Building Research & Information

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rbri20

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To cite this article: Tania Sharmin & Rihab Khalid (2021): Post occupancy and participatory design evaluation of a marginalized low-income settlement in Ahmedabad, India, Building Research & Information, DOI: 10.1080/09613218.2021.2018286

To link to this article: https://doi.org/10.1080/09613218.2021.2018286

Published online: 28 Dec 2021.

BUILDING RESEARCH & INFORMATION
https://doi.org/10.1080/09613218.2021.2018286

Post occupancy and participatory design evaluation of a marginalized low-income settlement in Ahmedabad, India

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ABSTRACT

This paper presents a post-occupancy evaluation (POE) of a participatory design project for a marginalized low-income community in Ahmedabad, India. Through a mixed-methods socio-technical approach, it presents an in-depth qualitative assessment of the architectural design and homeowners' use of and satisfaction with domestic spaces. Analysis shows that although a participatory design approach can lead to improved user satisfaction, it can have contradictory environmental and sustainability outcomes in low-income communities due to homeowner's limited environmental awareness, aspirations for improved social standing, and financial constraints. Findings show that combining POE with participatory design can help recognize occupants' housing needs while also revealing various hierarchical agencies in participation and power dynamics within the built environment. It further substantiates the need for a socio-technical approach in POE that integrates environmental standards with occupants' contextual socio-cultural needs and incorporates plans for future socio-economic growth, while providing assessment of the design process itself and engagement with various stakeholders. The study shows that successful Building Performance Evaluations (BPE) should incorporate bottom-up participation through incremental, and affordable demonstration projects in housing developments that take account of localized socio-cultural contexts and allow more inclusive development through stakeholder integration for long-term sustainable transitions.

ARTICLE HISTORY
Received 30 July 2021
Accepted 8 December 2021

KEYWORDS
Post-occupancy evaluation; participatory design; low-income housing; end-users' satisfaction; Global South

Introduction

Sustainable, affordable, and adequate housing provision is among the United Nation's (UN) Sustainable Development Goals (SDGs) and critical to meet climate change targets across the SDGs. Yet, according to the UN (2019), over one billion people (23.5% of total urban population in 2018) live in inadequate slums or informal settlements, predominantly in the Global South, and up to three billion people will require access to adequate and affordable housing by 2030. In most developing countries, low-income housing design receives little attention and slum redevelopment guidelines remain an under-researched area (e.g. Bardhan et al., 2018; Garrefa et al., 2021; Nix et al., 2019). This leads to poor quality housing, unstable structures, insufficient amenities and poor access to infrastructure facilities that increase the social vulnerability and precarity of the poor (Garrefa et al., 2021; Li et al., 2021).

In India, a country that faces critical urbanization and infrastructure development challenges under population expansion, low-income houses are only occasionally designed by architects, and almost never incorporate users in the design process. Under massive economic and development challenges faced in housing provision, architectural design characteristics are often neglected and compromised, with the common standpoint that 'with a problem so urgent and widespread, why even discuss architecture?' (Davis, 1995). Most government endeavours in low-income or subsidized housing traditionally lack material and design interventions (Sengupta, 2013) and are further compromised under misconceptions of meeting minimum standards and basic shelter requirements, so as to be 'basic, safe and clean – but no more' (Davis, 1995). This results in (re)producing housing conditions that face ever greater challenges of resilience under the combined threat of climate change, economic crises and diminishing energy supply (Stevenson et al., 2016). Apart from a lack of environmental considerations, such housing is also often devoid of local socio-cultural considerations and practices (Khalid and Sunikka-Blank, 2018). It is now increasingly recognized that sustainable housing and energy transitions

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require both technological and social intervention to meet Climate Change targets (Shove et al., 2008) through an integrated socio-technical approach in building design and evaluation (Stevenson, 2019).

Post-Occupancy Evaluation (POE) for such houses is rare, which further adds to the gap between estimated design criteria and actual performance and user satisfaction. To address these gaps, the paper draws on experiences of a participatory design project for a low-income, former leprosy-affected population, in Ahmedabad, India. As part of the project, bespoke low-income houses were built by local architects, employed by a local charity, in line with homeowners' requirements. By conducting an in-depth qualitative analysis of the participatory design process and by comparing and evaluating the architectural design and homeowners' perceptions of existing and co-designed houses, the study investigates the various challenges and limitations of the project, as well as the successes achieved. Through a socio-technical POE approach, the study seeks to answer: (1) what are the various socio-technical characteristics of homeowners' satisfaction in different housing types; (2) what insights can be gained from a socio-technical POE of the low-income participatory design project; and (3) what are the implications for designers and policy makers for future low-cost housing using participatory design. Such questions are particularly relevant in the Indian context where obsolete construction technologies, and lack of innovation and evaluation in low-income housing are common.

Literature review

Participatory design in architecture

Participatory design presents an alternative approach to conventional architectural design by de-centralising and democratizing the design process (Hester, 1987; Sanoff, 2007, 1999) that includes professional 'experts', like architects, builders and planners as well as citizens, such as homeowners, as the end-users. Co-production or participation can help empower homeowners and end-users as active agents towards meaningful and purposive adaptation and change to their daily environment (Boyle and Harris, 2009). Such positive outcomes informed by user's involvement in participatory design are well-established in the literature (e.g. Boyle and Harris, 2009; Carmon, 2002; Mubita et al., 2017; Nix et al., 2019; Sanoff, 2007; Sheng, 1990) and are associated with better understanding of design based on user's tacit knowledge (Spinuzzi, 2005), improved democratic choice and social capital (Carmon, 2002), and shared insights brought about from group interaction (Sanoff, 1999). Further, user's greater involvement often results in better management and maintenance of housing and neighbourhood infrastructure and services (Sheng, 1990), resulting in decreased economic costs and increased usable life of buildings through regeneration processes (Carmon, 2002).

Many participatory frameworks have been developed in the literature that identify the extent of a community's control and decision-making in the design and development process; for example, in relation to beneficiaries (e.g. Michener, 1998a; Moser, 1989), types of stakeholders involved (White, 1996), and the project levels or stages at which participation occurs (Cohen and Uphoff, 1980). In practice, the key difference is in whether participation is seen as a means or an end in development programmes (Parfitt, 2004): successful participation requires a reconfiguration of power between researchers/designers and end-users in a reciprocal relationship built on collective learning (Boyle and Harris, 2009; Sheng, 1990). In this, participatory design complements building performance evaluation (BPE) (Stevenson, 2019). Combining in-depth observation and end-user engagement during the design process with POEs provides better means of production, governance and maintenance (Garrefa et al., 2021; Stevenson and Petrescu, 2016).

There exists a long history of participatory projects in developing contexts that gained momentum in the 1970s under concerns for meeting the basic needs of the poor (Michener, 1998), particularly in the promotion of self-help housing and settlement upgrading in developing countries (Carmon, 2002). In India, participatory development took root in the sixties through small-scale local initiatives and then up-scaled to the urban level by the eighties through several town planning and development acts (Basu, 2016; Salamah, 2021). By the twenty-first century, most federal government funding to states was linked to participatory programmes (Basu, 2016). Recent initiatives like National Slum Development Programme and Jawahar Lal Nehru Urban Renewal Mission (JnNURM) also include participation (Basu, 2016). However, in most cases, participation can often be limited to notifying affected citizens or conducting consultations to manipulatively derive consensus towards a policy decision (Salamah, 2021). In this way, participatory processes can often be instrumental (Basu, 2016), discriminatory (Haque, 2018; Li et al., 2021), or tokenistic (Tiwari et al., 2021).

Further, numerous studies show that participation alone cannot guarantee success, especially when riddled with ambiguities in its relation to social development, equality, and justice. For instance, lack of accountability and resources can mean participation alone is insufficient to improve the quality of life of the poorest of the poor (1998). Increasingly bureaucratic processes can also result

in institutionalizing participatory approaches under limitations of resources, expertise, manpower, local knowledge and conflicting interests (Basu, 2016; Crook and Manor, 1998). Hence, successful participatory housing design requires integration with other reformative initiatives such as change in housing and planning regulations to improve flexibility, replacement of formal private marketization in lieu of pluralistic approaches and improved access to materials and construction techniques (Keivani and Werna, 2001; Valladares, 2017). This is particularly true for development landscapes rife with corporate- and profit-driven projects, planners and processes that undermine low-cost housing performance (Chaudhry et al., 2017; Miraftab, 2003; Salamah, 2021). Under such constraints, community participation can even perpetuate negative consequences for the larger built environment. Further, participation in sensitive contexts requires careful negotiation as it can trigger latent conflicts through the reallocation of resources, putting those most vulnerable at further risk (Jones and SPEECH, 2001; Neumann and Bliss, 2008).

Whilst most studies in the Indian context point to the constraints and challenges faced by participatory approaches, some studies also highlight successes. For example, Nix et al. (2019) show that participatory action research can be used to identify and prioritize low-income occupants' housing-related health concerns that can lead to more reactive and responsive interventions. Their study shows that greater degrees of discussion and knowledge exchange were required with the communities to reconcile principal objectives with participants' needs, desires and limitations. Other studies (e.g. Jones and SPEECH, 2001) show that introducing participatory action after building trust can help foster the community's localized knowledge into problem-solving and capacity building. Rather than an end-goal, participation can be used to integrate conscientisation and development. Tiwari et al. (2021) propose a 'middle-ground' approach to participatory planning for successful Indian slum upgradation. Building on existing models and past experiences, the authors show that this approach allows for adaptation to local organizational constraints, while reflexively engaging in meaningful participation. A key takeaway from this review is that post-completion project assessment and evaluation are essential to determine the success of participatory design.

POE in low-income housing

POE is an assessment of newly constructed buildings or retrofits in existing buildings. Preiser (1995) describes POE as 'the process of systematically comparing actual building performance, i.e. performance measures, with explicitly stated performance criteria' (p. 19). POE is commonly used for acquiring feedback on a building's performance in use, including energy and water assessments, indoor environment quality (IEQ), occupants' satisfaction, productivity, etc. (Li et al., 2018). Preiser (1995) categorizes three distinct levels of POE: indicative, investigative, and diagnostic. Indicative POEs include short (several hours), walk-through evaluations alongside stakeholder interviews, discussions with end-users and photographic (and written) documentation of building performance. Investigative POEs include more in-depth building investigation carried out over several weeks/months using questionnaire surveys and interviews with key stakeholders, photographic and video surveys and physical measurements. Diagnostic POEs include more focused, longitudinal, and cross-sectional evaluation of detailed performance criteria using complex data gathering and analysis techniques over several months or years.

A more recent (established since 1990s) and advanced method for evaluating building performance is BPE. BPE is a methodical approach for assessing the actual performance against expected performance across the building's life cycle through feedback and assessment at every stage of building, planning and occupancy (Gupta et al., 2019). While BPE provides a more robust evaluation method, it presents challenges in terms of complex data collection and processing required throughout the building's lifecycle. Therefore POE, which focuses on the in-use phase, proves useful in investigating the building from its occupant's perspective. This is especially advantageous in cases where both data and resources are limited to conduct an extensive BPE or Diagnostic POE study, as is the case in most developing countries. Likewise, POE at an early-occupancy stage – as in this study – can be equally helpful in understanding various aspects of design to enable modification and improvement of future design decisions.

Despite being a standard practice, current POE studies have limitations. Few POE studies have assessed the impact of architectural design on building occupants or users (Pati and Pati, 2013). Systematic occupant responses from completed buildings are rarely sought and received by design and construction professionals. Systematic feedback can be crucial for improving building performance (Sanni-Anibire et al., 2016) despite challenges in the ambiguity of how to use POE data to inform design decisions. Some POE studies have been conducted to examine design innovations (Baborska-Narozny et al., 2016; Kalantari and Snell, 2017), design features for certain occupant groups (Wongbumru and Dewancker, 2016), or the design process of a project

(Grangaard and Ryhl, 2016), while some studies have attempted to inform future project refurbishment/retrofitting (Thomas, 2010) or design (DeClercq and Cranz, 2014). In many cases, the architectural design intentions are largely predicted based on assumptions and lessons from experience, established knowledge and occupant engagement during the design process (Alvaro et al., 2016). Developing a standardized framework for POE studies is difficult as the purpose and methodologies differ for each case (Li et al., 2018). Further, cultural, policy and practical barriers can make international BPE knowledge-exchange difficult (Stevenson and Baborska-Narozny, 2018). Due to this subjectivity, POE studies are essentially context-based, making it challenging to generalize to the wider building industry (Li et al., 2018). This suggests that more context-specific studies are required in which designers can identify design decisions at an early phase supported by POE to address local, context-specific needs.

Further, the design of (low-income) housing is particularly challenging as it is characterized by not just the physical structure of the house– but also the social, economic, political, behavioural and cultural elements from the wider socio-environmental system that need careful consideration (Barakat, 2015; Bardhan et al., 2018; Khalid and Sunikka-Blank, 2018; Onibokun, 1974). As such, a socio-technical approach provides a more holistic understanding of the co-constitutive social and material arrangements that together define the built environment (Shove et al., 2008) and ascribe meaning to architectural spaces (Müller and Reichmann, 2015). In framing a socio-technical approach to POE, Chiu et al. (2014) contend that the limitations of current POE practices that remain largely quantitative and outcome-oriented can be overcome through an integrated in-depth analysis of the dynamic interactions between building design/retrofits and occupants' comfort practices. In line with this, Stevenson (2019) also advocates for a socio-cultural approach in BPE methodology that takes account of the multiple physical and social factors that determine how occupants interact with their homes. Further, a socio-technical lens implies a distributional agency of architectural design and the various stakeholders involved in the participatory design process, including homeowners, designers, and policymakers (Müller and Reichmann, 2015).

The impact of architectural design on cultural practices has been rarely discussed from a BPE/POE perspective, particularly in an Indian context. The Indian sustainability rating system called the Green Rating for Integrated Habitat Assessment (GRIHA, 2015) is mainly limited to the review of energy and water systems, and solid waste-management. In this, occupants' perspectives and needs are typically overlooked (Gupta et al., 2019). The limited BPE/ POE studies carried out in India have focused on occupant satisfaction, general thermal comfort, indoor air quality (Manu et al., 2016) and building energy consumption (Thomas and Baird, 2005). Even fewer studies have looked at design aspects; focusing more on building system design rather than architectural design (Maithel et al., 2017). In an attempt to identify a framework for BPE/POE studies in India, Gupta et al. (2019) identified several barriers, including lack of enthusiasm from professionals who dislike their work being judged, lack of policies, resources, time, and necessary expertise. Due to the complexity involved, it is unsurprising that POEs and subsequent successful low-income housing design in India are rare. Further, built environment professionals often neglect the more individual and context-based aspects that can be revealed through POE (Wijegunarathna et al., 2018). This study contributes to this knowledge gap by investigating user satisfaction at both individual and community level by exploring the various socio-technical factors that characterize affordable housing design. Further, as highlighted in the previous section, POE can play a crucial role in investigating the success or failure of participatory design processes by shedding light on the complex networks and conflicting interests at play and provide implications for future participatory projects.

Methodology

This paper presents a socio-technical POE of end-users' satisfaction with the participatory house design. Further, it provides an assessment of the participatory design approach, analysing the degree of success of the participatory method used, end-user's engagement in the design process and the outcome of the participatory process in terms of sustainability and user satisfaction.

The case-study

The case-study represents a low-income housing community located at the outskirts of Ahmedabad, India, founded as a sanctuary to bring together a marginalized population formerly affected by leprosy. The community consists of 113 households with a population of approximately 430 residents. The design project was initiated to bring residents together in building the community in a participatory approach alongside professional experts. Community members were therefore involved in decision-making during the building planning, design, and implementation process. Apart from the marginalized nature of its members, the community

site is in an area prone to seasonal flooding during which majority of the homes become uninhabitable and need to be evacuated.

The study compares three different categories of houses in the community. Type-1: Old-houses are the original houses built in 1968 through government initiatives when the community was first established (Figure 1). Type-2: New-builds consists of houses newly built after demolishing the original houses by individual homeowners themselves (Figure 2). Type-3: Co-design includes houses that are architecturally designed and built using the participatory approach under a UK-India charity programme (Figure 3). Old-houses were built using traditional practices, with 'low-cost' technologies – low-grade cement for construction and small, latticed screens as windows. In contrast, New-builds were built of stronger materials with concrete floor slabs. Unlike the single-storey structures of the old-houses, these were two- or three-storeys high. This study reports findings from five Old-Houses, four New-builds and six Co-design houses. The houses are listed as Old-house_01, New-build_01, Co-design_01 and so on. Two Co-designs (5 and 6) are discussed for their design strategies, but no data was collected from them as they were under construction during the study period.

Access to the community and fieldwork was facilitated by the intermediaries (the local charity organization in this case), who had been working closely with the community for some time and consequently gained their trust. Sample selection from Old-houses and New-builds was done strategically through the discretion of the charity and community leaders due to the sensitive nature of the community and its vulnerable population. In addition, all co-designed houses were included in the study sample. In this way, the 15 case-study houses (13% of total households in the community) are representative of the community as they include 10 former leprosy sufferers, which account for 25% of the total former leprosy sufferers in the community.

Old-houses are characterized by inadequate open spaces without provision for future extensions or family expansions, thereby constraining opportunities for any socio-economic upgradation. This has led to the unplanned growth of the community, as seen in New-builds. Similar practices elsewhere in India have steered 'urbanization into poverty', encouraging spatial exclusion through informal development (Bardhan et al., 2018).

Participatory design process

A participatory design approach was selected by the project patrons to build houses for the community. Community participation was ensured throughout the design process, including decision-making, implementation, benefits acquisition, and evaluation. Figures 4 and 5 illustrate the various stages and timeline of the participatory design process and stakeholders involved. A brief phasal description is given below:

Phase 1: Project Initiation: The initial selection of houses for upgradation was made through a fair system of lottery as well as direct selection of the most vulnerable, in agreement with the community. In the second phase, houses were selected using a lottery system between road numbers rather than individual houses to enable selection of two adjoining houses that needed rebuilding to minimize construction costs through the sharing of external walls and foundation structure. Co-design_05 and Co-design_06 were selected in this manner.

Phase 2: Housing design: Compared to existing houses, the architect had a strong motivation to ensure that houses were designed to be airy, daylit and thermally comfortable in addition to meeting homeowners' socio-cultural requirements and avoiding the risk of flood. Community involvement remained central during this process, and the architect ensured that the homeowners' housing needs and requirements were clearly communicated to the design team.

For this, interactive community engagement sessions were organized between the architect and community members with discussions facilitated using physical models of the houses (Figure 5).

Figure 1. Typical Type-1: Old-houses exteriors and interiors.

Phase 3: Project implementation: Houses were built with the help of local contractors and craftsmen, along with homeowners' participation in brick laying, preparation of floor tiles from local industry wastes, curing of concrete, etc. This helped in engaging homeowners while also providing a means for income-generation through their economic participation. Figure 6 shows two Co-design houses, with front and back courtyards.

Phase 4: Evaluation and re-design: In the first phase, four houses were constructed and handed over to the residents. Post-occupancy feedback highlighted that the homeowners were dissatisfied with open courtyard spaces. Consequently, the house design was altered to meet homeowners' requirements. Based on this evaluation, two further houses were constructed in the second phase.

Data collection and analysis

An indicative POE was carried out to identify major achievements and drawbacks of building performance (Preiser, 1995; Sanni-Anibire et al., 2016) in the selected case-study. Qualitative case-studies provide useful insights into complex social phenomenon (Yin, 2014), that can serve as evidence for validating or refuting critical theoretical framings (Flyvbjerg, 2006). Whilst case-studies may not be suited for broader statistical generalizations, Stevenson (2019) argues that even a single case-study of one home can validate a BPE if it provides insight into key issues for the housing sector.

The POE for the present study included a mixed-methods approach to collect data, using environmental monitoring, questionnaire surveys, transect walks, photography, semi-structured interviews, and a focus group discussion (FGD). Occupant questionnaire surveys were conducted in the 15 case-study households with 22 respondents. Table 1 provides details of the selected variables for quantitative analysis. A standard thermal comfort survey using ASHRAE 7-point scale (Sharmin and Steemers, 2018) was conducted with immediate measurements of air temperature, relative humidity, wind speed and mean radiant temperatures using

Figure 2. (a) Typical New-build house, (b) Entry, (c) Windowless bedroom, (d) Windowless living room, (e) Typical living room.

Figure 3. Front courtyard and entry of Co-design houses: (a) Co-design_01, (b) Co-design_02, (c) Co-design_03, (d) Co-design_04.

Testo 480 climatic instrument alongside three-day air temperature measurements using Tiny Tag data-loggers during the hottest month in May. In addition, qualitative variables based on user perceptions of thermal comfort and house satisfaction were also included (see Table 1).

Owing to the small sample size, the results from the quantitative survey cannot be generalized as a representative indication of occupant's housing satisfaction in the community. Rather, the analysis was used as a starting point to explore the relationship between spatial design and user satisfaction. This then guided specific directions of enquiry in the qualitative interviews for more in-depth analysis of variations in satisfaction levels between house types. The survey data showed interesting differences in occupants' satisfaction levels between the house types but also revealed somewhat conflicting results when compared with physical evaluation, environmental monitoring, and socio-cultural practices. Triangulation with qualitative analysis of interviews and FGD helped explain apparent conflicts, as elaborated in the Findings section. This approach is in line with previous studies (Gupta and Chandiwala, 2010; Stevenson, 2019) that emphasize the use of qualitative interview data for more enriched building evaluation as a valid scientific enquiry.

Semi-structured interviews were conducted in Hindi with 22 residents (of which 8 were men), lasting between 60–90 min. Within qualitative studies, sample sizes of 10 or more are generally considered sufficient for detailed thematic analysis (Corbin and Strauss, 2008; Galvin, 2015), since the objective is theory structuration and/or evidence of falsification, rather than statistical generalizability. In addition to interviews, a focus group was arranged between the various stakeholders involved in the community housing project, including the architects, researchers, construction contractor, charity representatives, community leaders as well as community residents. In line with a socio-technical approach to POE as outlined by Chiu et al. (2014) and Stevenson (2019), the key interview questions and FGD focused on user requirements and satisfaction within their spatial precinct, involvement in the participatory design process and wider community life. Consequently, questions were structured around understanding daily spatial practices in relation to housing layout and recognizing individual circumstances and reasons for relocation/migration, social acceptance within and outside the community, and access to education and other facilities within the community. Some questions presented in Table 3 initiated the discussion for more in-depth enquiry. The semi-structured approach allowed for adaptation to each situation, leading to more in-depth socio-spatial analysis. Interviews were later translated and transcribed into English. Analysis of interviews and focus group data was conducted using an inductive bottom-up approach with iterative qualitative coding cycles following literature guidelines (Miles et al., 2014; Saldana, 2015), which was then used to identify major themes. Coding is a qualitative data analysis technique whereby a detailed reading of the text is undertaken and words or phrases (labels) are assigned that symbolically designate a summative, salient, essence-capturing or evocative attribute/meaning to data (Saldana, 2015). A first-cycle line-by-line qualitative coding analysis of the data was followed by a second cycle coding. Various types of deductive, descriptive, and thematic codes were used during the cyclic process (e.g. spatial conflicts, negotiations of space, problems with courtyards, changing expectations, cultural norms, etc.) which were then used to draw out major themes. Coding was carried out iteratively by the authors through periodic discussions and exchange of notes to allow for reflection and review, which then led to agreement on the key coding categories that defined the overarching themes.

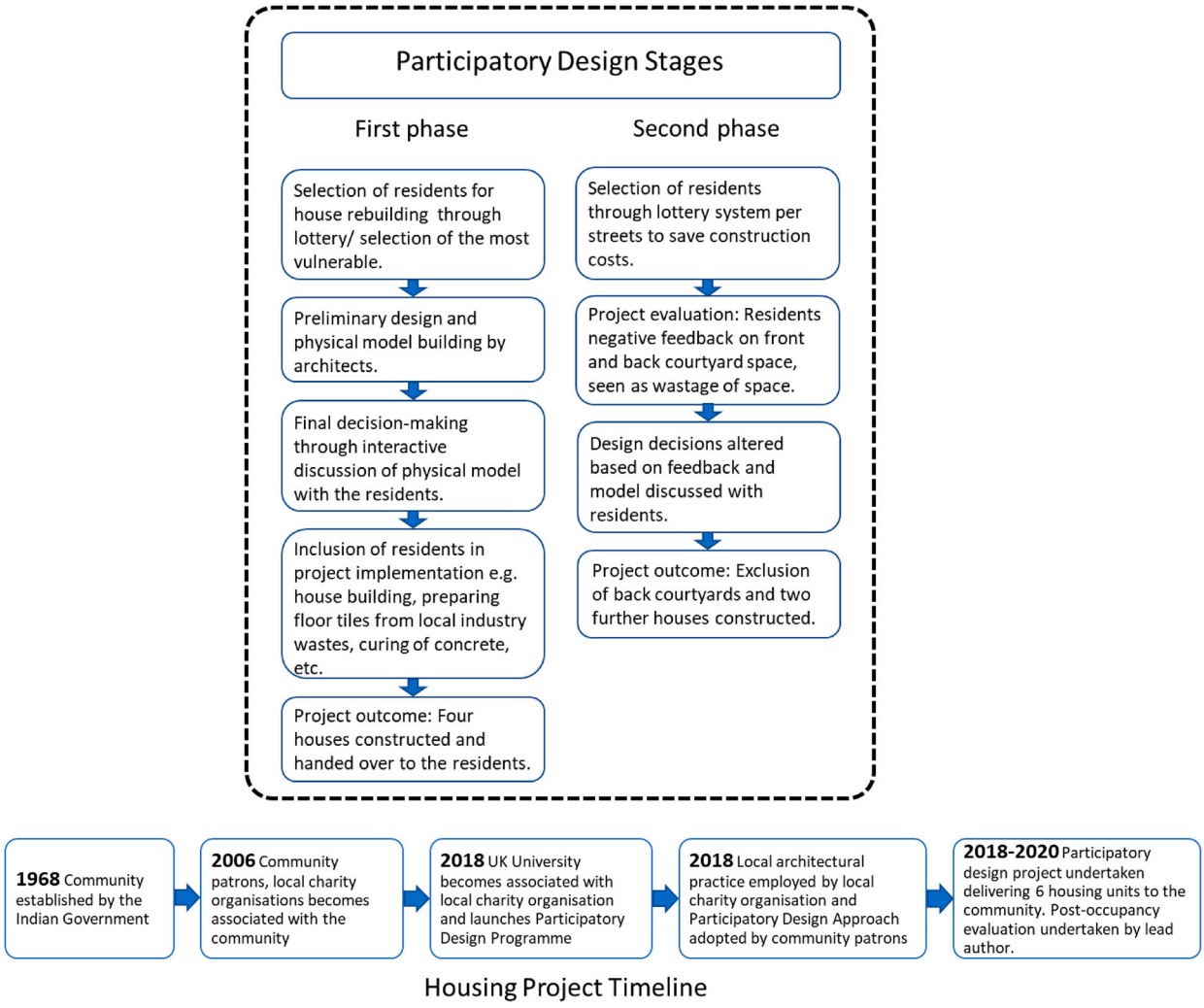

Figure 4. Various stages and timeline of the participatory design approach.

Results

This section presents the results of the quantitative data analysis from environmental monitoring and the home-owners' questionnaire survey on thermal satisfaction in different house types. Key results from the quantitative analysis are presented below:

The air temperature profile monitored during a 3-day period in May (Table 2) across the house types

Figure 5. Architect showing small-scale model of an individual house to community members during community engagement session.

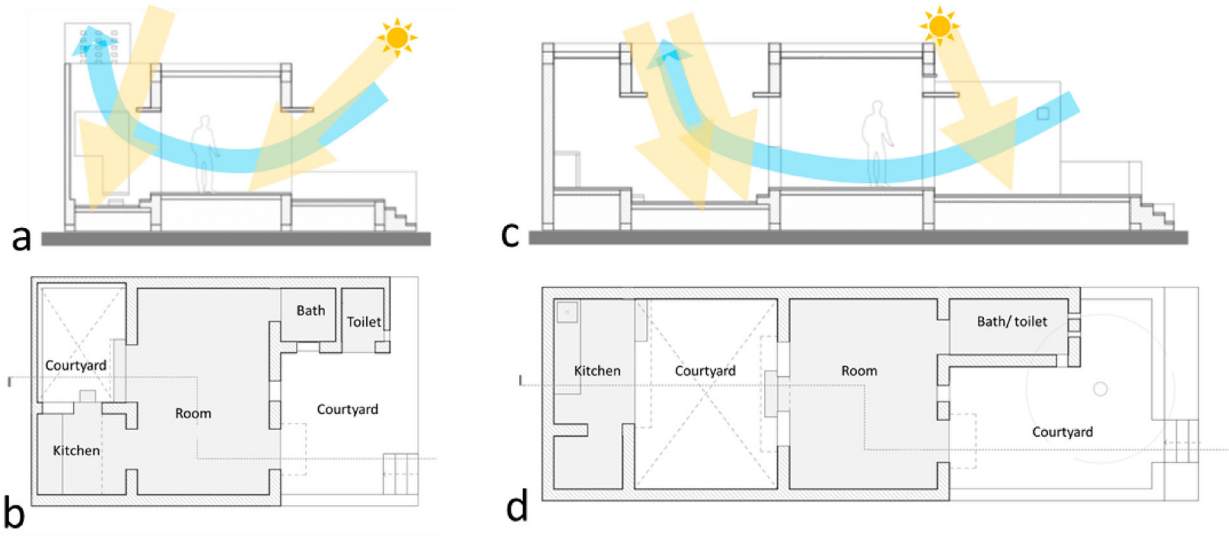

Figure 6. Co-design_03: (a) Section, (b) Plan; Co-design_04: (c) Section, (d) Plan.

showed a temperature variation between 30.7°C (Co-design_2) and 47.6°C (Old-house_01). These temperature ranges are well above the local thermal comfort range of 25.0°C–31.0°C in summer, as suggested by Udaykumar and Rajasekar (2015) for the hot-dry climate of Ahmedabad. The Thermal Sensation Vote (TSV) from the questionnaire survey (Figure 7) showed that 100% of the residents in the Co-design houses were comfortable, despite the very high average indoor temperatures (37.1°C). For the New-builds, approximately one-third of the residents felt comfortable, with the remaining feeling warm, in an average indoor temperature of 37.0°C. From the Old-houses that showed an average indoor temperature of 40.6°C, 77.8% of the residents indicated that they felt hot while 22.2% felt warm. The residents showed higher temperature tolerance compared to previous studies in a similar climatic context (Udaykumar and Rajasekar, 2015), which prompted the more detailed qualitative research.

Quantitative environmental analysis presented in Figure 8 revealed that house types differed significantly in: level of housing satisfaction/happiness, thermal acceptability, adequate daylighting and adequate ventilation. In terms of thermal acceptability, Old_houses were considered mostly unacceptable with only 22% homeowners indicating thermal acceptability. The use of corrugated tin roof made the thermal situation worse. Both New-build and Co-design homeowners were satisfied with the level of thermal protection provided by improved construction. Some of the rooms (including bedrooms, living rooms or prayer rooms) in the New-build houses did not have any window openings resulting in 78% and 89% satisfaction with daylighting and ventilation, respectively. Similarly, in

Table 1. Selected variables to understand house design performance.

Variables (User perception)	Description	Response
Thermal comfort	Thermal sensation on traditional ASHRAE 7-point scale	−3 = Cold, −2 = Cool, −1 = Slightly cool, 0 = Neutral, +1 = Slightly warm, +2 = Warm, +3 = Hot
Overall happiness with living quality of the houses	Are you happy with the overall living quality of the houses?	0 = no, 1 = yes
Thermal acceptability	Is the thermal condition during the interview period acceptable to you?	0 = no, 1 = yes
Adequate daylighting	Does the house have adequate daylighting?	0 = no, 1 = yes
Adequate ventilation	Does the house have adequate ventilation?	0 = no, 1 = yes

Table 3. Satisfaction with community and neighbourhood facilities.

Do you feel a part of your neighbourhood/block?	Yes – 100%
How many neighbours do you feel you know well? [numerical answer]	113 – 100%
Do you feel able to live independently in this neighbourhood?	Yes – 32%, No – 68%
Do you feel it is safe for children to play outside?	Yes – 100%
Do you feel your home gives you adequate privacy?	Yes – 100%
Do you feel disturbed by noise from neighbours and the outside?	No – 100%
Do you feel your neighbourhood gives you opportunities to stop and talk with people regularly?	Yes – 100%
Do you feel like you can get to local amenities easily in this neighbourhood?	Yes – 100%
Do you feel you can access spaces for recreation easily in this neighbourhood?	Yes – 100%
Do you feel you have a say in your neighbourhood?	Yes – 100%
Are you happy with the neighbourhood facilities (like schools, hospitals, shops, recreational facilities)?	Yes – 100%

Table 2. Air temperature profile of the house types during 3-day measurements and mean instantaneous temperature during the questionnaire survey.[3]

House type	Co-design_01	Co-design_02	Co-design_03	Old-house_01	Old-house_02	Old-house_03	Old-house_04	Old-house_05	New-build_01	New-build_02	New-build_03	New-build_04
Average – 3-day measurement	37.1	34.8	35.4	37.2	35.4	36.7	37.2	37.6	37.0	35.2	38.4	36.8
Minimum – 3-day measurement	34.4	30.7	32.6	32.6	32.6	34.2	33.5	34.6	35.7	33.2	35.5	35.6
Maximum – 3-day measurement	40.6	36.2	38.8	47.6	41.0	40.3	43.5	41.9	37.9	36.7	41.3	37.9
Mean instantaneous temperature during questionnaire survey	37.3	36.4	37.6	40.6	37.9	41.5	41.1	41.9	36.4	36.5	38.4	36.7

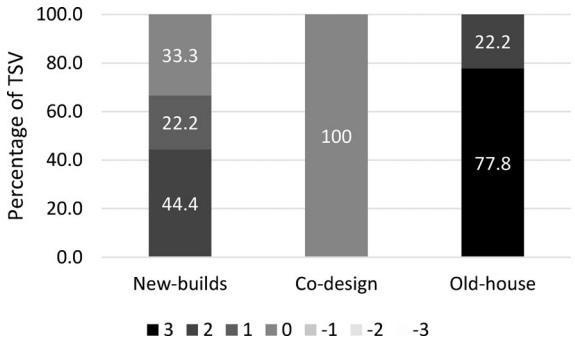

Figure 7. Percentage frequency for the TSV across different house types.

the Old_houses, the main living/bedroom had no window openings and daylighting. This meant that artificial lighting was essential in the inner rooms for both house types, as observed during the survey. In contrast, Co-design houses performed well in terms of daylighting and homeowners expressed satisfaction with the overall lighting conditions. The least amount of ventilation was experienced in Old_houses due to the absence of windows in the main bedroom. Whereas in the New-build houses, even without any window openings in the inner rooms, greater thermal comfort was achieved on the ground floor compared to the first floor due to double-storey construction and greater wall thickness. The Co-design houses, on the other hand, had ample air circulation due to careful design of cross-ventilation through the courtyards and ventilation shafts (Figure 6).

Respondents were also questioned regarding their satisfaction wider community and neighbourhood facilities (Table 3). A binary scale (yes/no) was used, and the overall response was found highly positive. All respondents felt that they were an integral part of the neighbourhood and well-acquainted with other community members. Nearly 70% thought they could not live without help from each other. 32% respondents (mostly those who had built their own houses and had relatively more stable incomes) were confident in living independently. They all agreed that the area was safe for children to play outside. The notion of privacy and noise pollution was not clear to them – these did not appear to be issues of concern. During site visits, privacy barriers between neighbours were observed to be small and homeowners were well accustomed to neighbours visiting throughout the day. Respondents were content with local amenities, recreation, and other neighbourhood facilities (such as a school and hospital, etc.). Overall, they had very little expectations from the wider community due to their long-term exclusion and discrimination from leprosy. Further, during the interviews, it was revealed that because homeowners were generally overwhelmed with more pressing issues such as flooding; issues related to community facilities were deemed insignificant.

Findings

Drawing on the results from the questionnaire survey, this section presents findings of the qualitative analysis of the interview and focus group data. A socio-technical analysis of the house design, homeowners' perceptions and use of domestic spaces and the underlying socio-cultural context helped reveal three key themes that shed light on the performance of low-income housing in the case-study, discussed below.

Courtyards and contestations

Traditionally, courtyards were seen as inseparable elements in the hot-dry climate of Ahmedabad. Inner courtyards often worked as an extension of the kitchen and bedrooms to provide space for activities that required privacy, such as bathing, washing, and sleeping for women, etc. Front courtyards often acted as an outdoor extension of the house and provided a sleeping area for men (Miyaoka et al., 2014). In the present study, interviews with homeowners revealed that privacy was not a major concern in the community. Most residents were accustomed to sleeping outdoors during the summer. Although Old_houses did not have internal courtyards, the front street-space was used for social and economic activities during daytime and for sleeping at night. In New-build houses that were devoid of courtyards, sleeping areas were moved from the ground level to the roof. In line with these socio-cultural norms, a front courtyard was incorporated in all Co-design (01–06) houses to preserve local customs and encourage economic activities. Additionally, backyards were incorporated in Co-design houses (01 and 03) for privacy and space for washing clothes and utensils, etc. (Figure 9(a,b)). Co-design_04 originally had an internal courtyard, and a front courtyard was added during upgradation (Figure 9(c,d)).

These additions by the architect were further incorporated to facilitate natural ventilation, improve daylighting and reduce peak temperatures experienced during Ahmedabad's harsh summers (as shown in Figures 6 and 10). Further, large window-cum-door openings (Figure 9(c)) were added to enhance cross-ventilation and could be folded aside to open the interiors completely to the outdoors.

Whilst the social and functional value of the courtyards was appreciated, findings from the interviews and FGD revealed that residents were not satisfied

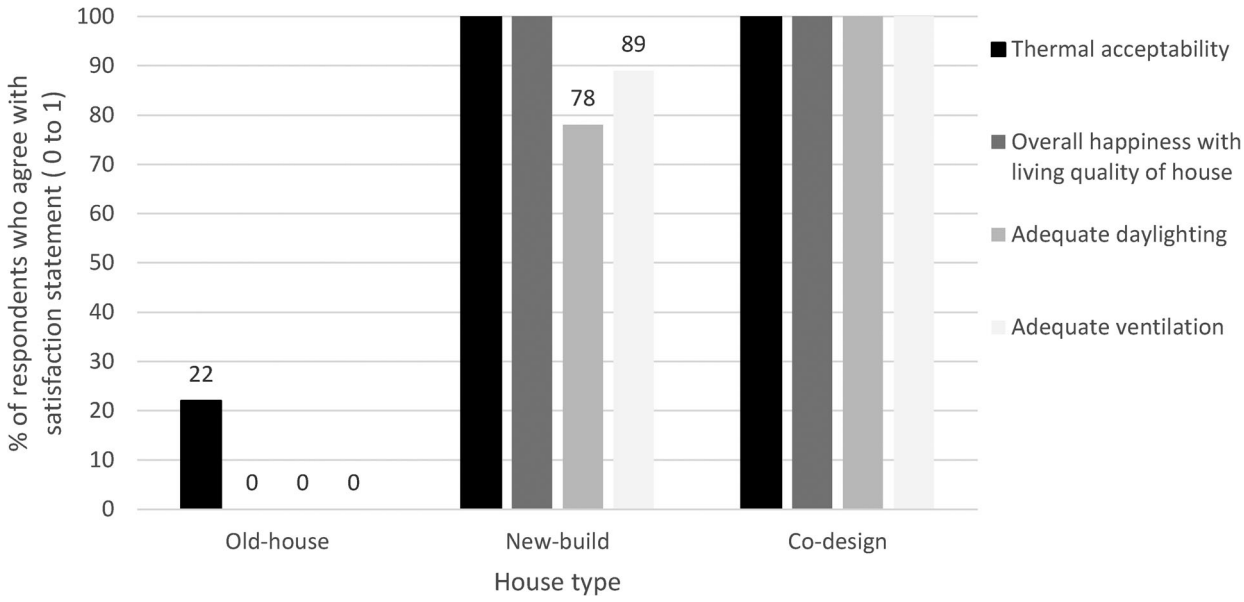

Figure 8. Percentage of respondents who agree with satisfaction statement.

with the front and back courtyards of their houses. For example, Rani[1], who lived in Co-design_02, used her courtyard for income-generating activities and socializing. However, she intended to sacrifice this open space for a new kitchen since she believed that the new layout did not meet the requirements of her large family:

> "I cannot keep my children with me due to lack of space in the house. They live with my mother in a separate city. There is no sleeping space for six people in the house, let alone storage space. I would like to convert the front courtyard into a kitchen after keeping minimal space for entry. I would also like to reduce the front opening and possibly replace the folding door, which cannot protect from the driving rain during the monsoon".

The backyard, essential for maintaining cross-ventilation throughout the house, was regarded by some homeowners as creating an uncomfortable windy indoor environment. For instance, Suneeta (Co-design_01), when asked about her preference for any design alterations, mentioned: "Yes, if I get the means in future, I will include the front-yard and backyard in the indoor spaces". In addition, the foldable window-cum-door design (Figure 10) was not welcome by most residents as they feared it would not provide necessary weather protection during heavy monsoon rains.

Such misconceptions attached with new design technologies together with increased socio-cultural requirements for indoor space meant that most homeowners had misgivings about open courtyard spaces, even when they appreciated the improved lighting and thermal comfort this configuration provided. Homeowners' discontent with the open house spaces mainly stemmed

Figure 9. (a) Backyard in Co-design_01, (b) Backyard in Co-design_03, (c) Internal courtyard in Co-design_04, (d) Front-yard in Co-design_04.

Figure 10. Airy and well-daylit interiors in (a) DMU-new-build_01, (b) DMU-new-build_03.

from their existing conceptions and use of outdoor (public) spaces. Since the Old_houses did not include any open courtyard spaces, most homeowners regarded the adjoining street-space in front of their house as part of their personal territory. This open outdoor space was often used by women during daytime for income-generating activities, household chores such as washing and drying as well as other social activities. It was also used by the children for playing and for sleeping outdoors at night. According to Bhavna, resident of an Old-house and a beggar by profession:

> During hot hours of the day, we go outside and sit under the shade in the field. We sleep and eat outside - come in the house to cook food. It is just too hot to sleep in the house. We only eat inside during winters or when it is raining.

Since homeowners were used to performing various domestic activities in the (public) outdoor spaces of adjoining neighbourhood streets and other community areas (Figure 11) beyond the boundaries of their own houses, the provision of a front courtyard in Co-design houses, within their property lines, was considered a waste for what could be extended indoor space for storage or accommodating guests, etc. The only alteration to this sleeping/eating culture existed for the New-build inhabitants in the form of roof terraces, often used for sleeping during hot summers.

These examples revealed that ownership was associated only with indoor household spaces in the community; wherein public outdoor spaces were encroached for various household activities that require performance outdoors. This resulted in conflicts between homeowners' lack of demand for courtyard spaces within plot boundaries on the one hand, and the provision of adequate lighting, ventilation and passive thermal comfort on the other. Due to the negative connotations attached with courtyards, the architect was compelled to exclude the backyard in lieu of an additional room in the two latter houses (5 and 6), compromising the initial design. In these two cases, the architect devised an alternative strategy to allow for some lighting and ventilation in the back room by raising it 10 in. above the front. Such deviations in design point to the conflicting demands of comfort and space use that must be considered and negotiated in low-income housing design.

Social expectations of space

Negative perceptions attached with courtyard spaces were further substantiated by homeowner's desire for greater indoor spaces under changing consumption characteristics and increasing material dependence. Most homeowners residing in Co-design houses expressed a need for greater storage space. Inadequate storage facilities were highlighted as a critical factor in the POE and ultimately affected the efficiency of the interior layout.

This additional demand for storage space was a result of the changing socio-cultural expectations attached to the elevated social status from owning a newly rebuilt house. This was seen in the case of Suneeta, sole occupant of Co-design_01. A street beggar by profession, Suneeta had minimal belongings to store in the house due to her poverty-stricken situation (Figure 12(a,b)). However, her newly elevated status meant that she now had several relatives visiting and staying with her for extended periods. During multiple visits for interviews, the house was observed to be frequently occupied by her daughter's family and even relatives from distant villages. This suggests that the new house became a symbol of social status for the homeowners. For the marginalized members of this community who had suffered

Figure 11. Income-generating activities in public spaces: (a) by homeowner Co-design_02 before new construction, (b) other community members

long periods of social exclusion because of leprosy, the newly built houses represented a shift towards social inclusion and integration. Their houses hence became a symbol of pride and reclaimed social standing. In light of these social imaginaries and expectations, although the interior space was more than adequate for a single person, Suneeta was disappointed with the provision of a backyard in her house and claimed that 'the backyard blows in dirt' – which essentially meant higher natural ventilation and had no apparent conflict with the design of the space. Although this open space at the exterior was designed for privacy and improved environmental conditions; Suneeta considered it a waste which, in her opinion, could have otherwise been used to extend the indoor space to accommodate her relatives.

Similarly, when comparing the size of her new house (Co-design_02) with the old, Rani felt that both houses provided a similar amount of space despite the new house being nearly twice the size of her previous house. She complained about the lack of adequate storage space and the small size of the toilet and bath (Figure 12(c,d)). Another example of this was seen in the case of homeowners of Co-design_03, who remained unconvinced that the new house provided more space compared to their previous accommodation, although they were able to divide the living/sleeping room into two separate spaces to allow for privacy for their female relatives, as claimed by the daughter Nirmala:

> We would prefer an additional indoor space instead of the backyard. Also, because the backyard is at a different floor level than the living areas, we cannot use this for sleeping purposes. Storage is a big problem as well. I would be very happy if [the architect] changes the courtyard into a room. Although there will be problem of ventilation, we would sacrifice that as we need space more urgently. If a guest visits us, we have a serious space issue.

Such examples show that the new house design resulted in changing household dynamics with an insurgence of extended family members, leading to greater use of and expectation for space.

The participatory design of the new houses had primarily focused on the environmental characteristics of the house spatial configuration, prioritizing improved thermal comfort. However, for the community residents, these houses had come to symbolize social prestige and acceptance in the wider society. Hence, architecture acted as a material manifestation of homeowners' social reintegration, and design became a means for reifying and reconstructing a respectable position in society. Consequently, this resulted in homeowners' greater expectations of indoor space use and demand for expanding house sizes with implications for the wider community. This changing landscape of the neighbourhood under homeowners' changing socio-cultural dynamics needs to be accounted for in future participatory approaches.

Negotiations of agency in spatial use and design

Negotiations of power and spatial agency in the community can be further understood when placed in the broader landscape of informal development in India. As Datta (2008) suggests, it is important to examine low-income housing architecture for the ways that it is produced by multi-scalar actors. Typical informal settlements in India feature unstable housing structures, insecure tenure, insufficient living area, and poor access to basic amenities (Li et al., 2021). Deprivation of space and resources therefore result in social conflicts across different stakeholder groups. Institutional and fiscal

Figure 12. (a), (b) Adequate storage facilities for a single person at Co-design_01, (c), (d) Inadequate storage facilities for a family of 6 at Co-design_02, (e) Inadequate storage facilities for a family of 3 at Co-design_03.

challenges associated with slum rehabilitation and development often result in exclusionary policies and lack of appropriate planning regulations (Hingorani, 2011). Consequently, in-situ slum upgradation has gained popularity in India, with a shift from strong centralized government intervention to reliance on civil society, market rationality, local urban governance and individual responsibility (Hingorani, 2011; Li et al., 2021). In the present case, this has meant that the government has played a passive role in the development of the case-study community, leaving it to individual homeowners to ensure housing and community development. In terms of government regulation, the only restrictions enforced to allow for ownership of housing so long as inhabitants continue to occupy their houses, and ownership ceases if the inhabitants decide to leave the community. With no other planning regulations in place, analysis revealed that spatial agency became a matter of power dynamics between the residents of the three different housing types. Old-house residents, being the most vulnerable, had access to only the very basic amenities with no means to upgrade and expand spatial ownership. Homeowners of the Co-design houses, while experiencing better living conditions under their recently upgraded housing, still faced economic constraints as their financial situation, for the most part, remained unchanged. As such, stakeholders from these two housing types had limited spatial agency. On the contrary, residents of New-builds, with their better resources and housing conditions, dominated the spatial territory of the community.

Instead of opposing such spatial encroachment, residents of the former two housing types aspired to do the same. During the FGD, it became apparent that community residents favoured the design of the multi-storied New-builds with their ample indoor spaces, personal verandas, and roof terraces. In particular, the community leader was thoroughly convinced with the approach of maximizing indoor space, justifying it on the basis of social customs whereby (male) children are expected to move-in with the parents to take financial responsibility of the family. Since the original houses were designed as single-family accommodations, multi-family requirements could only be accommodated through vertical

expansion. In the absence of state control through adequate planning legislation and building regulation, houses were expanded to their vertical and horizontal limits on the homeowners' discretion based on personal means, often encroaching on public spaces, and inhibiting most solar/daylight access. Other stakeholders involved in the community design, such as local charities and international volunteer agencies, although actively involved in providing community support, had no authority or law-enforcement capacity to control the physical growth of the community. Further, budgetary constraints acted as a major hurdle in negotiations of space within the house and beyond, as highlighted by the architect:

> I accept the fact that the residents are not fully happy about all aspects of design. They do not have full idea about the limited resources we had to work with! We even counted the pieces of bricks required for construction to save money and to keep within the budget.

In addition, it became evident from the FGD that residents had no clear vision for the future growth of the community. Those with a steady income source expanded their houses, to maximize occupancy without considering the quality of spaces being produced. This resulted in reduced ventilation and solar access in the neighbourhood streets, which in turn had consequences for the quality of the indoor environment (Figure 13). In this, marginalized community members that lacked a proper income source (including beggars and the disabled), had limited agency without the means to expand their houses. This shows that although participatory approach can be potentially empowering, involving: 'multi-dimensional social process that helps people gain control over their own lives' (Page and Czuba, 1999), the notion of empowerment can be lost due to the dominance of more capable members of the community. Among the 113 households in the community, almost half had been rebuilt by the homeowners through intrusion of adjoining neighbourhood spaces. Since houses were originally built without provision for expansion, continuation of this trend would inevitably result in inadequate access to air and light in the community houses. Further increase in household density would lead to environmental degradation resulting in adverse effects on the residents' health and well-being. Moreover, unplanned growth would mean depletion of soft land and outdoor recreation areas. This would further aggravate drainage issues and flooding. Although new houses were built on high plinths, this elevation would be insufficient to deal with rising flood levels, specifically if the drainage system failed to meet growing demands. Hence, flooding risks could be critical unless a proper strategy for planned future growth was put in place.

Discussion

The POE undertaken in this study identified several positive and negative factors in participation and design of the new houses. Compared to the existing houses, Co-design houses provided improved thermal comfort, adequate daylighting, reduced flood-risk and increased habitable indoor/outdoor spaces, as revealed from the POE environmental monitoring and quantitative analysis. Whilst the overall living conditions improved significantly in the new houses, qualitative analysis shows that important aspects like household density and future expansion prospects were not given due consideration. Other drawbacks associated with the design included lack of adequate space for sleeping and storage that partly originated from increased functional requirements due to household composition and partly from increased expectations for indoor space and individualized facilities in the new houses.

POE revealed the improved environmental performance of the new houses, resulting from the design of comfortable and sociable adjoining courtyard spaces, incorporated as a traditional architectural and environmental solution. However, these spaces were perceived to be undesirable, unprofitable, and impractical by the homeowners who lacked knowledge and understanding of passive design and environmental strategies. The architect's decision to exclude backyards in the subsequent houses was based on homeowners' increased demands for indoor space, compromising on environmental and social performance. The study shows that in the absence of regulatory mechanisms, government policies and top-down support for low-income housing, homeowners tend to focus on short-term individual benefits to the detriment of the larger community. This has inimical consequences for the quality of life, health, and well-being of the homeowners themselves. Consequently, under the confinements of a limited policy and planning landscape, bottom-up participatory design approaches have limited agency for long-term sustainable transitions. These findings corroborate other studies in the Indian context that demonstrate the challenges of bottom-up approaches under the failure of top-down processes (Hingorani, 2011; Li et al., 2021), advocating for a middle-ground approach (Tiwari et al., 2021).

Further, the study shows that although a participatory design approach can lead to improved user satisfaction, it can have contradictory outcomes in terms of

Figure 13. Obstruction of light and ventilation and encroachment of common spaces through unplanned building of Type-2: New-build houses.

environmental concerns and sustainability. Previous research has shown that participants' short-sightedness and self-interests can reduce the capacity of participatory design to address issues of environmental risks and poverty (Sanoff, 1999). In low-income, vulnerable, and marginalized communities, these risks and contradictions can be exacerbated due to lack of knowledge and environmental awareness, the need for fulfilling basic requirements and aspirations to climb the social ladder. In the present case, under such constraints, whilst the participatory design approach was able to influence house design for improved space and comfort, it was unable to convey the significance of investing in community-based, shared spaces and to meaningfully engage participants in community development through setting long-term planning objectives. Our findings indicate that in addition to considering occupants' cultural practices in housing design (Shove et al., 2008), low-income housing development policies should take account of occupants' future socio-economic needs, such as expanding family sizes, social networks and increased economic participation through home-based activities. This can be ensured by incorporating flexibility and adaptability in housing layouts (Garrefa et al., 2021), understanding energy 'redundancy' (Stevenson et al., 2016), and provisions for incremental development (Nix et al., 2019) for improved sustainability.

The small sample of survey data and co-designed houses in this study limits the statistical applicability of the occupant satisfaction results. Further quantitative research is needed to determine occupant satisfaction at scale. However, findings from the qualitative analysis show that performance evaluations of housing for low-income, marginalized communities require detailed contextualized analysis of what works and what doesn't. Further, POEs should not only focus on the end-design and user satisfaction, but also on providing assessments of the design process itself and engagement with various stakeholders. In this, participatory design should be understood as a 'situated social process' (Jones and SPEECH, 2001, p. 34) based on ideas of 'empowered participation' (Fung, 2005) in which capacity building, training, education, and skills development of participants goes hand in hand with energy and housing finance initiatives, better collaboration and engagement with government authorities and improved POE procedures.

Conclusions

This research addresses a significant gap in the post-occupancy and participatory design evaluation of low-

income housing in developing countries by conducting an in-depth assessment of the architectural design and homeowners' use of and satisfaction with domestic spaces. The study is carried out for a unique social group subjected to social stigma, discrimination, and exclusion due to leprosy. POE studies for such marginalized groups are rare. The study uses both qualitative and quantitative techniques in a socio-technical approach to provide a robust analysis of the impact of architectural design and the participatory design approach used on homeowners' thermal satisfaction and space use.

Owing to the unique nature of the case-study, it may be difficult to generalize findings to the wider domestic sector. However, the study contributes theoretically and methodologically to the literature on BPEs for low-income housing in two ways: First, it shows that combining POE with participatory design methods can improve understandings of occupants housing needs while also revealing the various hierarchical agencies in participation and power dynamics within the built environment. This has consequences for occupant satisfaction and so, a combined approach can provide the means to transform power relations that can ultimately improve building performance and housing sustainability. It also reveals the intermediary role that researchers and architects can play between end-users and developers/policymakers to improve housing performance and development (Garrefa et al., 2021; Janda and Parag, 2013).

Second, it further substantiates empirically the need for a socio-technical approach in POE, as advocated by Chiu et al. (2014) and Stevenson (2019). It reveals that even when occupants are engaged throughout a participatory design process at the various stages of pre-construction, building and post-occupation, satisfaction levels may still vary. This is because even though buildings may be designed to function better environmentally, occupants may develop unforeseen expectations of higher levels of comfort, convenience and satisfaction as a 'rebound' effect to improved building design. Previous studies have described this rebound effect in terms of higher levels of thermal comfort (Haas and Biermayr, 2000; Sorrell et al., 2009) or greater use of energy fuels and services (Greening et al., 2000; Khazzoom, 1980). Our study adds to this conceptualization of rebound effects in terms of higher expectations of social standing and social inclusion in low-income developments. This has implications for BPE researchers and policymakers alike. Moving beyond the mantra of meeting basic shelter requirements, low-income housing policies should take a socio-technical approach to integrate environmental standards with occupants' contextual socio-cultural requirements and plan for future socio-economic growth. In this, participatory governance (Schneider, 1999) that allows inclusive development through stakeholder integration within more stringent planning regulations can result in more sustainable development. In this regard, recent reforms in ownership laws in informal settlements in India[2] is a step in the right direction to help improve spatial planning and curtail encroachment.

The study also raises questions about how best to utilize POEs and occupant feedback. In the present case, owing to the incremental nature of the participatory design project, the POE was able to inform the subsequent housing design, which may not be the case in most mass-scale social housing development. This indicates that understanding the processual nature of POEs is as important as determining their content. It also shows that a BPE approach that incorporates smaller, incremental and affordable demonstration projects in housing development can take account of localized socio-cultural contexts and be better optimized (Stevenson and Baborska-Narozny, 2018).

Notes

1. Pseudonyms are used in place of real names throughout the paper as per interview ethical guidelines.
2. As per The National Capital Territory of Delhi (Recognition of Property Rights of Residents in Unauthorised Colonies) Bill, 2019, see https://prsindia.org/billtrack/the-national-capital-territory-of-delhi-recognition-of-property-rights-of-residents-in-unauthorised-colonies-bill-2019
3. Environmental monitoring for Co-design _04 could not be carried out due to logistics issues.

Acknowledgements

This paper is an output from Research England QR-GCRF project, 'Socio-cultural and environmental experiences in low-income, tropical housing' at the Architecture Research Institute, De Montfort University, UK. The authors would also like to thank Dhrupad Shukla and Sagar Odedra for the images of community discussions and SEALAB Architects for the discussions, design drawings and model photos.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Research England QR-GCRF De Montfort University.

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References

Alvaro, C., Wilkinson, A. J., Gallant, S. N., Kostovski, D., & Gardner, P. (2016). Evaluating intention and effect: The impact of Healthcare Facility design on patient and Staff well-being. *HERD: Health Environments Research & Design Journal*, *9*(2), 82–104. https://doi.org/10.1177/1937586715605779

Baborska-Narozny, M., Stevenson, F., & Ziyad, F. J. (2016). User learning and emerging practices in relation to innovative technologies: A case study of domestic photovoltaic systems in the UK. *Energy Research & Social Science*, *13*, 24–37. https://doi.org/10.1016/j.erss.2015.12.002

Barakat, S. (2015). Housing reconstruction after conflict and disaster.

Bardhan, R., Debnath, R., Malik, J., & Sarkar, A. (2018). Low-income housing layouts under socio-architectural complexities: A parametric study for sustainable slum rehabilitation. *Sustainable Cities and Society*, *41*, 126–138. https://doi.org/10.1016/j.scs.2018.04.038

Basu, A. M. (2016). Public participation, urban governance and planning: Perspectives and concerns. In P. Prakash, & A. Kumar (Eds.), *Public participation in planning in India* (pp. 41–63). Cambridge Scholars Publishing.

Boyle, D., & Harris, M. (2009). *The challenge of co-production: How equal partnerships between professionals and the public are crucial to improving public services*. NESTA.

Carmon, N. (2002). User-controlled housing: Desirability and feasibility. *European Planning Studies*, *10*(3), 285–303. https://doi.org/10.1080/09654310220121040

Chaudhry, S., Saxena, S., & Kumar, D. (2017). India's smart cities mission: Smart for whom? Cities for whom? (No. ISBN: 978-81-935672-1-0). Housing and Land Rights Network, New Delhi.

Chiu, L. F., Lowe, R., Raslan, R., Altamirano-Medina, H., & Wingfield, J. (2014). A socio-technical approach to post-occupancy evaluation: Interactive adaptability in domestic retrofit. *Building Research & Information*, *42*(5), 574–590. https://doi.org/10.1080/09613218.2014.912539

Cohen, J. M., & Uphoff, N. T. (1980). Participation's place in rural development: Seeking clarity through specificity. *World Development*, *8*(3), 213–235. https://doi.org/10.1016/0305-750X(80)90011-X

Corbin, J., & Strauss, A. (2008). Basics of qualitative research (3rd ed.). In *Techniques and procedures for developing grounded theory*. SAGE Publications, Inc. https://doi.org/10.4135/9781452230153

Crook, R. C., & Manor, J. (1998). India (Karnataka). In *Democracy and decentralisation in South Asia and West Africa : Participation, accountability, and performance*. Cambridge University Press. https://doi.org/10.1017/9780511607899.002

Datta, A. (2008). Architecture of low-income widow housing: "spatial opportunities" in Madipur, West Delhi. *cultural geographies*, *15*(2), 231–253. https://doi.org/10.1177/1474474007087500

Davis, S. (1995). *The architecture of affordable housing, choice reviews online*. University of California Press. https://doi.org/10.5860/choice.33-0075

DeClercq, C. P., & Cranz, G. (2014). Moving beyond seating-centered learning environments: Opportunities and challenges identified in a POE of a campus library. *The Journal of Academic Librarianship*, *40*(6), 574–584. https://doi.org/10.1016/j.acalib.2014.08.005

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative inquiry*, *12*(2), 219–245. https://doi.org/10.1177/1077800405284363

Fung, A. (2005). Empowered Participation : Reinventing Urban Democracy.

Galvin, R. (2015). How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge? *Journal of Building Engineering*, *1*, 2–12. https://doi.org/10.1016/j.jobe.2014.12.001

Garrefa, F., Villa, S. B., Bortoli, K. C. R., de, Stevenson, F., & Vasconcellos, P. B. (2021). Resilience in social housing developments through post-occupancy evaluation and co-production. *Ambiente Construído*, *21*(2), 151–175. https://doi.org/10.1590/s1678-86212021000200519

Grangaard, S., & Ryhl, C. (2016). Vandhalla - A sport centreand a successful example of first-generation universal design. *Studies in Health Technology and Informatics*, *229*, 243–245. https://doi.org/10.3233/978-1-61499-684-2-243

Greening, L. A., Greene, D. L., & Difiglio, C. (2000). Energy efficiency and consumption — the rebound effect — a survey. *Energy Policy*, *28*(6-7), 389–401. https://doi.org/10.1016/S0301-4215(00)00021-5

GRIHA. (2015). Green Rating for Integrated Habitat Assessment [WWW Document]. 2021. https://www.grihaindia.org/about-griha

Gupta, R., & Chandiwala, S. (2010). Understanding occupants: Feedback techniques for large-scale low-carbon domestic refurbishments. *Building Research & Information*, *38*(5), 530–548. https://doi.org/10.1080/09613218.2010.495216

Gupta, R., Gregg, M., Manu, S., Vaidya, P., & Dixit, M. (2019). Customized performance evaluation approach for Indian Green buildings. *Building Research & Information*, *47*(1), 56–74. https://doi.org/10.1080/09613218.2019.1525962

Haas, R., & Biermayr, P. (2000). The rebound effect for space heating Empirical evidence from Austria. *Energy Policy*, *28*(6-7), 403–410. https://doi.org/10.1016/S0301-4215(00)00023-9

Haque, N. (2018). Is Participatory Planning really working for the urban poor? Archit. Masses 2018, Environmental Remediation and Rejuvenation. 5.

Hester, R. T. (1987). Participatory design and environmental justice : Pas de deux or time to change partners ? Special Issue : Design and Democracy (December, 1987). Locke Science Publishing Company, Inc. https://www.jstor.org/sta 4, 289–300

Hingorani, P. 2011. Revisiting Low Income Housing: A Review of Policies and Perspectives. Indian Inst. Hum. Settl. 35.

Janda, K. B., & Parag, Y. (2013). A middle-out approach for improving energy performance in buildings. *Building Research & Information*, *41*(1), 39–50. https://doi.org/10.1080/09613218.2013.743396

Jones, E, SPEECH, 2001. 'Of other spaces' : Situating participatory practices : a case study from South India. Presented at the Working paper series, 137, IDS, Brighton.

Kalantari, S., & Snell, R. (2017). Post-Occupancy evaluation of a mental Healthcare Facility based on Staff perceptions of design innovations. *HERD: Health Environments Research & Design Journal*, *10*(4), 121–135. https://doi.org/10.1177/1937586716687714

Keivani, R., & Werna, E. (2001). Refocusing the housing debate in developing countries from a pluralist perspective. *Habitat International*, *25*(2), 191–208. https://doi.org/10.1016/S0197-3975(00)00024-2

Khalid, R., & Sunikka-Blank, M. (2018). Evolving houses, demanding practices: A case of rising electricity consumption of the middle class in Pakistan. *Building and Environment*, *143*, 293–305. https://doi.org/10.1016/j.buildenv.2018.07.010

Khazzoom, J. D. (1980). Economic implications of mandated efficiency in standards for household appliances. *Energy J*, *1*(4), 21–40. http://www.jstor.org/stable/41321476

Li, P., Froese, M. T., & Brager, G. (2018). Post-occupancy evaluation: State-of-the-art analysis and state-of-the-practice review. *Building and Environment*, *133*, 187–202. https://doi.org/10.1016/j.buildenv.2018.02.024

Li, Z., Alakshendra, A., & Smith, S. (2021). A people-centered perspective on slum formalization policy. *Housing Policy Debate*, *00*, 1–20. https://doi.org/10.1080/10511482.2021.1905025

Maithel, S., Bhanware, P., Jaboyedoff, P., & Reddy, B. (2017, Nov 27–Dec 1st). *Case study of an energy efficient commercial building: Validating design intent & energy simulation results with monitored performance data*. International symposium to promote innovation & research in energy efficiency, pp. 34–43, Jaipur, India. https://www.researchgate.net/publication/321476552_CASE_STUDY_OF_AN_ENERGY_EFFICIENT_COMMERCIAL_BUILDING_VALIDATING_DESIGN_INTENT_ENERGY_SIMULATION_RESULTS_WITH_MONITORED_PERFORMANCE_DATA

Manu, S., Shukla, Y., Rawal, R., Thomas, L. E., & de Dear, R. (2016). Field studies of thermal comfort across multiple climate zones for the subcontinent: India model for adaptive comfort (IMAC). *Building and Environment*, *98*, 55–70. https://doi.org/10.1016/j.buildenv.2015.12.019

Michener, V. J. (1998). The participatory approach: Contradiction and co-option in Burkina Faso. *World Development*, *26*(12), 2105–2118. https://doi.org/10.1016/S0305-750X(98)00112-0

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed). SAGE Publications.

Miraftab, F. (2003). The perils of participatory discourse: Housing Policy in postapartheid South Africa. *Journal of Planning Education and Research*, *22*(3), 226–239. https://doi.org/10.1177/0739456X02250305

Miyaoka, F., Tungnung, K., Kodama, Y., & Krishan, A. (2014, December 16-18). Sustainable habitat for emerging economies – Choosing the way forward. In *30th International PLEA (Passive and Low Energy Architecture) Conference: Sustainable Habitat for Developing Societies: Choosing the Way Forward - Proceedings* Vol. 1, (pp. 133–140). CEPT University, Ahmedabad, India., Part of ISBN: 978-93-83184-03-3.

Moser, C. O. N. (1989). Community participation in urban projects in the Third world. *Progress in Planning*, *32*, 71–133. https://doi.org/10.1016/0305-9006(89)90010-X

Mubita, A., Libati, M., & Mulonda, M. (2017). The importance and limitations of participation in development projects and programmes. *European Scientific Journal, ESJ*, *13*(5), 238. https://doi.org/10.19044/esj.2017.v13n5p238

Müller, A.-L., & Reichmann, W. (2015). *Architecture, materiality and society: Connecting sociology of architecture with science and technology studies*. Palgrave Macmillan.

Neumann, S., & Bliss, F. (2008). Participation in International Development Discourse and Practice: "State of the Art" and Challenges ((INEF-Report, 94/2008)). Institute for Development and Peace, University of Duisburg-Essen.

Nix, E., Paulose, J., Shrubsole, C., Altamirano-medina, H., Belesova, K., Davies, M., Khosla, R., & Wilkinson, P. (2019). Participatory action research as a framework for transdisciplinary collaboration : A pilot study on healthy, sustainable, Low-income housing in Delhi, India. *Global Challenges*, *3*(4), 1800054. https://doi.org/10.1002/gch2.201800054

Onibokun, A. G. (1974). Evaluating consumers' satisfaction with housing: An application of a systems approach. *Journal of the American Institute of Planners*, *40*(3), 189–200. https://doi.org/10.1080/01944367408977468

Page, N., & Czuba, C. E. (1999). Empowerment: What is it? *Journal of Extension*, *37*(5), 24–32. https://archives.joe.org/joe/1999october/comm1.php

Parfitt, T. (2004). The ambiguity of participation: A qualified defence of participatory development. *Third World Quarterly*, *25*(3), 537–555. https://doi.org/10.1080/0143659042000191429

Pati, D., & Pati, S. (2013). Methodological issues in conducting post-occupancy evaluations to support design decisions. *HERD: Health Environments Research & Design Journal*, *6*(3), 157–163. https://doi.org/10.1177/193758671300600312

Preiser, W. F. E. (1995). Post-occupancy evaluation: How to make buildings work better. *Facilities*, *13*(11), 19–28. https://doi.org/10.1108/02632779510097787

Salamah, A. (2021). Participatory urban development in India: A tale of Two townships. *Environment and Urbanization ASIA*, *12*(1), 136–147. https://doi.org/10.1177/0975425321990316

Saldana, J., 2015. *The coding manual for qualitative researchers* (3rd ed.). SAGE Publications Ltd.

Sanni-Anibire, M. O., Hassanain, M. A., & Al-Hammad, A. M. (2016). Post-Occupancy evaluation of housing facilities: Overview and summary of methods. *Journal of Performance of Constructed Facilities*, *30*(5), 1–9. https://doi.org/10.1061/(ASCE)CF.1943-5509.0000868

Sanoff, H. (1999). *Community participation methods in design and planning*. John Wiley & Sons.

Sanoff, H. (2007). Special issue on participatory design. *Design Studies*, *28*(3), 213–215. https://doi.org/10.1016/j.destud.2007.02.001

Schneider, H. (1999). Participatory Governance: The Missing Link for Poverty Reduction (OECD Development Centre Policy Briefs No. 17), OECD Development Centre Policy Briefs. https://doi.org/10.1787/888041015581

Sengupta, U. (2013). Affordable housing development in India : a real deal for low-income people ? 35. https://doi.org/10.3828/idpr.2013.17

Sharmin, T., & Steemers, K. (2018). Effects of microclimate and human parameters on outdoor thermal sensation in the high-density tropical context of Dhaka. *International*

Journal of Biometeorology, *64*(2), 187–203. https://doi.org/10.1007/s00484-018-1607-2

Sheng, Y. K. (1990). Community participation in Low-income housing projects: Problems and prospects. *Community Development Journal*, *25*(1), 56–65. https://doi.org/10.1093/cdj/25.1.56

Shove, E., Chappells, H., Lutzenhiser, L., & Hackett, B. (2008). Comfort in a lower carbon society. *Building Research & Information*, *36*(4), 307–311. https://doi.org/10.1080/09613210802079322

Sorrell, S., Dimitropoulos, J., & Sommerville, M. (2009). Empirical estimates of the direct rebound effect: A review. *Energy Policy*, *37*(4), 1356–1371. https://doi.org/10.1016/j.enpol.2008.11.026

Spinuzzi, C. (2005). The methodology of participatory design. *Technical Communication*, *52*(2), 163–174.

Stevenson, F. (2019). *Housing Fit for purpose: Performance, feedback and learning*. RIBA Publishing. https://doi.org/10.4324/9780429347870

Stevenson, F., & Baborska-Narozny, M. (2018). Housing performance evaluation: Challenges for international knowledge exchange. *Building Research & Information*, *46*(5), 501–512. https://doi.org/10.1080/09613218.2017.1357095

Stevenson, F., & Petrescu, D. (2016). Co-producing neighbourhood resilience. *Building Research & Information*, *44*(7), 695–702. https://doi.org/10.1080/09613218.2016.1213865

Stevenson, F., Baborska-Narozny, M., & Chatterton, P. (2016). Resilience, redundancy and low-carbon living: Co-producing individual and community learning. *Building Research & Information*, *44*(7), 789–803. https://doi.org/10.1080/09613218.2016.1207371

Thomas, L. E. (2010). Evaluating design strategies, performance and occupant satisfaction: A low carbon office refurbishment. *Building Research & Information*, *38*(6), 610–624. https://doi.org/10.1080/09613218.2010.501654

Thomas, L., & Baird, G. (2005, November 17-19). *Post-occupancy evaluation of passive downdraft evaporative cooling and air-conditioned buildings at torrent research centre, Ahmedabad, India*. Challenges for Architectural Science in Changing Climates. Australian and New Zealand Architectural Science Association Annual Conference, School of Architecture, Victoria University of Wellington.

Tiwari, R., Winters, J., & Trivedi, N. (2021). Balancing participatory design approaches in slum upgradation: When Top-down meets bottom-Up!. In C. O. García-Villalba (Ed.), *Resilient urban regeneration in informal settlements in the tropics, advances in 21st century human settlements* (pp. 127–147). Springer Singapore. https://doi.org/10.1007/978-981-13-7307-7_7

Udaykumar, A., & Rajasekar, E. (2015). Thermal comfort characteristics in naturally ventilated, residential apartments in a hot-dry climate of India. *Indoor and Built Environment*, *24*(1), 101–115. https://doi.org/10.1177/1420326X13504120

UN. (2019). The Sustainable Development Goals Report. New York.

Valladares, A. (2017). Successes and failures of participation-in-design: Cases from Old Havana Cuba. *Frontiers of Architectural Research*, *6*(3), 401–411. https://doi.org/10.1016/j.foar.2017.06.001

White, S. C. (1996). Depoliticising development: The uses and abuses of participation. *Development in Practice*, *6*(1), 6–15. https://doi.org/10.1080/0961452961000157564

Wijegunarathna, E. E., Wedawatta, G., Prasanna, L. J., & Ingirige, B. (2018). Long-term satisfaction of resettled communities: An assessment of physical performance of post-disaster housing. *Procedia Engineering*, *212*, 1147–1154. https://doi.org/10.1016/j.proeng.2018.01.148

Wongbumru, T., & Dewancker, B. (2016). Post-occupancy evaluation of user satisfaction: A case study of "old" and "new" public housing schemes in Bangkok. *Architectural Engineering and Design Management*, *12*(2), 107–124. https://doi.org/10.1080/17452007.2015.1106399

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed). SAGE Publications.