.

IR8: “Funding can be done by joint contribution from all partners, with extra support from the government for research and innovation. Private investors can also be involved for special projects. For fairness, contributions should depend on company

size, like big firms can pay more, small firms less. Government subsidy or tax benefits can balance the cost”

Country studies conducted show that innovation funding can originate from a variety of sources, depending on the structure of collaboration. In many cases, government support has played a catalytic role, accelerating the completion of business R&D projects, expanding their scale and scope, and encouraging firms to pursue more ambitious and collaborative research agendas (Georghiou & Clarysse, 2006). Other examples highlight shared or member-based funding models. The *Sematech* consortium, for instance, was an industry-led partnership in which both government and industry members contributed financially, combining $500 million in Department of Defense funding with matched contributions from participating firms to reduce R&D costs and strengthen the U.S. semiconductor supply chain (Wessner & Howell, 2024). Similarly, the Fraunhofer Alliances operate under a mixed financing model that blends government-based funding (about 30%) with contract research income (around 70%), the latter generated through industry collaborations and publicly funded projects (Jewell, 2017). Together, these cases demonstrate that collaborative innovation projects can be financed through member contributions, external partners, or government funding, which is also pointed out by the respondents.

When discussing cost recovery, respondent CR15 mentioned recovery through royalties and patents. CR16 was of the idea that innovation cost could also be recovered by implementing the innovation in construction projects, which could result in better efficiency.

CR16: “Look, I think the innovation costs can be recovered through efficiency gains in projects, and maybe through commercialisation of technologies, or subscription-based access for smaller stakeholders.”

Under Fraunhofer’s collaboration model, when private firms contribute funds or resources to a project, their investment is recognised in a partnership agreement that specifies both their contribution and the royalty entitlements they will receive upon commercialisation of the research results. In other words, the recovery mechanism for private players is built into the agreement: their financial participation entitles them to a share of the returns, typically through royalties, licensing revenues, or preferential access to the technology, proportional to their investment in the project (Jewell, 2017). Further, analysis of data from 195 high-tech companies showed that those engaging in external collaborations for product development increased their revenue by 3.95 times compared with non-collaborating firms, while also gaining indirect benefits from using the innovations internally (Hindi & Frenkel, 2022).

The next topic discussed with respondents was IP ownership and protection. Almost all respondents believed that the joint partnership should be the way to share the rights to an innovation. Although they felt that non-commercial aspects could be shared openly, the commercially valuable inventions remain protected.

CR14: “Joint ownership seems to be better among the partners whoever was involved in the project. The innovation can be shared with everyone for the sake of knowledge sharing with limited information, considering the no or limited financial impact.”

IR8: “If one partner creates something fully, they should own it, but if many partners are involved, then joint ownership with clear agreements is better. This way, openness and protection both can be balanced.”

For IP protection, respondent IR7 mentioned using Artificial Intelligence (AI) to flag breaches.

IR7: “Use AI-powered tools to continuously scan and audit project documentation and communication. This automates the enforcement of the joint IP agreement and boundary protocols, flagging any potential breaches or unauthorised sharing of sensitive data. It ensures legal compliance and protects intellectual property without constant manual oversight.”

Respondent CR16 believed that having transparent agreements really helps in the protection. He further added:

CR16: “Licensing is another practical mechanism. The IP owner can license technology to other collaborators or external companies under agreed terms, ensuring wider adoption while still protecting ownership. Universities, for instance, often prefer licensing models rather than outright selling IP.”

In collaborative research projects, intellectual property rights, including jointly developed trade secrets, can be shared among the participating parties, but these arrangements must be explicitly defined in contracts agreed upon by all collaborators. Such contracts often include detailed provisions to protect sensitive information that is critical to each party’s business interests (Barbera & Manstretta, 2024). Additionally, AI tools can support IP protection by automating infringement detection, filtering unauthorised use, and reducing the workload for human monitors, thereby strengthening overall enforcement of intellectual property rights in collaborative settings (Collopy, 2024). These publications align with the key informants' points on IP use and protection.

Next, the discussion focused on the suitable business model for this NCIAM framework; respondents named a few, including the Public-Private Partnership Model with profit sharing (CR15) and external sponsorship and government grants (CR16). However, the respondents identified project-based revenue sharing and subscription or membership fees as the most suitable sources of revenue. Respondent IR8 believed these two approaches would help in sharing the benefits fairly.

CR16: “I think the business model for this collaboration should be hybrid, combining multiple revenue sources. In my opinion, for capturing value, project-based revenue-sharing will work well, as we do on construction projects, especially when innovations lead to cost savings or new commercial products. Contractors and innovative firms can share financial benefits proportionally. Another thing could be membership or subscription fees from all stakeholders, which can provide steady funding, but also should be proportionate as per their size.”

IR7: “Joint Contributions from Members: This is the most critical component. All collaborating members, such as companies, NGOs, and government bodies, should contribute financially. This creates a shared sense of ownership and accountability. The funding from each party can be tied to the potential value they stand to gain, such as a large corporation contributing more in exchange for greater access to the innovation, while smaller organisations contribute less. Independent Auditing of the budget spent will also help to mitigate any financial disputes between the parties.”

The business model of any sustainable business network plays a crucial role in connecting organisations to exchange knowledge and promote the dissemination of CE innovations. However, in the absence of effective financing mechanisms, many networks face challenges in maintaining operations and achieving financial self-

sufficiency. Common funding approaches identified for sustaining a network in practice include membership subscriptions, donor or grant funding, crowdfunding initiatives, and the commercialisation of knowledge-based products and services (Muzamwese et al., 2024). Now, when looking at a project-based revenue-sharing model, it allocates both the income and uncertainty of a collaborative project among participants in agreed proportions, aligning incentives and distributing risk fairly. This structure encourages partners to increase their effort and commitment to achieve or exceed the project's expected outcomes (Du et al., 2019).

So, having multiple sources of finance is the way to go to sustain the NCIAM. One benefit of participating in this model is that clients and customers are part of the collaboration, so it is not necessary to go outside to find customers for innovative products or ideas in the construction industry. However, it would lead to extra financial income for the members.

In the literature part of this chapter, it has already been described that any kind of innovation that could bring any benefit should be the focus of innovation in NCIAM and not a specific kind of innovation, like just technical innovation. So, questions along a similar line were presented to the key informants. Respondents were of a similar opinion as well.

IR8: "The collaboration should aim for all levels, like process improvement, new product development, and long-term industry change. Sometimes innovation can be slow and step-by-step, and sometimes radical, depending on project need."

CR16: "In my view, the scale and scope of innovation outcomes in this collaboration should be flexible but ambitious. The innovations should make construction projects

faster, safer, and more cost-efficient. Or some innovation that is not there at all. And it could also include some sort of future digital ecosystem."

Members of a network engage in both incremental and radical research, sharing the results of incremental work to benefit all participants. Through this collective knowledge sharing, members submit aligned innovation hypotheses and divide rewards from successful outcomes, sustaining the network if innovation continues to succeed (Gilbert et al., 2001). This is in line with the flexible approach to the type of innovation that respondents want the NCIAM to adopt.

When asked about other benefits that participants of NCIAM can get besides innovation advantage, respondents specified benefits such as enhanced reputation and credibility (IR8, CR16), new market and business opportunities (IR8, CR16), strong long-term relationships (IR7), and Financial Stability (IR7), among others.

Table 3.8: Summary of Key Aspects of NCIAM

S. No.	Features	Description
1	Face Validity of the NCIAM framework	Respondents mostly agreed with the NCIAM framework design.
2	Funding Mechanism	Firms which are part of any innovation project in NCIAM must be responsible for funding the project, with occasional support from the government.
3	Cost Recovery	Cost could be recovered in the form of improved project efficiency and potentially through royalty and patent sales.
4	Business Model	Recommended business models are project-based revenue sharing and subscription or membership fees. Customers are already part of the NCIAM framework.
5	IP Protection	IP rights, including jointly developed trade secrets, can be shared among the participating parties, but these arrangements must be explicitly defined in contracts agreed upon by all collaborators. Use of AI to keep an eye on the misuse of innovation secrets.

6	Innovation Approach Type	Innovation should be both incremental and radical and must attack at all levels, which are process improvement, new product development, and long-term industry change.
7	Other Benefits	Besides innovation, NCIAM can help partners to gain access to long-term relationships, reputation, new business opportunities and financial stability.

(Source: Author's own)

3.6. Discussion

The development of the NCIAM framework offers a strategic approach to support the successful adoption of open innovation. This research sought to understand and identify the process construction companies can undertake when designing and implementing a collaborative NCIAM framework to improve the innovation landscape in India. This study develops a descriptive collaboration model that serves as an analytical point of reference for collaborative efforts in the Indian construction sector. Rather than representing an actual system, a model provides an abstract structure for interpreting behaviour and testing hypotheses (Warner et al., 2003). The model synthesises existing collaboration literature and connects it to practical contexts, offering a generic framework for subsequent design development and future evaluation of collaboration.

The process began with identifying the relevant partners, as this is critical to NCIAM. In the context of cross-sector partnerships, securing the 'right' partners and individuals involves prioritising inclusivity and actively seeking diversity, as highlighted in the literature (Ansell & Gash, 2007; Emerson et al., 2011). For innovation focused on sustainability, key considerations include resources, cultural alignment, reputation, specific characteristics, and the anticipated time frame for achieving results (Gray & Stites, 2013). The informants highlighted many aspects of the partner selection

process. Ultimately, the partners' profiles, capabilities, and roles were crucial in shaping the final model. Additionally, a set of rules and regulations was established to help govern the NCIAM framework effectively.

To generate value in an open innovation setting, companies must enhance the openness of their organisational boundaries to facilitate knowledge sharing with a wide range of partners. However, to effectively capture value, they must also establish governance mechanisms for their collaborative efforts and safeguard against unintended knowledge spillovers (Zobel & Hagedoorn, 2020). This paper adds to the concept of open innovation by showing how construction firms can benefit from collaborating with other firms while remaining within boundaries. Specific barriers to entry for this NCIAM framework have also been identified during its development, such as contractual obligations and financial hostages. This could help stop the leaking of information to unwanted firms.

When we look at the structure of NCIAM in Figure 3.4, the hierarchical governance structure puts a neutral or independent body at the top position, at least visibly. But that is not really the case. Their opinion only becomes supreme in case of bottlenecks or when the firms need support for some policies. They will not interfere in the everyday affairs of other participating firms, as the requirement is generated and fulfilled by other industry players in most cases. Noncorporate players such as NGOs, academics, and government bodies may offer input, but they are not integral operational partners (Nidumolu et al., 2014). This does not mean their roles are not important. It is very important, but the most important sector here is construction.

In this configuration, innovative firms are not subsumed within construction contractors and maintain the ability to engage directly with independent bodies. The reciprocal

interactions between contractors and independent bodies are indicated by the curved double ended arrows on the left side of the model, and the bottom tier represents firms that focus on delivering innovative capabilities. However, this does not imply that other companies will only follow the requirements generated by construction firms and cannot contribute new ideas. In this NCIAM framework, innovation or any new idea could come from any member who is part of this collaboration.

The design of the NCIAM framework represents an initial effort to introduce an additional analytical tool for construction contractors and institutions to assist them in detailing strategic guidelines for launching a collaboration to improve innovation scenarios in the Indian construction sector. Although the One-Stop-Shop business model inspires this NCIAM framework, there is a key difference. In the OSS concept-based cluster of actors, one actor takes the role of the coordinator and deals with outside customers with a single contract and single reference point (Pardalis et al., 2020). However, in the case of the NCIAM framework, the customers, which are the construction firms, are already part of this collaboration. They are not outside of this collaboration. They are a very integral part of this collaboration.

After the NCIAM framework was developed, it was validated by a new pool of respondents who provided feedback on the framework. Overall, respondents were satisfied with the initial attempt to enhance innovation in the Indian construction sector. They recommended incorporating multiple finance sources for innovation projects, developed collaboratively by NCIAM members, with funding contributed by participating members. Government or external funding and membership fees were also suggested to enhance the model's stability. Respondents emphasised joint ownership of intellectual property rights and the use of Artificial Intelligence (AI) to monitor their misuse.

Cost recovery for investors can be achieved through project performance and licensing. Since construction companies are part of the NCIAM model, a customer base is established, and the value proposition focuses on innovation development. The business model cycle is completed by defining funding mechanisms, cost recovery, client acquisition, and the value proposition. The four key components are the offering (innovation), customers (construction firms), infrastructure (the NCIAM framework), and financial visibility (membership fees, innovation funding, licensing) (Neck et al., 2023).

The NCIAM business model aligns with the cooperative model, where value is generated through collaboration with external parties (Osterwalder & Pigneur, 2010). In this framework, external economic actors contribute to value creation to deliver the collective value proposition (Stähler, 2001). Building cooperative networks, therefore, aims to optimise the business model and its value proposition (Dubosson-Torbay et al., 2001; Osterwalder & Pigneur, 2010).

3.6.1. Research Contributions

The NCIAM framework developed in this study structures participants into different tiers, each interacting to enhance the innovation landscape within the Indian construction industry. These tiers include competitors in the construction industry, innovative firms from sectors such as IT and manufacturing, and an independent body comprising government organisations, universities, and NGOs. The model facilitates continuous learning and stability within the system. Each tier, individually or in combination with others, can function as a subsystem, with its own dynamics and contributions. The collaboration between competitors at different levels reflects co-opetition dynamics, where simultaneous cooperation and competition could lead to generating novel outcomes.

The NCIAM framework contributes to the understanding of networked collaboration by linking network collaboration with systems theory. It shows how diverse actors interact to form a cohesive and dynamic system that supports innovation in the construction industry. This research applies a systems theory perspective to the NCIAM framework by viewing it as a system shaped by interactions between supply and demand, specifically the supply and demand of innovation and knowledge. The introduction of subnets within the wider NCIAM network further extends systems theory by showing how small and relatively simple systems can operate as essential components of a larger meta-system. While systems theory already suggests that larger systems are composed of individual elements that may themselves be subsystems (Carayannis et al., 2016), this research advances this understanding by designing an NCIAM framework that provides empirical evidence supporting this principle. Furthermore, this study extends this perspective by applying it to the innovation collaboration system in the construction industry, illustrating how interconnected subsystems drive innovation and knowledge exchange within a complex system.

External parties representing other non-construction sectors were involved in this study to bring in their knowledge and experience, which helped in the generation of significant strategic ideas during the model design process. Such engagements with a scientific knowledge base helped in understanding how to combine different strategies and long-term sustainability perspectives, as well as maintain accountability for the collective outcomes. Therefore, this paper also makes a methodological contribution in line with the suggestions made by Rampersad et al. (2009) by including key players from businesses, government agencies, research organisations, and universities instead of just one focal organisation or industry, as several previous studies have done.

In the context of open innovation, literature has made some advances from the perspective of large corporations (Mortara & Minshall, 2011) and, to a certain extent, open innovation advances in SMEs (Lee et al., 2010). However, the open innovation experience of YICs has received little attention (Lee et al., 2010; Usman & Vanhaverbeke, 2016). In this paper, I have sought to highlight this aspect by presenting a model in which large firms can coexist and benefit from SMEs' and YICs' contributions, and vice versa. All these various sizes of firms can help address the limitations that each class possesses.

Based on what has been discussed, this research makes a key theoretical contribution by advancing a prescriptive framework for a three-tiered stakeholder system that reconceptualises core principles of systems theory. It designs hierarchy as a functional scaffold to prevent coercive dominance and engineer equitable agency, thereby guiding emergence toward desirable outcomes such as widespread technology adoption. Furthermore, it formalises communication and control by suggesting a proper management information system and a meta-governance tier of neutral watchdogs, institutionalising a reflexive mechanism that can exert oversight across the hierarchy to break bottlenecks and ensure systemic resilience, thus moving beyond traditional top-down control models.

The model developed in this study contributes to discussions on collaborative and open innovation by outlining a possible process and structure for cooperation among firms with differing interests. Whereas much of the existing literature focuses on the potential benefits of collaboration, this study places greater emphasis on the practical aspects of how collaboration may be organised. The model is intended to be transferable and may be adapted to other contexts or industries where cooperation among innovation network actors is relevant. Once key actors, mechanisms, and

knowledge assets are identified, the NCIAM framework may be extended or integrated to reflect the characteristics of those settings.

3.6.2. Managerial Implications

The work by Beer (1972) outlines a system as an entity that is adaptable for survival in a changing environment. Although surviving is not an issue for the construction industry due to its importance, the world is moving towards sustainable usage of resources. And in this changing environment, this sector should change as well. Adopting the NCIAM framework gives the decision makers of construction firms the option to evolve and adopt something new and unique, as innovation is the most important solution to show the world their seriousness towards sustainability and circular economy activities.

The firm is viewed as a learning system equipped with various skills and competencies that allow it to generate its own knowledge (Nonaka & Tacheucki, 1995). It functions as a cognitive system, defining its identity, generating information, and leveraging its capabilities to produce knowledge through ongoing learning processes (Vicari, 1992). Being part of the NCIAM framework , which functions as a system, will involve participants with their own knowledge-generation setups that can assist other participants in acquiring new knowledge, innovations, and skills.

This research challenges conventional notions of competition by demonstrating that strategic collaboration with competitors at various levels can yield significant mutual benefits. Being part of the NCIAM framework will foster shared resources, drive joint innovation, and create value that benefits all participating firms. Managers can leverage this insight to explore opportunities for co-development of industry standards, engaging in joint ventures, or launching co-marketing initiatives. By adopting a more

cooperative mindset, managers can unlock new avenues for growth and competitive advantage that extend beyond traditional zero-sum competition.

At the industry level, this research suggests managers could adopt a broader perspective, shifting their focus from individual firm performance to the dynamics of the more extensive collaboration system. The findings illustrate how collaborative ecosystems can drive industry-wide evolution, leading to enhanced system-wide efficiency, alignment around shared goals, and collective problem-solving. Managers can play a pivotal role in fostering such ecosystems by initiating and participating in industry-wide collaborations that address common challenges, such as innovation, and create value for all stakeholders.

An additional managerial implication of the proposed NCIAM collaboration framework concerns the implementation of innovations in real-world construction projects. Since construction contractors are active participants in the collaboration network, the model provides an opportunity to test new innovations through pilot applications in ongoing projects among several contractors. Such pilot implementations would allow participating contractors to evaluate the practical feasibility of innovations developed through collaborative research before large-scale adoption. This approach can help bridge the gap between laboratory-based innovation development and real-world construction practices by enabling iterative testing, feedback, and refinement of new technologies, processes, or materials within actual project environments.

Furthermore, the research underscores the potential for collaboration with competitors to advance sustainable business practices. By aligning on shared sustainability objectives, firms can pool resources and expertise to implement environmental initiatives, optimise supply chain logistics, and reduce costs. This collaborative

approach will not only enhance individual firm sustainability but also contribute to broader industry and societal goals. Managers, once becoming part of the NCIAM framework , will view sustainability as a collective opportunity, where partnerships with competitors can amplify impact and drive meaningful progress toward long-term environmental and social objectives. On top of that, thrust from government bodies and NGOs, who are also members of this collaboration, will also be there.

3.6.3. Research Limitations

This study has some limitations. A preliminary structured collaboration model is developed here to provide an overview of collaborative processes in the open innovation context. I do not claim this model to be definitive; instead, it can be viewed as an exploratory catalyst for future research. The proposed NCIAM framework is exploratory. It could be tested in real-world settings across different industries and geographic locations. As the NCIAM framework developed here only caters to the requirements of the Indian construction sector, this collaboration model could be further expanded by having a greater variety of partners that have not come into the scope of this research and different industrial contexts.

According to Reitan (1997, 1998), there usually is a structural unwillingness to collaborate with other organisations. That could be true in the Indian construction sector context as well, although respondents in this study valued the importance of collaboration. However, are they willing to share data in collaboration? Would they be willing to work together? Future studies could look at this in further detail.

Clients are commonly considered to have an enormous capacity to influence firms and individuals involved in construction in a way that fosters innovation (Barlow, 2000; Kumaraswamy & Dulaimi, 2001). Although the government and, in many cases,

manufacturing firms serve as clients to construction contractors, clients were not explicitly included as stakeholders in this study during the development of the NCIAM framework, as the interview process had reached saturation. However, many manufacturing firms and government departments, which often act as clients in various capacities, were interviewed. As a result, the interviews did not include firms that function solely as clients, with no other involvement in the construction industry. This limitation of not considering clients as key collaborators in the NCIAM framework can be addressed in future studies.

In the collaboration model developed here, partners have been identified with diverse industrial and specialisation backgrounds, which also brings variations in self-interest. Further studies can determine if different motivations and interpretations of collaborative innovation can help or hinder the alignment efforts among the NCIAM collaborators. Also, the concept of trust and simplicity regarding contracts and agreements needs detailed exploration. We truly hope that future research will build on and extend my ideas.

While this research has identified key themes such as appropriate business models, the scope of innovation, funding mechanisms, and intellectual property rights within NCIAM, these complex issues warrant more detailed examination in future scholarly research.

3.7. Conclusion

The NCIAM framework developed represents a new contribution to the literature on sustainable innovation practices. The proposed model provides in-depth details on initiating a collaborative relationship to improve innovation in the Indian construction sector. While the existing literature offers useful insights into the consequences of

sustainable innovation processes, the NCIAM framework builds on them. This study describes the mechanisms through which the Networked Construction Innovation Alliance Model ecosystem, a multi-tiered system, functions as a catalyst to enhance innovation and mitigate barriers arising from a fragmented industry structure within the complex construction environment. This study aims to inspire others to begin similar work by presenting the collaborative NCIAM framework.

Strategic alliances are more than just tools for achieving collective goals that benefit the partners involved. They also represent the corporate social capital of each partner firm, granting access to various resources controlled by other members of the alliance network. These alliances allow participants to leverage the resources, knowledge, and skills of their partners in a series of inter-firm agreements (Todeva & Knoke, 2005). Interfirm collaborations may be more efficient than arm's-length exchanges, especially when dealing with innovations and overcoming legal and political issues in a developing nation like India.

Based on ongoing research and input from key informants who participated in this study, a comprehensive collaboration model can effectively bring together different agencies for a common purpose. This deliberate and systematic NCIAM framework can articulate policies, designs, activities, and accountability, thus promoting cooperation and coordination where appropriate. This approach to collaboration presents an exciting opportunity to build greater trust and cohesion among diverse stakeholders.

Appendices

Appendix A - Additional interview excerpts

Themes	Interview Excerpt
Perception of Collaboration for Innovation	CR2: “I'll try this solution (OSC) and see how much improvement I can make. Then it will be helpful. I think it's a similar concept in retail. If we talk about a sachet, for example. Instead of purchasing a bottle, we purchase a sachet, saying that if we are able to use it, if you know the sachet benefits me, then probably I'll go for a bottle.”
	CR5: “Definitely anything which adds value to the existing process is helpful. So, I'm not against any sort of innovation or any sort of new thinking or anything in the construction industry because I do agree, I do agree that our construction industry is lacking compared to our peers. ……Yeah. And in that, if you are building something wherein it's like a virtual marketplace, also wherein I could get everything. Anything like any sort of platform which brings together everything and one thing, it will be really helpful.”
	CR7: “So it's quite difficult (to bring competitors to work together), but this can be a blessing in disguise also because there are so many competitors. But this type of solution (OSC) has not been provided yet. So, it can be a game changer.”
	CR10: “Group is better. Certain teams can dedicate 10 people from here and 10 people from there, like a cluster they have to. We call the word cluster innovation. A cluster is when different companies join together. This is why the word is cluster. You know I've seen in the wooden industry 10 small, small guys like small 10 - 10 people use the one machine only. Sharing of a machine in 24 hours, they share 6 hours on the machines.” (When asked about if innovating alone is better or in groups)
	CR2: “Once they share, they will also have access to this portfolio of innovations that are gathered from all the companies, and if they share 1, they will get 10, and therefore that will bring their cost of operations down or cost to executing the projects down.”
Stages of OSC Model formation	GR2: “I think that after agreeing to a collaboration, and in future if it's not progressing and the people are cancelling their agreement. So that happens because of a major decision between both parties' mutual decision. And there are experts on both sides, so both of them must have gone through something, and they must have decided mutually that this is not working together. That's why they're getting apart. A third entity can be a mediator type of entity which you're talking about. That is, I think, understanding between those 2 parties, only that in their agreement, if such a dispute arises, we need to go to this mediator agency.”
	NR1: “NGO will be neutral.”
	CR2: “I don't think in the Indian context, the government is the right body because it is itself very slow in adopting changes. It's a huge machinery that takes its own sweet time.” (Related to providing initiation push for OSC)
	CR3: “Big company can play a big role in that. But a government body, I don't think they will be involved in these new things. They are, these people are the person who is working in the government, they will not involve in innovation most of the people. Some people can be involved, but the private platforms can involved in that”
	CR7: “Yeah, it can happen because in a country like India, which is still developing, and there's a lot of scope for development in terms of infrastructure, everything. So there these bodies (Government Bodies) can collaborate, and they can bring all the contractors under one roof” (For initiation of OSC type of collaboration)
Preliminary features of the OSC Model	CR2: “I'm not in favour of contracts, but I'm saying that there has to be an entry barrier or something that makes you subscribe to this. An entry barrier could be anything. It could be a subscription model, or a certain amount of money that you could get, and therefore want to get value out of it, or it could be a certain number of innovations that I bring in this. ”

	CR3: “You can get a patent out of that. It is your copyright. You can get the copyright for that. Nobody can copy. You will get the copyright, and nobody can copy. You have the patent for that. Who can copy your things?”
	CR7: “Yes, definitely the contract is must for building the trust and building faith. amongst all the players.”
	CR10: “Like in this thing, clusterability, the government has to be involved in. Some kind of fight between knowledge-sharing partners will always happen. That they can tackle it from that.”
	CR12: “What we did in the first few months was, we didn't take the money, the government did support us. But later on, there was a membership fee. Not much. There was a membership fee and that paid for getting the posting and everything done. So eventually government was there as a backup and we led it.,” (When asked about financial hostage)
Design of the OSC Model	GR2: “Both options are fine. It's always better when there are more stakes. You are unable to break them. So basically, if the group is coming like it's an association or an organisation which has more members, and they are representing a certain thing, that is also good because, in a way, being in a group, your voice is heard by everybody, and you grab attention. But the individual is also important, because nowadays there is no discussion which can be done without the AI now, which is going on. So, if the company is working in AI and they have a good innovative product with them, and they want to highlight it. There are people nowadays who are willing to talk to that particular organisation and get that AI innovation and buy the existing projects because everybody now wants to ride on the bandwagon of AI so that is the thing.” (When asked about SMEs coming as a group or as individual firms)
	CR7: “Technical universities can only provide technical support in terms of design or weighing the design, like whatever the work is executed, it is done as per the specification. They can be used as the auditors. NGOs can be used so that no law is broken or not complied like labour laws, or the benefits labourers should have, they are getting ignored. In those ways universities and NGO can contribute, yeah.”
	CR10: “No, not enforce it. Enforcing will not work. They have to take by their own wish.” (When asked about enforcing and innovation by the government on to firms)
	CR12: “I see them as a top body where at least every agency should have that respect. See, somebody has to have the stick. To put them in the right area, not saying discipline them, but put them in the right. Sometimes the conversation can go off track. You'll be talking about construction, suddenly becoming something else, and then egos come in. Somebody who can control that. That's it. But eventually, in my experience, eventually like these bodies are able to run on their own, you don't need that mediator later.”
	IR3: “Yeah, some director should be there. So yeah, someone should be heading the group and then they have to direct the team in the right direction.” (When asked about how to manage a tussle between partners in OSC-like collaboration)
After the OSC Model design	CR16: “All in all, I agree with this design. I truly hope that the hurdle of bringing such diverse partners could be resolved. And maybe if I have to add a member, I would say to include client members also, if possible, in the model. ”
	IR7: “Joint Contributions from Members: This is the most critical component. All collaborating members—companies, NGOs, and government bodies—should contribute financially. This creates a shared sense of ownership and accountability. The funding from each party can be tied to the potential value they stand to gain, such as a large corporation contributing more in exchange for greater access to the innovation, while smaller organisations contribute less. Independent Auditing of the budget spent will also help to mitigate any financial disputes between the parties.”
	CR15: “Joint partnership ensures the IP problems. Make the stakeholders as active partners.”

	CR14: “Project-based seems to be fair and reasonable, which can be made public after a certain validity period, as in other cases of IP rights.”
	IR7: “Not all projects need radical disruption. For example, a road project may benefit more from incremental process innovations.”
	IR8: “Yes, partners can gain many other benefits—better networking, access to new markets, improved reputation, skill development, and stronger long-term relationships with other firms and government.”

Appendix B - Semi-structured Interview Questions

Q. No.	Semi-Structured Interview Questions
1	Can you tell me a little bit about yourself?
2	Can you tell me about your work?
3	What is your opinion on the role of collaboration in improving innovation among construction contractors?
4	Do you think that any construction firm could achieve greater innovation benefits by working together with other construction contractors and related firms than those gained from working independently? Kindly elaborate.
5	What is your opinion on network-based collaboration models such as One-Stop-Shop?
6	How do you envision a collaboration between the construction industry contractors and other participating companies?
7	How do you envision initiating a new collaboration, such as OSC, between the construction industry contractors and other participating companies?
8	Could you please describe or sketch the processes or phases and associated activities you undertook/are undertaking for any collaboration?
9	With whom and from which sectors would you consider partners for the initial phase of the OSC model? Will this evolve over time? If so, why, and how would this happen?
10	Would you try to include partners who are either friends or friends of friends, and/or possess a positive reputation in the market? Why?
11	What is your opinion of including a neutral body as part of this new OSC body? And who could be its members?
12	What is your opinion on the importance of non-construction contractors like Universities, NGOs, and Governments not directly involved in construction projects? Can they contribute in multiple ways to the OSC?
13	Would you be willing to consider working with companies of all sizes, like young innovative companies, SMEs, etc., with diverse backgrounds in this collaborative model?
14	Should these firms be given individual representation or a collective one in the OSC owing to their small sizes and different interests compared to large and medium-scale enterprises?
15	What is your opinion on financial hostage? Should it be allowed in this partnership as a formal safeguard? Should this financial collateral hostage decrease with time when members have proved their trustworthiness? Kindly explain.
16	Do you see independent bodies, which could comprise of government, NGO and university representatives, sitting in final authority positions where the government’s role is extra important as far as public funding goes in this OSC collaboration?
17	Would you suggest an independent management team representing their firms as part of this collaboration? If Yes, Why?
18	Would you recommend putting a liaison team to resolve any bottlenecks?
19	How can self-interested competition among the participants be managed?
20	What would be the function of contracts when dealing with known versus unknown partners, especially during the initial days of setting up this OSC?
21	How will the standard format for information or knowledge flow system be created? Should a new one be created, or should it be adapted from already existing ones?
22	Should an innovation be approved only after the acceptance of every partner, or will subnetworks be allowed to function?
23	Will it be allowed for companies to participate in multiple OSCs or other collaborations at the same time?

24	Should the government participants influence policymaking teams to change the legal framework in a way that would weaken the position of imitators outside of the OSC network and strengthen the position of radical innovators inside the OSC network?
25	Should all the participants be forced by government bodies/policy makers to adopt an innovation if it brings social and environmental benefits?
26	Are there other important aspects of your experiences of working in a collaborative environment that you feel I have left out and could be important? Please share if any.
Information sought after the Model design	
27	This model is designed as an open innovation system with semi-permeable boundaries to balance openness and protection. Do you agree with this design? Would you recommend any changes to make it more effective in practice? Would you want any other industry to be a member of this collaboration (and why?)?
28	In your opinion, how should innovation projects and the collaboration itself be funded? How the innovation cost might be recovered?
29	How should intellectual property be managed in this collaboration model? Who should own the intellectual property generated within this collaboration?
30	Could you explain what the business model should be for this collaboration? How should value be created and captured among the partners?
31	In your view, what should be the scale and scope of innovation outcomes one can aim for through this collaboration?
32	Do you think that by participating in this collaboration model, partners could gain other benefits besides innovation improvement?
33	Do you have any final suggestions or concerns about this collaboration model?

4 Chapter 4 - Assessing the Impact of Networked Construction Innovation Alliance Model on Indian Construction Firms: A Perceptions-Based Study

Having established the structure and features of the collaboration model in the previous chapter, this chapter examines the tangible and intangible benefits, beyond innovation, that may emerge from participation in such a framework.

4.1. Introduction

Networks have emerged as a key organisational structure for fostering and spreading innovations across various industries. These innovation networks enable companies to address the challenges posed by intensifying competition and fast-evolving markets (Wirtz, 2011). The various viewpoints generated through such collaborative arrangements can serve as a vital competitive edge (Tracey & Clark, 2003). Businesses engaged in partnership networks may more effectively leverage their internal strengths, thereby improving their overall performance (Zaheer & Bell, 2005). Today, firms increasingly pursue innovation excellence through collaboration, which has shifted from being optional to a critical strategic imperative (MacCormack et al., 2007).

Innovation serves as a driver for progress, where collaborative efforts enhance the success of innovative initiatives and the development of new ventures (Powell et al., 1996; Teece et al., 1997). Research suggests that greater cooperation leads to superior new product performance compared to limited collaboration (Olson et al., 2001, p. 269). Partnerships between organisations can strengthen capabilities, alleviate resource constraints, facilitate knowledge integration, stimulate creativity, and support the discovery and utilisation of new business links. These advantages

ultimately contribute to the economic expansion of the organisations through partnerships and heightened competitive strength (Hewitt-Dundas, 2006; Daugherty et al., 2005).

Collaborative firms demonstrate greater agility in adjusting their offerings and operational processes to meet evolving market needs (Wilkinson & Young, 2002). The performance benefits of collaboration stem from shared access to complementary resources and expertise. Organisations can no longer rely solely on internally developed knowledge and assets (Swaminathan & Moorman, 2009), as inherent limitations, such as unpredictable strategic outcomes, resource constraints, and the prohibitive costs of knowledge acquisition, make success increasingly unattainable when working alone (Wilkinson & Young, 2002).

Collaborative relationships offer significant value to firms, particularly by enabling risk mitigation and access to complementary resources, which can improve financial outcomes and strengthen competitive positioning (Baah et al., 2021). Strategic alliances enhance knowledge utilisation efficiency by leveraging economies of scale and scope in shared expertise (Grant & Baden-Fuller, 2003). For example, within green innovation networks, participants actively collaborate to advance sustainable innovations, driving substantial environmental benefits (Melander & Arvidsson, 2022). Additionally, robust networks foster trust among inter-organisational partners, encouraging willingness for knowledge exchange (Kowlaser & Barnard, 2015) and cooperative problem-solving. The effect of trust in effective network management and information sharing further enhances organisational learning capabilities (Klein et al., 2020).

The construction sector has historically lagged other industries in innovation performance (Hampson et al., 2014). To address this gap, the previous chapter developed a network-based collaborative framework, the Networked Construction Innovation Alliance Model (NCIAM), specifically tailored for the Indian construction context. While industrial sectors like automotive, shipping, and aerospace have demonstrated significant improvements in efficiency, quality control, productivity, and cost reduction (Ranta, 1993), the construction industry has failed to realise similar gains (Fernández-Solís, 2008). Productivity growth in construction remains stagnant compared to other sectors, representing a long-standing challenge that continues to constrain the industry's development and operational effectiveness (Sompie, 2024). Despite several studies focusing on innovation-based collaborations, findings related to its influence on improving inter-organisational stakeholder trust, creating new business opportunities, environmental performance and improving a firm’s financial performance are not available in the context of the construction sector.

This study examines how the NCIAM framework may impact environmental performance, inter-organisational stakeholder trust, financial performance, and new business opportunities, as perceived by Indian construction professionals. To address these impacts of NCIAM, the current study draws on the extended resource-based view (ERBV) theory (Lavie, 2006) to investigate.

Jap (2001) posited that inter-organisational collaboration constitutes a distinctive strategic resource. By cultivating dense relational networks, firms can acquire valuable external resources that would otherwise remain inaccessible yet critically relevant to competitiveness (Cao & Zhang, 2010). The Extended Resource-Based View (ERBV) provides a comprehensive framework for understanding competitive advantage in collaborative contexts (Son et al., 2014). The ERBV explains how networked firms can

sustain and enhance their competitive positioning through interconnected relationships, offering a systematic approach to analysing how firms achieve competitiveness in interorganizational ecosystems (Lavie, 2006; Son et al., 2014). The current study adopts the view of ERBV to document and test the impacts of adopting NCIAM membership on the different types of competitive advantages arising from collaboration.

This study examines relationships between constructs as perceived by relevant stakeholders, consistent with established approaches in management and organisational research. The chapter is organised as follows: the next two sections present the literature review and hypothesis development, respectively. This is followed by detailed sections on research methodology, empirical results, and an integrated discussion that examines theoretical and managerial implications and limitations. Finally, the chapter offers some concluding remarks.

4.2. Literature Review

This section reviews the theoretical and empirical foundations that inform this study. It begins by outlining the rationale for adopting the Extended Resource-Based View (ERBV) as the primary theoretical lens. Following this, the previously introduced collaboration model, the NCIAM, is revisited, highlighting its relevance to collaborative dynamics in the construction sector. The latter part of the chapter focuses on the key variables expected to be influenced by participation in the NCIAM: environmental performance, inter-organisational stakeholder trust, financial performance, and new business opportunities.

4.2.1. Theoretical Background

Prior research has examined networked collaborations through theoretical lenses such as the Relational View (RV) and Resource-Based View (RBV) (Yang et al., 2019). As emphasised by Barney (1991), competitive resources must possess critical attributes: value, rarity, inimitability, and non-substitutability in order to meaningfully enhance firm performance. Subsequent scholarship has extended RBV theory by demonstrating how strategically aligned firms can synergistically combine resources through effective collaboration to generate competitive advantages for the focal organisation (Dubey et al., 2017; Yang et al., 2019).

In the construction industry, firms often display a certain or broad degree of homogeneity, following similar processes, technologies, and project execution patterns to those of a more successful firm (Staniewski et al., 2016; Tetteh et al., 2025; Cao et al., 2025). Under such conditions, the Resource-Based View (RBV) faces limitations. While RBV emphasises the importance of rare and unique resources for generating competitive advantage (Barney, 1991), the principle of equifinality suggests that multiple resource configurations can produce similar levels of value (Schoemaker, 1990). Consequently, even if firms possess rare resources, in a context where most firms operate similarly and can achieve comparable efficiency, these resources may not translate into sustained competitive advantage. In other words, value generation, rather than resource rarity alone, becomes the more fundamental determinant of competitive advantage (Priem & Butler, 2001). This suggests that in a sector like construction, where standardisation exists in many processes, several diverse firms may often converge on comparable strategies (Cao et al., 2014; Akbar et al., 2018), which implies that the RBV may overstate the explanatory power of resource uniqueness (Barney, 1991; Schoemaker, 1990). It has also been concluded that the

traditional Resource-Based View (RBV) wrongly identifies the source of long-term competitive advantage in dynamic markets, overemphasises leveraging existing resources strategically, and becomes less applicable or even limited in fast-changing, high-velocity market environments (Eisenhardt & Martin, 2000).

Scholars have also critiqued the Resource-Based View (RBV) for its constrained theoretical foundations. Kraaijenbrink et al. (2009) argue that RBV remains anchored in neo-classical economic rationality, limiting its potential for theoretical advancement. This is because the neoclassical perspective neglects the Schumpeterian dynamics of resource recombination, transformation, and integration (Pereira & Bamel, 2021).

While RBV has emphasised competitive advantage through economic and financial performance metrics, Battisti et al. (2021) propose expanding this focus to include non-financial performance dimensions. Their research demonstrates how Corporate Venture Capital-acquired resources can generate competitive advantages manifested through environmental and social performance outcomes, suggesting the need for RBV's potential evolution beyond purely economic paradigms (Battisti et al., 2021). Although the context of Corporate Venture Capital differs from construction industry collaboration, the underlying principle, that external resource acquisition can drive broader performance benefits, highlights the need for RBV's evolution beyond purely economic paradigms. As Baah et al. (2021) demonstrate, RBV offers a robust framework for building competitive advantage through valuable, rare, inimitable, and non-substitutable resources. However, RBV's traditional focus on firm-level profitability and competitiveness, even within alliances, limits its capacity to address broader concerns. It underemphasises sustainability, collaborative value creation, and environmental impact, exposing theoretical gaps in responding to modern strategic challenges.

In response to the RBV's firm-centric limitations, particularly in capturing inter-organisational value creation, scholars have turned to the Relational View (RV), which highlights the importance of collaborative relationships in resource development. The Relational View (RV) recognises that critical resources often extend beyond organisational boundaries. Dyer et al. (2018) contend that collaborative partnerships are essential for achieving superior profits, as relational rents cannot, by definition, be realised in isolation. This perspective has fostered the widespread adoption of inter-firm collaborations, extending RV's core premise that organisations function as nodes within strategic networks where interdependent relationships enhance collective performance. While the Relational View (RV) has emphasised collaborative practices as pathways to competitive advantage, contemporary business realities require revisiting its foundational assumptions alongside the Resource-Based View (RBV). Although the RV broadens the scope of value creation to include dyadic partnerships, it falls short in explaining the intricacies of multi-firm network dynamics, a limitation that the Extended Resource-Based View (ERBV) aims to overcome.

Despite its theoretical promise, the Relational View (RV) has not yet been established as a dominant framework. Much of the early empirical support, largely derived from the works of Dyer and colleagues (Dyer, 1997; Dyer & Hatch, 2006; Dyer & Singh, 1998; Dyer, Singh, & Kale, 2008), was not consistently confirmed in subsequent studies, which often employed variations of the original theoretical structure. For instance, Deboçã and Martins (2015), in their qualitative study of inter-organisational relationships in two furniture centres, found no evidence of RV constructs. Similarly, Tescari and Brito (2018) highlight that the operationalisation of the RV as an explanatory framework requires further refinement and deeper investigation.

While the RV offered a way to extend RBV beyond the firm, scholars have also expanded RBV internally to better address change and uncertainty. One significant development in this direction is the dynamic capabilities framework. Recognising the limitations of RBV, Teece et al. (1997, p.516) expanded RBV through their dynamic capabilities framework, defining these capabilities as “the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments”. So, to assess the impacts of the adoption of NCIAM on several other (non-innovation) performances, this study draws on the Extended Resource-Based View (ERBV). Lavie (2006) extended the RBV to shape the competitive advantage of the networks by highlighting the VRIN characteristics at the network level.

From a strategic resource perspective, early RBV research distinguished among resource types, such as non-strategic “inferior resources” and valuable but widely shared “common resources” (Peteraf, 1993, p. 180; Branzei & Thornhill, 2006). More recent extensions, however, emphasise that value is created less by individual resources than by how they are combined (Warnier et al., 2013). This aligns with network-based collaboration, where firms rely on shared and complementary assets. The dynamic capabilities perspective strengthens this view by shifting focus from categorising resources to differentiating capabilities, such as ordinary versus dynamic or first- versus second-level capabilities, which are central to how firms jointly reconfigure resources in collaborative settings (Drnevitch & Kriauciunas, 2011; Winter, 2003). Likewise, resource management research conceptualises the orchestration of the entire resource portfolio, a process in interfirm networks that extends beyond a single firm (Sirmon et al., 2007; Warnier et al., 2013). Taken together, these extensions underscore the importance of adopting an Extended RBV (ERBV) to study

collaboration, as it highlights how competitive advantage emerges from managing and integrating shared resources and capabilities across organisational networks.

By integrating elements of the traditional RBV, the Relational View (RV), and social network theories, the Extended Resource-Based View (ERBV) provides a comprehensive framework for exploring firm behaviour in dynamic network settings (Lavie, 2006). A fundamental difference arises between the ERBV and the RV. The RV is centred on dyadic relationships, where firms generate relational rents through partner-specific ties, as seen in Toyota's keiretsu, where a central firm connects otherwise independent suppliers (Dyer & Singh, 1998; Lavie, 2006), which again is a multiple dyadic relationship with a focal firm. The NCIAM framework is characterised by a fluid, decentralised, and multi-lateral collaboration model, created to reflect the dynamic, project-based nature of the construction industry. And therefore, the NCIAM framework should be understood as fundamentally distinct from keiretsu structures. This structure is analogous to the ERBV, which explains resource exchange across multi-partner alliance networks characterised by dynamic, multi-lateral interactions that are not centred on a single focal firm (Lavie, 2006). The Extended Resource-Based View (ERBV) posits that firms can enhance their competitive capabilities and performance by leveraging internal resources to cultivate external resources and competencies. ERBV fundamentally diverges from RBV by asserting that strategic resources and knowledge originate both within organisational boundaries and through external networks (Mathews, 2003). This perspective recognises that critical capabilities are often embedded within broader interorganizational relationship systems (Squire et al., 2008), necessitating the integration of internal and external resources for capability development (Teece et al., 1997; Grant, 1996). Crucially, ERBV maintains that sustainable competitive advantage emerges from strategic

resource orchestration, where strong internal capabilities simultaneously enable more effective absorption and utilisation of external resources.

Empirical applications of the ERBV demonstrate its theoretical validity. Arya & Lin (2007) substantiate this perspective, revealing that interorganizational collaboration enables firms to augment their capabilities while achieving both financial and non-financial benefits. Early ERBV research predominantly examined horizontal governance structures, particularly knowledge transfer through strategic alliances and joint ventures (Mathews, 2003). More recent scholarship has expanded this theoretical lens to investigate vertical relationships, including strategic buyer-supplier partnerships, as examined by Squire et al. (2008). This evolution reflects the framework's growing applicability across diverse inter-organisational contexts.

The explicit implementation of the ERBV in the construction industry remains limited. However, insights can be drawn from the dynamic capability literature, which is recognised as an extension of the RBV developed to explain how firms adapt to changing environments (Chryssochoidis et al., 2016). Dynamic capabilities emphasise continuous environmental monitoring, capturing opportunities, and developing new capabilities (Wahid et al., 2023). Due to its usefulness, this framework has been adopted in several construction-related studies (e.g., Adam & Lindahl, 2017; Green et al., 2008; Aghimien et al., 2021). By analogy, this suggests strong potential for applying the ERBV in the construction sector research and underscores the novelty and contribution of this research in employing ERBV as its theoretical lens.

4.2.2. Networked Construction Innovation Alliance Model (NCIAM)

NCIAM is designed to improve the collaboration ecosystem in the Indian construction sector. NCIAM takes its inspiration from the OSS business model. The OSS model

represents an integrated approach where a primary entity, potentially through strategic partnerships, delivers comprehensive yet customised solutions (Mahapatra et al., 2013). Academic research has established collaboration as an effective mechanism for mitigating cross-functional and interorganizational tensions while fostering unique relational advantages (Moberg et al., 2003; Nicovich et al., 2007). This empirical evidence positions collaborative competence as a critical dynamic capability (Agarwal & Selen, 2009). Sophisticated collaboration practices diminish inefficiencies by facilitating: (1) strategic objective alignment, (2) enhanced transparency in information exchange, (3) increased managerial engagement, (4) reciprocal transfer of specialised knowledge and assets, and (5) balanced risk-reward distribution among partners. (Stonebraker & Afifi, 2004; Eng, 2006; De Luca & Atuahene-Gima, 2007). Strategic collaboration enhances organisational performance by optimising resource allocation and increasing operational flexibility, ultimately improving both process efficiency and customer experience (Barratt, 2004; Li et al., 2010). In today's volatile industrial landscape, network-based collaboration has become essential for maintaining a competitive advantage. This paradigm shift has led operations scholars to argue that modern enterprises no longer compete as standalone entities but as interconnected members of broader industrial ecosystems (Hwang et al., 2008; Khilwani et al., 2009). It is also worth noting that current trends demand environmental collaborations in networked collaboration; this study seeks to investigate how the NCIAM framework can influence environmental performance and other variables.

4.2.3. Inter-Organisational Stakeholder Trust

Partners in a network, along with their participating and non-participating stakeholders, should have trust in the unit that shares the information. Trust could be conceptualised as 'confidence in an exchange partner's reliability and integrity' (Morgan & Hunt, 1994,

p. 23). Unlike project-specific knowledge transfer, trust-based relationships demand more intensive relational investments, requiring sustained commitment of time and resources to develop and maintain (Larson, 1992). As Jing et al. (2019) emphasise, trust constitutes a critical success factor across all organisational levels and business relationships. Therefore, stakeholder and inter-firm connections must be grounded in trust to achieve mutually beneficial outcomes. The strategic importance of trust is underscored by empirical evidence demonstrating that poor trust management can precipitate the downfall of even large multinational corporations (de Oliveira & Rabechini, 2019), such as evidenced by the failures of once-prominent firms, including Enron, AOL, WorldCom, and Tyco. Greenwood and Van Buren III (2010, p. 426) explained trust as “the reliance by one person, group or firm, upon a voluntarily accepted duty on the part of another person, group or firm, to act in a manner that is ethically justifiable”. This relational dynamic extends to stakeholders, whom Baah et al. (2020) characterise as entities either influencing or impacted by organisational activities. As de Oliveira and Rabechini (2019) emphasise, trust represents a fundamental attribute of productive organisational relationships and interactions. This suggests that for the NCIAM network to create value and become a fertile source of competitive advantage, there should be trustworthy interactions among construction contractors and partners in the NCIAM framework.

4.2.4. Environmental Performance

Contemporary research underscores the growing imperative for businesses to prioritise environmental conservation and sustainable development, with both scholars and industry leaders recognising this as a strategic priority (Awan, 2017; Acquah et al., 2020). Notably, enterprises engaged in extensive interorganizational networks and those operating within concentrated industrial clusters demonstrate superior

performance in green innovation initiatives (Fusillo et al., 2020). Strategic collaboration among competing firms can serve as an effective mechanism for reducing ecological footprints while enhancing societal value creation (Melander & Arvidsson, 2022). The manufacturing industry, for example, faces mounting pressure to address sustainability challenges given its substantial resource consumption, energy demands, and greenhouse gas emissions (Baah et al., 2020). Current research reveals a dichotomy in corporate sustainability approaches: While most manufacturers employ reactive compliance strategies primarily driven by regulatory pressures and cost concerns (Agyabeng-Mensah et al., 2020; Baah et al., 2020), a minority of firms proactively embrace environmental stewardship. These forward-thinking organisations recognise the competitive advantages and long-term benefits associated with sustainable business practices.

4.2.5. Financial Performance

Financial performance evaluation assesses a company's operations and overall standing. In financial analysis, ratios are commonly employed due to their straightforward nature and the depth of insight they offer. These ratios enable trend analysis, cross-sectional comparisons, and benchmarking against other firms. Additionally, managerial commentary plays a vital role in interpreting financial outcomes accurately. Companies with stronger financial performance tend to provide more comprehensive discussions of their results in annual reports than those with weaker financial outcomes (Myšková & Hájek, 2017). Open innovation is based on the readiness of companies to exchange knowledge and innovations within a collaborative network. By sharing ideas, firms can gain both financial and strategic advantages from each other’s innovations (Chesbrough et al., 2006; Kline, 2003). Research by Shin et al. (2019) emphasised the significance of building strong partnership commitments to

achieve successful innovation outcomes and enhance financial performance. Integrating knowledge plays a key role in developing new products (Zander & Kogut, 1995) and boosting financial outcomes (Zahra & George, 2002). In many high-tech sectors, strategic partnerships are crucial for enhancing financial results, as they provide access to knowledge essential for building capabilities and launching new products (George et al., 2001).

4.2.6. New Business Opportunities

When firms form partnerships, those that succeed often establish clear collaborative strategies and implement organisational adjustments to enhance innovation performance. These efforts enable them to discover and capitalise on new business opportunities. Overall, collaboration is becoming a key driver of competitive advantage. Collaboration has gained attention at the executive level and is now a core element of strategic planning, with stakeholders recognising its value in boosting business outcomes (MacCormack et al., 2007). According to Köhler et al. (2022), participants viewed the shared goal of their network as replacing conventional building methods with circular economy approaches, which in turn opened new business opportunities. Social capital is widely acknowledged as a critical factor influencing the likelihood of success and sustainability in new ventures (Audretsch et al., 2011). Ramos-Rodríguez et al. (2010) argue that individuals' access to external knowledge through social networks plays a vital role in building the ability to identify and leverage emerging business opportunities.

Grounded in the ERBV of the firm, this study examines how participation in the NCIAM network may influence the performance of construction firms. The ERBV offers a suitable theoretical lens for exploring the competitiveness of the NCIAM, which is characterised by both vertical and horizontal relationships, as well as the strategies of

interconnected organisations within an infrastructure and construction network context. The literature review reveals that studies grounded in the ERBV are relatively scarce compared with the Resource-Based View (RBV). Moreover, existing ERBV research has predominantly focused on sectors such as manufacturing, information technology, non-profit organisations, petrochemicals, and pharmaceuticals (Arya & Lin, 2007), with little to no application in the context of the built environment or construction networks. In the preceding section, the five key variables of participation in the NCIAM, financial performance, environmental performance, inter-organisational stakeholder trust and the development of new business opportunities were detailed. This chapter now proceeds to analyse the interplay between these variables as perceived by construction professionals. The analysis places particular emphasis on the impact of participation in the futuristic NCIAM framework on the other key performance outcomes.

4.3. Hypothesis Development

As discussed in the previous chapter, the three-tiered NCIAM framework was developed to enhance the innovation ecosystem in India's construction sector. This model's effective implementation relies on exchanging relevant and valuable information across networks. By collaborating with external stakeholders, including suppliers, customers, competitors, and research institutions (such as universities or government labs), firms can strengthen both knowledge sharing and market insight. This being a networked style collaboration will expand the firm's knowledge base, ultimately boosting its innovation capabilities (Clauss & Kesting, 2017; Luzzini et al., 2015; Zhou & Li, 2012). Ahuja and Katila (2001) highlight that critical knowledge for driving radical innovation often lies beyond a firm's boundaries, residing instead with customers, competitors, and suppliers. Similarly, scholars argue that knowledge

sharing fosters cross-organisational cooperation, enhances collective learning, revitalises existing knowledge pools, and sparks novel ideas for breakthrough innovations (e.g., Tsai, 2001; Zander & Solvell, 2000). Ultimately, firms strive to enhance collaboration to improve performance (Cao & Zhang, 2010). Those that fail to adopt open and collaborative practices may encounter significant competitive drawbacks, including a long-term decline in innovation capacity (Chesbrough, 2003; Diener & Piller, 2013).

Implementing collaborative initiatives with suppliers contributes to better environmental outcomes (Gimenez et al., 2012). The current open innovation framework primarily emphasises the value creation that arises from working with external partners. It generally assumes that such collaborations boost product innovation, which then positively influences financial results. Specifically, it suggests that engaging with external partners strengthens product innovation capabilities, ultimately leading to improved financial performance (Faems et al., 2010). According to Acquah et al. (2021), participating in collaborative efforts can enhance both environmental and financial outcomes. Highly interconnected networks help foster trust (Ahuja, 2000). When a network includes partners with numerous overlapping and redundant connections, it creates a foundation for building trust and encouraging cooperation (Coleman, 1988; Portes & Sensenbrenner, 1993). Furthermore, effectively managed partnerships can strengthen brand reputation, generate goodwill, and reveal new business prospects and revenue streams (Austin, 2010, p. IX). From the above, I propose the following hypotheses:

H1: Inter-organisational stakeholder trust is perceived by key informants to be positively associated with participation in the NCIAM.

H2: Environmental performance is perceived by key informants to be positively associated with participation in the NCIAM.

H3: Financial performance is perceived by key informants to be positively associated with participation in the NCIAM.

H4: The generation of new business opportunities is perceived by key informants to be positively associated with participation in the NCIAM.

As indicated in the literature review, inter-organisational stakeholder trust plays a critical role in business partnerships, as companies fundamentally operate through relationships with various stakeholders (Jing et al., 2019; Swift et al., 2019). Transparent and meaningful communication with stakeholders is key to fostering trust and loyalty (Wamba, 2018). Similarly, Baah et al. (2020) emphasise in an environmental context that businesses adopting sustainable practices meet stakeholder expectations for environmental preservation, enhancing their reputation through improved environmental performance. Wamba (2018), aligning with Chin et al. (2015), further notes that strengthening environmental partnerships and performance attracts eco-conscious stakeholders, ultimately leading to a larger market share and financial performance.

Wamba (2018) suggests that addressing trust deficits within corporations can enhance productivity, financial performance, and overall reputation. Research by Ramakrishnan (2008) indicates that businesses prioritising strong stakeholder ties tend to achieve greater profitability and long-term viability compared to those solely focused on short-term financial gains. Additionally, positive inter-organisational stakeholder relationships, rooted in trust and loyalty, serve as a strategic asset that safeguards against profit erosion from other core activities. Even during financial

downturns, these relationships prevent firms from becoming trapped in unfavourable positions and instead facilitate a faster recovery (Choi & Wang, 2009). For network organisers, fostering trust through intentional initiatives, such as informal gatherings, alignment on shared objectives, transparent communication, and safeguarding confidential information, can yield significant advantages. These efforts may also enhance entrepreneurs' ability to capitalise on business opportunities. Research by Bergh et al. (2009) indicates that cultivating trust within learning networks can unlock valuable knowledge-sharing and facilitate the pursuit of new ventures. Furthermore, relational trust strengthens the entrepreneurial process in multiple ways, including reinforcing mutual reliability among participants and predicting each other's behaviour. Trust plays a pivotal role throughout an established company's new venture development process, delivering both economic advantages (such as cost reductions) and social benefits (including stronger commitment and collaboration). Additionally, it enhances employee satisfaction and engagement, which are critical factors in successful new business creation (Zahra et al., 2006). Therefore, I propose the following hypotheses:

H5: Financial performance is perceived by key informants to be positively associated with inter-organisational stakeholder trust.

H6: Environmental performance is perceived by key informants to be positively associated with inter-organisational stakeholder trust.

H7: The generation of new business opportunities is perceived by key informants to be positively associated with inter-organisational stakeholder trust.

While there is continued discussion about whether environmental performance, such as lowering carbon emissions, reducing pollution, and sustainable resource use, directly enhances a company's financial results, some argue that the connection is not straightforward (Saeidi et al., 2015; Feng et al., 2018). However, most prior studies suggest a positive correlation, as eco-friendly practices, though not instantly boosting profitability, may lead to lower regulatory costs, a stronger brand reputation, and a competitive edge (Shashi et al., 2019; Baah et al., 2020). Similarly, Li et al. (2017) support this perspective, noting that adopting eco-friendly practices promotes cleaner production, enhances operational efficiency, and improves waste management, carbon emission reduction, and resource utilisation — all of which contribute to better financial performance. These advantages also help attract environmentally conscious consumers, sustainable investors, and green suppliers, further boosting profitability. Additionally, integrating sustainable practices and developing green products can strengthen a firm's market position.

A proactive environmental strategy entails companies adopting initiatives like sustainable practices while recognising that ecological challenges can create new business prospects (Ambec & Lanoie, 2008; Aragón-Correa & Sharma, 2003). By leveraging innovative green technologies to address environmental concerns, firms can not only prevent regulatory penalties and public backlash but also strengthen their brand reputation and uncover new market potential—ultimately boosting their competitive edge (Berry & Rondinelli, 1998; Kao et al., 2010). Similarly, Goodman and Veritas (1998) argued that effective environmental management enhances environmental performance, which in turn opens lucrative opportunities for businesses. Accordingly, the following hypotheses are derived:

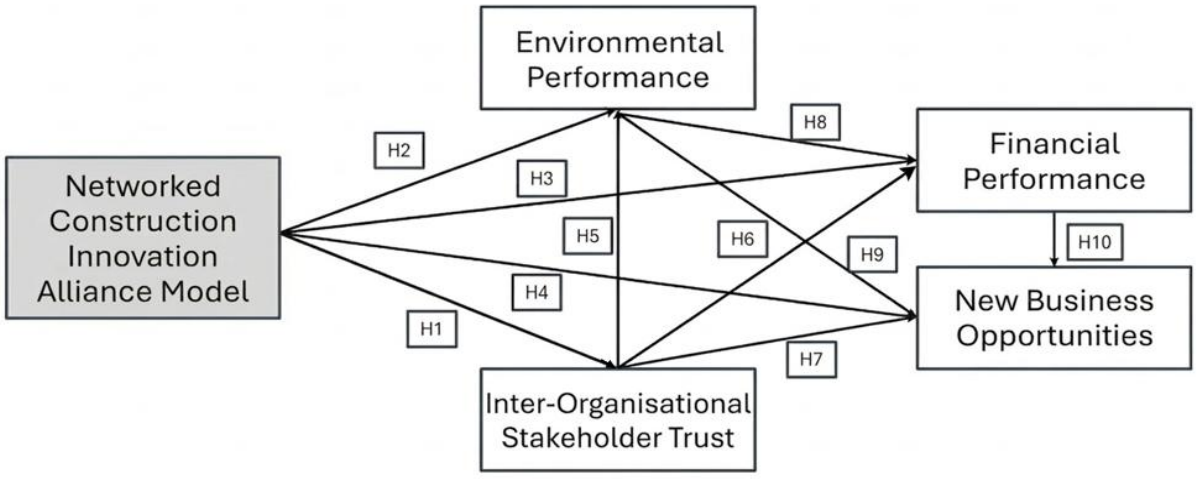
H8: Financial performance is perceived by key informants to be positively associated with better environmental performance.

H9: The generation of new business opportunities is perceived by key informants to be positively associated with better environmental performance.

Strong financial performance is a key priority for corporate leaders, as it lays the foundation for organisational stability and expansion (Baby et al., 2024). The resource-based view (Barney, 1991) posits that sustainable growth stems from initial profitability, as competitive advantage (reflected in strong earnings) enables firms to pursue strategic growth aligned with their core competencies (Davidsson et al., 2009). Moreover, robust intellectual capital enhances financial outcomes, creating greater potential for business growth (Melani & Kusuma, 2020). Thus, the following hypothesis:

H10: The generation of new business opportunities is perceived by key informants to be positively associated with better financial performance.

Figure 4.1: Research Model and Hypothesis



(Source: Author's own)

4.4. Research Methodology

4.4.1. PLS-SEM Methodology

This study employed PLS-SEM to evaluate the structural model, as it is well-suited for small sample sizes and non-normally distributed data while maintaining statistical robustness (Hair et al., 2013). In this study, the influence of five constructs on each other is studied. As depicted in Figure 4.1, there are hypothesised relationships among the independent latent variables. Therefore, the analysis of the model (Refer to Figure 4.1) utilises Partial Least Squares (PLS) as a method. PLS-SEM is a statistical method extensively used for regression analysis and structural equation modelling (SEM). This method proves particularly valuable when examining complex relationships among multiple variables, especially in studies with smaller sample sizes where traditional SEM approaches may be less effective (Becker et al., 2023). PLS-SEM has become increasingly popular due to its distinct strengths, especially in forecasting latent constructs. As a modelling method grounded in structural equation theory, PLS-SEM emphasises predictive causal analysis by examining variances among parameters and their associated indicators, enabling effective evaluation of cause-and-effect relationships (Chin, 1998).

This research employed PLS-SEM because it is considered well-suited for estimating the predictive models as outlined in this study (Baah et al., 2021). Researchers have increasingly favoured PLS-SEM for its ability to handle complex variables that are not easily measurable (Henseler et al., 2016; Duarte & Raposo, 2009). Adamy and Bakar (2018) highlight that PLS-SEM is a valuable tool in the construction industry for examining relationships between variables, especially when dealing with naturally hard-to-measure constructs.

4.4.2. Unit of Analysis

The unit of analysis for this study is the individual firm operating within the construction sector and its associated industries. Although the collaboration model examined in this research is intended to unite several firms to co-innovate, share risks and pursue new market possibilities, the outcomes of such collaboration, improvements in firm performance, enhanced stakeholder confidence, and greater access to business opportunities, are ultimately realised at the firm level. While inter-organisational collaboration facilitates value creation, the appropriation of such value occurs primarily at the firm level (Dyer & Singh, 1998; Roehrich et al., 2019). For this reason, each firm is considered the focal analytical unit, capturing its strategic choices and its ability to leverage the results of the collaborative process. This focus is consistent with earlier work in construction supply chain management, where the firm has similarly been used as the unit of analysis to investigate inter-organisational dynamics (Khouja et al., 2021; Ingirige & Sexton, 2005; Wang et al., 2023). These studies reinforce the appropriateness of adopting a firm-level perspective in this research, particularly given the inherently networked characteristics of the construction industry.

4.4.3. Sample and Data Collection

The data for this study were collected through a questionnaire survey targeted at construction professionals within the Indian construction sector. The survey was self-administered and distributed via an online link, with participants reached through the LinkedIn platform. The questionnaire comprised three sections: the first focused on demographic information, the second outlined the structure of the NCIAM, and the third included the measurement items.

Quantitative research typically includes a pre-test and pilot study in developing new questionnaire constructs (Churchill, 1979). The pre-test was carried out to improve sequencing, flow, and wording and to reduce possible ambiguities in the questionnaire. Two academic experts were involved, one of whom was a lecturer and the other an advanced-level doctoral colleague. After minor adjustments, a pilot study was carried out to test and refine the survey. The participants belonging to the key informant category were identified. Six participants were selected from the sample population with an average of more than eleven years of experience. While the number of informants was small for the pilot study, their expertise ensured the collection of rich and meaningful feedback. Then the survey was distributed to the final respondents.

The online survey link was distributed via LinkedIn to 348 participants. A total of 178 key respondents belonging to sixty-eight construction contracting companies participated in the survey, yielding a response rate of approximately 51.14 percent. Using key respondents offers the advantage of obtaining information that is both accurate and dependable within their specific areas of expertise (Poggie, 1972). Participation in this study was voluntary, and informed consent was obtained from all respondents prior to their involvement. Participants were informed about the purpose of the research and how the data would be used. They were also assured that their identities would remain anonymous and that all personal information would be treated confidentially.

This study employed random purposeful sampling, given the extensive pool of potentially insightful participants and the absence of any obvious criteria for selecting one over another (Sandelowski, 2000). After reviewing research works that focused on collaboration in the construction industry (Hughes, 2018; Elsayegh & El-Adaway, 2022; Rantsatsi et al., 2023), candidates were selected with a minimum of three years'

experience in the Indian construction industry, belonging to cadres such as project engineer, project manager, quality engineer, construction manager, senior manager, safety officer, etc. I connected with each respondent over LinkedIn and requested them to complete the survey. After cleaning the data, all responses were retained, leaving 178 completed, usable questionnaires.

Given the small sample size, the research employed the PLS estimation method to mitigate the limitations associated with a small sample size (Aibinu & Al-Lawati, 2010). The widely referenced ten-times rule (Barclay et al., 1995) recommends that the sample size should be at least ten times the number of independent variables involved in the most complex regression within the PLS path model. In other words, the minimum required sample size should be ten times the highest number of arrows directed toward any single latent variable in the model (Hair et al., 2021). The sample size requirement for this research work, in that case, is just 40 (< < 178). However, more respondents are included here to obtain a larger sample and ensure more rigorous results (Farooq et al., 2018). As per Hair et al. (2021), the minimum sample size needed to run a PLS SEM analysis should be 155. An examination of research publications in both construction industry-related studies (Romo et al., 2024; Gamil et al., 2020; Aibinu & Al-Lawati, 2010) and business administration research (Matheus et al., 2023; Ma et al., 2024; Ali et al., 2021) that have employed PLS-SEM as a methodology shows that sample sizes have remained around one hundred. So, because selected informants come from the construction industry alone, the sample size requirement does not need to be high due to relative homogeneity in the sample population. Table 4.1 reflects the profile of the construction firm's respondents, representing sixty-eight firms.

Table 4.1: Profile of Respondents

Characteristic	Frequency	Percentage (%)
Work Experience (in Years)		
3 - 5	53	29.78
5 - 10	61	34.27
10 - 15	38	21.35
15 – 20	13	07.30
20 and Above	13	07.30
Education Qualification		
Diploma	13	07.30
Bachelor's	71	39.89
Master's (or Post-Graduate)	94	52.81
Job Qualification/ Cadres		
Engineer	66	37.07
Manager	49	27.53
Senior Manager	34	19.10
Executive Level	12	06.75
Others	17	09.55
Gender		
Female	16	08.99
Male	162	91.01

(Source: Author's Own, N = 178)

4.4.4. Scale Development

The final survey included twenty questions, in addition to demographic questions, categorised to measure five constructs. Following common practice, a five-point Likert scale (ranging from Strongly Disagree to Strongly Agree) was used. Measures used in this study were drawn from the existing literature with minor changes of a linguistic and/or contextual nature.

Measures for NCIAM were adopted from Baah et al. (2021) and Najafi-Tavani et al. (2018). This required minor adjustments in grammar and the context of NCIAM. Previously, the items were used in supply chain and innovation collaboration settings. The stakeholder trust measurement items were extracted from Baah et al. (2021) without any change. The questionnaire items measured this construct as Stakeholder

Trust. However, to more accurately reflect the nature of the relationships captured by these items, namely trust among organisations participating in collaborative innovation activities, the construct is labelled Inter-Organisational Stakeholder Trust in the structural model. Similarly, items for environmental performance were sourced from Baah et al. (2021) with minor adjustments in just two out of four items to maintain continuity. Financial performance was assessed through the measurement items adapted by Shashi et al. (2019). Two items each used for measuring new business opportunities were adapted from Tang et al. (2010) and Kuckertz et al. (2017), respectively. In the published studies, the items were measured from the perspective of individuals. However, in this study, it is done from the firm's perspective. As most respondents in this study were working at different positions and locations in various-scale construction firms, their direct involvement in strategic decision-making regarding new business opportunities may be limited. However, the objective was not to measure strategic intent itself, but rather employees' perceptions of their company's orientation toward opportunity-seeking. Such perceptions reflect how strategic priorities are communicated and interpreted within the organisation. Notably, informal feedback gathered from two respondents employed at large construction firms indicated that while official information on new project pursuits may not be widely disseminated, employees often become aware of such initiatives through internal networks and word-of-mouth. This aligns with prior research (e.g., Denison, 1996), which supports the use of employee perceptions, regardless of formal hierarchy, for assessing firm-level constructs such as organisational culture and strategic posture.

Required adjustments were incorporated into the survey based on the results of in-depth interviews from the previous chapter. These adjustments improved the survey's

relevance to various potential network participants in the futuristic NCIAM context. Also, refer to Table 4.2.

Table 4.2: Measurement Items

Latent Variable	Item Code	Measurement Item	Factor Loading	Reference
Networked Construction Innovation Alliance Model (NCIAM)	NCIA1	By participating in an OSC model, our firm and OSC partners will share benefits and costs	0.608	(Baah et al., 2021)
	NCIA2	By participating in an OSC model, our firm and OSC partners will jointly search, acquire, assimilate and apply relevant knowledge	0.772	
	NCIA3	By participating in an OSC model, our firm and OSC partners will have agreements on the relevance of improvements that benefit the whole OSC network	0.709	
	NCIA4	By participating in an OSC model, our firm will collaborate with competing partners in OSC network	0.764	(Najafi-Tavani et al., 2018)
Inter-Organisational Stakeholder Trust (IST)	IST1	Our company considers stakeholders' interests in making decisions	0.752	(Baah et al.., 2021)
	IST2	Our company creates skills for effective coordination in the execution of plans	0.825	
	IST3	Our company implements strategies to ensure quality relationships	0.800	
	IST4	Our company involves stakeholders in the tasks needed to produce and deliver products and services to customers	0.697	
Environmental Performance (EP)	EP1	Our firm makes efforts to minimise the environmental impacts of its operations	0.817	(Baah et al., 2021)
	EP2	Our firm allows environmental audits	0.807	

	EP3	Our firm adopts cleaner construction methods	0.777	
	EP4	Our firm reuses and recycles materials	0.755	
Financial Performance (FP)	FP1	The return on investment of our company is higher compared to competitors	0.831	(Shashi et al., 2019)
	FP2	The return on assets of our company is higher compared to competitors	0.834	
	FP3	The sales growth and profitability of our company are higher compared to competitors	0.776	
	FP4	The total operating costs of our company are lower compared to competitors	0.642	
New Business Opportunities (NBO)	NBO1	Identifying potential new business opportunities comes very naturally to my organisation	0.618	(Tang et al., 2010)
	NBO2	My organisation has a special alertness or sensitivity toward profitable opportunities	0.811	
	NBO3	My organisation research potential markets to identify business opportunities	0.770	(Kuckertz et al., 2017)
	NBO4	My organisation regularly scan the environment for business opportunities	0.757	

(Source: Author's own)

4.5. Results

Several steps were taken prior to testing the hypotheses using PLS-SEM. First, factor loading was calculated, followed by a Common Method Bias check. Second, validity and reliability were assessed for all measures. Finally, a bootstrapping process was carried out to test the hypothesis. *SmartPLS* 4 software was employed to analyse measurement reliability and validity and test the proposed hypothesis in the structural model. Bootstrapping is a non-parametric resampling technique used in PLS-SEM to assess the reliability and significance of model estimates without assuming a normal

data distribution. In this study, bootstrapping (with 5,000 resamples) was used to test the significance of hypothesised relationships by generating confidence intervals and p-values (Hair et al., 2019).

4.5.1. Assessment of Common Method Bias (CMB)

Following Shashi et al. (2019), we evaluated common method bias by applying Harman's single-factor test to further validate the appropriateness of the model construct measurements. As Podsakoff et al. (2003) noted, this test involves conducting an exploratory factor analysis (EFA) with all observed variables to determine whether a single factor accounts for fifty percent or more of the cumulative variance. If this condition is met, it suggests the presence of common method bias (Baah et al., 2021). The EFA performed using the principal component analysis extraction method indicated that the single factor explained 26.875 percent of the cumulative variance, confirming that common method bias is not a concern in this research model.

Although non-response bias is a potential concern in survey research, this study did not conduct a formal non-response bias test for several grounded reasons. First, data collection occurred over a brief period span of one to six days from every respondent after the survey was shared with them, with minimal variation in response times and no significant late response wave. Additionally, the survey administration involved follow-ups, ranging from just one to three reminders per participant, further reducing the likelihood of systematic differences between respondents and non-respondents. Lastly, as the sample population is highly homogeneous (i.e., a small, well-defined professional group), the likelihood of systematic differences between respondents and non-respondents may be minimal. Halbesleben and Whitman (2013) note that such segregating efforts often diminish the practical impact of non-response bias, since true

non-respondents are not accurately modelled by late responders. Lin and Schaeffer (1995) and Davern et al. (2010) similarly argue that even those who respond only after repeated prompting do not necessarily represent non-respondents.

Second, all responses were fully complete, with no item non-response, eliminating concerns about missing data bias (Little & Rubin, 2001). Similarity between respondents and non-respondents in key demographic or contextual characteristics is a strong indicator that non-response bias is unlikely to threaten the validity of results (Prince, 2012). In this study, all respondents were professionals from a single industry (construction) and were based in the same national context, India. This relative homogeneity reduces the likelihood of systematic differences between those who responded and those who did not. Given this context and considering the other methodological justifications provided, non-response bias is not considered a significant concern in this study.

4.5.2. Assessment of Construct Reliability and Validity

According to Hair et al. (2013), standardised factor loadings should ideally be ≥ 0.70, indicating that at least forty-nine percent of the variance in an indicator is explained by the underlying construct. However, Hair et al. (2010) also acknowledge that loadings of 0.50 to 0.70 are acceptable when the overall construct demonstrates adequate reliability and validity. In this study, four items had loadings below 0.70, the lowest being 0.608 for item NCIA1 (see Table 4.2). These items were retained because the constructs still met accepted thresholds for internal consistency reliability (e.g., composite reliability ≥ 0.70), convergent validity (AVE ≥ 0.50), and discriminant validity. Furthermore, these items were conceptually important and did not adversely affect the model's fit or explanatory power. As Cheung et al. (2023) reaffirm, indicators with

loadings above 0.50 may be retained if they contribute meaningfully to the construct and do not compromise validity.

The properties of the scales were further investigated in terms of internal consistency, reliability, and validity. As suggested by Henseler et al. (2016), reflective models as used in this study must be assessed to prove reliability and validity by focusing on composite reliability, convergent validity and discriminant validity. To establish that the model has internal consistency, Cronbach's Alpha and composite reliabilities of constructs were scrutinised. The next step focused on convergent validity by investigating the Average Variance Extracted (AVE) of the constructs and, ultimately, discriminant validity by considering the Fornell–Lacker criterion and Heterotrait-Monotrait Ratio (HTMT).

The study results indicated that construct reliability, as portrayed by Cronbach's Alpha and composite reliability. Composite reliability was within an acceptable range of 0.807 - 0.868, as it met the threshold of ≥ 0.70 stipulated by Hair et al. (2013). The lowest Cronbach's alpha is 0.689 for one variable, which is marginally below the commonly used threshold of 0.7 but still acceptable. In assessing internal consistency reliability, values between 0.60 and 0.70 are considered acceptable in exploratory research or early-stage studies (Sarstedt et al., 2014; Kante & Michel, 2023). These indicate that the constructs have high internal consistency reliability, noting that Cronbach's Alpha and composite reliability were within an acceptable range of 0.689 to 0.799 and 0.71 to 0.807, respectively. An AVE value of 0.50 or higher indicates that the construct explains more than half of the indicator variance (Baah et al., 2021). From the results presented in Table 4.3, the model has convergent validity since the lowest value of AVE recorded was 0.513 (> 0.5). Multicollinearity was not an issue in the study since

the highest VIF value collected was 1.852, which is less than the accepted threshold of <3 for both inner and outer VIFs as noted by Ringle et al. (2015).

Table 4.3: Constructs Reliability and Validity

Construct	Collinearity statistics (VIF)	Cronbach's Alpha	Composite reliability	Average variance extracted (AVE)
Networked Construction Innovation Alliance Model		0.689	0.807	0.513
NCIA1	1.245			
NCIA2	1.395			
NCIA3	1.313			
NCIA4	1.295			
Inter-Organisational Stakeholder Trust		0.770	0.853	0.593
IST1	1.457			
IST2	1.756			
IST3	1.65			
IST4	1.342			
Environmental Performance		0.799	0.868	0.623
EP1	1.619			
EP2	1.656			
EP3	1.651			
EP4	1.51			
Financial Performance		0.777	0.856	0.600
FP1	1.766			
FP2	1.738			
FP3	1.582			
FP4	1.311			
New Business Opportunities		0.725	0.830	0.551
NBO1	1.177			
NBO2	1.566			
NBO3	1.522			
NBO4	1.405			

(Source: Author's own)

The discriminant validity of the model was assessed next by referring to the Fornell–Lacker criterion and the HTMT ratio. The Fornell–Lacker criterion was assessed by emphasising that a model attains discriminant validity when the square roots of the AVEs are larger than the correlations of the variables in the model (Baah et al., 2021). As indicated in Table 4.4, the model achieves discriminant validity since the key assumption of the Fornell–Lacker criterion is achieved. Finally, discriminant validity was assessed using the HTMT ratio, which suggests that values should be less than 0.90. The HTMT ratio presents estimates of inter-construct correlations by examining the heterotrait-monotrait ratio of correlations by assessing heterotrait-heteromethod correlations relative to monotrait-heteromethod correlations (Baah et al., 2021). From Table 4.5, the model has discriminant validity based on the HTMT ratios.

Table 4.4: Fornell-Lacker criterion

Construct	EP	FP	NMO	NCIA	IST
EP	0.789				
FP	0.160	0.775			
NBO	0.503	0.277	0.742		
NCIA	0.082	0.304	0.114	0.716	
IST	0.624	0.247	0.454	0.317	0.770

(Source: Author's own)

Table 4.5: HTMT

Construct	EP	FP	NMO	NCIA	IST
EP					
FP	0.229				
NBO	0.647	0.367			
NCIA	0.147	0.394	0.215		
IST	0.781	0.309	0.611	0.431	

(Source: Author's own)

4.5.3. Hypothesis Testing

For a ninety-five per cent significance level and a one-tailed test, the t-value should be greater than 1.645 (critical value) and therefore, an acceptable level to support the

hypotheses (Gao & Shao, 2022). Hypothesis testing in the structural model was identified by performing bootstrapping in SmartPLS4 software after the measurement model was evaluated for reliability and validity, and values met all requirements.

Table 4.6: Structural Model

Construct	***R²***	***Adjusted R²***	***Q²***
Inter-Organisational Stakeholder Trust	0.100	0.095	0.055
Environmental Performance	0.404	0.397	-0.016
Financial Performance	0.119	0.104	0.067
New Business Opportunities	0.314	0.298	-0.006

Hypothesis	Coefficient (*β*)	*t*-statistics	*P*-values	Inner VIFs	Supported
H1: Inter-organisational stakeholder trust is perceived by key informants to be positively associated with participation in the NCIAM	0.317	3.221	0.001	1.000	Yes
H2: Environmental performance is perceived by key informants to be positively associated with participation in the NCIAM	-0.128	1.713	0.043	1.112	No
H3: Financial performance is perceived by key informants to be positively associated with participation in the NCIAM	0.258	3.338	0	1.139	Yes
H4: The generation of new business opportunities is perceived by key informants to be positively associated with participation in the NCIAM	-0.033	0.384	0.351	1.215	No
H5: Financial performance is perceived by key informants to be positively associated with inter-organisational stakeholder trust	0.128	1.093	0.137	1.852	No
H6: Environmental performance is perceived by key informants to be positively associated with inter-organisational stakeholder trust	0.664	10.141	0.000	1.112	Yes

H7: The generation of new business opportunities is perceived by key informants to be positively associated with inter-organisational stakeholder trust	0.202	2.124	0.017	1.215	Yes
H8: Financial performance is perceived by key informants to be positively associated with better environmental performance	0.059	0.573	0.283	1.678	No
H9: The generation of new business opportunities is perceived by key informants to be positively associated with better environmental performance	0.350	4.225	0	1.682	Yes
H10: The generation of new business opportunities is perceived by key informants to be positively associated with better financial performance.	0.181	2.246	0.012	1.136	Yes

(Source: Author's own)

Bootstrapping was performed with a bootstrap sample size of 5000 and a significant α of 0.05 (Hair et al., 2011). *P*-values, *t*-values and each path coefficient (*β*) were used for finding the support for the hypothesis. According to Henseler et al. (2016), Stone-Geisser's Q^2 or predictive relevance value is obtained using the blindfolding procedure. A model is deemed to have predictive relevance when Q^2 values are greater than 0. The blindfolding procedure shows that the model has no predictive relevance for environmental performance (Q^2 = -0.016) and new business opportunities (Q^2 = -0.006). When we look at the other endogenous constructs, financial performance (Q^2 = 0.067) and inter-organisational stakeholder trust (Q^2 = 0.055), the model demonstrates predictive relevance, as suggested by Ringle et al. (2015), although the predictive power is very weak. Furthermore, as shown in Table 4.6 and Figure 4.2, the model explains 40.4 percent of the variance in environmental performance, 11.9 percent in financial performance, 10.0 percent in inter-

organisational stakeholder trust, and 31.4 percent in new business opportunities. While the explanatory power varies across constructs, with stronger results for environmental performance and new business opportunities, these findings are considered acceptable given the exploratory nature of the study, where the primary aim is to identify potential relationships rather than achieve high levels of explained variance.

The results of the study, as presented in Table 6 and Figure 4.2, indicate that participation in the Networked Construction Innovation Alliance Model (NCIAM) has a positive and statistically significant effect on inter-organisational stakeholder trust (β = 0.317, t = 3.221, p = 0.001). This finding provides empirical support for Hypothesis 1, suggesting that being part of NCIAM has the potential to positively influence the trust among the participating stakeholders. Furthermore, the results indicate that perceived participation in the NCIAM framework has a negative and statistically significant effect on environmental performance, leading to the rejection of Hypothesis 2 (β = –0.128, t = 1.713, p = 0.043). This supports Calza et al. (2020), who argue that while collaboration offers certain advantages, simply engaging in it does not guarantee improved environmental performance. True environmental benefits from collaboration arise only when participating firms share common sustainability objectives.

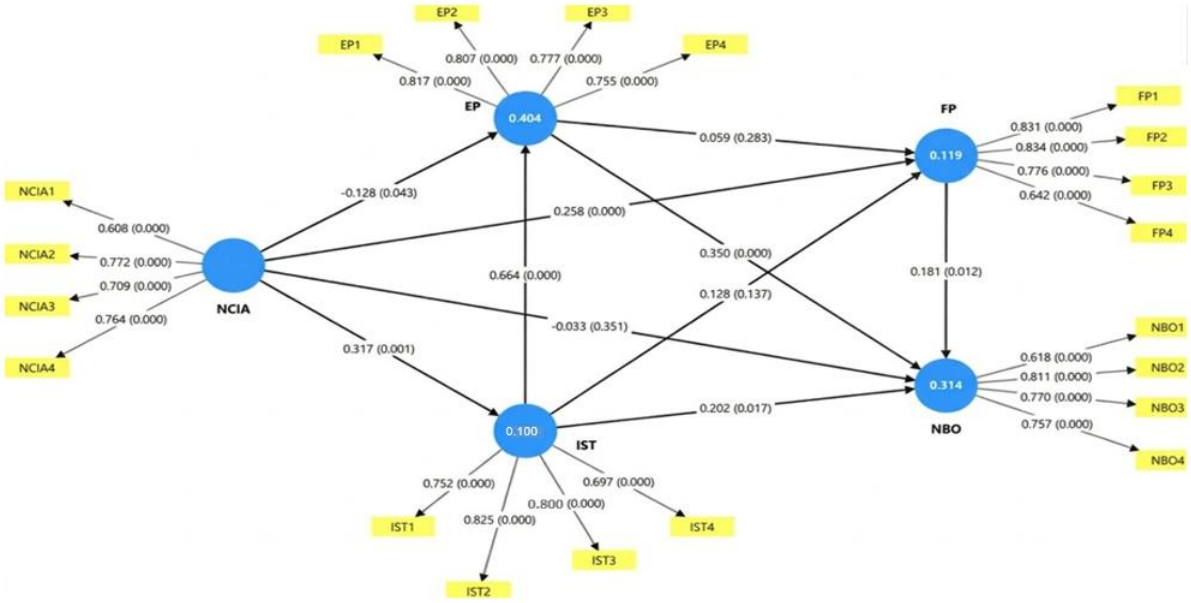
In addition, Hypothesis 3 results indicate that key informants perceive participation in the NCIAM framework to be positively and significantly associated with the improved financial performance of the partner firms (β = 0.258, t = 3.338, P = 0.000). However, Hypothesis 4, which proposed that firms participating in the Networked Construction Innovation Alliance Model (NCIAM) would gain access to new business opportunities, is not supported by the findings of this study (β = –0.033, t = 0.384, p = 0.351). Given that this model is still conceptual, it may be too early to detect meaningful effects. The

analysis also indicates that inter-organisational stakeholder trust is not significantly associated with financial performance. Although the path coefficient is positive (β = 0.128), the relationship is statistically insignificant (t = 1.093, p = 0.137), suggesting that the observed effect may be due to chance. Consequently, Hypothesis 5 is not supported.

The interpretation of the data analysis also showed that inter-organisational stakeholder trust is positively and significantly associated with environmental performance, thereby supporting hypothesis 6 (β = 0.664, t = 10.141, p = 0.000). It aligns with the research by Yeh et al. (2020), which says that relationship trust has a significant and positive impact on stakeholders' environmental awareness. Hypothesis 7 is supported, as the analysis indicates that respondents perceive a positive and statistically significant relationship between inter-organisational stakeholder trust and the generation of new business opportunities (β = 0.202, t = 2.124, p = 0.017). Furthermore, hypothesis 8, which posits a positive effect of environmental performance on financial performance, is not supported (β = 0.059, t = 0.573, p = 0.283). Since the NCIAM is still at a conceptual stage, key informants may not perceive a strong link between environmental performance and financial performance.

Hypothesis 9 is supported in this study since better environmental performance is positively and significantly associated with new business opportunities (β = 0.35, t = 4.225, P = 0.000). Eller et al. (2020) found that businesses that embed environmental priorities in their strategic planning often discover novel ventures and expand into emerging markets. Hypothesis 10, the final hypothesis, is supported (β = 0.181, t = 2.246, p = 0.012), indicating that key informants perceive a positive association between financial performance and new business opportunities.

Figure 4.2: Structural model showing factor loadings, β, p-value and R-Squared



(Source: Author's own)

4.6. Discussions of the Results

4.6.1. Discussion

In line with *H1*, Laan et al. (2011) show that the advantages of construction project alliances are closely tied to developing trust among inter-organisational stakeholders. Their research shows that collaborative actions, such as selecting the right personnel, encouraging informal interactions, and promoting open communication, actively contribute to building trust in partnering arrangements. As trust strengthens through these collaborative efforts, it leads to more transparent discussions about risks, more efficient risk management, and ultimately more successful outcomes. As the primary purpose of the NCIAM is fostering innovation, this will lead to the exchange of information and ideas, shared problem-solving and flexibility, which further will lead to cementing inter-organisational stakeholder trust. *H2* is rejected. The negative relationship between being a collaborator in the NCIAM and environmental

performance may reflect the way construction professionals perceive innovation. Respondents seem to have focused on technological or operational improvements that ease project execution, rather than innovations with environmental benefits. Additionally, construction projects often emphasise short-term cost efficiency, so professionals may discount environmental gains that accrue only in the long term. Professionals might also perceive substantial barriers to achieving better environmental performance, such as a lack of coordination among practitioners, research institutions, and environmental organisations, or the need for significant resource investment. For example, research conducted by Fathalizadeh et al. (2021) in a developing nation (Iran) found that there were several influential barriers to incorporating sustainability in construction projects, such as a lack of understanding of the potential benefits, insufficient cooperation among practitioners, research institutions and environmental organisations and a lack of a systematic approach to pursuing sustainability goals. Overcoming obstacles to implementing sustainable methods in construction management demands significant resource investments (Fathalizadeh et al., 2021). This leads to a mindset among construction professionals that does not believe in improved environmental performance when firms collaborate.

In relation to *H3*, research indicates that collaborative approaches in construction projects can lead to significant financial gains (Xue et al., 2017; Kats, 2003; Gambatese & Hallowell, 2011). This is attributed to improved integration between design and construction disciplines, optimised design efficiency, innovative construction methodologies, and the systematic sharing of knowledge across projects (Gambatese & Hallowell, 2011). Thus, this finding that participation in NCIAM is perceived to positively affect financial performance is supported by the literature as well. As mentioned in *H4*, it was perceived that participating in the innovation network,

i.e. NCIAM, may lead to the development of new products and relationships that would create new business opportunities, but it is not significantly supported here. Also, the path coefficient is negative. The presence of a negative and non-significant relationship may be indicative of contextual influences specific to this study. Organisational resistance to change and limited leadership support can constrain the translation of innovative ideas into opportunity creation. Moreover, when financial, knowledge, and institutional constraints are present, firms involved in open innovation may favour established routines over the exploitation of emerging opportunities (De Araújo Burcharth et al., 2015; Levinthal & March, 1981; March, 1991).

H5 posits a positive perceptual association between inter-organisational stakeholder trust and financial performance, but it was not statistically significant. While inter-organisational stakeholder trust is often considered beneficial for organisational success, prior research has indicated that it doesn't always directly correlate with improved financial performance. Scholtens and Zhou (2008) show that there is a lack of evidence supporting a positive relationship between financial performance and social strengths, despite what many earlier studies have proposed. Here, stakeholder trust is interpreted as a key element of social strengths (Tang & Yang, 2023). *H6* and *H7* reveal that strong stakeholder ties facilitate eco-innovation, which enhances new product performance, suggesting that trust-based stakeholder relationships are instrumental in driving sustainable innovation and opening new business opportunities (Adomako & Tran, 2023). The inter-organisational stakeholder trust that will develop from being part of the NCIAM can lead to improvements in environmental performance among the participating firms and will also be vital in securing new business opportunities.

H8 is not supported. The findings may reflect that not all construction professionals, particularly in developing countries like India, perceive environmental performance as yielding financial benefits, especially when they expect higher initial costs and longer payback periods. Prior research indicates that a major challenge in adopting sustainable practices is the common perception that such approaches increase project costs, coupled with a limited understanding of their potential benefits (Aigbavboa et al., 2017). Furthermore, Eller et al. (2020) provide evidence that entrepreneurs who focus on environmental sustainability are more likely to discover innovative business opportunities that align with sustainable development goals, and thus support Hypothesis 9. If better environmental performance of construction firms is due to the development of a green product or processes, that might easily help them in getting more projects and possibly in new geographical markets as well, letting construction firms exploit a business opportunity due to the development of a sustainable product or process. Finally, hypothesis 10 is supported in this study. This result supports the assumption that better financial performance could lead to the acquisition of new business opportunities. It could easily be said that financial performance does contribute to the development of new business opportunities. There are other factors involved as well, such as the firm's strategic posture or entrepreneurial, etc. New or enhanced competencies can improve a firm’s financial performance by expanding strategic options and reducing costs (Burgelman, 1991). These gains provide a foundation for pursuing new products, processes, and business opportunities (Zahra et al., 1999).

Since the networked construction innovation alliance model is still in its conceptual stage and has not been tested, some of the obvious relationships between variables that should have a positive impact on one another are not supported here. But the

practical implications might be different. For example, a study on supply chain collaboration (SCC) does provide evidence that SCC has a positive and significant effect on environmental performance. Again, inter-organisational stakeholder trust and environmental performance are positively associated with financial performance (Baah et al., 2021).

4.6.2. Theoretical Implications

This research advances the Extended Resource-Based View (ERBV) by showing how strategically designed innovation networks, in this case, the networked construction innovation alliance model (NCIAM) approach, are perceived by respondents to have the potential to help firms access, exchange, and utilise valuable resources and capabilities beyond their own organisational limits.

This research study demonstrates that the NCIAM is perceived by respondents to facilitate a leased innovation network approach that can enable construction firms to leverage the capabilities of both competitors and partners. By doing so, it extends the Extended Resource-Based View (ERBV) literature, illustrating how strategically accessing external resources is perceived by respondents to enhance performance across multiple dimensions. Additionally, the study reveals that while these networks (e.g. NCIAM) would initially be established for a core purpose (e.g., innovation), respondents perceive that they may generate unintended organisational benefits, further enriching strategic value.

The RBV has traditionally emphasised the financial advantages of a central or focal firm. This study draws on the ERBV, which conceptualises advantage as emerging across networks of collaborating firms. In a volatile, uncertain, complex, and ambiguous environment, reliance on financial performance measures alone may

provide an incomplete assessment of organisational outcomes. The hypotheses explored in this study are broadly aligned with the proposition that collaborative arrangements among construction firms may be associated with a range of outcomes, including financial performance, environmental considerations, and stakeholder relationships. Viewed in this way, the study contributes to ongoing discussions in the ERBV literature by examining network-level perspectives on value creation.

The contemporary business environment is increasingly dynamic, which presents limitations for traditional applications of the RBV. This study examines how participation in NCIAM may support firms in combining internal and external resources under such conditions. The findings suggest that this integration may be associated with financial outcomes as well as strategic advantages, including access to emerging market opportunities in rapidly changing environments. In this way, the study contributes to the ERBV by illustrating how systemic forms of collaboration can support the creation of strategic value in response to contemporary organisational challenges.

The NCIAM structure introduces a three-tiered collaborative framework that may extend beyond conventional buyer-supplier dyads to incorporate diverse interorganizational relationships. This also includes buyer-buyer partnerships as well as strategic alliances with external stakeholders such as government agencies, academic institutions, and NGOs. This is a kind of evolution presented by this study, which contributes to the growing applicability of the ERBV framework across diverse interorganizational contexts involving vertical and horizontal relationships and not just buyer-supplier (vertical) relationships.

Finally, this research offers an alternative perspective on construction contractors, moving beyond views that emphasise isolated and profit-focused behaviour. It

considers contractors as participants in resource-sharing networks embedded within complex inter-organisational relationships, a perspective that remains relatively underexplored in the strategic management literature.

4.6.3. Managerial Implications

The study found that NCIAM membership can be a significant component in building and improving inter-organisational stakeholder trust and financial performance directly, and environmental performance and new business opportunities indirectly. This suggests to managers in the construction industry that more efforts should go into delivering relevant and meaningful collaborations to participate and practically establish a networked construction innovation alliance model , which will lead to higher performance and healthy stakeholder relations. Thus, managers should ensure efficient and effective networked construction innovation alliance model implementation to enhance the management of inter-organisational stakeholder trust and avoid stakeholder withdrawals. The prime purpose of the NCIAM is to innovate. Thus, that, along with inter-organisational stakeholder trust, will lead to the improvement of financial performance and the creation of new business opportunities. Thus, the NCIAM in this study presents win-win scenarios for the construction contractors and other firms and organisations. In today's sustainability-driven business environment, managers who foster strong collaborations are more likely to earn stakeholder trust, which significantly impacts a firm's environmental and financial performance. This approach can also help lower costs related to waste management, inventory, and raw material use, while minimising legal risks and penalties tied to emissions or pollution. Additionally, it can contribute positively to the firm's overall reputation.

4.6.4. Limitations and future research

This study presents limitations that future research should consider. The study modelled all variables as composites, which means it wasn't fully comprehensive. Future research could explore additional theoretical dimensions of the selected variables to provide a more complete understanding of these concepts and how they interact with one another. Furthermore, future research can consider more latent variables than those considered in this study, seeing that market trends and technological changes, such as NCIAM visibility, enhanced market reach, etc. Should the NCIAM become a reality, longitudinal data can be collected to enhance understanding in relation to the long-term influences of the networked construction innovation alliance model on the tested and new variables. Finally, future studies should capture more environmentally oriented variables since, in recent times, it has become compulsory to adopt and implement environmental practices, thereby expanding innovation and sustainability literature. A primary limitation of this study lies in its hypothetical design, which restricts the interpretation of findings to correlational relationships rather than causal conclusions. However, perception-based data are widely used in exploratory and theory-building research to capture early insights where empirical evidence is limited. Further empirical research is therefore required to examine and validate the proposed model using *ex-post* data.

4.7. Conclusion

In the face of growing environmental concerns and increasing business pressures, innovation has emerged as a vital strategy for addressing sustainability and maintaining competitiveness. The construction industry, traditionally conservative in its operations, must shift toward more collaborative, long-term approaches to fully realise

these benefits. This study explored the potential of the NCIAM as a vehicle for driving such transformation within the construction sector of a developing country.

Among the ten hypotheses tested, only four directly examined respondent perceptions of the relationship between NCIAM and the outcome variables: environmental performance, inter-organisational stakeholder trust, financial performance, and new business opportunities. The remaining six hypotheses focused on the respondent perceptions of interrelationships among these variables, particularly the mediating role of inter-organisational stakeholder trust. Although only six of the hypotheses were supported, the findings suggest that NCIAM may exert both direct and indirect effects. For instance, when NCIAM enhances inter-organisational stakeholder trust, and this trust in turn improves environmental performance and opens new business opportunities, the NCIAM framework contributes through a chain of influence. These indirect pathways reinforce the value of adopting NCIAM, even when not all outcomes are directly linked.

The study contributes to theory by extending the application of the Extended Resource-Based View to a collaborative context within infrastructure-oriented settings. It highlights how competitiveness may be shaped through the mobilisation of resources and capabilities that extend beyond organisational boundaries. In doing so, the study underscores the perceived strategic relevance of inter-organisational collaboration not only for innovation or efficiency, but also for the perceived salience of the development of distinctive market positions. While the NCIAM framework remains conceptual, this research provides a perceptual foundation to support its examination and potential application in future empirical work.

Appendices

Appendix C: Latent Variables Correlation

	EP	FP	NBO	NCIAM	IST
EP	1	0.16	0.503	0.082	0.624
FP	0.16	1	0.277	0.304	0.247
NBO	0.503	0.277	1	0.114	0.454
NCIAM	0.082	0.304	0.114	1	0.317
IST	0.624	0.247	0.454	0.317	1

Appendix D: Harman's Single-Factor Test Results

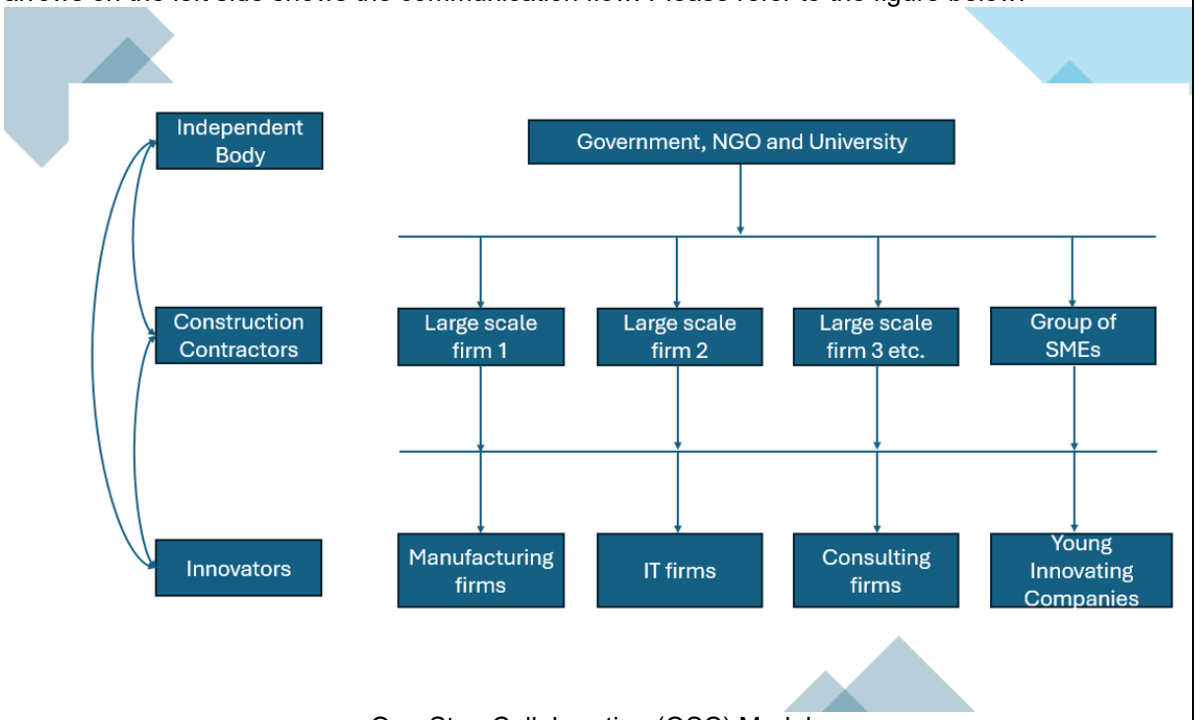
Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.375	26.875	26.875	5.375	26.875	26.875
2	2.526	12.630	39.505	2.526	12.630	39.505
3	1.845	9.227	48.731	1.845	9.227	48.731
4	1.263	6.314	55.045	1.263	6.314	55.045
5	0.982	4.911	59.956			
6	0.950	4.748	64.704			
7	0.865	4.327	69.031			
8	0.737	3.686	72.717			
9	0.655	3.277	75.994			
10	0.617	3.085	79.079			
11	0.613	3.065	82.144			
12	0.582	2.908	85.052			
13	0.550	2.750	87.802			
14	0.461	2.306	90.108			
15	0.443	2.214	92.322			
16	0.371	1.856	94.177			
17	0.354	1.772	95.949			
18	0.324	1.621	97.570			
19	0.280	1.399	98.968			
20	0.206	1.032	100.000			
Extraction Method: Principal Component Analysis.						

Appendix E: Survey Instrument

Explanation of the One-Stop Collaboration Model or OSC Model

Innovation collaboration networks involve a company working with various partners—such as suppliers, clients, competitors, consulting firms, universities, research centres, and government institutions. These partnerships play a crucial role in the company's ability to develop new products and improve processes. One example of this type of network is the hypothetical **OSC** collaboration network.

A preliminary one-stop collaboration model has been created based on interviews with experienced stakeholders connected to the construction industry. The model aims to enhance the innovation ecosystem in India's construction sector. It consists of three levels: government bodies, NGOs, and universities at the top; construction contractors in the middle; and innovating firms at the bottom. The arrows on the left side shows the communication flow. Please refer to the figure below:



One-Stop Collaboration (OSC) Model

Competing partners refer to two or more organisations, companies, or individuals that work together in certain aspects of a business or project while also competing against each other in other areas.

Stakeholder trust signifies the reliance of stakeholders on focal firms to ethically undertake actions that will benefit all parties.

A 5-point Likert scale is used to collect your responses.
Description of the 5-point Likert Scale :
1 - Strongly Disagree
2 - Disagree
3 - Neither Agree nor Disagree or Neutral
4 - Agree
5 - Strongly Agree

Questionnaire

Imagine that you and your firm are participants in the above-described One-Stop Collaboration (OSC) model. Please share your opinion on the questionnaire below, drawing from your experience working in your organization, collaborating with others, and considering the details of the OSC model provided above.					
Rate the following statements in relation to being part of One-Stop Collaboration (OSC) Model					
	1	2	3	4	5
By participating in an OSC model, our firm and OSC partners will share benefits and costs					
By participating in an OSC model, our firm and OSC partners will jointly search, acquire, assimilate and apply relevant knowledge					
By participating in an OSC model, our firm and OSC partners will have agreements on the relevance of improvements that benefit the whole OSC network					
By participating in an OSC model, our firm will collaborate with competing partners in OSC network					
Rate the following statements in relation to the stakeholder trust					
Our company considers stakeholders' interest in making decisions					
Our company creates skills for effective coordination in the execution of plans					
Our company implements strategies to ensure quality relationships					
Our company involves stakeholders in the tasks needed to produce and deliver products and services to customers					
Rate the following statements in relation to the environmental performance					
Our firm makes efforts to minimizes the environmental impacts of its operations					
Our firm allows environmental audits					
Our firm adopts cleaner construction methods					
Our firm reuses and recycles materials					
Rate the following statements in relation to the financial performance					
The return on investment of our company is higher compared to competitors					
The return on assets of our company is higher compared to competitors					
The sales growth and profitability of our company are higher compared to competitors					
The total operating costs of our company are lower compared to competitors					
Rate the following statements in relation to seeking new business opportunity					
Identifying potential new business opportunities comes very naturally to my organisation					
My organisation has a special alertness or sensitivity toward profitable opportunities					
My organisation research potential markets to identify business opportunities					
My organisation regularly scan the environment for business opportunities					
If you have any additional comments, suggestions, or thoughts, please feel free to write them below.					

5 Chapter 5 – Summary of the Dissertation

Sectors across the economy are adopting advanced and innovative approaches or working towards them, and that includes construction. But the difference between other sectors and the construction industry is that construction is doing it at a much slower pace relative to its peers. And this inspired the central theme of this dissertation. To address the slow innovation process, collaboration seemed like a good strategy to adopt, especially given challenges such as short project durations, sector fragmentation, and limited financial resources for innovation, all associated with the construction sector. Besides, the collaboration became the obvious choice because construction projects bring together contractors and other stakeholders who are well-versed in managing key contributors to any construction project.

Also, the construction industry's slow pace of innovation and adoption of new ideas is another important reason to investigate this industry: its economic importance to any country and the dependence of other sectors on the construction sector make it a valuable area to examine. Besides, construction is a heavy contributor to environmental pollution and a major consumer of natural raw materials. In sustainability approaches as well, this industry needs some support. The target geographic region selected to test the assumptions through this research work was India for a few reasons. First, India is one of the top 4 construction markets. Second, it is in the transition phase, and its growing construction market will soon replace Japan to improve its global position. Moreover, India, being a fast-developing economy, is heavily dependent on this industry, not only due to its economic contribution but also the way it supports the growing population in terms of providing housing and office space, as well as being the second biggest employer in the country. There is a broad and rich literature that explores the salience of collaboration for improving innovation.

There are a lot of research activities dealing with collaborative innovation and open innovation themes.

This dissertation differs from much of the existing literature by moving beyond a general discussion of the importance of collaboration to explore how collaboration may be structured in practice within the construction sector. In doing so, it sought to offer insights that are relevant to industry contexts while also contributing to ongoing theoretical discussions related to open innovation, systems theory, and the EBRV. The central focus of the doctoral research was an examination of what a suitable collaboration model might entail for supporting innovation within the Indian construction sector. In this respect, the study responded to concerns in the literature regarding systemic fragmentation and limited innovation linkages within the sector. This dissertation also examined existing collaboration models for innovation and sought to build on their strengths and address their limitations to best fit the Indian construction industry, such as the triple helix or open innovation model.

This dissertation has sought to provide a solution in the form of a design for a suitable potential collaboration model or framework, called the Networked Construction Innovation Alliance Model (NCIAM). The NCIAM structure design was inspired by the One-Stop-Shop (OSS) business model. The goal was to apply the OSS to the construction industry, allowing firms to access all types of innovation and their processes from a single point. This centralised approach was also designed to reduce risk through its shared nature. Furthermore, a networked style of relationships emerged as an additional benefit of this OSS-inspired framework. The focus was on improving the innovation situation for the whole industry and not just thinking from an individual firm's perspective. Therefore, the networked collaboration scheme was the most suitable one.

This doctoral thesis comprised three sequential chapters that contribute to the development and evaluation of a novel Networked Construction Innovation Alliance Model (NCIAM). The NCIAM framework was conceived in this dissertation as a streamlined approach to enhance collaboration among stakeholders in the construction industry. The second chapter aimed to establish the philosophical and methodological grounding for the approach to this conceptually driven research informed by practitioners' perceptions. The third chapter focused on the formal development of the NCIAM framework. The fourth chapter employed PLS-SEM to assess the impact of NCIAM on key organisational variables. The research adopted a multidisciplinary and genuinely mixed methods approach, using two distinct methodologies across the studies. In the last two chapters, data were gathered from key informants, individuals with substantial knowledge and insight into their organisations' collaborative practices.

The second chapter sets out and supports the philosophical and methodological foundations of this dissertation, offering the ontological, epistemological and methodological rationale that anchors the overall research design. It also underscored the significance of stakeholder perceptions in shaping the outcomes of a forward-looking study that brings together theoretical, conceptual and empirical components. This dissertation adopted a stratified realism ontology, which provides a crucial basis for the two interconnected studies that follow. The core of stratified realism is the belief that reality is not limited to what we can see and measure. Instead, it is composed of deep, layered structures in which higher levels emerge from lower levels but operate under their own unique rules. Complementing this ontological foundation, the epistemological stance is grounded in Critical Realism, acknowledging that while reality exists independently of our perceptions, it can only be accessed indirectly

through context, theory and interpretation. In line with these commitments, the research adopted a sequential mixed-methods strategy. This approach enabled a critical examination of various collaboration models, providing the theoretical basis for the proposed Networked Construction Innovation Alliance Model (NCIAM), an OSS-inspired, future-focused framework designed to strengthen innovation ecosystems within the Indian construction sector.

The third chapter used systems theory to design a suitable NCIAM structure to improve the innovation ecosystem in the construction sector. It employed semi-structured interviews to collect data not only from the construction sector but also from other sectors and organisations involved in construction-related projects, such as manufacturing, government, and consulting. This also showed the importance of SMEs and YICs in contributing to the creation and adoption of innovations. Government, NGO, and University participants have more than one role to fulfil beyond maintaining the stability of this collaboration. This study adopted the Gioia approach to develop themes. Additionally, this study provided preliminary features of NCIAM to facilitate practitioners' adoption of this collaboration model. This study adopted an abductive approach, and the data and the literature jointly validate the results. This study contributed to the theory by emphasising the importance of subnets in this mega-network alliance. This aligned with the system's theory, which views the system as the integrated whole of its individual components and interactions.

To position the proposed Networked Construction Innovation Alliance Model (NCIAM) within the broader collaboration literature, it is useful to compare it with several established frameworks discussed earlier in the thesis (refer to Chapter 2), including the Triple Helix model, Open Innovation, and the Fraunhofer innovation system. These models provide important insights into how universities, industry, and government

organisations interact to support innovation. However, they tend to focus either on institutional relationships, firm-level knowledge exchange, or research-driven partnerships rather than addressing the coordination challenges of fragmented industries such as construction. The NCIAM framework builds on insights from these approaches while extending their scope to support a structured multi-stakeholder collaboration ecosystem tailored to the needs of the construction sector.

Some collaboration arrangements, such as university–industry collaboration (UIC) and traditional R&D partnerships, focus primarily on bilateral or small-group research relationships. While these forms of collaboration are valuable for knowledge generation and technology transfer, they typically involve a limited number of actors and are therefore less suited to addressing industry-wide innovation challenges. For this reason, the comparison presented in Table 5.1 focuses on broader collaboration frameworks that more closely align with the objectives of the proposed NCIAM model. Detailed discussion and references for these models are provided in Chapter 2, Section 2.2.

Table 5.1: Model Comparison

Model ➡ / Feature ⬇	Triple Helix Model	Open Innovation	Fraunhofer Model	Fraunhofer Building Alliance	NCIAM (The Extension)
Model Structure	Collaborative framework of firms, governments, and universities.	Distributed process based on managed knowledge flows across boundaries.	Decentralised network of specialised institutes affiliated with universities.	A collaborative platform bringing together eleven specific institutes.	Three-tiered system: Independent body (top), construction contractors (middle), and innovative firms (base).
Geographic Context	Predominantly Western-centric in literature, implementation in construction	Predominantly Western-centric, construction implementation is fraught with	Specifically, a German-centric applied research system.	German-centric, serving as a central interface for the German	Developing Country Context: Specifically designed for the Indian

	is less documented.	barriers and challenges.		construction industry.	construction sector.
Positioning & Role	Strategic framework for national/regional innovation policy.	Business model for managing external collaborations and knowledge.	Technology transfer model for knowledge-intensive industries.	Specialised interface for building-related technologies and lifecycle.	Industry-Wide Meta-System: A one-stop solution for the fragmented construction ecosystem.
Integration of Customers	Universities often lack the entrepreneurial capacity to reach firms.	Challenged by the complexity of managing numerous external partners.	Requires intensive marketing and "hotlines" to find industrial customers.	Clients must approach the alliance for specific technological solutions.	Embedded Customers: Contractors are integral, permanent members of the network.
Trust Mechanism	Hindered by relationship barriers like differing cultures and mistrust.	Plagued by concerns over IP protection and knowledge leakage due to permeable boundary conditions.	Headquarters must balance competition and cooperation among institutes.	Operates within a socio-political framework with varied stakeholder expectations.	Enforced Trust: Uses "financial/economic hostages," formal contracts, and AI monitoring. The presence of a neutral body, including the government, can break bottlenecks.
Implementation Gap	Suffers from bureaucratic processes and rigid structures in universities.	Difficulty scaling lab innovations to real-world construction site applications.	Focuses on high-complexity solutions that may take 5–10 years to be relevant.	The research scope is primarily building-focused, often missing large-scale infrastructure.	Active contractor participation allows for direct pilot testing in ongoing projects, not just limited to technical innovation, nor just focused on building construction.
Connectivity	Often limited by cultural/mistrust barriers.	Limited by firms' reluctance to share information.	Often dyadic (1-to-1) and secretive.	Multiple institutes under one umbrella.	Meta system: Everyone is connected via subnets.
Industry-wide Impact	Limited	Firm Level	Limited to Research and technology development, also at the company level	Limited to Research and technology development, mostly at the firm level	Designed for sector-level innovation transformation, the reach of innovation impact is much higher due to the

					networked structure with larger participation

(Source: Author's own)

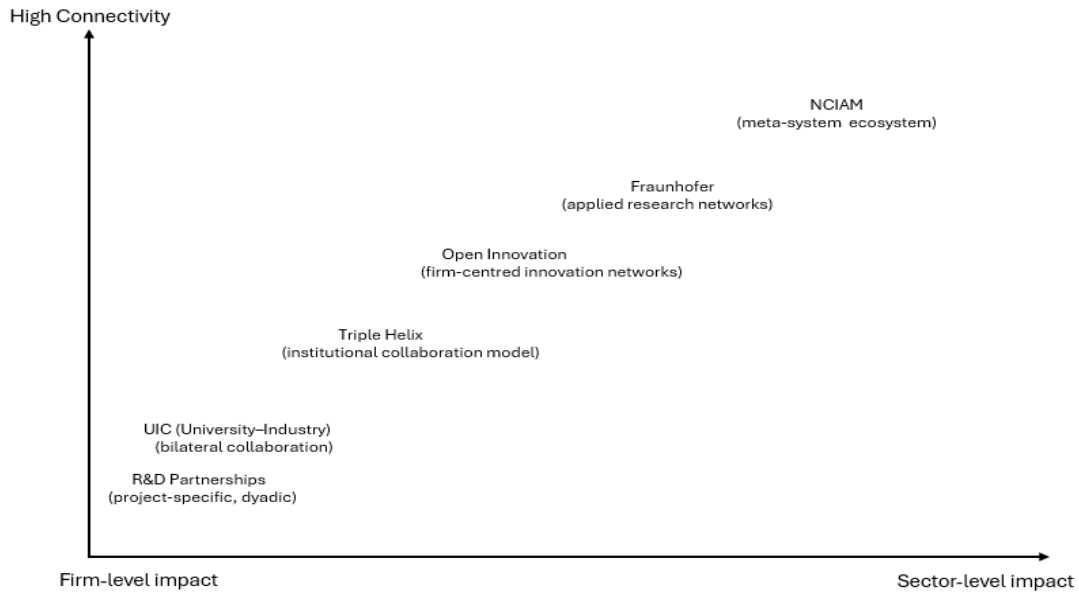
While Fraunhofer establishes its impact by actively building alliances through applied research networks, the NCIAM model represents the peak of this evolution as a high-connectivity meta-system ecosystem. This transition marks the shift from collaborative research partnerships to a fully integrated, sector-level impact.

Overall, while earlier collaboration models provide valuable insights into innovation partnerships, they tend to focus either on institutional interactions (Triple Helix), firm-level innovation strategies (Open Innovation), or research-driven collaboration networks (Fraunhofer). The NCIAM framework extends these approaches by integrating multiple stakeholders into a structured collaboration platform that supports innovation within the construction ecosystem. By combining research institutions, contractors, innovative firms, and institutional actors within a coordinated framework, the model aims to facilitate not only knowledge exchange but also the practical testing and diffusion of innovations within real construction projects.

Figure 1 positions collaboration models based on their level of participant connectivity and potential industry-wide impact. It illustrates a progression from limited, dyadic collaborations such as R&D partnerships and UIC towards more integrated models. The proposed NCIAM framework occupies the highest position, reflecting its role as a multi-stakeholder ecosystem designed for sector-level innovation impact.

The fourth chapter contributed theoretically by extending the RBV, which limits itself to economic performance from a focal firm's point of view. But the modern world is

Figure 5.1: Conceptual positioning of collaboration models



(Source: Author's own)

dynamic, and that's why businesses should think about the resources coming from the network of firms rather than just depending on themselves. And the success story could be told not just from a profit perspective but from another point of view, like environmental performance or new market opportunities, etc. This study sought to identify other benefits that could await the members of this futuristic NCIAM framework beyond innovation. The results of this study suggest that, by being part of NCIAM, each partnering firm can improve its financial performance and gain greater inter-organisational stakeholder trust.

Overall, this thesis contributes to potential societal implications. Participation in NCIAM may be associated with innovation-related benefits that could extend beyond firms to society more broadly, for example, through more efficient construction practices and environmental improvements. However, these societal outcomes were not directly examined within this study. The findings provide an initial conceptual foundation that future researchers and practitioners may build upon, particularly in relation to the

theoretical sustainability of the NCIAM. Empirical investigation in real-world settings, involving active participation by industry actors, is required to assess its practical viability. Future research could also explore the contractual arrangements that may support NCIAM membership, as well as additional outcomes such as potential improvements in industry standards. Finally, the model may be examined in other geographical contexts, including regions such as Europe, where innovation-oriented practices and open systems approaches are more established.

The research presented in this thesis identified aspects of the networked construction innovation alliance model which are ‘desirable’ or ‘nice to have’ in an ideal situation. However, these aspects could be used to produce an advanced model of NCIAM for those stakeholders who have become accomplished in the use of the ‘essential’ aspects and want to gain more from the NCIAM . In summary, the NCIAM seems to be a suitable choice for improving the innovation ecosystem in the Indian construction industry, which could bring a lot of other benefits. Adoption of the NCIAM could contribute to the cause of sustainability in an industry which really needs it.

6 List of Abbreviations

AEC – Architecture, Engineering and Construction

AI – Artificial Intelligence

AVE – Average Variance Extracted

BAI - Builders' Association of India

BEA – U.S. Bureau of Economic Analysis

BMTPC - Building Materials and Technology Promotion Council

CE – Circular Economy

CII - Confederation of Indian Industry

CME - Construction Management and Engineering

CR - Critical Realism

DSR - Design Science Research

ERBV – Extended Resource-Based View

ESMM - Exploratory Sequential Mixed Methods

FICCI - Federation of Indian Chambers of Commerce & Industry

HTMT – Heterotrait-Monotrait Ratio

ICT - Information and Communication Technologies

IIT – Indian Institute of Technology

MNC - Multinational Corporations

NCIAM - Networked Construction Innovation Alliance Model

NAREDCO - National Real Estate Development Council

NASSCOM - National Association of Software and Services Companies

NGO - Non-Governmental Organisations

OI – Open Innovation

OSC – One-Stop Collaboration

OSS – One-Stop Shop

PLS – Partial Least Squares

PSU – Public Sector Undertakings

R&D – Research and Development

RBV – Resource-Based View

RV – Relational View

SCC – Supply Chain Collaboration

SDG – Sustainable Development Goal

SEM - Structural Equation Modelling

SME - Small and medium-sized enterprises

UIC - University-Industry Collaboration

URI - Universities or Research Institutions

VIF – Variance Inflation Factor

VUCA – Volatile, Uncertain, Complex, Ambiguous

YIC - Young Innovative Companies

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