



Schools as social infrastructure for urban quality of life: Strategies for fostering inclusivity

Jamil Binabid ^{*} , Qusai Anteet

Department of Architecture and Building Science, College of Architecture and Planning, King Saud University, Riyadh 11421, Saudi Arabia

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ABSTRACT

As cities evolve toward human-centered development, schools hold untapped potential to serve as key elements of social infrastructure that promote urban quality of life. This study investigates how school facilities can be reimagined as inclusive, multifunctional community hubs that support social cohesion, equity, and neighborhood resilience. Using a thematic qualitative methodology, the research analyzes four global case studies to identify spatial and architectural strategies that extend the function of schools beyond education. These include shared public spaces, adaptability, environmental connectivity, and boundary integration. The findings are synthesized into a framework of design parameters that enable schools to become more accessible, inclusive, and contextually integrated within their urban settings. This research offers actionable insights for designers, planners, and policymakers aiming to transform schools into vital civic assets that contribute to sustainable and inclusive urban environments.

1. Introduction

Despite increasing global attention to schools as community hubs, there remains a notable lack of design-focused research on how spatial strategies can actively support inclusivity and multifunctionality. While many schools informally share spaces for services like adult education and recreation, few are purpose-built for such use; in Australia, only 18% of surveyed school staff indicated that their facilities were intentionally designed for sharing [1]. Case studies highlight successes but often lack generalizable design lessons. Additionally, limited research explores how schools connect with their urban contexts through physical integration and programming. Evidence shows that co-located services and accessible green spaces can enhance social cohesion [2,3], yet such benefits are rarely supported by deliberate design interventions. Implementation is further constrained by governance challenges and insufficient community engagement, which may worsen social disparities if not carefully managed [4]. To address these limitations, this study proposes a framework of design parameters – including adaptability, shared spaces, permeability, and contextual responsiveness-to reconceptualize schools as inclusive, multifunctional urban infrastructure.

Our contribution lies in the structured integration of existing concepts into a framework for reimagining schools as social infrastructure. Despite growing recognition of schools as potential community assets, a

critical implementation gap persists between policy discourse and spatial practice. In many urban contexts, cities simultaneously experience shortages of accessible civic infrastructure, increasing social fragmentation, and pressure on public budgets, while school facilities remain largely underutilized outside academic hours. This condition represents not merely an opportunity but an emerging urban challenge: existing educational environments are rarely designed, governed, or evaluated as shared social infrastructure. Consequently, planners and designers lack spatially explicit guidance on how schools can operationally support inclusivity, community engagement, and neighborhood resilience. The absence of design-oriented frameworks capable of translating social infrastructure theory into architectural decision-making creates practical uncertainty for stakeholders seeking scalable and implementable solutions. Addressing this gap establishes the central problem of this study: how spatial and architectural strategies can systematically enable schools to function as inclusive civic assets within contemporary urban environments.

Moreover, a synthesis of the reviewed literature reveals several recurring limitations that collectively define the research gap addressed in this study. First, existing research on social infrastructure largely conceptualizes schools as community assets at the policy or sociological level, while offering limited translation into spatial or architectural design strategies. Second, studies examining community engagement

^{*} Corresponding author.

E-mail address: jbinabid@ksu.edu.sa (J. Binabid).

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and inclusivity frequently emphasize governance models, programming, or institutional partnerships, yet seldom articulate how physical environments enable or constrain these outcomes. Third, although individual case examples demonstrate successful school–community integration, they rarely produce transferable or comparative spatial parameters that can guide future design practice. Taken together, these patterns indicate a disciplinary disconnect between social infrastructure theory and architectural implementation. This study responds to this gap by synthesizing conceptual insights and empirical case analysis into a spatially grounded framework intended to bridge theory, design, and urban practice.

This research focuses on the role of schools and their facilities as vital components of social infrastructure that contribute to urban quality of life. Schools, often underutilized outside of academic hours, have the potential to be transformed into multifunctional spaces that foster social cohesion, community engagement, inclusivity, and neighborhood well-being. By examining the theoretical relationship between schools as physical and social hubs, this research explores how they can play a pivotal role in creating and sustaining inclusive urban communities, especially in cities striving to transform from vehicle dependency to human-centric environments. To address this gap, the study investigates how school facilities can be transformed into inclusive social infrastructure that supports urban quality of life. The research is guided by the following questions: (1) How can school buildings be spatially and programmatically reimagined to serve as multifunctional community hubs? (2) What design parameters enable schools to promote inclusivity, community engagement, and integration with their urban context? These questions frame the exploration of design strategies that position schools as civic assets beyond their educational function.

Additionally, the research will be grounded in the concept of social infrastructure, specifically focusing on schools as central community assets that foster inclusivity. Schools are positioned as educational institutions and community anchors, capable of fostering broader social interactions and enhancing community networks. A particular emphasis will be placed on how inclusive design strategies can help transform these spaces into hubs that welcome people from all backgrounds, reinforcing equity and community resilience. This is pursued by a three-step methodology. The first is a literature review to present the concept of social infrastructure, community engagement, and Inclusivity. Second, four case studies will be sampled and distilled into design typologies that effectively foster social quality of life and inclusivity. These case studies will include examples where schools have been successfully reimagined as inclusive social hubs, with an analysis of the strategies used to accommodate diverse community needs. Third, thematic discussion between the first two steps to identify strategies for fostering social cohesion, promoting inclusivity, and providing accessible spaces for community engagement, where schools can contribute significantly to urban neighborhoods' overall well-being and adaptability.

1.1. Social infrastructure

1.1.1. Within the urban context

The concept of social infrastructure in schools encompasses a broad range of elements that facilitate social interaction, community engagement, and students' overall well-being. Social infrastructure refers to the physical and organizational structures that support social activities and relationships within educational settings. This includes not only the physical facilities such as classrooms, libraries, and recreational areas but also the social networks, programs, and services that foster a supportive learning environment. The integration of social infrastructure into educational contexts is crucial for enhancing student engagement, promoting inclusivity, and addressing the diverse needs of learners.

This vision closely resonates with the concept of urban commons, which refers to shared urban resources that are collectively managed by communities to ensure equitable access, inclusive governance, and long-term sustainability. As Camerin [5] argue, urban commons go beyond

traditional public infrastructure by fostering participatory stewardship, where citizens are not merely users but co-creators and caretakers of shared spaces. Reimagining schools as urban commons positions them as vital civic assets embedded within neighborhoods, accessible to all and responsive to diverse community needs. Such an approach aligns with the ethos of social infrastructure by encouraging co-use, mutual responsibility, and spatial justice-qualities essential for inclusive urban development and resilient community networks.

Contemporary debates on sustainable and liveable environments are shaped by tensions between globalised “world city” agendas, often driven by urban regeneration, mega-projects, and star-architecture-led waterfront revitalisation that may result in inefficient land use and resource-intensive development, and alternative approaches grounded in landscape-based, locally embedded, and long-term strategies for resilience [6–8]. The effectiveness of these approaches is closely linked to the capacity of local authorities to coordinate planning, land-use management, and public health objectives, a capacity that has historically been challenged by fragmented governance structures and limited institutional capacity [9]. Within this context, underutilised urban areas, or “urban voids,” are increasingly recognised as opportunities for integrated regeneration, enabling more efficient land use and supporting inclusive, healthy, and community-oriented environments when addressed through coordinated, multi-scalar frameworks [10].

In parallel, processes of city brandification and culture-led regeneration further reinforce a shift toward image-driven urban development, where cultural investments and flagship projects are mobilised to enhance competitiveness and reshape urban identity [11,12]. While such strategies can contribute to regeneration and social cohesion, they may also privilege symbolic value over socially inclusive and context-responsive development. In contrast, counter-approaches such as placemaking emphasise locally grounded, participatory, and context-sensitive interventions that prioritise social value and everyday use, thereby reinforcing the role of the built environment in fostering inclusive and liveable communities [13].

One significant aspect of social infrastructure in schools is its role in fostering social ties among students. Budhiraja [14] highlights that social ties act as infrastructures of sociality, providing a safety net for disadvantaged students through the sharing of knowledge and resources. This notion emphasizes the importance of creating environments where students can form meaningful connections, which are essential for their academic success and emotional well-being. Furthermore, the physical spaces within schools, such as common areas and collaborative learning environments, are instrumental in facilitating these interactions, thereby reinforcing the idea that social infrastructure is not merely about physical facilities but also about the relationships they enable.

Moreover, the integration of social infrastructure into educational planning is vital for addressing equity and access issues. Franz and Gruber [15] argue that student housing can be viewed as a form of social infrastructure that supports the broader educational ecosystem. By recognizing the importance of housing and community resources, schools can better serve diverse student populations, particularly those from marginalized backgrounds. This perspective aligns with the findings of Wojewódzka-Wiewiórska and Stawicki [16], who assert that social infrastructure is essential for the socio-economic development of rural areas, indicating that schools in these regions must adapt to the unique challenges faced by their communities.

The role of social infrastructure in schools also extends to the provision of support services that cater to the holistic needs of students. Educational infrastructure encompasses not only the physical facilities but also the administrative and support systems that facilitate teaching and learning processes [17]. This includes counseling services, extra-curricular programs, and community partnerships that enhance the educational experience. By investing in these support systems, schools can create an inclusive environment that promotes student engagement and academic achievement.

Furthermore, the concept of social infrastructure in schools is closely linked to the broader discourse on public–private partnerships (PPPs) in education. Levey et al. [18] explore how PPPs can enhance social infrastructure by leveraging private resources to improve public educational facilities. This approach can lead to innovative solutions that address the funding challenges faced by many schools, ultimately benefiting students and communities. However, it is essential to ensure that such partnerships prioritize equity and access, preventing the exacerbation of existing disparities in educational opportunities.

In addition to physical and organizational elements, social infrastructure in schools also encompasses the cultural and social dynamics that shape the educational experience. The work of Högström et al. [19] suggests that social infrastructure is not a static concept but rather a dynamic interplay of various factors that influence urban planning and educational environments. This perspective encourages educators and policymakers to consider the cultural context in which schools operate, recognizing that social infrastructure must be adaptable to meet the evolving needs of students and communities.

Moreover, the impact of social infrastructure on student outcomes cannot be overstated. Research indicates that well-developed social infrastructure contributes to improved academic performance, higher levels of student engagement, and enhanced social skills [20]. This is particularly relevant in the context of inclusive education, where social infrastructure plays a critical role in supporting students with diverse needs. By fostering a sense of belonging and community, schools can create an environment where all students feel valued and empowered to succeed.

The integration of technology into social infrastructure also presents new opportunities for enhancing educational experiences. As noted by Ott et al. [21], the use of mobile technology in schools can serve as a social resource that bridges the gap between academic and leisure activities. By leveraging technology to facilitate communication and collaboration, schools can enhance the social infrastructure that supports student learning. This technological integration must be thoughtfully implemented to ensure that it complements existing social structures rather than undermining them.

Additionally, social infrastructure plays a critical role in urban design, influencing the quality of life, community cohesion, and overall urban sustainability. The concept encompasses various facilities and services that support social interaction, health, education, and community development. This multifaceted nature of social infrastructure necessitates a comprehensive approach in urban planning, where the integration of social, economic, and environmental considerations is paramount.

As highlighted by Sha, effective social infrastructure planning can significantly enhance the mobility of diverse populations, particularly in the context of urban renewal. This involves not only the physical aspects of infrastructure but also the investment in social enterprises and community development programs that cater to the needs of various demographic groups, including families, the elderly, and long-term residents [22]. The need for a holistic approach is further emphasized by Horton and Penny, who argue that social infrastructures are essential for maintaining the distinct identities and practices of working-class communities, especially in the face of austerity and real estate pressures [23].

The challenges associated with social infrastructure in urban planning are multifaceted. Högström et al. [19] discuss the complexities of localizing social infrastructures, emphasizing the need for equitable access to services and facilities. This is particularly relevant in cities where socio-economic disparities are pronounced, necessitating targeted interventions to ensure that all community members benefit from urban development initiatives.

The integration of technology into urban infrastructure planning is another emerging trend. Tien et al. [24] propose a social media sensing framework to enhance urban infrastructure management, illustrating how digital tools can facilitate community engagement and improve

service delivery. This approach aligns with the growing recognition of the role of technology in fostering connectivity and enhancing the resilience of urban systems.

Emerging research on well-being and resilience increasingly adopts computational approaches to evaluate alternative development scenarios. For instance, [25] demonstrate how fuzzy expert systems (FESs) can formalise expert knowledge, while self-organising maps (SOMs) identify patterns from data without predefined assumptions. These methods are valuable for decision-support in complex urban systems. However, such approaches typically rely on structured, quantifiable inputs and scenario-based evaluation. In parallel, a growing body of research highlights the built environment itself as a critical yet under-explored dimension in shaping population well-being and resilience. This study, therefore, focuses on the spatial and architectural conditions that enable social infrastructure, adopting a qualitative, design-oriented approach to identify recurring spatial strategies rather than modelling predefined scenarios.

1.1.2. Educational buildings

Educational infrastructure encompasses not only the physical buildings but also the resources, technology, and support systems that facilitate effective teaching and learning. A well-planned educational infrastructure is crucial for enhancing the quality of education and ensuring that students achieve their academic potential. Dewi et al. [26] emphasize that the planning of educational facilities is foundational for future designs and implementations, aiming to optimize student learning activities in senior high schools. This assertion aligns with findings that highlight the direct correlation between infrastructure quality and educational outcomes, where adequate facilities significantly influence the overall quality of education [27].

Moreover, the role of total quality management in educational facilities is pivotal in improving institutional quality. Pakpahan and Hidayati [28] argue that the design and management of school infrastructure directly impact the performance of teachers and the health of both students and educators, thereby affecting the teaching and learning process. This perspective is supported by research indicating that the presence of adequate facilities and infrastructure is essential for creating an environment conducive to learning, which ultimately leads to better educational achievements [29]. The implications of these findings are profound, suggesting that investments in educational infrastructure are not merely expenditures but rather critical investments in the future workforce and societal well-being.

The integration of information technology within educational infrastructure is another critical aspect that influences educational quality. The utilization of modern technological tools in schools has been shown to enhance learning experiences and outcomes. Research indicates that infrastructure that supports the integration of information technology significantly influences the quality of education, with facilities being more dominant than traditional infrastructure in this regard [27]. This highlights the need for educational institutions to not only invest in physical infrastructure but also in technological advancements that can facilitate innovative teaching and learning methods.

In addition to physical and technological infrastructure, mobility and spatial accessibility are crucial yet often overlooked aspects of educational equity. Universities, in particular, can shape and be shaped by urban mobility patterns. As Bretones et al. [30] emphasize, the integration of universities within public transport networks and walkable environments significantly influences access for students, staff, and surrounding communities. Enhanced mobility infrastructure not only supports attendance and academic engagement but also promotes social inclusion by ensuring that educational facilities are reachable by diverse populations. This perspective reinforces the importance of planning educational buildings as integrated elements within broader urban mobility systems.

Furthermore, the management of educational facilities is a crucial component of ensuring that infrastructure effectively supports

educational goals. Astuti [31] emphasizes that effective management of educational facilities is essential for providing high-quality education. This involves planning, acquiring, and maintaining educational infrastructure to meet the evolving needs of students and educators. The literature suggests that without proper management, even the most well-designed facilities may fail to deliver the intended educational outcomes [32]. Thus, educational leaders must prioritize infrastructure management as a fundamental aspect of educational administration.

In addition to physical and technological infrastructure, the social aspects of educational facilities also play a significant role in shaping the educational experience. The presence of supportive environments, such as libraries, recreational areas, and community spaces, contributes to a holistic educational experience that fosters student engagement and well-being [33]. The importance of creating inclusive and supportive educational environments is further emphasized by research indicating that social infrastructure directly impacts student satisfaction and academic performance [34]. Therefore, educational institutions must consider the social dimensions of their infrastructure to create environments that promote learning and personal development.

The implications of educational infrastructure extend to broader societal outcomes, including health and social equity. Studies have shown that investments in educational infrastructure can lead to improved health outcomes and reduced income inequality [35]. This is particularly relevant in contexts where educational disparities are linked to broader social determinants of health. By addressing the infrastructural needs of schools, policymakers can contribute to a more equitable society where all individuals have access to quality education and the associated benefits.

1.1.3. Schools facilities

The physical infrastructure of schools, including classrooms, libraries, sports facilities, and technology labs, plays a crucial role in shaping educational outcomes and community well-being. Research indicates that the quality and management of educational facilities significantly influence the learning process and overall academic achievement of students, particularly in social sciences [31,36,37]. In urban settings, schools often serve as critical components of the social fabric, providing not only education but also essential services and resources to the community. Schools can act as safe spaces for children and adolescents, particularly those with emotional and behavioral disorders, by offering supportive environments that promote social skills and emotional well-being [38]. The reciprocal relationship between schools and their surrounding communities highlights the importance of investing in school infrastructure to foster social cohesion and community resilience [39].

Moreover, the presence of adequate school facilities can significantly impact the broader social determinants of health and well-being. Schools equipped with sports facilities, libraries, and community spaces can promote physical health, mental well-being, and social interaction among students and their families. Moreover, these facilities not only support educational activities but also serve as venues for community events, health screenings, and social services, thereby enhancing the overall quality of life in the community. Additionally, the concept of asset-based community development emphasizes the importance of leveraging existing community assets, including schools, to foster social capital and enhance community resilience [40]. By recognizing schools as vital social assets, communities can mobilize resources and support systems that contribute to the holistic development of children and families. This approach aligns with the broader goals of sustainable development, which seek to create inclusive and equitable educational opportunities for all [37].

1.2. Community engagement and inclusivity

1.2.1. Social cohesion

The transformation of schools into multifunctional spaces presents a significant opportunity to enhance social cohesion, community engagement, inclusivity, and overall neighborhood well-being. Schools, traditionally viewed as centers for academic learning, possess the potential to serve as vibrant community hubs that cater to diverse needs beyond the academic calendar. This transformation aligns with contemporary educational philosophies that advocate for the integration of educational environments with community resources, thereby fostering a more inclusive and cohesive society.

Multifunctional spaces within schools can serve various purposes, including cultural, recreational, and social activities, which are essential for community engagement. According to Sabatini, multifunctional spaces are integral to the grassroots ecosystem, acting as social and cultural centers that facilitate community interactions and collaborations [41]. This notion is echoed by Eriksson et al. [42], who highlight the role of social capital in schools and neighborhoods, suggesting that cohesive school environments contribute positively to children's well-being and social health. By utilizing school facilities for community events, workshops, and cultural programs, schools can become pivotal in fostering social ties and enhancing community identity.

The architectural design of schools plays a crucial role in their multifunctional capabilities. Podymova emphasizes that modern educational spaces must adhere to principles of safety and hygiene while also accommodating diverse functions [43]. This flexibility in design allows schools to adapt their spaces for various community needs, such as hosting after-school programs, community meetings, and cultural events. Furthermore, the integration of outdoor spaces, as discussed by Krajnović et al., can activate school grounds as public spaces that encourage physical activity and social interaction among community members [44]. The design of these spaces should prioritize accessibility and inclusivity, ensuring that all community members can benefit from the resources available.

Teachers and educational staff are pivotal in realizing the potential of schools as multifunctional spaces. Continuous professional development (CPD) for educators, as highlighted by Singh, is essential for equipping them with the skills to promote citizenship and social cohesion within the classroom and beyond [45]. By fostering an inclusive environment, teachers can encourage students to engage with their communities, thereby enhancing social capital. This engagement is particularly important in diverse societies, where bridging social capital can mitigate tensions and foster understanding among different cultural groups [46].

Moreover, the role of schools in promoting social cohesion extends to their ability to address the needs of marginalized groups. Ribeiro et al. [47] discuss the challenges faced by students with high abilities within the education system, emphasizing the importance of recognizing and accommodating diverse needs. Schools that embrace inclusivity can serve as safe spaces for all students, including those with disabilities or from underrepresented backgrounds. The implementation of specialized programs and resources, such as Multifunctional Resource Rooms, can further support these efforts, ensuring that all students have equitable access to educational opportunities [48].

The community's involvement in school activities is vital for fostering a sense of belonging and ownership. Schools can facilitate partnerships with local organizations, businesses, and community groups to create a network of support that enhances the educational experience for students and the community alike. This collaborative approach not only enriches the educational environment but also strengthens community ties, as evidenced by the work of Gauthier et al. [49], who explores the impact of school attachment on community engagement. When schools actively engage with their communities, they become more than just educational institutions; they transform into vital community resources that promote social interaction and cohesion.

Furthermore, the potential for schools to serve as multifunctional spaces can be particularly beneficial in urban areas, where access to community resources may be limited. The work of Zhou et al. [50] illustrates how schools can be designed to accommodate various functions, thereby maximizing their utility for the surrounding community. By rethinking the use of school facilities, urban planners and educators can create environments that not only support academic achievement but also foster community well-being and social interaction.

1.2.2. Community anchors

Schools can serve as vital community anchors by fostering collaboration, enhancing educational quality, and addressing the diverse needs of their local populations. This multifaceted role is increasingly recognized in educational discourse, emphasizing the importance of schools as hubs for community engagement and support.

Firstly, schools can act as community anchors by facilitating partnerships between educational institutions and local communities. Such partnerships are essential for enhancing the quality of education and addressing the specific needs of students and their families. For instance, Herlina et al. [51] highlight the significance of collaborative efforts between schools and community members, which can lead to improved educational outcomes and a more engaged student body. Additionally, aligning school goals with community needs, schools can create a supportive environment that fosters academic success and personal development. This partnership approach is echoed by Medina et al. [52], who emphasize the role of community school councils in promoting collaborative engagement among educators, parents, and community partners, thereby ensuring that educational support is aligned with the needs of learners.

Moreover, schools can serve as centers for community resources and services, addressing various social and health-related issues that affect students and their families. The concept of community schools, as discussed by Maier and Rivera-Rodriguez [53], illustrates how schools can integrate educational and community resources to create a supportive environment for student learning and development. This model not only enhances academic performance but also promotes the overall well-being of students by providing access to health services, counseling, and extracurricular activities that are crucial for their development [54]. Schools can thus become pivotal in bridging gaps in health and educational services, particularly in underserved communities [55].

In addition to fostering partnerships and providing resources, schools can also play a critical role in promoting social cohesion and community resilience. As highlighted by Grover et al., [56] schools that cultivate a sense of community contribute positively to students' long-term educational and social outcomes. By engaging families and community members in school activities, schools can strengthen relationships and build trust, which are essential for creating a supportive educational environment. This engagement is particularly important in times of crisis, as schools can mobilize community resources and support systems to address challenges faced by students and families [57].

Furthermore, the role of schools as community anchors extends to their involvement in local governance and decision-making processes. Schools can empower community members by involving them in school committees and councils [58]. This participatory approach not only enhances accountability but also ensures that the voices of community members are heard in shaping educational policies and practices. By fostering a culture of collaboration and shared responsibility, schools can enhance their legitimacy and effectiveness as community institutions.

The integration of health and wellness programs within schools further exemplifies their role as community anchors. School-based health centers (SBHCs) have been shown to improve access to health-care services for students, particularly in low-income areas [59]. These centers provide essential health services, including mental health support, which is crucial for fostering a conducive learning environment. By addressing health disparities and promoting wellness, schools can

significantly impact students' academic performance and overall quality of life [55].

Moreover, schools can leverage technology and innovative practices to enhance community engagement and support. The use of digital platforms for communication and collaboration can facilitate connections between schools and families, ensuring that parents are actively involved in their children's education [60]. This technological integration can also help schools to disseminate information about available resources and services, thereby enhancing community awareness and participation [61].

1.2.3. Cultivate community within inclusivity

Schools serve as pivotal community assets that foster inclusivity, acting as environments where diverse learners can thrive together. The concept of inclusive education emphasizes the importance of integrating all children, regardless of their abilities or backgrounds, into mainstream educational settings. This approach not only benefits students with special needs but also enriches the educational experience of all students by promoting understanding, empathy, and collaboration among peers. Research indicates that inclusive schools can significantly enhance community cohesion and social capital, thereby reinforcing their role as central community assets [62,63].

The implementation of inclusive education requires a multifaceted approach that involves collaboration among various stakeholders, including educators, parents, and community members. Effective inclusive education practices are contingent upon the establishment of a supportive school culture that values diversity and promotes equal opportunities for all students [64]. For instance, schools that actively engage parents and the community in the educational process tend to create a more inclusive environment. This collaboration fosters a sense of belonging and shared responsibility, which is essential for the successful implementation of inclusive practices [65]. Moreover, the physical accessibility of school facilities plays a crucial role in ensuring that all students can participate fully in school activities [66].

Research has shown that the attitudes and perceptions of teachers significantly influence the success of inclusive education initiatives. Teachers who possess a positive outlook towards inclusive practices are more likely to implement effective strategies that accommodate the diverse needs of their students [67]. Professional development programs that focus on building teachers' competencies in inclusive education are vital for fostering an inclusive school culture. Such training equips educators with the necessary skills to address the unique challenges posed by diverse classrooms, thereby enhancing the overall learning experience for all students [68].

Furthermore, the role of school leadership is critical in promoting inclusive education. Effective school leaders are those who not only articulate a clear vision for inclusivity but also actively engage in the implementation of policies and practices that support this vision [69]. Leadership that prioritizes inclusivity creates an environment where teachers feel empowered to innovate and adapt their teaching methods to meet the needs of all learners. This, in turn, cultivates a school culture that embraces diversity and fosters a sense of community among students, parents, and educators [65].

In addition to the internal dynamics of schools, external factors such as government policies and community support also play a significant role in shaping inclusive education practices. Policies that mandate inclusive education and provide adequate funding and resources are essential for the successful implementation of inclusive practices [70]. Community involvement in supporting inclusive education initiatives can enhance the effectiveness of these programs by providing additional resources, expertise, and advocacy [64]. For example, community organizations can partner with schools to offer specialized training for teachers or to create inclusive extracurricular activities that promote social interaction among students of different abilities [71].

The socio-cultural context in which schools operate also influences the effectiveness of inclusive education. Schools that reflect the cultural

values and norms of their communities are more likely to gain support from parents and community members, thereby enhancing the overall inclusivity of the educational environment. Moreover, addressing the unique needs of students from diverse backgrounds, including those with disabilities, requires a nuanced understanding of the cultural factors that shape their experiences [72]. This cultural competence is essential for educators to create inclusive classrooms that respect and celebrate diversity.

Inclusive education not only benefits students with special needs but also fosters a sense of belonging and acceptance among all students. By learning in diverse environments, students develop critical social skills, empathy, and respect for differences, which are essential for their future interactions in society [62]. Research indicates that inclusive schools can lead to improved academic outcomes for all students, as they promote collaborative learning and peer support. Furthermore, inclusive education contributes to the development of a more equitable society by challenging stereotypes and reducing stigma associated with disabilities [63].

While governance structures, participatory processes, and institutional partnerships are widely recognized in the literature as critical components of social infrastructure, the present study focuses specifically on the spatial and architectural conditions that enable such processes rather than evaluating them empirically. Much of the existing evidence on governance and participation relies on policy analysis or post-occupancy observations that are not consistently accessible through architectural documentation. Consequently, this research approaches these dimensions as operational layers that inform the conceptual framing but remain beyond the empirical scope of the current analysis. By concentrating on spatial configurations and design strategies, the study seeks to identify how built environments can create the physical preconditions for engagement, inclusivity, and shared use, while recognizing governance and institutional dynamics as complementary areas for future investigation.

2. Methodology

The methodological approach adopted in this study is intentionally aligned with the research gaps identified in the preceding literature review. While prior research has largely examined schools as social infrastructure through policy analysis, governance models, or social outcomes, limited attention has been given to systematically understanding how architectural and spatial configurations enable these roles. Addressing this gap requires an analytical method capable of translating conceptual discussions into spatial knowledge. Thematic architectural case analysis was therefore selected as a bridging methodology, allowing recurring spatial strategies to be identified across diverse built examples and synthesized into transferable design parameters. By comparatively examining architectural projects through thematic coding, the study moves beyond descriptive case reporting toward extracting spatial patterns that directly respond to the absence of design-oriented frameworks highlighted in existing research.

Four outstanding case studies are sampled and distilled into design parameters that effectively foster social quality of life and inclusivity. These case studies include examples where schools have been successfully reimaged as inclusive social hubs. Considering the explorative nature of the study, a qualitative approach is adopted, with a thematic analysis of the strategies used to accommodate diverse community needs.

In qualitative research, thematic analysis is a popular technique for finding, examining, and interpreting meaningful patterns (themes) in data. It is adaptable and applicable to a variety of theoretical and epistemological stances [73]. To avoid the subjectivity of thematic analysis we followed a systematic approach for coding the data.

The quality of coding can have a major impact on the quality of research [74], and a well-considered coding technique may assist in moving the discussion of ideas from descriptive to theorizing [75]. For

Saldaña [76], a “code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocating attributes ...” for parts of all forms of data.

Coding was viewed as a continuous process that unfolds in “cycles” to facilitate data analysis. The codes or ideas vary in scale and structure, necessitating ongoing checking, revising, and refining during the coding process to identify themes most relevant to the research focus. This process involved generating detailed codes, referred to in the literature as “splitting,” which later evolved into broader, more comprehensive categories, known as “lumping” [75,76]. These broad categories are considered themes that can be design parameters.

Moreover, the thematic analysis followed a structured multi-stage procedure. First, architectural documentation for each case study—including plans, descriptive narratives, and visual materials—was systematically reviewed to extract spatial characteristics relevant to inclusivity, accessibility, and community integration. Second, an initial cycle of open coding was conducted to identify recurring spatial features and design intentions across cases. Third, codes were iteratively compared and refined through constant comparison, allowing similar concepts to be grouped into higher-order thematic categories. Fourth, these themes were evaluated across all cases to identify patterns of convergence and divergence, ensuring that emerging findings were not case-specific but analytically recurring. Finally, the validated themes were synthesized into broader design parameters representing spatial strategies that support schools as social infrastructure. [Supplementary materials](#) provide detailed coding tables to support traceability between raw observations and synthesized outcomes.

2.1. Scales of analysis

The first task was identifying what should be analyzed. Which elements of the school can contribute to social infrastructure and urban quality of life? We suggest two levels of engagement: indoor and outdoor (Fig. 1), categorized in terms of:

- Spaces, activities, and buildings.
- Boundary conditions.

The chosen categories—Spaces/Activities/Buildings, and Boundary Conditions—are grounded in both empirical gaps and conceptual models identified in recent interdisciplinary literature. Specifically, we draw on Nordquist and Laing’s [77] Networked Learning Landscape model, which proposes a multi-scalar view of educational environments encompassing classrooms, buildings, campuses, and cities. Their work underscores the importance of considering not only spatial configurations but also the porous boundaries between formal and informal, physical and virtual environments.

“Spaces, activities, and buildings” reflect the physical and functional affordances of the learning environment at the micro and meso scales, aligning with well-documented calls for greater alignment between spatial design and pedagogical intent [77,78]. “Spaces” refer to areas that can be shared with the community during or outside school hours. Outdoor spaces include, for example, schoolyards, rooftops, parks, sports fields, botanic gardens, and amphitheaters. Indoor spaces may include clinic, gymnasium, library, learning halls, and auditorium. The spaces create potential and opportunities for social “activities”, and vice versa. The physical characteristics of “buildings” and their symbolic meaning are considered in the analysis.

“Boundary conditions” capture the liminal, often-overlooked zones where schools interface with their broader urban contexts. As Nordquist and Laing [77] highlight, these “in-between spaces” are essential for fostering connectivity and hybrid uses, resonating with the idea of schools as nodes within a distributed, networked civic landscape. “Boundary conditions” refers to borders or spaces (thresholds) that separate spaces with different level of publicness. A school wall or fence is the most prominent border between public and private spaces, which

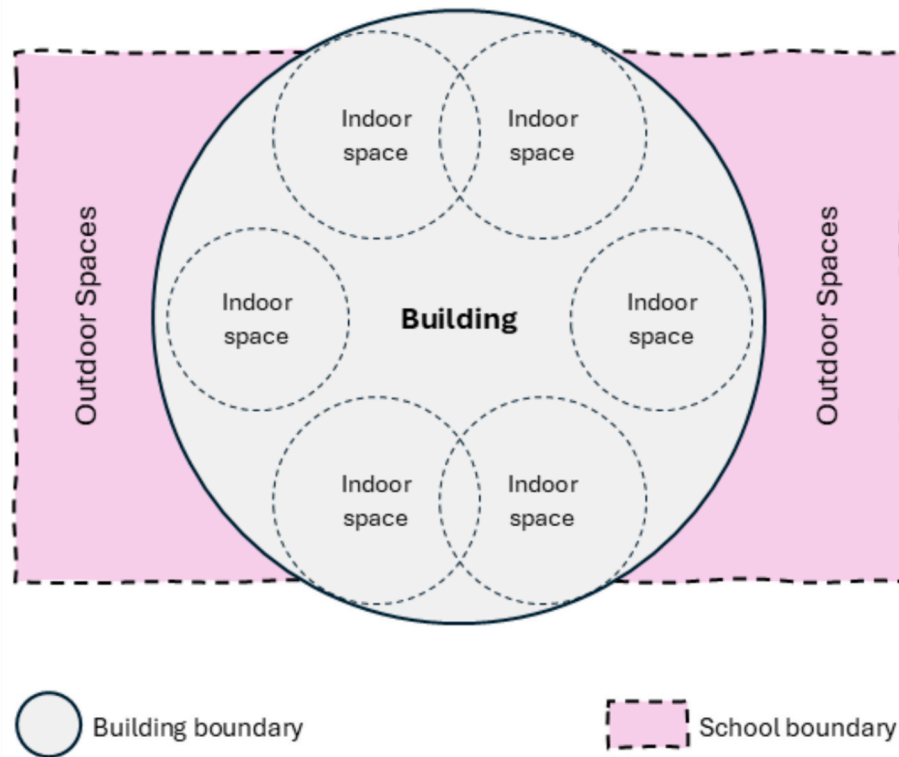


Fig. 1. Scales of analysis.

has potential to be a multifunctional interface between the school and its urban context. The challenge is also identifying what is considered semi-public and what is semi-private, and how these boundary conditions change based on operational times and types of users.

The study excluded the operational dynamics, including organizational and managerial dimensions such as co-governance, access policies, and community programming that literature has identified as critical enablers or barriers to inclusivity and multifunctionality [4,79]. The operational dimension focuses on processes that promote inclusivity, sustainability, and urban integration. The operation involves multiple stakeholders and requires coordination facilitated by well-defined roles and responsibilities. Facility management can be important to play this role. While these elements are essential for realizing the full potential of schools as inclusive community hubs, the present analysis focuses on spatial patterns and design parameters, rather than examining operational processes.

2.2. Sampling the case studies

We used an online search engine to look for well-known global schools that fit the research inquiry. We used a diverse combination of keywords such as “urban community schools”, “schools as community hubs”, “after-hours use of schools”, “no walls/fence schools”. The results were scattered and, in many cases, irrelevant. For instance, we found four examples of “School Without Walls”, but none of them seemed to have a mission or policy related to engaging the community. Thus, the online search engine did not lead to any useful case studies.

Next, we sought examples of how schoolyards are utilized as adaptable spaces that can cater to both regular school users and the neighborhood. One of the promising findings was a non-for-profit organization in North America founded in 1972 called The Trust for Public Land. According to TPL website [80], the organization is driven by the belief that everyone deserves access to nature and outdoor spaces near their homes, within the cities and neighborhoods where they live. It

collaborates with communities to develop parks and safeguard public lands in the areas that need them the most, prioritizing health, equity, and justice. They publicized examples of how they contributed to transforming many schoolyards and connected them with their communities.

The Trust for Public Land (TPL) advocates for converting underutilized public schoolyards into green spaces to address the ongoing issue of park equity. According to their School's Out report [81], equipping all 90,000 public schools in the U.S. with “community schoolyards” could significantly expand access to quality public green spaces. TPL proposes that opening schoolyards as part-time, all-access community hubs could place a park within a 10-minute walk for nearly 20 million people, addressing the lack of outdoor access for one-fifth of the 100 million Americans without a nearby park. They urge a large-scale effort to transform schoolyards, supported by increased federal funding. These community schoolyards aim to revitalize neglected and unappealing spaces into vibrant, green, and healthy environments.

Although the transformed schoolyards by TPL show a strong connection between schools and urban quality of life, we did not sample case studies for this research from TPL work for two reasons. First, the schools represent a narrow sample within the U.S. only, which could risk being biased to a certain culture and context. Second, TPL's work focuses merely on recreating outdoor spaces. Our goal is to find schools that are established on holistic visions and policies that include indoor and outdoor spaces as potential environments for enhanced urban quality of life and inclusivity.

A holistic view of schools as social infrastructure is investigated in Australia's “Building Connections: Schools as Community Hubs” project, which links research, policy, and practice by studying “how best to plan, design, govern and manage schools to operate successfully as ‘more than a school’, encouraging the development of resilient and connected communities” [1]. Their research included a “framework for building schools as community hubs” comprising six principles and twelve factors for success. The principles are “equitable”, “efficient”, “responsive”,

“impactful”, engaging”, and “achievable”. The project team presented 24 examples of Australian schools that incorporated the community in various ways to benefit the school and the community. But for the same reason of disqualifying samples from TPL to avoid bias towards one nation, we did not select case studies from “Building Connections” Project.

To find global case studies, we eventually sought them on ArchDaily [82] website, the world’s most visited architecture platform. Until 28 January 2025, ArchDaily offered information on 56,644 architectural projects, making it a suitable source for a variety of global case studies. The selection of case studies was not solely based on keyword matching or iterative exclusion. Rather, we applied several purposive criteria to identify projects that exemplify spatial innovation, multifunctionality, and contextual integration—characteristics aligned with the themes under investigation. The selected case studies were chosen based on:

- Descriptive richness in narrative text and visuals that illustrate spatial strategies,
- Geographic and typological diversity to support comparative analysis, and;
- Evidence of multifunctional or community-oriented use, as conveyed in project documentation and site programs.

The reliance on architectural documentation as a primary data source inevitably favors projects that are extensively published and visually documented, which are often located in urban contexts and represent architecturally prominent examples. This introduces a selection bias that may limit representativeness across broader institutional, socio-economic, or geographically diverse school environments. However, the intention of case selection in this study is analytical rather than statistical. The projects are treated as illustrative exemplars that provide sufficient spatial resolution to enable comparative architectural analysis and thematic synthesis. The goal is therefore not to generalize across all schools, but to identify transferable spatial strategies and design parameters that can inform future research and practice. This approach aligns with qualitative case study traditions that prioritize analytical insight and conceptual development over population representativeness.

Three combinations of search keywords generated relevant results: “urban community schools”, “neighborhood schools”, and “schools as community hubs”. In an iterative process of scanning the articles and disqualifying irrelevant results, four case studies were sampled, as shown in (Table 1).

3. Analysis

3.1. Case studies

Table S1, enclosed as a Supplementary Material, shows a comparative analysis of the implementation of strategies across the specified case study schools, categorized into “Spaces, activities, and buildings” and “boundary conditions”. The table provides a structured cross-case mapping of spatial strategies, enabling the identification of recurring

Table 1
The case study schools.

School Name	Location	Area	Year Built
Jiading New City of Shanghai Experimental School	Shanghai, China	77,233 m ²	2024
TBS School	Barcelona, Spain	12,210 m ²	2022
wəkwʰaːnəs tə syaqʷəm Elementary School	Vancouver, Canada	3,385 m ²	2022
Baldivis Secondary College	Baldivis, Australia	42,000 m ²	2015

patterns and variations across the analyzed projects. The interpretive and critical analysis—particularly in relation to inclusiveness and urban quality of life—is developed in Sections 3.2 through 3.4 and further elaborated in the Discussion.

The commonalities in the themes emerging from the case studies are notable. The recurrence of similar design parameters across diverse contexts suggests a degree of consistency in how schools are being spatially integrated into their urban environments. These recurring spatial patterns indicate how specific architectural strategies—such as shared public spaces, permeable boundaries, and contextual integration—may support broader goals of accessibility, community interaction, and multifunctional urban use. While this alignment reinforces the credibility of the identified themes, we acknowledge that it does not constitute validation in a strict empirical sense. Given the reliance on architectural descriptions from ArchDaily, the comparative analysis confirms the presence of particular design strategies, but not necessarily their social effectiveness or long-term impact. In all cases, the designs extended beyond the school buildings themselves to engage with surrounding urban conditions—through visual, physical, and programmatic connections that support multifunctionality and inclusivity. These connections illustrate how spatial configurations can potentially facilitate interaction between school communities and surrounding neighborhoods. The following table (Table 2) presents an initial synthesis of

Table 2
Preliminary themes.

School	Spaces, Activities, and Buildings	Boundary Conditions
Jiading New City of Shanghai Experimental School	<ul style="list-style-type: none"> • Activated rooftops • Varied activities • Gardens • Shared spaces with community • Vibrant public space 	<ul style="list-style-type: none"> • Enhanced accessibility • Adjacency to urban life • Integration with urban environment • Noise mitigation • Integration with context • Views • Enhanced transparency / visibility • Connection with nature
TBS School	<ul style="list-style-type: none"> • Public spaces • Shared spaces with the city • Architectural language reflecting place • Public spaces on ground floor • Activated rooftops 	<ul style="list-style-type: none"> • Supporting urban planning regulations • Integration with urban environment • Integration with context • Enhanced accessibility • Enhanced permeability • Enhanced transparency / visibility • Vertical segregation between public and private • Connection with nature • Views • Participatory design • Enhanced transparency / visibility • Connectivity with nature
wəkwʰaːnəs tə syaqʷəm Elementary School	<ul style="list-style-type: none"> • Building proportions • Intelligibility • Human scale • Adaptable spaces • Open spaces • High spatial integration • Shared spaces • Collaborative spaces • Small learning communities • Breakout spaces • Collaborative teaching • Unified interior vibe 	<ul style="list-style-type: none"> • Integration with contexts • Blurred boundary • Distance buffer (from freeway) / noise mitigation
Baldivis Secondary College	<ul style="list-style-type: none"> • Architectural language reflecting place • Adaptable spaces 	<ul style="list-style-type: none"> • Integration with contexts • Blurred boundary • Distance buffer (from freeway) / noise mitigation

recurring themes derived from the cross-case analysis.

3.2. Spaces, activities, and buildings

The case studies show that engaging the school and community includes a design consideration of both outdoor and indoor spaces and anticipation of varied activities by different groups of users. Across the cases, these spatial arrangements demonstrate how architectural configurations can accommodate multiple forms of use, supporting both educational functions and community-oriented activities.

The spatial strategies include, for example, activating rooftops, not only for school use but also for visual connectivity with the street and urban context, reducing the possible separation by high walls or solid fences. Such strategies may contribute to visual openness and perceived accessibility, which are often associated with inclusive urban environments. In addition, sharing spaces with the community can include outdoor areas such as a sports pitch and garden or indoor areas such as an atrium, both contributing to creating intelligible, vibrant and highly integrating and open public spaces. Most of the public spaces are on the ground floor, suggesting a vertical segregation between public and private. This spatial arrangement allows community-oriented functions to remain accessible while maintaining secure and controlled areas for school activities. The spaces can be adapted for various functions, which are sometimes enabled by large openable partitions to extend an internal space or merge it in the outdoor environment. The designs also created learning activities more socially engaging by providing shared, collaborative, and breakout spaces for learning communities. These spatial features illustrate how design can support informal interaction, collaborative learning, and broader social engagement. The architectural language of the case study school buildings blended buildings in the surrounding, showing a reflection of place, heritage, and identity by considering the use of local materials, alignment with urban patterns, proportions, and human scale. Such contextual responsiveness strengthens the relationship between school facilities and their surrounding urban environments.

3.3. Boundary conditions

Considering both physical and non-physical boundaries, the case study schools blurred the schools' territories using considerably consistent strategies, while making design decisions to mitigate noise from the street. These strategies demonstrate how boundary design can balance openness with environmental control. There was an apparent design intention to connect internal spaces with nature either through views or by bringing natural elements into space. The connectivity and integration were also with the adjacent urban environments and contexts by enhancing mutual visibility in one way and transparency of activities in another way. Such spatial relationships may contribute to increased legibility and a stronger sense of connection between schools and their surrounding communities. The enhancements also included accessibility and permeability. Improved accessibility and permeability enable smoother transitions between public and semi-public spaces, potentially supporting broader community engagement. There were also interesting indications to supporting urban planning regulations, which was realized in participatory design approach for one of the cases.

3.4. Design parameters

The design parameters presented in this section were developed through an inductive thematic synthesis, combining insights drawn from the literature on social infrastructure and inclusivity with recurring spatial strategies identified in the case studies. Initially, spatial features were broken down into fine-grained codes to capture design diversity across cases (splitting). These were then grouped into broader, recurring themes (lumping) based on functional similarity and shared affordances. This analytical process enabled the translation of observed spatial

strategies into transferable design parameters relevant to inclusive school environments.

The next step is classifying the emerging themes in higher-level categories to suggest design parameters for schools to enhance urban quality of life and inclusivity. This task includes combining synonyms under one category to simplify the results. The design parameters are presented in Table 3. Conceptual grouping was guided by three criteria: (1) shared functional intent, referring to the primary spatial role of a feature in enabling interaction or access; (2) spatial scale, distinguishing between architectural elements, spatial configurations, and broader urban relationships; and (3) relevance to identified challenges in the literature related to inclusivity and community use.

Although several parameters—such as accessibility, permeability, transparency, and spatial integration—are conceptually related, they capture distinct spatial qualities and mechanisms. Accessibility refers to the ease with which users can enter, navigate, and reach different parts of the school environment. Permeability describes the degree to which boundaries allow physical or visual passage between spaces. Transparency concerns visual connectivity and spatial legibility, enabling users to perceive activities and spatial relationships across different areas. Spatial integration, in contrast, addresses how school facilities are embedded within the surrounding urban fabric and connected to neighborhood circulation and public spaces. Together, these parameters describe complementary spatial mechanisms that may support inclusivity and community interaction in school environments.

For example, “vertical segregation” and “blurred boundaries” may appear contradictory, but in context they capture different aspects of boundary design: one refers to zoning through floor levels (often to separate users temporally or hierarchically), while the other refers to edge conditions that foster permeability and shared use.

The comparative analysis of the four case studies reveals a strong alignment with the proposed design parameters, particularly in relation to spatial accessibility, boundary permeability, and shared public space strategies. For example, Jiading Experimental School and TBS School clearly embody environmental connectivity and contextual integration, reinforcing the adaptability of the framework in dense urban settings. Meanwhile, wəkʷaʎəs tə syaqʷəm Elementary School's emphasis on

Table 3
Design parameters from the case studies.

Spaces, activities, and buildings	Boundary conditions
Shared and Public Spaces	Spatial Accessibility and Integration
<ul style="list-style-type: none"> • Vibrant public space • Public spaces on ground floor • Active rooftops • Shared spaces with community and city • Collaborative spaces • Small learning communities 	<ul style="list-style-type: none"> • Enhanced accessibility • Adjacency to urban life • Integration with urban environment • Integration with context • Enhanced permeability • Spatial intelligibility
Adaptability and Flexibility	Transparency and Inclusivity
<ul style="list-style-type: none"> • Adaptable spaces • Varied activities • Breakout spaces 	<ul style="list-style-type: none"> • Enhanced transparency • Enhanced visibility • Participatory design
Architectural Identity and Human Scale	Environmental Considerations
<ul style="list-style-type: none"> • Building proportions • Architectural language reflecting place • Human scale • Unified interior vibe 	<ul style="list-style-type: none"> • Noise mitigation • Distance buffer • Views • Local materials
Connection with Nature	Urban Planning and Regulation Support
<ul style="list-style-type: none"> • Gardens • Open spaces • Views 	<ul style="list-style-type: none"> • Supporting urban planning regulations • Vertical segregation between public and private • Blurred boundaries

participatory design and human scale underscores the social dimension of inclusivity. These examples illustrate how the identified parameters operate in practice across different contexts while contributing to broader goals of inclusive and community-oriented school environments.

4. Discussion

Social infrastructure encompasses physical facilities and the networks they enable to support social activities and community well-being. Schools, as noted in the research, can act as anchors of social interaction and resilience when they are designed to facilitate inclusivity and accessibility. However, to enhance social infrastructure strategies, Activated Rooftops and Shared Public Spaces are included. Transforming rooftops and ground-level spaces into accessible areas for recreation and social activities promotes interaction and reduces the separation between schools and their urban surroundings. Also, integration with Urban Context: Incorporating architectural language that reflects local identity and ensuring adjacency to urban life fosters a seamless connection between schools and their neighborhoods. Moreover, transparency and Accessibility: Designing with enhanced permeability and transparency allows schools to integrate visually and functionally with their environment, enabling broader community use of these facilities. These observations should also be understood in relation to broader urban development dynamics, where globalised, image-driven approaches may conflict with locally grounded and resource-efficient strategies [8,12]. Furthermore, the cross-case analysis reveals recurring spatial strategies and a comparative understanding indicates that these strategies are not uniformly applied but are shaped by distinct contextual conditions. Variations across the cases can be understood in relation to differences in urban density, socio-cultural frameworks, and environmental constraints. For example, in high-density urban contexts such as Shanghai and Barcelona, strategies such as vertical segregation, rooftop activation, and compact shared spaces emerge as responses to limited ground-level availability and the need to maximize spatial efficiency. In contrast, cases such as Baldivis Secondary College, located in a lower-density suburban environment, rely more on horizontal expansion, buffer zones, and landscape integration, reflecting fewer spatial constraints and greater emphasis on environmental mitigation. Similarly, the presence of participatory design approaches in the Canadian case suggests a socio-cultural condition in which inclusivity is operationalized through community involvement, whereas other cases reflect more institutionally driven design processes. These differences indicate that spatial strategies are not inherently transferable but are contingent upon local urban form, governance structures, and environmental pressures. Understanding these conditions is critical, as it highlights that the effectiveness of design parameters depends not only on their spatial configuration but also on their alignment with contextual realities.

However, the ability of schools to serve as spaces for community engagement is tied to their functionality as shared resources. As the document emphasizes, reimagining schools as multifunctional spaces for educational, recreational, and social purposes can significantly enhance their role in fostering participation and ownership among diverse stakeholders. Key design strategies supporting community engagement include collaborative and Adaptable Spaces: Designing classrooms and communal areas with movable partitions or flexible layouts allows for various uses, ranging from after-school programs to cultural events, ensuring optimally utilized spaces. Additionally, participatory Design Approaches: Engaging community members in the planning and design process ensures that the facilities align with local needs and aspirations. As well as boundary Conditions: Incorporating semi-public and semi-private spaces blurs the traditional divides between schools and their surroundings, encouraging interaction and shared use.

Furthermore, Inclusivity is critical for reimagining schools as equitable and accessible spaces. Schools should be designed to welcome

marginalized and underrepresented groups, ensuring all community members feel valued. Relevant design strategies include Adaptability and Flexibility: Creating spaces that can be easily reconfigured to meet the diverse needs of different user groups supports equity and enhances usability. In addition, Small Learning Communities: Designing smaller, interconnected spaces fosters a sense of belonging and promotes collaborative learning for all students, including those from disadvantaged backgrounds. Also, environmental Considerations: Integrating elements like natural light, gardens, and noise mitigation features ensures that spaces are comfortable, welcoming, and conducive to learning and social interaction.

Finally, by synthesizing social infrastructure, community engagement, and inclusivity, schools can evolve into dynamic hubs that enrich urban life. Strategies such as creating vibrant public spaces, integrating schools into their urban context, and prioritizing accessibility and equity provide a pathway to achieving these goals. As noted in the introduction, such transformations align with broader efforts to transition from vehicle dependency to human-centric environments, ultimately fostering neighborhoods that are resilient, connected, and inclusive. This study attempts to modestly extend the discussion of Building Connections: Schools as Community Hubs framework by articulating how specific physical design elements-such as rooftop activation, spatial intelligibility, and human-scale architectural language-can operationalize these principles in built form.

While the spatial strategies identified in this study demonstrate consistent patterns across the analyzed cases, their relationship to broader outcomes such as inclusivity, social cohesion, and urban quality of life should be interpreted with caution. The analysis is based primarily on architectural documentation and design narratives, which provide insight into spatial intent rather than verified patterns of use or social impact. As such, the identified design parameters are best understood as potential enablers or spatial preconditions that may support inclusive and community-oriented outcomes, rather than as empirically validated determinants of such outcomes. The extent to which these spatial configurations translate into measurable social benefits depends on additional factors, including governance models, operational practices, and user behavior, which fall beyond the scope of the present study. Future research incorporating post-occupancy evaluation, user-based studies, and longitudinal analysis would be necessary to substantiate the causal relationship between spatial design and social outcomes.

Although governance structures, participatory processes, and institutional frameworks fall outside the empirical scope of this study, the identified spatial parameters can be understood as materially structuring the conditions under which such processes occur. Spatial features such as permeability, accessibility, shared public zones, and boundary articulation do not directly produce participation or inclusivity; rather, they configure the physical interfaces through which interaction, visibility, and co-presence become possible. In this sense, spatial design operates as a mediating layer between architectural form and social processes, shaping the opportunities for engagement while remaining dependent on complementary governance and operational mechanisms. This perspective helps reconcile the theoretical emphasis on participation and institutional dynamics with the study's focus on spatial analysis by framing design parameters as necessary, but not sufficient, conditions for enabling inclusive and community-oriented practices.

While the Building Connections: Schools as Community Hubs project in Australia [1,79,83] offers a policy-oriented framework emphasizing governance, service integration, and inter-agency collaboration, the current study contributes a complementary spatial perspective grounded in cross-case design analysis. The suggested design parameters (Table 3) intersect with their six core principles-such as "equitable," "responsive," and "engaging"-by translating them into spatial and architectural strategies. For instance, their call for equity and responsiveness aligns with our emphasis on enhanced accessibility, varied activity zones, and participatory design. Similarly, the "engaging" and

“impactful” principles are echoed in our attention to shared public spaces, visual permeability, and contextual integration.

4.1. Social infrastructure

The case study schools demonstrated social infrastructure both physically-through spatial configurations and facilities-and socially, via functions that engaged the broader community. Sharing public spaces and resources created a platform for forming social bonds, aligning with Budhiraja’s [14] framing of social ties as infrastructures of support. Our findings reinforce this idea by showing how architectural elements-such as open courtyards, multipurpose halls, and permeable boundaries-were designed to encourage informal interaction and shared use, thus spatially enabling the development of social capital.

A notable aspect observed across the cases was the integration of each school with its cultural and urban context [19]. This was reflected in architectural expressions that merged with their surroundings and referenced local identity. The adaptability emphasized in the literature was translated in the case studies into spaces that were flexible not only in form but also in function, responding to the evolving needs of both students and community users.

Additionally, the emphasis on permeability and accessibility-particularly at the street level-strengthened the schools’ connection to the public realm. Such design decisions enhanced transparency and openness of activities, which can help ensure equitable access to amenities for socio-economically diverse groups [15,81].

Finally, fostering social infrastructure relies not only on spatial strategies but also on collaborative planning and policy support. The literature highlights the importance of stakeholder coordination [51,52] and the role of urban planning regulations that are sensitive to context [16]. Participatory design emerged as a common thread in these references-suggesting that long-term success in creating inclusive community hubs depends on involving users of all ages and backgrounds [22]. This reinforces the importance of aligning spatial strategies with local governance capacity and context-sensitive planning approaches [9].

4.2. Community engagement

While the available case study documentation did not provide comprehensive information about community engagement practices, the emerging design parameters can be interpreted as enablers of such engagement, rather than evidence of direct actions. These spatial strategies-such as the inclusion of flexible, multipurpose areas and open-access outdoor spaces-support environments that facilitate informal interaction, shared use, and collaboration. Collectively, they contribute to children’s well-being, social health [42], and community attachment [49], thereby enhancing quality of life.

Providing multifunctional spaces emerged as a key strategy across the case studies. These spaces increase utilization potential and allow for a variety of programs, including cultural, recreational, and civic activities [41,50]. Their design also addressed practical concerns of safety and hygiene [43], making them viable venues for sustained community use.

Moreover, the emphasis on spatial accessibility and outdoor integration aligns with Krajnović et al.’s [44] findings on how physical openness can promote community participation through shared amenities. These design approaches suggest that while direct engagement strategies may not be explicitly reported, the architectural decisions made at the design stage can enable future community involvement by creating accessible, inviting, and socially responsive spaces. Such spatial enablers resonate with placemaking approaches that prioritise local needs, participation, and everyday use [13].

4.3. Inclusivity

Inclusivity in the case study schools was promoted through physical and social design strategies that sought to integrate diverse users into the school environment. The findings indicate a consistent focus on embedding local cultural identity in both architectural form and functional programming. This approach aligns with Iryna et al. [72], who emphasize the importance of cultural congruence in fostering inclusive educational settings.

Two case studies in particular demonstrated strong commitments to enhanced accessibility, especially when schools were closely integrated with their urban surroundings. Accessibility is a fundamental component of inclusive design, ensuring that people of all abilities and backgrounds can participate fully in school life [47,66].

The design parameters also considered spatial and vertical circulation-activating rooftops, creating multi-level experiences, and offering varied circulation routes. While such strategies can enrich spatial diversity, they must be carefully managed to avoid creating access barriers, particularly for people with disabilities. Inclusive design, therefore, must balance experiential richness with universal access.

In summary, the case studies suggest that inclusive schools are not merely defined by physical access or policy declarations but by how design fosters belonging. Through culturally rooted architecture, spatial permeability, and inclusive programming, schools can become environments where diversity is not only accommodated but actively celebrated.

However, due to limitations in the available case study documentation, particularly the lack of post-occupancy or operational details, we are unable to report with confidence on how these spaces were actually accessed or used in practice.

4.4. Practical implications for stakeholders

The design parameters identified in this study offer practical guidance for a range of stakeholders involved in shaping inclusive, multi-functional school environments. Derived from the cross-case thematic analysis presented in Section 3, these parameters translate observed spatial strategies into design considerations that may support accessibility, community interaction, and integration with the surrounding urban context.

The applicability of these design parameters is not uniform and should be interpreted in relation to specific urban, institutional, and governance conditions. In high-density urban environments, where land availability is limited, strategies such as vertical layering of functions, rooftop activation, and compact shared spaces may be prioritized to maximize spatial efficiency while maintaining accessibility. In contrast, lower-density or suburban contexts may allow for greater emphasis on horizontal expansion, landscape integration, and buffer zones that support environmental comfort and community use. Institutional and governance conditions further influence how these parameters can be implemented; for example, schools operating under more open or community-oriented governance models may be better positioned to adopt permeable boundaries and shared-use spaces, whereas more controlled institutional settings may require clearer spatial zoning and regulated access points. Additionally, regulatory frameworks and planning policies can either enable or constrain the degree of permeability, accessibility, and mixed-use integration achievable in practice. Recognizing these contextual differences allows decision-makers to selectively adapt design parameters in ways that are responsive to local constraints and opportunities, rather than applying them as universal solutions.

For architects, the framework emphasizes spatial strategies-such as permeability, shared thresholds, and adaptable layouts that were identified across the analyzed case studies as recurring mechanisms that can facilitate visual openness, flexible use of space, and opportunities for informal social interaction. These strategies can guide early-stage design decisions toward social responsiveness.

For urban planners, the study highlights the importance of integrating schools into the public realm, ensuring that their boundaries are active, permeable, and contextually embedded. The analysis shows that spatial connections—such as visible entrances, accessible ground-floor public spaces, and transparent edges—can strengthen the relationship between school facilities and surrounding neighborhoods.

School administrators may benefit from understanding how spatial flexibility and accessibility can support broader community use and educational equity, especially in after-hours programming. Design features such as adaptable shared spaces and clearly defined public zones may allow schools to accommodate both educational and community-oriented activities while maintaining appropriate levels of security and control.

Lastly, for policymakers and legislators, the findings underscore the need for regulatory frameworks that support shared use, inclusive design, and participatory planning processes. The design parameters identified in this study can inform the development of design briefs, planning guidelines, and evaluation criteria that encourage schools to function as community-oriented social infrastructure.

Although the case studies did not provide operational data on how features like rooftop spaces were practically made accessible, the proposed parameters offer a foundation for developing design briefs and evaluation tools that address both spatial intent and community functionality. As noted in the study's limitations, these implications remain spatial and design-oriented and should be complemented by future research examining operational practices, stakeholder engagement, and post-occupancy outcomes. These considerations further highlight the need to balance global development models with locally responsive and institutionally feasible design strategies [11].

5. Conclusion

This research sets out to explore how schools can function as social infrastructure to enhance urban quality of life, with a particular emphasis on inclusivity, community engagement, and integration into the urban fabric. Through a literature review and the thematic analysis of four global case studies, the study identified design parameters that enable schools to serve not only as educational institutions but also as accessible, multifunctional community hubs. Highlights include the importance of adaptability, shared public spaces, permeability, architectural identity, and environmental connectivity in transforming school facilities into inclusive urban commons. These parameters support community cohesion and resilience, and reinforce the role of schools in fostering spatial equity and well-being. While the findings highlight the potential of spatial design parameters to support inclusive and community-oriented school environments, they also reveal important limitations that should be acknowledged to clarify the scope and applicability of the findings. First, the research is grounded in qualitative case study analysis, which, while offering rich spatial insights, does not provide quantitative validation of the long-term social impacts of the proposed design parameters. Future research would benefit from incorporating longitudinal or mixed-methods approaches to evaluate the effectiveness of these spatial strategies in practice.

Second, the selected case studies are drawn primarily from urban contexts and were chosen based on the availability of detailed architectural documentation. As such, they may not fully represent the complexities of rural, informal, or under-resourced educational environments, where different social, cultural, and infrastructural conditions may lead to alternate design needs and challenges. Third, the data source, primarily architectural narratives from platforms like ArchDaily, limits access to information on operational dynamics, such as governance structures, management models, and processes of community engagement. These elements are critical to realizing the full potential of schools as inclusive community hubs. While Section 4.2 openly acknowledges the study's limited ability to analyze community

involvement in depth, this constraint also applies for the operational dimension. Without firsthand accounts, user feedback, or post-occupancy evaluations, the analysis remains spatially focused and cannot account for how these spaces are activated or experienced by diverse stakeholders.

Finally, although the study highlights participatory design as a key enabler of inclusive and context-sensitive educational environments, it does not include empirical data on stakeholder engagement during the design or implementation phases of the case studies. Future research should explore co-design processes, stakeholder perceptions, and lived experiences to complement the spatial analysis and to ensure that the proposed framework is grounded in both design intent and user outcomes.

CRediT authorship contribution statement

Jamil Binabid: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Qusai Anteet:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cacint.2026.100364>.

Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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