

READY-MIX CONCRETE IN DEVELOPING ECONOMIES: MARKET ADOPTION, BARRIERS AND SUSTAINABLE TRANSITION PATHWAYS

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ABSTRACT

Ready-mix Concrete (RMC) presents a technically and economically superior alternative to conventional site-mixed concrete, yet its adoption across South Asia remains disproportionately low relative to global benchmarks. Despite evidence that RMC delivers higher compressive strength at a lower total project cost, markets in the region continue relying on conventional site-mixing technique. This systematic literature review consolidates evidence on RMC adoption, drivers and barriers across five South Asian economies within unified comparative framework, drawing on peer-reviewed studies published between 2013 and 2025. Three categories of barrier are consistently found throughout the region: a perception and awareness deficit in which clients systematically underestimate RMC's total cost advantage, logistical constraints, primarily urban traffic congestion which compromise concrete quality during transit, and structural market weakness characterized by high entry costs, regulatory gaps and an unorganized informal sector. Country level analysis reveals that Nepal's primary barrier is a cost perception paradox, Bangladesh faces quality degradation and trust deficits caused by the transportation, while India struggles with market penetration despite its advanced production capacity. Sri Lanka and Pakistan are identified as priority areas for future empirical research due to the near total absence of peer-reviewed literature. Strategic pathways include low-carbon supplementary cementitious materials, advanced quality assurance mechanisms and supply chain digitalization. The findings provide a consolidated evidence base to guide industry strategy, regulatory reform and future academic inquiry.

Keywords: RMC, barriers, South Asia, Strategic pathway, 2013 - 2025

1. Introduction

Concrete is the second most consumed material on earth after water, serving as the foundation material for nearly all civil infrastructure worldwide, including roads, bridges, housing, and

water systems (Gagg, 2014). Ready-mix Concrete (RMC) is a construction material which is manufactured at a centralized batching plant under controlled conditions and delivered to the construction site in a ready-to-use state (Makwana & Pitroda, 2013). Demand of concrete is linked to population growth and economic development, particularly in rapid urbanization regions. The South Asian construction sector is one of the most essential in the world, contributing 6.4% of global GDP (Bhusal, 2025) and with urbanization projected to add 2.5 billion people to cities by 2050 and predominantly in Asia and Africa (United Nations, 2018). The globally market for ready-mix concrete was valued at approximately USD 548 billion in 2023 and is expected to grow at a compound annual growth rate of 6.5% to reach USD 965 billion by 2032. This growth is driven predominantly by rapid urbanization, infrastructure investment and rising demand for high quality assured construction materials (Polaris Market Research, 2023). Consequently, the construction sector faces growing pressure to deliver a quality material quickly and reliably.

Ready mix concrete is a construction material which is produced through computerized batching system that ensures uniform mix quality, consistent compressive strength and reduced material waste on site unlike that of site-mixed concrete which relies completely on manual batching and is liable to inconsistencies in mix proportions and water cement ratios (Makwana & Pitroda, 2013; Nagaraju et al., 2019). RMC not only reduces the need for onsite raw material storage, manual mixing and required labor, it significantly helps to reduce dust of construction site, noise and material wastage, making RMC particularly suitable for dense urban construction environments where space, time and environmental conditions are limited (Chakraborty & Farhan, 2022). Although the initial cost of Ready-mix concrete may appear higher than site mix concrete, but ultimately ready mix concrete proves more economical because it helps in saving costs for labor, time required for construction and construction material wastages, indicating the high-cost estimation is a wrong belief of total value rather than genuine financial constraint (Shah et al., 2014). RMC supports environmental sustainability by allowing the inclusion of supplementary cementitious material such as fly ash and ground granulated blast furnace slag, which will ultimately reduce the carbon footprint of concrete by 13% to 22%, a contribution of growing importance given that cement production accounts for more than 7% of annual global greenhouse gas emissions (Miller et al., 2021; Supriya et al., 2023).

In developed economies such as Japan, ready-mix concrete comprises about 70% of the total cement consumption, while for the United States and Europe has about 60-75%, establishing RMC as the dominant standard method of concrete supply in modern day construction sector (Lr & Anvekar, 2015). By contrast, in developing countries there is still less than 10% of total cement consumption through RMC with as much as 72% of cement still consumed through conventional site mix method, a gap caused by the lack of awareness and willingness to not change rather than any technical or economic shortcoming of RMC itself (Oladiran et al., 2022). In South Asia, this gap is particularly striking, India being the region's most advanced RMC market uses only about 20% of national cement consumption through RMC while countries like Nepal, Bangladesh, Sri Lanka and Pakistan are at even lower percentage to use RMC despite having a clear proof of RMC's technical and economic advantages over site mix method (Khade, 2024; Shah et al., 2014).

In Nepal, experimental research shows that ready mix concrete is about 26% cheaper per cubic meter than government rates for M20 grade site mix concrete and about 45% cheaper for M25 grade, without compromising the compressive strength yet being slightly higher but due to the price misconception among the clients and contractors they still believes RMC is expensive (Mishra et

al., 2023). In Bangladesh, big developers adopt RMC commercially, but public still does not trust in RMC due to severe transit delays making concrete quality inconsistent due to its critical 90 minutes workability timeframe (Chakraborty & Farhan, 2022). India, the most advanced RMC market in South Asia, with approximately 3,881 batching plants and annual production of 35-40 million cubic meters, still faces significant market penetration challenges, with mechanized concrete production accounting for about 20% of total cement consumption in India due to influence of an unorganized informal construction sector (Khade, 2024; Shah et al., 2014). Despite operating a formal RMC sector since 1978, Sri Lanka continues to face a significant barrier to wider construction technology adoption, which includes limited access to modern methods, restrictions on finance and poor regulatory enforcement (Abeydeera et al., 2024; Lanka Ready Mix Concrete Association, 2024). Similarly, in Pakistan RMC was first introduced commercially only in 2007, where systemic construction quality management was the primarily driven by limited awareness of modern methods, economic instability and insufficient enforcement of standards all of which continue to restrict RMC sector development (Afzal et al., 2022; CemNet, 2023).

Although interest in RMC adoption across South Asia has grown considerably, existing research remains largely dispersed, country specific and isolated analytically. Existing studies address RMC adoption in individual South Asian countries but none has examined all five countries together within a single comparative framework, leaving a significant gap in the regional literature (Chakraborty & Farhan, 2022; Khade, 2024; Mishra et al., 2023). Studies on barriers to concrete technology adoption identify awareness deficits and social acceptance as among the least investigated yet most impactful factors, a pattern directly applicable to the RMC challenges observed across South Asian market (Al-Otaibi, 2024). This gap is of growing urgency as cement is one of the source of pollution and cement emission from the developing countries are estimated to grow from 0.7 gigatons in 2018 to as much as 3.8 gigatons by 2050, making a transition to more efficient and lower carbon concrete supply methods a regional development priority rather than just a market preference (Cheng et al., 2023). Rogers diffusion of Innovations theory explains that even when a product is clearly better, people will not adopt it unless they are aware of its advantages, it fits their existing practices and they can see others using it successfully (Rogers, 2003). In South Asian markets, all three conditions are demonstrably weak such as clients lacks awareness of RMC's true cost advantage, RMC does not fit established informal construction practices and visible success stories remain scarce which explains why adoption remains persistently low despite proven technical and economic superiority (Chakraborty & Farhan, 2022; Khade, 2024; Mishra et al., 2023). This review is therefore guided by three research questions:

- What are the key drivers and barriers to RMC adoption across South Asian economies?
- How do these barriers vary across individual country contexts?
- What transition pathways can accelerate sustainable RMC adoption in the region?

Therefore, this study aims to consolidate peer reviewed evidence on RMC adoption drivers and barriers across South Asia, compare country specific situation across India, Nepal, Bangladesh, Sri Lanka and Pakistan within a unified regional framework, identify sustainable transition pathways centered on low-carbon materials, quality assurance and supply chain digitalization and highlight priority research gaps to support future scholarly inquiry and evidence-based policy development.

2. Material and Method

This study is based entirely on a systematic literature review designed to consolidate and synthesize existing knowledge on ready mix concrete adoption across South Asia, with focus on India, Nepal, Bangladesh, Sri Lanka and Pakistan. A systematic literature review provides an organized and repeatable framework for identifying, evaluating and integrating findings from previously published studies, thereby reducing selection bias and improving the transparency of conclusions, unlike primary research methods that generate new empirical data (Mishra et al., 2023). This method is especially appropriate for a topic like RMC adoption in developing economies, where the academic literature lacks a common regional perspective and knowledge is fragmented across isolated country specific research.

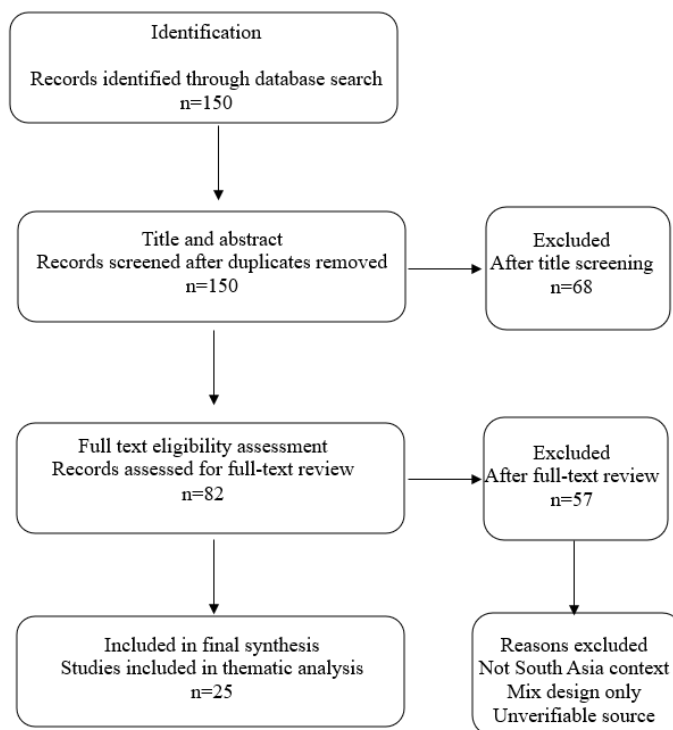


Figure 1. PRISMA -style literature screening and selection process

A thorough search was conducted across Google Scholar, Scopus and Web of Science using search terms including “ready-mix concrete South Asia”, “RMC adoption barriers”, “ready-mix concrete Nepal”, “ready-mix concrete Bangladesh”, “ready-mix concrete India market”, “concrete adoption developing countries” and “cement carbon emissions South Asia”. The search was limited primarily to English language peer reviewed publications published between 2013 and 2025, however the foundational studies published earlier were retained if they contained essential technical or definitional material. For Sri Lanka and Pakistan supplementary evidence was gathered from reliable industry sources and international demographic reports to provide contextual background.

Publication that met the following criteria were included in the review:

- Directly addressed RMC adoption, market dynamics, quality performance or barriers and drivers in a South Asian or comparable developing country.
- Were published in credible conference proceedings or peer-reviewed journals.
- Provided sufficient methodological detail to allow meaningful extraction of findings relevant to the study objectives.
- Were available in full text in the English language.

The methodological quality of included studies was assessed based on three criteria: clarity of research design and data collection methods, credibility of the publication venue and direct relevance of findings to RMC adoption, barriers or market dynamics. Publication were excluded if they were sourced from unverifiable publication venues or focused exclusively on concrete mix design or material properties without reference to market or adoption context. Following this screening process, 25 sources were retained for comprehensive theme synthesis from an initial pool of over 150 titles identified through the database search (see Figure 1).

It is acknowledged that the quality and indexing status of included sources varies. While the majority of studies were drawn from Scopus-indexed peer-reviewed journals, a small number of open-access engineering journals and industry sources were included where Scopus-indexed equivalents were unavailable, particularly for India specific market data. In all cases, factual claims from these sources were corroborated by evidence from higher ranked publications within the review.

Thematic analysis was conducted inductively, themes emerged through repeated careful reading of the included studies rather than from a predetermined framework. Similar findings were progressively grouped into broader categories, with papers revisited as needed to ensure accurate representation of the evidence. Findings were organized into three overarching categories: adoption drivers, adoption barriers and sustainable transition pathways reflecting the core objectives of this review. Each source was reviewed multiple times to identify recurring patterns across country contexts, and similar themes were consolidated into broader analytical categories while retaining country specific nuances where relevant. The findings of this review are subject to several limitations. Peer reviewed literature particularly addressing RMC adoption in Nepal, Sri Lanka, and Pakistan is considerably sparser than that available for India, meaning that country level studies for these three markets rely on a narrower evidence base. Additionally, the review is remains qualitative in nature because quantitative meta-analysis was not possible due to the methodological heterogeneity across the included studies. A further limitation is the restriction of the search to English language publications, which may have excluded relevant studies published in regional languages such as Nepali, Bengali, Sinhala and Urdu. As this review was conducted independently, the possibility of interpretive bias in thematic coding cannot be entirely excluded, though this was mitigated this by systematically verifying all identified themes against the original source texts. These constraints are acknowledged as evidence of significant research gaps that future empirical work should prioritize.

3. Results

3.1 Global RMC Market Context and the Developing Country Gap

Within this growing global market, there is a clear difference in RMC penetration between developed and developing economies. In Japan, RMC makes up about 70% of total cement consumption, while

comparable figures of 60 to 75% are recorded for the US and Europe, where RMC has established itself as the unquestionable standard for modern construction (Lr & Anvekar, 2015). In comparison, RMC consumption in developing countries as a group record less than 10% of overall cement use, with as much as 72% of cement still consumed through conventional site-mixing (Oladiran et al., 2022). This discrepancy is caused by a combination of awareness deficits, logistical limitations and market structural weakness that consistently suppress demand for a clearly superior product rather than RMC's technical or economic inferiority, as the evidence reviewed in this study repeatedly shows (Al-Otaibi, 2024).

3.2 India- Market Scale with Penetration Challenges

India represents the most commercially advanced RMC market in South Asia, with over 3,881 batching units and estimated annual production of 35 to 40 million cubic meters (Khade, 2024). Government infrastructure initiatives, such as the National Infrastructure Pipeline, which allocates approximately USD 1.4 trillion to infrastructure development, the smart cities mission and the Pradhan Mantri Awas Yojana housing scheme, have created sustained large-scale demand that inherently favors RMC's qualities of consistency, speed, and quality assurance (Khade, 2024). South India alone accounts for an estimated 45 to 50% of the country's commercial RMC volume, reflecting the concentration of high-rise residential, commercial, and IT sector building in places like Bengaluru, Hyderabad and Chennai (Lr & Anvekar, 2015).

Despite this scale, only about 20% of India's total cement consumption accounts from mechanized RMC production, revealing a significant market penetration gap (Shah et al., 2014). The dominant explanation is found in the structure of India's construction industry, which remains substantially unorganized and characterized by small contractors with little access to funding and technical expertise (Lr & Anvekar, 2015). The historical supply of low-cost manual labor has also reduced the economic incentive for smaller operators to transition from site mixing to RMC, especially for residential and small commercial projects where informal methods are still strongly embedded (Shah et al., 2014). One of RMC's core operating advantages is undermined by urban traffic congestion, which is severe and worsening in Delhi, Mumbai and Bengaluru (Nagaraju et al., 2019). These findings are consistent with more extensive studies on the informality of the construction industry in developing countries, which identifies the dominance of unregulated informal sectors as a structural impediment to the uptake of contemporary construction technologies (Boadu et al., 2020). Through the lens of Rogers' Diffusion of Innovations framework, India's challenge is primarily one of observability and trialability; RMC's benefits are clearly visible in large commercial and infrastructure projects but remain largely invisible to the small contractors and individual homebuilders who dominate construction activity by number (Rogers, 2003). This situation represents a structural lock-in rather than a simple awareness problem. The informal sector in India maintains its competitive position not because site mixed concrete is superior but because regulatory enforcement is weak and RMC's lifecycle cost advantages remain invisible at the scale of individual homebuilders and small contractors. Addressing this requires interventions that go beyond improving RMC supply specifically, quality enforcement regulations that raise the cost of informal Site-Mixed Concrete (SMC) practices and demonstration projects that make RMC's advantages tangible and observable at the small project where most construction decisions in India are actually made. While India's challenges are primarily structural and market depth related, the barriers operating in Nepal present a fundamentally different character rooted in psychology and

information rather than industry organization.

3.3 Nepal- The Cost-Perception Paradox

Nepal presents one of the most analytically striking cases in this review, a market where persistent consumer misconceptions prevent a technically superior and empirically cheaper product from achieving meaningful adoption. Mishra et al., (2023) demonstrate through thorough field research that RMC is approximately 26% cheaper per cubic meter than government-established SMC rates for M20 grade concrete, and approximately 45% cheaper for M25 grade, all while providing comparable or higher compressive strength. Furthermore, after having direct experience with the product, over 60% of respondents said they preferred RMC to SMC (Mishra et al., 2023). Despite this evidence, clients and contractors' misconceptions about prices continue to remain the dominant barrier to adoption.

This paradox has significant analytical implications. It shows that rather than being technical or financial, the barriers to RMC adoption in Nepal are fundamentally psychological and informational. Consumers frequently mistake unit price, or the apparent cost per cubic meter, with the total project cost, failing to account for labor savings, reduced construction times and less material waste that RMC provides throughout the project lifecycle (Shah et al., 2014). This result is consistent with Al-Otaibi (2024), who identify societal acceptance and awareness as the least studied but most significant obstacles to the concrete technology adoption globally, a pattern that is directly and demonstrably present in the Nepali market. Rogers' framework identifies perceived relative advantage as the most critical adoption determinant yet in Nepal this advantage is systematically misperceived, suggesting that targeted informational interventions correcting the unit price misconception could be significantly more effective than supply side or regulatory measures alone (Rogers, 2003). This finding suggests that in markets where a product's total cost advantage is not immediately visible from its unit price as is structurally the case with RMC market forces alone cannot drive adoption. The informational gap documented in Nepal is not a temporary market imperfection but a persistent structural condition requiring deliberate institutional intervention, including transparent pricing information, industry awareness campaigns and professional training for engineers and contractors.

The scope of Nepal's continuous development makes it even more urgent to remove this barrier. The number of concrete buildings in Nepal has increased by approximately 24% over the past ten years due to growing urbanization and post-earthquake reconstruction after the 2015 Gorkha disaster, which destroyed over 500,000 homes (Bhattarai et al., 2025; Qiu et al., 2026). Even though RCC systems produce 1.64 times more CO₂ than other building systems, the majority of the concrete used in that rebuilding used mostly informal site-mixed (Shrestha, 2021). Continuing with SMC has major environmental consequences as cement materials accounts for about half of all energy use and emissions from Nepal's buildings (Bhattarai et al., 2025).

Addressing Nepal's cost-perception paradox requires targeted efforts at the technical and informational levels. Mishra et al., (2023) specifically identify that structural designers are failing to take advantage of RMC's superior compressive strength in mix specifications, optimizing designs to use RMC's higher strength would reduce required concrete volumes and amplify the cost advantage beyond the already demonstrated savings. At the informational level, awareness campaigns must run through professional engineering associations, construction colleges, and

government procurement departments are needed to correct the misconception that unit price equals entire project cost (Al-Otaibi, 2024; Mishra et al., 2023). Without deliberate intervention of both fronts, Nepal's construction expansion risks continuing on the basis of a demonstrably inferior and more carbon intensive method purely due to a failure of information. In contrast to Nepal's informational barriers, Bangladesh faces a more operationally acute challenge one in which the physical environment of delivery systematically undermines product quality and market confidence.

3.4 Bangladesh- Logistical constraints and the Trust Deficit

In order to meet the rising demand for urban construction, Bangladesh's ready mix concrete sector has expanded considerably in recent years, with new batching facilities built throughout Dhaka and Chittagong. However, a serious operational vulnerability transit related quality degradation has coincided with this physical expansion. Before initial setting compromises structural integrity, concrete must be delivered and placed within approximately 90 minutes of leaving the batching plant (Shah et al., 2014). In Dhaka, one of the most densely populated and traffic congested cities, delivery times routinely exceed this threshold during peak hours, degrading workability and in some cases reducing compressive strength below specified values (Chakraborty & Farhan, 2022).

The consequences extend beyond individual product failures. According to survey data from Chakraborty and Farhan (2022) sufficient RMC supply exists to meet demand, but commercially available products have inconsistently met specified compressive strength requirements. This creates a fundamental trust deficit that suppresses demand even in situations where reliable supply is available. This quality confidence cycle where transit failures create distrust, decreased demand limits investment in logistics improvement, and poor logistics sustain quality failures, represent a structural market failure that cannot be resolved by supply-side measures alone. Therefore, commercial RMC adoption is still mostly limited to large scale developers with the technical capability to independently test product quality and manage delivery schedules (Chakraborty & Farhan, 2022). From diffusion of innovations perspective, Bangladesh's trust deficit directly undermines the observability factor when visible product failures dominate market experience, the adoption cycle stalls regardless of actual product quality or supply availability (Rogers, 2003). This analysis reveals that Bangladesh's RMC challenge is fundamentally different from Nepal's where Nepal requires informational intervention, Bangladesh requires optional and institutional reform. Specifically, investment in GPS-enabled logistics technology and third-party quality certification is needed to break the quality confidence cycle by making product performance independently verifiable and delivery reliable measurably improved.

The environmental consequences of Bangladesh's continued dependence on site mixed concrete are equally significant. Construction and demolition waste in Dhaka represents about 41% of total solid waste, which reflects the material inefficiency of SMC dominated construction methods (Haque et al., 2025). For Bangladesh's rapidly urbanizing construction sector, a successful transition to RMC which reduces on site waste through precise computerized batching would simultaneously address issues with construction waste and product quality reliability, making it a market and environmental priority. Sri Lanka and Pakistan, while sharing some structural similarities with Bangladesh and India, present an additional analytical challenge the near total absence of peer reviewed literature that would allow rigorous country level diagnosis.

3.5 Sri Lanka and Pakistan- Emerging Markets with Evidence Gaps

Sri Lanka is actually the oldest RMC market in South Asia, having operated a formal RMC sector since 1978, making it the regional pioneer in ready mix concrete (Lanka Ready Mix Concrete Association, 2024). Despite this long history, RMC has not spread widely beyond major infrastructure projects and urban contractors. Research on Sri Lanka's construction sector identifies significant structural obstacles to technology adoption, including limited access to modern construction methods, financial constraints among small and medium contractors and weak regulatory enforcement mechanisms (Lebunu Hewage et al., 2024). These findings suggest that Sri Lanka's RMC sector faces adoption barriers structurally comparable to those reported in India and Bangladesh market fragmentation and regulatory weakness, rather than a fundamental incompatibility between the product and the national context.

Pakistan's Ready Mix concrete company was established only in the year 2007, making it the least developed RMC market among the five countries studied in this review (CemNet, 2023). Since then, macroeconomic instability, including currency depreciation, high inflation and a 24.2% year on year decline in cement dispatches in 2023, has severely limited sector development, compressing construction activity and reducing investment capacity across the industry (CemNet, 2023). Beyond macroeconomic pressures, Pakistan's construction industry has systemic quality management issues. These issues include low awareness of contemporary construction methods, insufficient enforcement of technical standards and economic incentives that favor cost cutting over quality assurance (Afzal et al., 2022). Together, these factors create an environment that is detrimental to the adoption of RMC, where the informal sector thrives precisely because quality accountability is still low.

One of the important findings of this review is the near total absence of peer reviewed academic literature specifically addressing RMC adoption processes in both Pakistan and Sri Lanka. It demonstrates that these two markets represent the most urgent priorities for future empirical research in the South Asian RMC field. Without country specific studies examining market structure, consumer awareness, regulatory frameworks and logistical conditions, it is not possible to design targeted interventions capable of accelerating RMC adoption in either context. This evidence gap also limits the regional comparative analysis presented in this review, and findings relating to Sri Lanka and Pakistan should therefore be viewed as indicative rather than definitive. Future research should urgently address this limitation (Al-Otaibi, 2024). Taken together, the five country profiles reveal consistent patterns that transcend individual national contexts patterns that are best understood through a cross regional analytical lens. Taken together, the five country profiles reveal consistent patterns that transcend individual national contexts patterns best understood through a cross regional analytical lens.

3.6 Cross Regional Barrier Analysis

The most common obstacle identified across all five South Asian markets is a perception and awareness deficit. In Nepal, clients and contractors systematically underestimate RMC's total cost advantage by confusing unit price with total project cost (Mishra et al., 2023). In Bangladesh, transportation related quality problems have created a generalized trust deficit which reduces the demand even though a reliable supply is available (Chakraborty & Farhan, 2022). In India, significant awareness gaps remain among small contractors and individual homebuilders in semi

urban areas (Khade, 2024). Across Sri Lanka and Pakistan, the lack of knowledge of modern construction technologies indicates weakness in technical education and professional training systems (Afzal et al., 2022; Lebunu Hewage et al., 2024). Research on concrete technology adoption globally confirms that awareness deficiencies and social acceptance are the least researched yet most impactful barriers, this pattern is clearly and consistently observed across this review (Al-Otaibi, 2024). This is simultaneously a market failure in which accurate total cost information does not reach decision makers and an institutional failure in which professional engineers and architects have not consistently advocated for RMC's evidence-based advantages.

The second barrier operating consistently across South Asian markets is logistical and supply chain limitations. The 90-minute concrete workability window which is an unchangeable technical constraint, yet severe traffic congestion in Dhaka, Delhi, Mumbai and Karachi frequently violates it, that degrades concrete quality before it reaches the construction site (Chakraborty & Farhan, 2022; Nagaraju et al., 2019). This problem is made worse by the tropical and subtropical climate of South Asia where high ambient temperatures accelerate cement hydration, effectively reducing the workability window and increasing the risk of quality loss during transit (Nagaraju et al., 2019). In fast growing peri-urban zones, where many infrastructure projects are taking place but plant coverage is still few, the geographic distribution of batching plants in relation to construction sites presents additional delivery distance challenges (Khade, 2024). These logistical limitations translate directly into product failures, contractual disputes and reputational damage that reinforce the awareness and trust obstacles described above creating a self-reinforcing cycle of underperformance and under adoption.

The third systematic barrier is market structure and regulatory weakness. The establishment of an RMC operation requires substantial capital investment in batching plant infrastructure, transit mixer fleets, electronic quality control system and trained technical staff, creating an industry structure that is poorly suited to serving the small and dispersed projects that make up the majority of South Asian construction (Makwana & Pitroda, 2013). In India, Pakistan and Sri Lanka, the historical dominance of low-cost informal labor has further reduced the economic incentive for smaller operators to switch from site-mixing to RMC (Afzal et al., 2022; Shah et al., 2014). Regulatory frameworks governing concrete quality specification and enforcement remain inconsistent across all five countries examined, creating no meaningful legal or competitive pressure to improve substandard SMC (Khade, 2024; Lebunu Hewage et al., 2024). In the market where RMC is most needed, the informal sector's economic logic will continue to push it out in the absence of regulatory change that mandates minimum concrete quality standards and enforces compliance.

The cross regional synthesis presented above is, however, constrained by a critical limitation of the available literature itself. The majority of studies reviewed are published in engineering and construction technology journals, which tend to prioritize technical performance metrics compressive strength, workability and mix design, over the economic, social and institutional dimensions of RMC adoption. As a result, the evidence base for understanding why informal sector actors resist RMC adoption despite its proven advantages remains underdeveloped. The psychological and behavioral dimensions of the cost-perception paradox documented in Nepal, for instance, would benefit from investigation through a behavioral economics or consumer psychology lens rather than purely through engineering methodology. Similarly, the institutional barriers operating in Sri Lanka and Pakistan regulatory weakness, enforcement gaps and market fragmentation require

analysis from public administration and institutional economics perspectives that are largely absent from the current literature. This disciplinary gap represents both a fundamental limitation of the existing evidence base and a priority direction for future interdisciplinary research (Al-Otaibi, 2024; Rogers, 2003).

Table 2. Summary of RMC adoption drivers and barriers across South Asian economies

Country	Primary Driver	Primary Barrier	Secondary Barrier
India	Government infrastructure investment	Informal sector dominance	Low awareness among small contractors
Nepal	Post-earthquake reconstruction and urbanization	Cost-perception paradox	Failure of designers to leverage RMC strength
Bangladesh	Rapid urban construction demand	Transit related quality degradation	Public trust deficit
Sri Lanka	Infrastructure development	Regulatory weakness and market fragmentation	Financial constraints among small contractors
Pakistan	Urban growth and construction expansion	Macroeconomic instability	Systematic quality management failures

3.7 Sustainable Transition Pathways

Addressing the market structure and regulatory barrier which currently provides no competitive incentive for informal SMC operators to improve the adoption of supplementary cementitious materials offers a pathway that simultaneously reduces environmental impact and lowers production costs. The most immediately scalable pathway to sustainable RMC growth in South Asia is the substitution of ordinary Portland cement with supplementary cementitious materials. Research demonstrates that replacing 65% of cement with fly ash reduces CO₂ emissions by about 54% while also lowering the cost of concrete by 34% making SCM adoption both an economic and environmental priority (Supriya et al., 2023). India produces approximately 270 million tons of fly ash annually as a byproduct of coal-fired power generation, giving RMC makers instant access to plentiful and economical local source of fly ash (Supriya et al., 2023). In South Asia, where cement related carbon emissions in developing countries are expected to increase from 0.7 gigatons in 2018 to as much as 3.8 gigatons by 2050 if no action is taken, therefore supplementary cementitious materials (SCM) blended concrete is particularly significant to reduce carbon emissions (Cheng et al., 2023). Following India's example, where fly ash and GGBS incorporation in RMC production is already standard procedure, Nepal and Bangladesh should adopt similar regulations by allowing and encouraging the use of blended cement specifications in public procurement contracts (Lr & Anvekar, 2015). However, the adoption of SCMs across South Asia is not without challenges. The quality of fly ash varies considerably depending on coal source and combustion conditions, and inconsistent fly ash quality can affect concrete workability and long-term strength development (Supriya et al., 2023). Supply chain reliability for GGBS also varies significantly across the region, with Nepal and Bangladesh facing considerably greater constraints than India. These practical limitations should be acknowledged in any policy framework promoting blended cement specifications.

Directly targeting the trust deficit documented in Bangladesh and the perception gap identified

in Nepal, advanced quality assurance mechanisms represent the most effective intervention for rebuilding market confidence in RMC. Skrzypczak et al., (2020) propose using a modern quality checking system that combines statistical and fuzzy logic quality assessment method that reduces the probability of incorrectly classifying concrete batches, improving both structural safety and resource efficiency in RMC production. Beyond laboratory methods, third party certification schemes, compulsory tracking of every concrete batch, mix design and delivery records, and independent testing laboratories would create accountability structures that are currently lacking in a large portion of the South Asian RMC market (Chakraborty & Farhan, 2022). These systems would help people in Nepal compare the real costs of RMC and SMC using reliable information, and they would also improve trust in Bangladesh, where concrete has not consistently met the required compressive strength (Mishra et al., 2023). When product performance is independently verifiable and publicly accessible, the informational barriers that currently prevent rational purchasing decisions are systematically removed.

The logistical barrier the immutable 90-minute workability window routinely violated by South Asian urban traffic cannot be solved by product or regulatory changes alone. Supply chain digitalization offers the most technically credible solution to this constraint. The third pathway has the greatest potential to improve South Asia's construction sector. Gps-tracking of delivery vehicles, real-time traffic data integration, and predictive dispatch scheduling, which can significantly reduce transportation delay incidents and their effects on concrete workability, helping improve RMC quality across South Asian cities (Khade, 2024). New technologies such as automated aggregate blending and artificial intelligence based delivery planning can increase delivery range of RMC, making it easier for small contractors and peri-urban projects, which presently make up the bulk of the region's construction activity (Khade, 2024). These digital innovations are expected to support the growth of the global RMC market's which is projected to increase from USD 548 billion in 2023 to USD 965 billion by 2032. South Asian producers that invest in digital technologies at an early stage will be better prepared to benefit from this market growth while providing safer, more sustainable, and more dependable construction outcomes for the region's growing urban populations (Khade, 2024; Polaris Market Research, 2023).

4. Conclusion

This systematic literature review has provided the first comprehensive overview of ready-mix concrete adoption patterns in South Asia, by combining data from India, Nepal, Bangladesh, Sri Lanka and Pakistan into a single comprehensive framework. The main findings is a regional paradox, a construction material that is consistently underutilized throughout a region dealing with unprecedented infrastructure demand, despite being empirically superior in quality, demonstrably cheaper in total project cost, and less environmentally damaging than conventional site-mixed concrete. This paradox is consistently explained by three types of barriers in all five markets such as a lack of awareness that prevents people from understanding the actual cost of RMC, transportation and supply chain problems caused by urban traffic congestion, weather conditions, and market structure and regulatory weakness that allow informal SMC practices to continue without proper quality control.

A country-wise analysis shows that these obstacles appear differently in each country. Nepal shows the biggest contradiction, although RMC is 26-45% cheaper than SMC based on government rates,

many people still do not use it because they wrongly believe it is more expensive, demonstrating the primary of informational rather than economic barriers (Mishra et al., 2023). Bangladesh faces a different kind of contradiction, although there is a enough supply of RMC, transit related quality issues have reduced people's trust that limits commercial adoption to large developers (Chakraborty & Farhan, 2022). India most developed RMC sector with 3881 plants, but because the informal construction sector is dominant, RMC only accounts for 20% of the country's cement consumption, creating a contradiction in the market (Khade, 2024). Despite their respective histories of RMC operations, Sri Lanka and Pakistan represent crucial evidence gaps, and one important conclusion of this analysis is the almost complete lack of peer-reviewed literature.

Addressing these barriers requires coordinated action across three strategic pathways: the adoption of low carbon supplementary cementitious materials to reduce the environmental impact of concrete, the implementation of advanced quality assurance mechanisms to build the market trust and the use of digital supply chain technologies to solve transportation and delivery challenges. The construction industry is not the only one at risk. In South Asia, increasing the use of RMC dominated concrete supply would simultaneously reduce construction related CO₂ emissions, improve building safety through more dependable structure performance and accelerate the delivery of housing and infrastructure needed for the region's rapidly growing urban populations (Cheng et al., 2023; United Nations, 2018). To address the research gaps identified in this review, future studies should focus on collecting nationally representative empirical studies for Nepal, Sri Lanka, and Pakistan, regional life cycle assessment data for Supplementary Cementitious Materials (SCM)- blended RMC mixes and longitudinal studies tracking market penetration against policy interventions.

For policymakers, the most urgent priorities are regulatory reform mandating minimum concrete quality standards in Nepal and Bangladesh and tax incentives for RMC plant investment across all five markets. For industry associations, targeted awareness campaigns correcting the price misconception among Nepali contractors and third-party certification schemes in Bangladesh represent the highest-impact interventions. For construction firms, early investment in GPS-enabled fleet management and digital dispatch systems will reduce transit failures and rebuild market confidence in RMC quality across the region.

It should be acknowledged that RMC's environmental benefits are not unconditional. The carbon advantages of SCM-blended RMC depend on the availability and quality of local fly ash and GGBS sources, the energy mix of the regional electricity grid and transport distances involved in material supply. Full life cycle assessment studies specific to South Asian conditions are needed before definitive environmental comparisons between RMC and SMC can be made.

References

- Abeydeera, U., Mesthrige, J., & Too, E. (2024). Barriers to risk management in small construction projects in Sri Lanka. *Built Environment Project and Asset Management*, 14. <https://doi.org/10.1108/BEPAM-06-2023-0104>
- Afzal, N., Hanif, A., & Rafique, M. (2022). Exploring the impact of total quality management initiatives on construction industry projects in Pakistan. *PLOS ONE*, 17, e0274827. <https://doi.org/10.1371/journal.pone.0274827>
- Al-Otaibi, A. (2024). Barriers and Enablers for Green Concrete Adoption: A Scientometric Aided Literature Review Approach. *Sustainability*, 16(12), 5093. <https://doi.org/10.3390/su16125093>
- Bhattarai, B., Bhattarai, B. S., Maskey, R. K., & Bhochhibhoya, S. (2025). Life Cycle Assessment of Reinforced Concrete

Residential Buildings in Nepal: Pathways to Carbon Footprint Reduction through Sustainable Construction. *Building and Environment*, 281, 113199. <https://doi.org/10.1016/j.buildenv.2025.113199>

Bhusal, L. B. (2025). Change in the South Asian construction sector: Insights from a structural decomposition approach. *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-025-07119-x>

Boadu, E. F., Wang, C. C., & Sunindijo, R. Y. (2020). Characteristics of the Construction Industry in Developing Countries and Its Implications for Health and Safety: An Exploratory Study in Ghana. *International Journal of Environmental Research and Public Health*, 17(11), 4110. <https://doi.org/10.3390/ijerph17114110>

CemNet. (2023). Pakistan's cement industry faces significant challenges. *International Cement Review*. <https://www.cemnet.com/News/Story/175006/pakistan-s-cement-industry-faces-significant-challenges.html>

Chakraborty, P., & Farhan, M. (2022). Study On Ready-Mix Concrete, Including A Survey And Experiment In The Context Of Bangladesh.

Cheng, D., Reiner, D. M., Yang, F., Cui, C., Meng, J., Shan, Y., Liu, Y., Tao, S., & Guan, D. (2023). Projecting future carbon emissions from cement production in developing countries. *Nature Communications*, 14(1), 8213. <https://doi.org/10.1038/s41467-023-43660-x>

Gagg, C. R. (2014). Cement and concrete as an engineering material: An historic appraisal and case study analysis. *Engineering Failure Analysis*, 40, 114–140. <https://doi.org/10.1016/j.engfailanal.2014.02.004>

Haque, S. E., Nahar, N., Chowdhury, N. N., Gazi-Khan, L., Sayanno, T. K., Muktadir, Md. A., & Haque, Md. S. (2025). Identification of recycling potential of construction and demolition waste: Challenges and opportunities in the Greater Dhaka area. *Environmental Monitoring and Assessment*, 197(6), 646. <https://doi.org/10.1007/s10661-025-14081-8>

Khade, V. (2024). Evolution, Challenges, and Opportunities in Ready Mix Concrete (RMC) Industry in India. *International Journal for Research in Applied Science and Engineering Technology*, 12(6), 1148–1151. <https://doi.org/10.22214/ijraset.2024.63294>

Lanka Ready Mix Concrete Association. (2024). Lanka Ready mix Concrete Association In Sri Lanka, Sri Lanka concrete—Ready mixed companies. Informex Concreting (Pvt) Ltd, L H Piyasena And Company (Pvt) Ltd, Maga Engineering (Pte) Ltd, RN Readymix (Pvt) Ltd, Sanken Lanka (Pvt) Ltd, Sathuta Builders (Pvt) Ltd, Sathuta Ready—Mix (Pvt) Ltd, Sierra Ready Mix, Sri Lanka Land Reclamation And Development Corporation, Sunbee Readymix (Pvt) Ltd, Tokyo Super Mix, Tudawe Brothers Ltd., <http://www.lrca.lk/>

Lebunu Hewage, U. W. A., Wadu Meethrige, J., & Too, E. G. (2024). Barriers to risk management in small construction projects in Sri Lanka. *Built Environment Project and Asset Management*, 14(2), 296–311. <https://doi.org/10.1108/BEPAM-06-2023-0104>

Lr, M., & Anvekar, S. (2015). Recent Developments in the Indian Ready Mixed Concrete Industry: Effects on Sustainable Construction. *Civil Engineering & Construction Review*.

Makwana, A., & Pitroda, Dr. J. (2013). An Approach For Ready Mixed Concrete Selection For Construction Companies Through Analytic Hierarchy Process. 4, 2878–2884.

Miller, S. A., Habert, G., Myers, R. J., & Harvey, J. T. (2021). Achieving net zero greenhouse gas emissions in the cement industry via value chain mitigation strategies. *One Earth*, 4(10), 1398–1411. <https://doi.org/10.1016/j.oneear.2021.09.011>

Mishra, A. K., Sudarsan, J. S., & Nithiyantham, S. (2023). Feasibility study on application of ready mix concrete in construction projects in Nepal. *International Journal of Environmental Science and Technology*, 20(7), 7569–7576. <https://doi.org/10.1007/s13762-022-04380-9>

Nagaraju, A., Kumar, P. S., Meena, M., & Reddy, S. V. B. (2019). Impact of Retention of Slump on Growth of Ready Mixed Concrete. 9(2).

Oladiran, O., Kilanko, O., & Kilanko, A. (2022). Investigating The Awareness And Barriers Of Just-In-Time Concrete

Delivery On Construction Projects. *Ethiopian Journal of Environmental Studies and Management*, 15, 13–21.

Polaris Market Research. (2023). Ready-Mix Concrete Market Size, Analysis Report 2032. Polaris. <https://www.polarismarketresearch.com/industry-analysis/ready-mix-concrete-market>

Qiu, C., Wang, J., Jiang, T., Du, X., & Liu, H. (2026). Probabilistic life-cycle assessment of post-earthquake embodied carbon emission: A case study of steel-framed hospital building. *Journal of Building Engineering*, 122, 115791. <https://doi.org/10.1016/j.jobe.2026.115791>

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press. <https://teddykw2.wordpress.com/wp-content/uploads/2012/07/everett-m-rogers-diffusion-of-innovations.pdf>

Shah, A., Pitroda, Dr. J., & Bhavsar, J. (2014, March 29). Ready Mix Concrete: Economic And Qualitative Growth For Construction Industry.

Shrestha, J. K. (2021). Assessment of energy demand and greenhouse gas emissions in low rise building systems: Case study of five building systems built after the Gorkha Earthquake in Nepal. *Journal of Building Engineering*, 34, 101831. <https://doi.org/10.1016/j.jobe.2020.101831>

Skrzypczak, I., Kokoszka, W., Zięba, J., Leśniak, A., Bajno, D., & Bednarz, L. (2020). A Proposal of a Method for Ready-Mixed Concrete Quality Assessment Based on Statistical-Fuzzy Approach. *Materials*, 13(24), 5674. <https://doi.org/10.3390/ma13245674>

Supriya, Chaudhury, R., Sharma, U., Thapliyal, P. C., & Singh, L. P. (2023). Low-CO2 emission strategies to achieve net zero target in cement sector. *Journal of Cleaner Production*, 417, 137466. <https://doi.org/10.1016/j.jclepro.2023.137466>

United Nations. (2018). 2018 Revision of World Urbanization Prospects. United Nations. United Nations. <https://www.un.org/en/desa/2018-revision-world-urbanization-prospects>