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POLICY AND PRACTICE

Building regulations are a barrier to affordable housing in Indian cities: the case of Ahmedabad

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Abstract Cities in developing countries seldom consider the cost increases that regulations impose on development. To build legal housing, developers must meet a high minimum cost threshold established by mandatory standards. Many standards impose costs on building construction, make them less affordable to low-income households, deprive them access to legally built housing, and fuel the formation of slums. This study analyses the impact of relaxing a few mandatory building and site planning regulations on the cost of small two-room homes in Ahmedabad by developing two alternative layouts for the same site, one in accordance with prevalent regulations, and another after modifying a few regulations. It shows that rationalizing regulations can reduce housing cost by 34% and increase supply by as much as 75% without significantly lowering quality or compromising safety. It also shows that for a large portion of poor households, the costs imposed by mandatory standards are not trivial and have a high impact on the affordability of legally built housing. It recommends that if municipal authorities are interested in tackling the rapid growth of slums by expanding the supply of affordable housing, they should critically examine their building regulations and modify them to address the housing needs of their low-income residents.

Keywords Affordable housing · Ahmedabad, India · Building regulation · Housing affordability · Slum formation

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1 Introduction

Development regulations include planning for zoning and land use, site planning, and building standards. To ensure higher levels of safety, health, sustainability, and comfort, municipal authorities in India are quick to ratchet up construction, infrastructure, and space standards that buildings in their jurisdictions must mandatorily meet. In recent years, newer and progressively more stringent regulations have been introduced to enhance fire and structural safety, improve accessibility, increase sustainability[1] through rainwater harvesting, energy efficiency, renewable energy, and meet other objectives. Further, by specifying minimum sizes for rooms, staircases, lobby, and common areas, building regulations establish an amount of built space that must be consumed. Planning regulations also require a certain level of land consumption by mandating minimum lot sizes, minimum road widths, maximum Floor Space Index (FSI),[2] maximum ground coverage, maximum building height or number of floors, minimum building setbacks and margins, minimum open spaces, minimum parking, and other requirements.

Regulations directly determine the cost of construction and the amount of land consumed to build housing. While mandating higher standards, municipal and development authorities give insufficient consideration to the fiscal impact of regulations, do not analyze their impact on building intensity or space consumption, and fail to consider household incomes and affordability to low-income residents. While regulations are mandated with the best of intentions, in a country where a third of the urban population lives in slums, unreasonable and rigid regulations make building more expensive, making formal sector housing unaffordable to millions. A few regulations are a result of efforts to keep densities low, prevent land from being developed intensely, and limit the number of units that can be built on land. Gross underutilization of serviced urban land imposes high costs on society by limiting the amount of affordable floor space and increases the cost of homes.

Much of the discussion on affordable housing[3] in India has focused on the supply-side constraints within urban land markets that raise the cost of serviced urban land, making housing unaffordable. It is well understood that land is limited and is being used inefficiently, resulting in high cost of both land and built space (Sivam 2002; Bertaud 2010; Annez et al. 2010; Gandhi 2012; Gopalan and Venkataraman 2015). However, unaffordable housing is more than a factor of restricted land supply or low FSI stipulation. Due to lack of empirical evidence, there is little understanding of the role of regulations in determining the cost and supply of affordable housing, and the overall costs they impose on society. Regulations that work against market forces are contrary to the needs of a growing economy, and not flexible to accommodate growth pressures. High standards impose unnecessary costs on residents, users, and developers by making housing more expensive.

[1] For instance, recent regulations for Ahmedabad City enforced in 2015 and those for Surat City enforced in 2016 mandate rainwater harvesting for buildings larger than 80 sq. m. and lots larger than 500 sq. m. Proposed GDCR for Gandhinagar included in its draft 2024 Development Plan for GUDA mandate rooftop solar water heating for lots larger than 500 sq. m., rainwater harvesting for lots larger than 1000 sq. m., and graywater recycling for lots ranging from 5000 to 10,000 sq. m.

[2] Floor Space Index (FSI) is defined as the ratio of the total floor area on all floors to the lot area. It is similar in concept to the floor area ratio (FAR).

[3] Affordable housing concept is based on the amount of household expenditure that goes toward housing as a portion of the total household income, and a threshold of 30–35% is generally considered affordable (Gopalan and Venkataraman 2015). The Government of India considers both income and size criteria to define affordable housing and adopts a threshold of 30–40% gross monthly household income as affordable (GOI 2012).

For instance, in Mumbai, severe shortage of land and restrictive regulations have pushed up property prices so much that only 5–6% residents can afford a formal sector home and 54% live in slums (Gandhi 2012; Patel and Phatak 2014). Local governments are not able to realize larger public benefits such as providing affordable housing to millions of poor slum households (Annez et al. 2010; Bertaud 2010; Sridhar 2010).

This study emerged from a need to understand the specific regulations that limit supply and raise costs of affordable housing. It was initiated in 2012 at the request of the Mahila Housing Trust (MHT), promoted by the Self Employed Women's Association (SEWA). SEWA is a renowned NGO based in Ahmedabad and works to improve the economic and living conditions of over a million poor women members employed in the informal sector. MHT's objective is to improve housing delivery and infrastructure provision for its members living in slums. It wanted to build homes for them, but realized that under the prevalent regulatory framework it was not possible to build homes that were affordable as well as fully compliant.

This study analyzes the impact of relaxing a few planning and building regulations on the cost of small, two-room homes using two comparable housing layouts for the same site on the periphery of the city. The purpose is to determine the costs incurred to produce a minimum cost, legally built, formal sector home and understand how regulations inflate the cost and constrain the supply of affordable housing. Comparing housing supply, costs, regulations, and affordability, the study shows that modifying select regulations can reduce cost by 34% and increase supply by 75% without significantly lowering quality or compromising safety. This paper argues that setting high minimum standards considerably increases the cost of housing, constrains supply, and recommends that cities need to critically analyze and relax their regulations to increase the supply and affordability. Section 2 discusses proliferation of slums due to regulations and the inability of the housing market to respond to housing demand. Section 3 discusses the housing supply in Ahmedabad, and Sect. 4 presents the case study with comparative layout designs. Case study findings are presented in Sect. 5, followed by broad policy recommendations in Sect. 6. Section 7 includes a brief discussion, and conclusions are in Sect. 8.

2 Mandatory minimum standards fuel the formation of slums

Formal housing supply is determined by compliance to a variety of regulations, including land ownership and title, conversion of agricultural land to urban use, land-use zoning for residential use, layout and subdivision regulations, site planning regulations such as minimum lot size, ground coverage, setbacks, density, FSI and parking, and building and construction standards (Patel and Phatak 2014). Regulations directly influence the quantity and cost of affordable housing built within the formal housing market (Annez et al. 2010). They determine the cost of construction and the quantity of livable space that can be built on a parcel of land. Stipulating unreasonably high standards increases the cost of construction and prevents optimal land utilization, making housing unaffordable for many poor people. Regulations thus determine the portion of affordable housing that is built within the formal housing market, pushing the remaining to the informal sector and fueling slum formation. High standards prevent the private formal sector housing market from producing homes that the poor can actually afford, and in the quantities required to move millions of slum households into formal housing. In situations where the supply of serviced urban land is constrained, the greater the number of units that can be accommodated on land, the more affordable they are. Bertaud and others have argued that that revision of expensive regulations and relaxing standards should be critical to removing constraints in affordable housing

supply to enable more poor households to move into formal sector housing (Arnott 2009; Annez et al. 2010; Bertaud 2010; Mehta et al. 1989; Sridhar 2010; Payne 2005).

Slum formation can be understood as a response to the failure of the formal housing market to meet the market demand, and the inability of regulations to improve the city's capacity to absorb current and new residents (Lall et al. 2006). Evidence from Brazilian cities suggests that zoning and density controls (such as large minimum lot size and low FAR) limit the quantity of housing, influence rural-to-urban migration, and slum formation. Price elasticity of housing supply is the capacity of the formal housing sector to absorb urban migrants. Inelastic supply limits the housing stock adjustment to migration and urban expansion and stimulates slum formation. When the formal housing market is unresponsive to changes in housing demand, a substitution effect happens into the informal sector, meaning, when regulations pose barriers to residents to enter the formal housing market, people meet their demand in slums (Lall et al. 2006).

Historically, to discourage large-scale rural-to-urban migration many countries deliberately set high standards for formal sector housing, making housing unaffordable. Stricter regulations provide migrant-unfriendly signals to poor people in rural areas, discouraging their migration to cities (De Soto 2000). Regulations in India are also a relic from its colonial past, derived from spacious British standards that are irrelevant for popular housing today because they specify lot sizes and land uses that the majority of the poor cannot afford (Mehta et al. 1989). Many unrealistic standards have continued to this day and have contributed to the widespread proliferation of slums and affordable housing shortage. In an example from Tanzania, generous lot sizes and road widths allowed only 3900 lots, instead of 15,000 possible with more realistic standards (Kironde 2006). Indonesia seems to have a relatively functional and affordable housing market as enforcement is flexible (Monkkonen 2013). However, relaxing regulations may stimulate some migration from rural areas, so the net benefit may depend on the extent to which the formal housing supply is able to absorb demand from slum dwellers (Lall et al. 2006).

Millions of slum dwellers are unable to access formal sector housing and are forced to live in unhygienic and stressful conditions without access to basic infrastructure and sanitation. Informal settlements are a coping mechanism by the poor to gain citizenship and social capital, as well as education and employment opportunities, even though it necessitates a trade-off with health (Cardoso 2002). They are unable to build the capital assets they need to break out of the poverty cycle, as being outside the formal market economy they are not able to leverage their sizable but informal assets into capital (De Soto 1990). Local governments are also burdened as they are forced to spend scarce resources on intermediate slum improvement programs to extend basic urban services such as water supply, sanitation, waste management, roads, streetlights, health, and education facilities, undertake sites and services or other interventions (O'Hare et al. 1998).

Taiwo (2015) suggests private sector involvement for viable low-income housing in Nigeria where 70% of population is poor, and urbanization rates have far surpassed public resources to build affordable housing. Ogu and Ogbuozobe (2001) suggest a review of restrictive planning and building codes that inhibit private sector housing production and promote unauthorized construction. For Indian cities, Sivam et al. (2001) recommend that of the various stages of planning, land assembly, development, construction, and disposal, the responsibility for land development and housing construction should be privatized. In 2015, the Indian government adopted an ambitious mission: "Housing for all by 2022" for rehabilitation of slum households with active participation of private developers and using land as a resource.[4]

[4] "Housing for All by 2022" Mission—National Mission for Urban Housing. Available online http://www.pmindia.gov.in/en/news_updates/housing-for-all-by-2022-mission-national-mission-for-urban-housing/.

3 Household income and housing supply in Ahmedabad

India has the largest slum population in the world that continues to grow (GOI 2008). In spite of significantly reducing extreme poverty and slum population, in 2014 about 24% of Indian urban population lived in slums and often spend more than a generation living there (UN Habitat 2014; GOI 2008). Even with high levels of sustained long-term economic growth and rising incomes, an estimated 38 million urban dwellers will not be able to access market-priced housing (McKinsey 2010). There is a stark mismatch between those who need housing and the kind of housing being built. In 2012, almost all of the housing shortage in India was in the affordable sector. Of the total shortage of 18.78 million units, 56% was for households with annual incomes under 100,000 Rs. and 40% for incomes under 200,000 Rs. (GOI 2012). A National Housing Board study estimated that of the 30% urban population that lives in slums, a large portion can afford to live in better quality, small-sized units ranging from 25 to 40 sq. m., but there is no supply of good quality, affordably priced, formal sector units (MIM 2010; Agarwal et al. 2013). Often government-built and subsidized affordable units meant for low-income residents are occupied by middle-income residents as the poor cannot afford them (Sivam 2002). In almost all cities of India, slums can be seen as the physical manifestation of government and market failure to provide low-income housing as they have not been able to meet the growing demand (Sivam and Karuppannan 2002).

The stock of affordable housing is limited in Indian cities and most of it is government built. Restrictive regulations have prevented the private sector from supplying affordable housing at a scale that can make a difference. Since 2008, Indian developers have started building affordable housing at a modest scale, and the private market is improving for good, private sector built, quality, affordable housing. Developers have initiated affordable housing projects in various cities and are getting robust return on investment, particularly in Ahmedabad, as they see a scale-opportunity with value in mass production of affordable housing (MIM 2010). Housing finance innovations are increasingly provide access to the poor, and the government has started improving land development mechanisms by removing supply-side constraints to serviced urban land (Joshi and Sohail 2013). While these are encouraging trends, regulations have not been critically examined to enable private sector production of affordable housing in large numbers.

Ahmedabad is a large, bustling, and fast-growing city located in India's western state of Gujarat. In 2011, it had a population of 5.57 million, making it India's fifth largest city and seventh largest metropolitan area (Census of India 2011). According to housing typology and household income analysis, only 40% residents can actually afford the existing formal sector housing in Ahmedabad (Annez et al. 2010). Incomes in the city have grown considerably, with only 5% residents below the Indian poverty level, almost 30% live in slums.[5] Despite increases in household incomes, there are limited options for the poor to access formal sector housing. Many slum households could afford a formal sector low-income home, but there is a shortage of such homes in the city (MIM 2010; Annez et al. 2010). Only 8.1% of the existing housing stock is affordable, but most of it is currently

[5] "Slum" refers to informal settlements that may have inadequate infrastructure and services, absence or lack of recognition of legal tenure, overcrowding and poor quality, or location in areas not suited for habitation. Slum population data as reported are unreliable, as it varies considerably from 4.5 to 30%. As per the 2011 census, there were 51,451 slums in Ahmedabad having a population of 250,681 (about 5% of total population). However, census counts only notified slums, which exclude small slums and upgraded slums de-notified by local governments for the purpose of providing basic services. Patel and Phatak (2014) estimate the 2001 slum population of Ahmedabad to be about 25%.

occupied by middle-income households. The old Walled City and *chawls*[6] provide cheaper, formal sector housing options to another 35% residents. The poorest households at the very bottom of the income distribution live in riverbank slums or on the pavements (Annez et al. 2010).

Regulations are only one level of constraint in a complex, bureaucratic, and multilayered process of converting agricultural land on the urban periphery to developable land suitable for urban use and housing production. These greatly add to the cost, time, and risks for the developer, all of which are eventually built into the housing cost and transferred to the consumer, making housing unaffordable (Annez et al. 2010; Patel et al. 2009). In Ahmedabad, the housing development process includes at least 16 lengthy steps that require coordination between the private sector, the state's urban development and revenue departments, the Ahmedabad Municipal Corporation (AMC), and the Ahmedabad Urban Development Authority (AUDA). These processes include zoning for urban use in the city-level Development Plan which must be approved by the state (Adhvaryu 2011); building the regional trunk infrastructure including roads, sewers, and water supply; undertaking detailed area planning using land readjustment in the form of town planning schemes (TP Schemes) that must also be approved by the state (Ballaney and Patel 2009; Ballaney 2008); implementing neighborhood level infrastructure; lot-by-lot conversion of agricultural land for urban use by the state's revenue department (Patel et al. 2009); land sale from owner to developer and payment of stamp duties; obtaining a building permit, construction and monitoring at different stages; and obtaining a building use/occupancy permit. Policy reform to streamline procedures for permits, conversion of land from agricultural to urban use, and housing development will reduce costs and time, bring land into development, and reduce speculation (Annez et al. 2012).

The Gujarat Housing Board, the AMC, and AUDA have built most of the affordable housing in Ahmedabad. Government agencies have built affordable housing using realistic standards; however, the private sector was not allowed to use them, resulting in a monopoly (Bertaud 2010). Because of revised income criteria for affordable housing in 2013, millions more slum households have become eligible for accessing government subsidies.[7] Although the government has increased the affordable housing production, demand far outstrips supply. In Ahmedabad, 43,000 applications were received against 4000 units, most of them for small two-room units.[8] Since 2008, the private sector has entered the affordable housing market in a small but significant way in Ahmedabad, which has been a testing ground for developers for the low-income segment (MIM 2010).

Municipal and development authorities in Gujarat enjoy a wide range of regulatory powers under the Gujarat Town Planning and Urban Development Act, 1976, that establishes the legal planning framework for the state. The General Development Control Regulations (GDCR) form a part of the city's long-range urban Development Plan and modified as part of a comprehensive plan update every 10 years. Cities commonly use TP Schemes to create serviced urban land on the urban periphery, of which up to 10% land is mandated for affordable housing (GoG 1976). However, much less land becomes available

[6] Chawls are large low-rise buildings having multiple one-room tenements with shared toilet facilities. In Ahmedabad, most of chawls are located near older industrial areas on the eastern periphery, are old and in dilapidated state (AMC and AUDA 2006).

[7] The financial eligibility criteria were below Rs. 100,000/year (approximately Rs. 8300/month). Recently, the threshold income was increased to Rs. 250,000/year.

[8] Presentation to CSMC by A. Kumar, I.A.S., Secretary (Housing), Urban Development & Urban Housing Department, Govt. of Gujarat dated 03-17-2016.

to local governments. Ahmedabad's revised plan earmarked more land for affordable housing, offers FSI bonuses, and requires the private sector to build some affordable housing in large developments (Joshi and Sohail 2013).

4 Case study in Ahmedabad

This study examines the effect of relaxing a few mandatory site planning and building regulations on the cost of small, two-room houses with a floor area of 27.2 sq. m. in Ahmedabad. The specific research questions investigated are: How much does it cost to produce a minimum cost, legally built, formal sector home? How do regulations inflate the cost and constrain the supply of low-income housing, and to what extent? How can key regulations be modified and relaxed to reduce the cost of housing, and at the same time increase supply?

4.1 Methodology

Two comparable housing layouts were designed for the same site having an area of 1.7 hectares at the periphery of the city. First, a layout was designed in accordance with the Ahmedabad's GDCR prevalent in 2012. Specific regulations for their potential impacts on the quantity and cost of affordable housing were examined, along with a review of comparable national and recommended standards. Site visits were undertaken to several low-income housing developments built by AUDA. Next, an alternative layout design that allowed for relaxed regulations and minimum standards was developed without significantly compromising important safety or quality of life aspects. Cost estimates were derived for both layouts, and the cost of a single unit in each layout was determined. The two layouts were evaluated comparing the total number of units that could be built on site, costs, and impact on housing affordability.

4.2 Comparing two layout designs

Figure 3 shows the original layout that conforms to regulations specified in the prevalent GDCR, and Fig. 4 shows the alternative layout for the same site after relaxing a few mandatory regulations. A three-dimensional visual of both layouts is given in Fig. 2 to illustrate the differences in the built form composition, street network, open spaces, and other features. Both layouts were developed through an iterative process to come up with designs that maximized built space and accommodate the maximum number of units to keep the cost of an individual unit low. In both layouts, the design and habitable area of the individual unit remains the same—each unit having a usable area of 27.2 sq. m, including a living room, bedroom, kitchen, toilet, and bathroom (Fig. 1a). The gross unit areas (including staircases and lobby) are 29.7 sq. m for the original layout and 34.0 sq. m for the alternative layout. Recommended minimum is 25 sq. m. with provision of two rooms, a toilet, and a kitchen (GOI 2009).

(a) *Number of units* In the original layout, it was possible to accommodate 640 units, organized within 20 buildings of 4 floors each, each floor having 8 units (Fig. 1b). In comparison, the alternative layout accommodates 1120 units on the same site (Table 2). This is a 75% increase in the number of units, achieved mainly through



Fig. 1 **a** *Top left* Individual unit design, **b** *top right* building design for original layout, and **c** *bottom* building design for alternative layout. *Source*: Prepared by authors

more intense land utilization, accommodating more buildings on site, and adding an additional floor to increase the total built space.

(b) *Building heights and elevators* Ahmedabad GDCR stipulate that an elevator must be provided in buildings taller than 13 m for convenience. In the original layout, buildings are restricted to G + 3 (total four) floors to avoid the additional costs of installing, operating, and maintaining elevators. Maintaining and operating elevators in affordable housing is challenging, as residents are unwilling or unable to pay recurring costs. This limits the built space and the number of units that can be built. In the alternative layout, the elevator requirement is modified and buildings are designed to be five-story walk-up apartments, adding quite a few units. National standards require elevators in 15 m or taller buildings (BIS 2005; TCPO 2016). In the alternative layout, buildings are G + 4 (total five floors), limiting their height within 15 m.[9] By adding an additional floor, it became possible to fully consume the maximum permissible FSI of 1.8. While it is possible to have buildings taller than five floors without elevators, they may inconvenience residents more, or result in negative externalities such as traffic congestion from higher densities. Keeping within the stipulated FSI also ensures that densities do not exceed planned infrastructure capacity.

(c) *Internal roads* In the original layout, the width of internal roads is consistent with prevalent GDCR that specify 7.5- or 9.0-m-wide internal roads up to 150 and 300 m long, respectively. In the alternative layout, the total area under streets increased from 29 to 32%, but access roads are reduced to 6.0 and 4.5 m, which is enough for vehicles to pass each other. The national standards recommend minimum vehicle access of 5.0 and 6.0 m up to the entrance of cluster-type housing development (BIS 2005; TCPO 2016). Poor households in India hardly own cars and tend to rely more

[9] The 2012 Ahmedabad GDCR and the National Building Code of India 2005 (BIS 2005) specify minimum floor height for a habitable room at 2.8 m., so a five-story building can be built within 15 m.

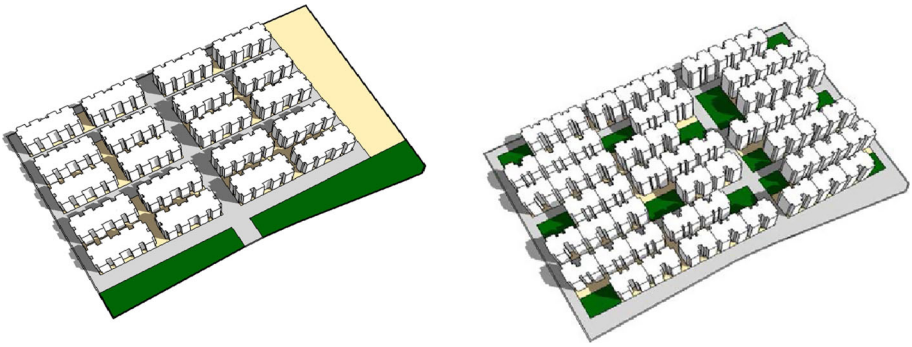

Fig. 2 Three-dimensional views of original (*left*) and alternative (*right*) layout designs. *Source*: Prepared by authors

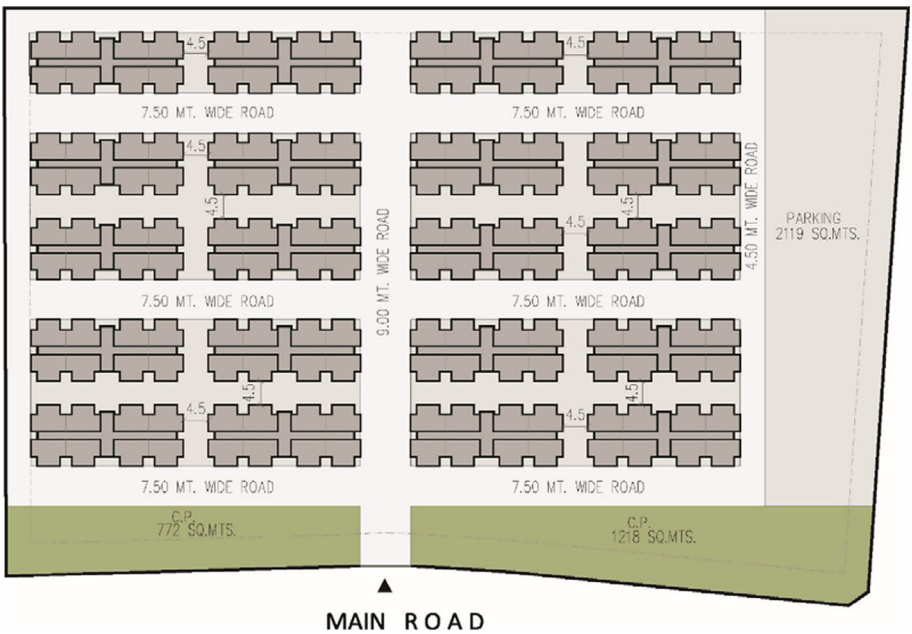

Fig. 3 Original layout design of low-income housing designed in accordance with prevalent regulations. *Source*: Prepared by authors

on two-wheelers and bicycles, which do not need wide roads. Site visits showed that wide roads in low-income housing are not optimally used (Fig. 5). Narrower internal streets enable optimal use of valuable land, slow down internal traffic, and increase safety of residents and children playing on the streets.

(d) *Pathways* In the alternative layout, minimum distance between buildings has been reduced from 4.5 to 3.5 m for façade with openings and 2.5 m for façade without openings. This will ensure adequate light and ventilation through doors and windows and accommodate approach pathways to buildings from the street. The proposed change is consistent with the national standards that stipulate minimum



Fig. 4 Alternative layout design of low-income housing designed after modifying few regulations. *Source*: Prepared by authors

2.0-m pathways up to 30 m long and 3.0-m pathways up to 50 m long for slum resettlement (BIS 2005). Model bylaws recommend access pathway to building entrance to be 1.8 m wide (TCPO 2016).

(e) *Ground coverage* In the alternative layout, there are several changes proposed to parking, open space, setbacks, and other regulations that determine the total ground coverage. As a result, ground coverage increased from 32% in the original layout to 39% in the alternative layout. Regulating ground coverage does not serve any specific purpose, as the built form and density are determined by the FSI, building heights, setbacks, and margins. In the alternative layout, the maximum ground coverage requirement is removed. From an environmental perspective, it is more rational to regulate impervious surface area to encourage groundwater recharge.

(f) *Common open plot (COP)* Ahmedabad GDCR require COP to be left at minimum 10% of the lot, with a minimum size of 200 sq. m. and a minimum dimension of 10.5 m. Often the COP is provided in left over areas and is neither well used nor properly maintained, doing little to enhance the quality of life of residents (Fig. 5). In the original layout, a large consolidated large COP is provided, about half of which also doubles as parking (as permissible by the GDCR). In the alternative layout, the minimum dimension and size requirements are relaxed. The total area under open spaces remains about the same, but distributed differently. Several smaller, usable, community-level open spaces are dispersed around buildings, making them accessible to many more households (Fig. 4). A better sense of ownership will result in their better usage, improve maintenance, and increase safety. In contrast to the original layout, which is regimental and monotonous, the alternative layout is more varied consisting of an interesting mix of various types of

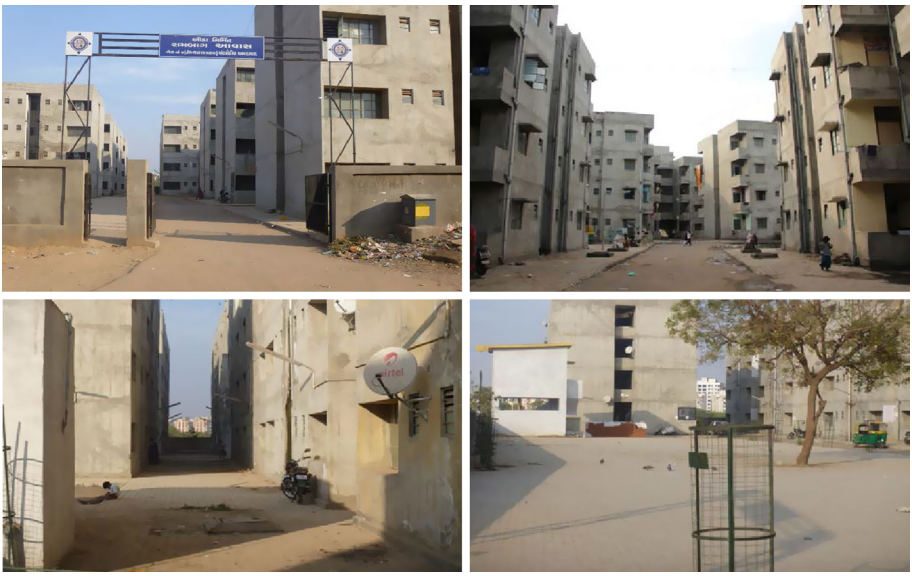

Fig. 5 Typical low-income housing built by AUDA in accordance with their prevalent regulations. *Source*: Photographs by authors

open and built spaces. These spaces could generate greater social interaction among neighbors, as well as create spaces for children play areas and hosting community gatherings and events (Fig. 6).

(g) *Parking* Prevalent Ahmedabad GDCR stipulate that a minimum of 15% of utilized FSI must be provided as parking, and up to half of the COP may be used to meet this requirement. In the original layout, the FSI consumed is only 1.2, and parking is provided at 15% along the side margin (Fig. 3). Dedicated parking takes up 12% of the site, in addition to about half of the COP. In the alternative layout, minimum parking is not mandated and hence not provided, which results in higher land utilization, allowing more units to be built, and free up the COP to function as open spaces instead of parking. Site visits to several low-income housing societies showing the presence of few two-wheelers, an occasional three-wheeler, and no cars (Fig. 5). In the alternative layout, two-wheelers can be parked around buildings on the paved areas. Mandating minimum parking in low-income housing is wasteful and forces developers to provide parking for residents who are not likely to own cars, and more likely to rely on two-wheelers and bicycles, or use public transportation. The income group for whom this kind of affordable housing is targeted is very poor, earning well below the affordability of owning a car.[10] Should the need arise in the future, some of the COP could be converted to parking, since the proposed change does not prevent provision of parking.

(h) *Floor Space Index (FSI)* In the original layout, the FSI consumed is 1.2, only 60% of the maximum permissible FSI of 1.8. Several regulations when applied together

[10] While disposable incomes and car ownership rates are rapidly increasing in India, the cheapest car still costs more than 10 times the annual income of target households.



Fig. 6 Visualization of the alternative layout low-income housing designed after modifying key regulations. *Source*: Prepared by authors

constraint the amount of built space and prevent full consumption of the maximum permissible FSI. These include the elevator requirement, minimum parking requirements, minimum margins between adjacent buildings, minimum width of internal streets, minimum size of common open space, and others. It was not possible to build more or increase the number of units without considerably increasing building and maintenance costs. In the alternative layout, it was possible to consume the entire 1.8 FSI by relaxing key regulations outlined above. The maximum permissible FSI remains 1.8 for both layouts (Table 2).

(i) *Fire and emergency access* While some regulations have been modified in the alternative layout, it conforms to important building safety and performance regulations as specified in the Ahmedabad GDCR. Materials, construction and workmanship quality, and natural hazard safety standards have been included in Ahmedabad GDCR based on the Indian Standard codes and the National Building Code of India.[11] Specifically, the alternative layout considered emergency vehicle access to each building to ensure fire safety, and lot corners left open to facilitate turning of emergency vehicles. The city's Chief Fire Officer provided valuable local fire guidance and expressed satisfaction with the fire safety provisions. In the original layout, each building has a 1.2-m-wide staircase shared by 32 units. In the alternative layout, each building has two 0.9-m-wide staircases and 20 units share one 0.9-m-wide staircase each, which enhances emergency egress (Fig. 1). Model byelaws recommend a 0.9-m-wide staircase for residential low-rise buildings (TCPO 2016).

[11] Part IV Structural Design, Part V—Building Materials and Part VII—Construction Practices and Safety of the National Building Code of India 2005 (BIS 2005). Ahmedabad GRCDs also mandate several Indian Standard (IS) Codes for structural, seismic, cyclone, and wind storm protection.

5 Case study findings

5.1 Comparing development regulations

The alternative layout has a much higher land utilization intensity. Compared to the original layout, for every square meter of built-up space, the land consumed under the alternative layout decreased by 33.88%. Compared to the original layout, land consumed by each unit decreased by 42.85% (Table 1). The modified regulations allow much more built-up space on the same site, resulting in a net building density increase of 51.23%.

While low FSI stipulation does limit the amount of built space, it is just one of the several regulations that constrain the low-income housing supply. Table 2 summarizes key regulations within in the prevalent GDCR and suggested modifications that directly impact the cost and supply of affordable housing. Modifications made it possible to accommodate as many as 1120 units compared to 640 in the same land, while still maintaining the maximum permissible FSI at 1.8.

The cost of building the cheapest legal house is constrained by a host of regulations applied together, and adherence to other regulations makes it impossible to consume the FSI. Prevalent GDCR stipulate that minimum 10% of the lot must be left as COP, minimum 15% of the consumed FSI must be left as parking, minimum road widths of internal

Table 1 Area comparisons. *Source*: Compiled by authors

	Layout design with prevelent regulations	Layout design with modified regulations	% Change
Total lot area	17,000 sq. m.	17,000 sq. m.	
Total built-up area	20,144 sq. m.	30,464 sq. m.	51.23
FSI consumed on site	1.2	1.8	51.23
No. of floors	Ground + 3	Ground + 4	25
Total no. of units	640	1120	75.00
Dwelling unit density (no. of units per hectare)	376.47	658.82	75.00
Individual housing unit areas			
Carpet area	24.3 sq. m.	24.3 sq. m.	−12.65
Built-up area	27.2 sq. m.	27.2 sq. m.	
Gross built-up area[a]	34.0 sq. m.	29.7 sq. m.	
Average land area consumed by each unit	26.56 sq. m.	15.18 sq. m.	−42.85
Average land area consumed by each sq. m. of built floor space	0.84 sq. m.	0.55 sq. m.	−33.88
Ground coverage utilized	32.20%	38.98%	21.06
Common open plot (COP)	11.71%	11.34%	−3.16
Percentage of area under roads	29.35%	32.38%	10.30
Percentage of land under dedicated parking	12%	0%	
Other open and marginal spaces	14.27%	17.30%	21.23
Net building density (sq. m./ha)	11,849.41	17,920.00	51.23

[a] Includes commonly shared areas such as lobbies and staircases

Table 2 Comparison of building regulations. *Source*: Compiled by authors

	Regulations as per prevalent GDCR	Modified and relaxed regulations
Maximum allowable FSI	1.8	1.8
Minimum common open plot (COP)	10% of lot area	10% of lot area
Minimum size	200	Not specified
Minimum dimension	10.5 m	Not specified
No. of floors (without elevators)	Ground + 3	Ground + 4
Maximum ground coverage	45%	Not specified
Internal road widths for road length		
Up to 150 m	7.5 m	4.5 m
Up to 300 m	9.0 m	6.0 m
Minimum distance between two low-rise buildings		
Façade with openings	4.5 m	3.5 m
Façade without openings	4.5 m	2.5 m
Front and rear margins/setbacks	As per GDCR	s per GDCR
Parking	15% of FSI consumed or utilized	Not specified
Minimum width of staircase flight	1.2 m	0.9 m

streets must be 7.5 m, minimum margins of 4.5 m must be left between two adjacent buildings, and an elevator must be provided in buildings higher than 13 m. These regulations force developers to leave a significant portion of land undeveloped, lowering the building intensity and residential density, as well as provide services (parking and elevators) that increase the unit cost. In the alternative layout, several standards were relaxed, including minimum dimension and size of the COP, maximum number of floors that can be built without an elevator, minimum width of the staircase, minimum width of internal streets and approach roads, minimum distance between buildings, and minimum parking to be provided.

Economically weaker section housing built by AUDA suffers from even greater inefficiency in land utilization. A quick analysis of four housing complexes shows that their FSI consumed hovers around 1, much lower than the permitted 1.8 (Fig. 7). AUDA's 2012 GDCR included special low-income housing regulations, which restricted building heights to two floors resulting in horizontal development, with a resultant density of 225 units per hectare (AUDA 2004). Considered together, they allowed a maximum FSI consumption of only 0.78. AUDA decided not to use these standards to build their affordable housing, and these regulations have since been revised.

5.2 Comparing housing costs and affordability

We estimated costs for both layout designs and compared the total cost of building a single house. There are three major cost components: cost of the land, cost of construction, and cost of stamp duty and registration charges paid at the time of property transaction. Table 3 gives cost estimate comparisons for a single unit for both the layouts.

1. *Land cost* In Indian cities, land is typically the largest cost component in housing. While the total land cost in both layouts is the same at Rs. 425 million, land cost is

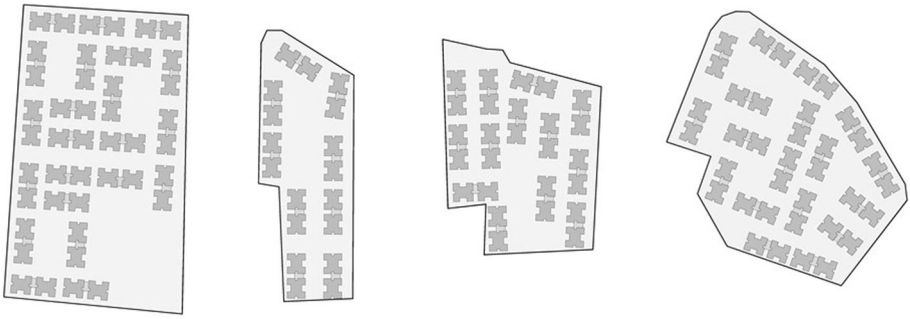

Fig. 7 FSI consumed by four housing projects built by AUDA in accordance with prevalent regulations. *Source*: Compiled by authors

Table 3 Cost comparison. *Source*: Compiled by authors

Details of cost comparison	Prevalent regulations	Modified regulations	% Change
General details			
Built-up area per each unit (sq. m.)	27.2	27.2	
Total built-up area (sq. m.) on all floors including common areas	20,144	30,464	51.23
Total number of units	640	1120	75.00
Gross built-up area per each unit (sq. m.)	34.03	29.7	−12.72
(*a*) *Land cost*			
Total lot area (sq. m.)	17,000	17,000	
Land cost per unit area (Rs/sq. m.)	25,000	25,000	
Total land cost for the entire lot	425,000,000	425,000,000	
Land cost per unit area of built space (Rs./sq. m.)	19,517	12,777	−34.53
Subtotal a: Land cost per unit	664,063	379,464	−42.86
(*b*) *Construction cost including profit*			
Construction cost per sq. m. of gross built-up area (Rs./sq. m.)	8600	8600	
Subtotal b: Construction cost per unit	292,615	255,420	−12.71
Land and construction cost per unit (a + b)	956,678	634,884	−33.64
(*c*) *Transaction (stamp duty and registration) charges*			
Stamp duty @ 4.9% of land and construction cost (a + b)	46,877	31,109	−33.64
Registration charges @ 1.1% of land and construction cost (a + b)	10,523	6984	−33.63
Subtotal c: Total charges per unit	57,401	38,093	−33.64
Total cost per unit including land, construction, and transaction charges (a + b+c)	1,014,078	672,977	−33.64

All costs are in Indian Rupees (Rs.). In 2012, 1 USD was equal to approximately 56 Rs.

Table 4 Comparison of home mortgage. *Source*: Compiled by authors

	Prevalent regulations	Modified regulations	% Change
Loan repayment term (in months)	240	240	
Interest rate per year[1] (% per year)	13	13	
Down payment (@ 15%)	143,502	95,233	−34
Total mortgage or loan amount (Rs.)	813,176	539,652	−34
Installment or EMI (Rs. per month)	9257	6322	−32

All amounts are in Indian rupees (Rs.). In 2012, 1 USD was equal to approximately 56 Rs.

[1] Mortgage interest rates in India are quite high. In 2012 they ranged from 12 to 14% per annum

distributed among the total number of units that are accommodated in each layout. In the original layout, the share of land cost per unit is Rs. 664,063 (total 640 units), which in the alternative layout reduced to Rs. 379,464 (total 1120 units). This is a 42.86% reduction, as the total land cost is shared by 1120 households in the alternative layout as compared to only 640 households in the original layout.

2. *Construction cost* The cost of construction per sq. m. of gross built-up area is taken at the rate of Rs. 8600 per sq. m. for both layouts.[12] In the alternative layout, the gross floor area per unit reduces from 34.03 to 29.70 sq. m. due to reduction in common lobby and staircase areas. Since there is a 12.7% reduction in gross area, the construction cost per unit also reduces by 12.7% from Rs. 292,615 to Rs. 255,420.
3. *Transaction cost* Considering the land and construction cost components, the cost of each unit in the alternative layout is reduced by 33.64%. Transaction charges add an additional 6% in the state of Gujarat. The state government of Gujarat charges stamp duty at the rate of 4.9% and sale deed registration at the rate of 1.1% of total cost. In the alternative layout since the cost of each unit declined by 33.64%, the transaction charges also declined similarly.

In most public housing projects, land is supplied by the local government. Since serviced urban land is a scarce resource, it makes economic sense to optimally use the limited land available and benefit as many poor households as possible. To encourage private sector involvement in the production of affordable housing, it is imperative to bring down the land cost as the private sector assembles the land from the market. The total reduction in the cost of one unit in the alternative layout is Rs. 341,101 which is 33.64% lower as compared to the cost of one unit in the original layout. Of this total reduction in the cost of one unit, the largest share is accounted for by the reduction in the share of land cost amounting to Rs. 284,599 (83.44% of total reduction of Rs. 341,101 in unit cost). This site is located at the periphery of Ahmedabad city where land costs are relatively lower. Where the site considered for the study more central, and therefore higher priced, the cost reduction in the land component would have been much greater. The reduction in the construction cost is Rs. 37,195 (10.90% of total cost reduction), and reduction in the share of transaction cost is Rs. 19,308 (5.66% of total reduction).

Table 4 compares the impact that these two different layouts have on housing affordability. Developing cheaper formal sector housing after relaxing few regulations can save poor urban households about 34% toward their housing mortgage, which translates to 32%

[12] This rate includes the developer's profit, but does not include the cost of site development such as providing roads and pathways, developing open spaces and other amenities.

savings (about Rs. 3000) in their equated monthly installment[13] (EMI) toward home loan repayment, making it more affordable.

For a large portion of Ahmedabad's poor households, their income levels being very low, the costs imposed by mandatory standards are not trivial and have a high impact on their affordability. The income group that MHT works with typically earn about Rs. 5000–6000 each in a two-member earning household, resulting in a monthly income of Rs. 10,000–12,000. The threshold household income for accessing formal housing in Ahmedabad is around Rs. 20,000, with the existing low-income housing beyond their reach (Annez et al. 2010). For the target group, the housing expenditure as a portion of household income reduces from about 75% with prevalent regulations to about 50% with modified regulations. This is still above the acceptable 30–40% government criteria for affordable housing (GOI 2012). Modifying regulations will reduce the affordability gap significantly, and the remaining gap may be met with some government subsidy. For these urban poor households, a saving of Rs. 3000 translates to a saving of 25% of their monthly household income. Households can channel this saving toward important expenditures such as better nutrition, access better education and health care, and improving livelihoods (Mueller and Tighe 2007). Lower costs and greater supply could enable many poor households living in slums to access formal sector affordable housing.

6 Policy recommendations

If local authorities in India are interested in tackling the rapid growth of slums by expanding the supply of affordable buildings, they must critically examine and revise their building and planning regulations. While developing the alternative layout, discussions were held with city officials from AMC and AUDA to obtain insights into the feasibility of implementing planning and building regulation modifications. Generally, city officials indicated a willingness to consider practical and rational modifications if benefits are evident and could be demonstrated. Officials indicated that regulations were formulated several decades ago, with outcomes and unintended consequences of regulations never critically and comprehensively evaluated. As a result, city officials were generally unaware of their effectiveness, cost implication, or impact on society. Based on the insights from this study, we suggest the following policy recommendations:

1. *Critically analyze the costs and benefits of development regulations* Careful formulation of regulations must take into consideration the cost of the resultant built space and affordability related to residents' income. The societal benefits resulting from moving millions of current slum dwellers into formal sector, legally built housing, and preventing formation of future slums are considerable. A critical analysis should determine the consequences of each regulation and provide local governments with the information necessary to modify regulations in order to increase the quantity of affordable housing that can be built within the formal housing market.
2. *Examine rationale behind development regulations* In the context of the current affordable housing shortfall, as well as long-term growth needs, cities need to develop a much better understanding on the original objectives of regulations and their

[13] Equated monthly installment (EMI) is a fixed mortgage payment made by a borrower to a lender each month. EMI includes both interest and principal. Over a specific number of years, the loan is paid back in full.

relevance and effectiveness today. Examining and documenting the rationale behind each regulation while formulating it into policy will make it possible to analyze its effectiveness over time and identify its unintended consequences and cost implications.

3. *Revise and relax standards for affordable housing* Standards for affordable housing should encourage higher-density development that allows more intensive land utilization. As suggested by Bertaud (2010), wherever construction is cheaper than land in low-income housing markets, it makes economic sense to substitute capital (construction of built space) for land as an input factor. Relaxing standards will make development more realistic, so that affordable housing is actually affordable to the urban poor and at the same time is cost effective for developers. Moving away from prescriptive standards toward performance standards will ensure an acceptable level of building performance, reduce unnecessary costs, increase design flexibility, meets construction and operation standards, and has the potential to improve quality of life for residents.
4. *Encourage private market supply of affordable housing* Authorities should develop strategies to encourage the private sector to build more affordable housing that is better suited to the level and distribution of household incomes in cities. A market-friendly mechanism will enable the private sector to respond to the existing demand of small-sized, good quality, formal sector homes. Relaxing government regulations to increase building and land utilization intensity provides a cost incentive for the private sector to move down-market to build affordable housing at a large scale that responds to the current demand, and increases the affordable housing stock in the city. However, enabling mechanisms for increasing market-driven affordable housing must be cautiously framed to ensure developer accountability and consumer acceptable delivery outcomes (Mukhija 2004; Mahadevia et al. 2014). Relaxing standards has the potential to scale up private sector affordable housing supply that is in line with the income range of urban slum households.

7 Discussion

A large proportion of Indian urban dwellers are not able to access formal sector housing because mandatory standards impose additional costs on housing and limit supply, and because they are too poor to afford the limited housing that is available. This study shows how regulations restrict housing supply and diminish housing affordability and highlights the possibility of expanding affordable housing supply by relaxing specific regulations. Regulatory frameworks developed for planned urban development have become barriers to achieving housing for all income levels. A comprehensive audit that leads to revised regulations will reduce proliferation of future slums by lowering the cost of entry to legal housing, improving access, enabling efficient use of urban land, and removing development constraints (Payne 2005). Efficient land management through better regulations also stimulates a functioning land and housing market, increases the elasticity of formal land and housing supply in response to demand, and manages the rate of slum formation (Lall et al. 2006). Many housing markets distortions can be corrected through regulatory intervention to enable commercially viable, large-scale, low-income housing by the private sector.

This case study compares the outcomes of the original and alternative layouts and is only one scenario in a range of possible scenarios for this location. Multiple layouts are possible within a low-rise, high-density typology. This exercise illustrates the restrictive impacts of a few key regulations and how they contribute to limiting the quantity of built space and restrict full consumption of permissible FSI. The specific outcomes from other layout alternatives, other locations, or other regulations may be quite different. While the regulations discussed in the case study are specific, the policy recommendations put forth in the paper are quite general. As illustrated here, a 75% increase in the number of affordable housing units and a 34% reduction in the cost of each unit are a compelling argument for examining and modifying regulations.

This type of denser but more affordable housing can be targeted to existing slum households to enable them to move into their first, formal sector, small-sized home. Clearly, there is a need to match regulations with residents' income and affordability so that they are relevant to the local context, particularly setbacks, building heights, ground coverage, lot size, and use regulations (Payne and Majale 2004). Access to infrastructure and facilities that formal housing offers will immensely improve their quality of life and enable them to break the poverty cycle through asset building. Further, this approach can also help reduce the government use of human and financial resources for slum clearance, resettlement, or upgrading of existing slums. City authorities can redirect their resources into formal housing and augment infrastructure to deal with increased demand due to new housing. As part of future research, post-occupancy surveys can provide valuable insights on residents' perceptions and satisfaction. This user perspective will be useful to determine the impact and sense of community of living in denser, but good quality, legal, and affordable housing and identify strengths and weaknesses of regulatory reform. These insights, along with cost analysis, could determine feasibility and form the basis of implementing modified regulations in Indian cities.

8 Conclusions

Regulations affect the affordability of legally built housing and have a high impact on affordability and force millions of poor households to live in slums. This study demonstrates that a myriad of mandatory minimum standards when applied together raise the cost of construction, do not allow intensive land utilization, and prevent full consumption of the permissible FSI. It shows that even in conditions of high cost and constrained land supply, and low FSI stipulation, it is possible to significantly increase the amount of built space and reduce costs by relaxing mandatory minimum standards. Relaxing standards has the potential to scale up the supply of affordable housing sufficiently to address its short supply without significantly lowering quality or compromising safety. In developing countries, such as India which is grappling with large-scale informality, and where almost a third of the urban population lives in slums, regulatory reform has the potential to enable millions of slum dwellers into good quality, formal sector, legally built, affordable housing.

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