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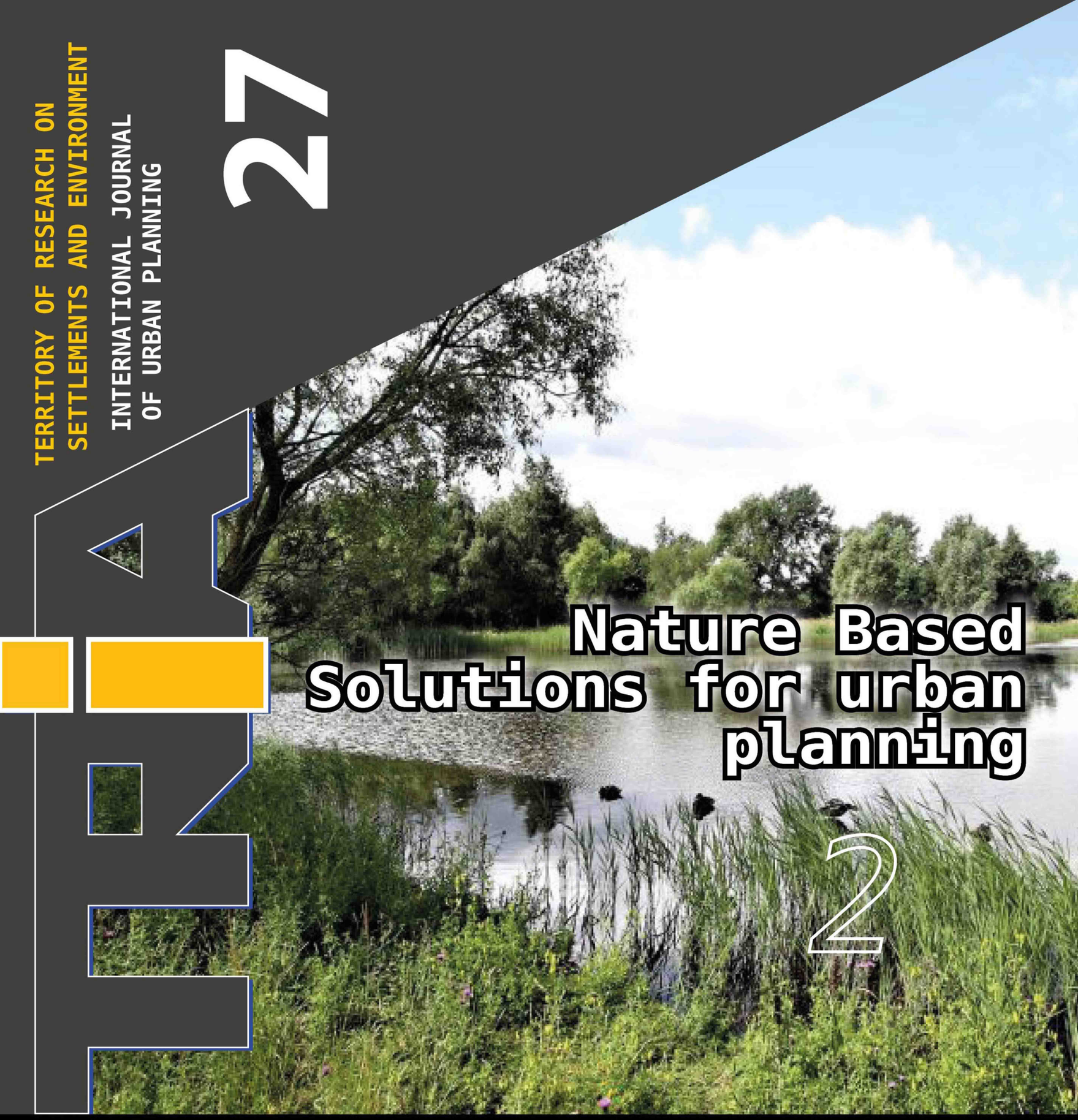

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
CENTRO INTERDIPARTIMENTALE L.U.P.T.

Federico II University Press

fedOA Press

Vol. 14 n. 2 (DECEMBER 2021)
e-ISSN 2281-4574

TERRITORIO DELLA RICERCA SU INSEDIAMENTI E AMBIENTE

TRIA TERRITORY OF RESEARCH ON SETTLEMENTS AND ENVIRONMENT
INTERNATIONAL JOURNAL OF URBAN PLANNING

WoS (Web of Science) indexed journal http://www.tria.unina.it

Università degli Studi Federico II di Napoli
Centro Interdipartimentale di Ricerca L.U.P.T. (Laboratorio di Urbanistica e Pianificazione Territoriale) "*R. d'Ambrosio*"

Responsible Editor in chief: Mario Coletta | electronic ISSN 2281-4574 | © 2008 | Registration: Cancelleria del Tribunale di Napoli, n° 46, 08/05/2008 | On line journal edited by Open Journal System and published by FedOA (Federico II Open Access) of the Federico II University of Naples

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DOI 10.6092/2281-4574/8809
www.tria.unina.it - Web of Science (WoS) indexed journal

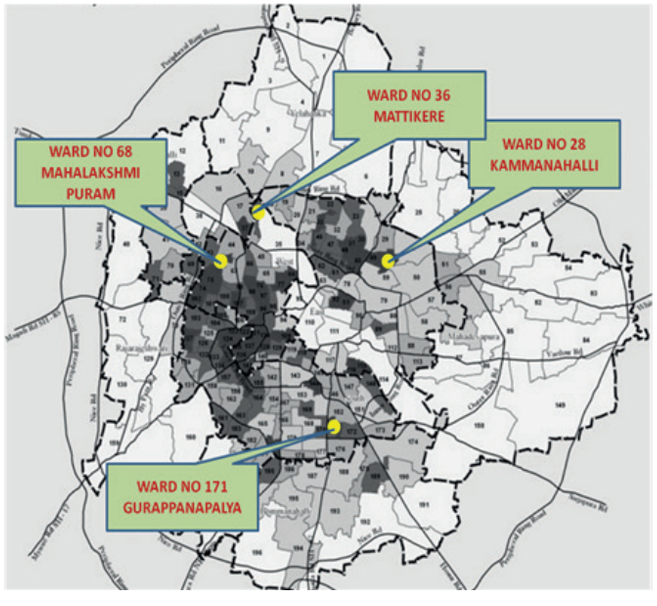
abstract

Quality despite density? Learnings on quality of life from dense urban residential neighbourhoods: Bengaluru, India

Shubhi Sonal

Abstract

Rapid influx of population and rising land prices has gradually transformed the residential landscape of Bengaluru city. The study looks at the phenomenon of gradual unplanned transformation in housing typology and its impact on quality of life in urban residential neighbourhoods in the city of Bengaluru, India. A set of 4 high density neighbourhoods were selected from the intermediate zone of the city to comprehend the transformations in housing typologies as intermediate city neighbourhoods continue to densify. Detailed analysis of data collected through household surveys and physical mapping indicate a cultural acceptance of high density in urban Indian neighbourhoods. In sharp contrast to experiences reported in the global North, recently densified urban neighbourhoods continue to display an acceptable quality of life despite transformations in urban form and housing typologies. The paper finally suggests some urban planning



lessons from Bengaluru neighbourhoods which can make high density living acceptable.

Keywords:
Housing Typology, Urban form, residential neighbourhoods, density, Quality of life

Qualità nonostante la densità? Nozioni sulla qualità della vita da quariteri residenziali urbani densi: Bengaluru, India

Il rapido afflusso di popolazione e l'aumento dei prezzi dei terreni hanno gradualmente trasformato il paesaggio residenziale della città di Bengaluru. Lo studio esamina il fenomeno della trasformazione graduale e non pianificata della tipologia abitativa e il suo impatto sulla qualità della vita nei quartieri residenziali urbani della città di Bengaluru, in India. Un insieme di 4 quartieri ad alta densità è stato selezionato dalla zona intermedia della città per comprendere le trasformazioni nelle tipologie abitative man mano che i quartieri intermedi della città continuano a densificarsi. L'analisi dettagliata dei dati raccolti attraverso le indagini sulle famiglie e la mappatura fisica indicano un'accettazione culturale dell'alta densità nei quartieri urbani indiani. In netto contrasto con le esperienze riportate nel Nord del mondo, i quartieri urbani recentemente densificati continuano a mostrare una qualità di vita accettabile nonostante le trasformazioni nella forma urbana e nelle tipologie abitative. Il contributo suggerisce infine alcune lezioni di pianificazione urbana dai quartieri di Bengaluru che possono rendere accettabile la vita ad alta densità.

Parole Chiave:
Tipologie di housing, Forma urbana, Quartieri residenziali, Densità, Qualità della vita

Quality despite density? Learnings on quality of life from dense urban residential neighbourhoods: Bengaluru, India

Shubhi Sonal

1. Introduction

The form and configuration of our cities have been the most fundamental yet complex issue in urban planning. House types in a city are a function of the socio-cultural ethos, economic constraints, available technology, stylistic aspirations and urban development controls. The collective public memory of a pleasant and attractive neighbourhood also at times guides the way people envisage and build their houses. Since 70% of the city is composed of residential development, residential types and form dictate the urban form of the city to a large extent. Several studies in the Asian context have pointed out a direct positive correlation between the housing domain of quality of life and overall quality of life for the residents (Zebardast, E. ,2009, Karim, H. A.,2012). Peck, C., & Kay Stewart, K.,1985, Sirgy, M. J., & Cornwell, T., 2002 concluded that housing satisfaction does contribute to overall life satisfaction, and housing satisfaction is related to neighborhood satisfaction and characteristics of the dwelling unit.

Urban form is usually defined by spatial character, visual character, density and overall architectural character. Housing character including typologies contribute to the urban form of an area. Urban development controls such as landuse regulations, plot size, setbacks and height also play an important role in determining the urban form of a neighbourhood. Demiri (1983) defined typology as “the formal and spatial characteristics of buildings, which are rooted in culture and history”. Scheer, B. C. (2017) further elaborate that a “type” of house can be described based on its circulation, overall shape and scale, entrance condition and situation on site. According to Petruccioli (2007), Remali, A. M., Salama, A. M., Wiedmann, F., & Ibrahim, H. G. (2016), housing typologies evolve over a period of time as a testimony to the socio-cultural milieu of the place. Vernacular architecture with its climatic, social and occupational linkages along with its place based ties in form of construction technology and materials was a mainstay of Indian residential architecture for a long time. However there has been a steady decline to a state of absolute decimation of the vernacular when it comes to urban Indian living. Lack of space, rising land prices and a fascination with western modernistic aesthetics has brought in various new housing typologies in our Indian cities. Typological transformations are usually rooted in market demand, technology, changing cultural values, infrastructure creation and regulations (Scheer B, 2017). Metropolitan Cities in India such as Mumbai, Kolkata, Chennai, Bengaluru etc have seen their housing types evolving despite their strong historical and social context.

This paper picks housing typologies and density as prime proponents of urban form. Density is an important attribute which finds recurring mention in research literature,

especially in the context of quality of life offered by a neighbourhood. The term perceived density is an interesting concept first introduced in the seminal works of Rapoport, 1975. It distinguishes itself from physical density since it is based on individual perception. While physical density can be seen as a neutral quantitative indicator, perceived density is a neutral subjective indicator as it represents the collective socio cultural ethos of the people residing in an area (Cheng, V, 2010).The subjective nature of density was further elucidated by Friedman, A., 2014 where he stated that the idea of density is specific to a particular location and culture.

Urban planning literature has seen density as an evolving concept. From its humble origins of a problem seen in dense industrial housing, density has occupied the centre stage in theories offered by several famed researchers including Ebenezer Howard's Garden city, Corbusier's high modernism to Koolhaas' delirious New York vitalized by density, (Harper C., 2013). Over the past three decades the concept of compact cities has been gradually gaining strength whereby density is seen as a necessary ingredient for sustainable urban living. Most researchers agree that High density increases the accessibility benefits in a residential area. Increase in residential density bears a positive correlation with public transport availability (Bertaud, A., & Brueckner, J. K., 2005, Burton, E, 2000) and usage (Milakis D., Barbopoulos, N., Vlastos, Th., 2005). However Dajun D., 2010 confer that road safety may be compromised if dense neighbourhoods do not have adequate infrastructure. Amongst housing quality attributes, high density living translates into reduced space per capita (Burton, E, 2000, Durga R G, 1985) and access to light and ventilation is often compromised (Ng, Edward, 2003). Both Floor area ratio and Ground coverage are seen to have a positive relationship with density but the same cannot be said about plot area and dwelling unit size as these are complex variables with multiple linkages to cultural and demographic setting (Alexander, E R., K. David Reed & Peter Murphy, 1988).

Research literature on impact of high density living on the environment is specific to context and often conflicted (Norman, Jonathan, Heather L. MacLean, and Christopher A. Kennedy, 2006, Hickman, R., and D. Banister, 2007 Karen Wright, 2006, Newman, Peter, 2014, Kyushik Oh, Dongwoo Lee, 2012). A similar conflict can be observed in the social realm where both positive as well as negative impacts of high density on quality of life have been documented by researchers (Bramley, G., & Power, S., 2009, Dempsey, N., Brown, C., & Bramley, G., 2012., Patel, Shirish B., Alpa Sheth, and Neha Panchal, 2007, Burton, Elizabeth, 2000, Sokido, D. L., and Sanjukta Bhaduri, 2013). Firouz J, Rasoul G, 2013 maintain that "increasing urban density is a policy indicated for sustainable development, especially from social's aspects", but, they point out that "it is necessary to consider other factors like urban carrying capacity, existent streets, infrastructures, access to facilities". The density-QoL link further finds detractors in Dempsey, Nicola, Caroline Brown, Glen B, 2012 who conclude that "while the compact city model appears to offer various benefits, its contribution to social sustainability is not entirely positive". Bramley, G, and Sinead P, 2009, further point out the role of socio-economic factors in establishing sustainable urban form as they propound that "who lives where within the

urban form, and with what resources and choices, may be more critical to making urban communities work."

A cultural dimension is also indicated to the acceptance of density and spatial compactness, especially in the developing world (Jenks & Burgess 2000, Arundel, R., 2015). The cultural acceptance of high density in Asian cities finds its roots in the twin theories of proxemics and collectivism. The theory of Proxemics (Hall E.T., 1966) accounts for the preference for closer interpersonal distances and proximate personal space in contact cultures as compared to non-contact cultures. Hall E.T., 1966 also proposed that contact cultures would be more tolerant of crowding than noncontact cultures. The collectivist theory accounts for frequent and close social interaction (Evans et al 2000) in collectivist cultures as seen in Asian cities.

Raman, S., 2010 indicated that some of the adverse impacts of high-density living can be partially remedied through design of the neighbourhood. It is amply clear from the review of relevant literature that though density plays a dominant role in determining the quality of life in a neighborhood, it will be erroneous to generalize its impacts on the neighbourhood, especially in the Indian scenario.

2. Methodology & Scope

Part 1 of the study gives an insight into the emerging housing typologies in urban neighbourhoods in Bengaluru as a result of rapid densification of the intermediate city areas. Historical data has been compiled through a systematic survey of available literature and supplemented with primary evidences in form of sketches and photographs wherever feasible. The second part of the study looks at delineating the impact of urban form transformations on the quality of life offered by urban residential neighbourhoods. The study relies extensively on primary data sourced through household surveys, physical surveys and structured interviews carried out in 4 high density neighbourhoods in Bengaluru. The term *Unplanned* is used to indicate that the transformations in house type, form and occupancy are neither regulated nor supported by a corresponding increase in urban utilities. Furthermore, this is an incremental and organic process instigated by small developers and plot owners within existing plotted residential layouts. The local planning norms limit themselves to customary indication of ground coverage, setbacks and heights. In the absence of strict implementation and scope, these regulations have been found to be ineffective in regulating urban form for the benefit of the residents. The study refrains from commenting on the economic and environmental impacts of the transformations in housing typology. Further, slums and their derivative typologies have been kept out of the scope of the study.

3. Case of Bengaluru: Evolution of housing typologies in intermediate city areas

The city of Bengaluru has the dubious distinction of being the fastest growing city in

India. The census 2011 data shows a massive 46.68% decadal growth rate of population for the city. Promising job opportunities, supply of skilled labour and salubrious climate is pulling people from all over the country as well as abroad to come and settle in the city. At present the city spans over an area of 704.34 sq.km (BBMP limits) with an average population density of 275 persons per hectare. The average ward Population varies depending on the location of the ward in the city structure. The total population of Bengaluru was estimated to be around 9.59 million as per the Census of India 2011. People's choice of residential location depends on multiple factors such as accessibility, level of infrastructure provision, area attractiveness. The largely mono centric city structure also appears to play a crucial role in density distribution across the city.

Bengaluru has seen rapid expansion of its city limits as it developed from a small fortified settlement under Kempegowda in 1537 to British Civil and Military station in the early

	HISTORIC PETE AREA		**CANTONMENT AREA**	
Type	Organic settlement		Planned settlement	
Landuse	Mixed use with residential, industrial and commercial usage		Mixed use with residential and commercial usage	
Density	499 persons per hectare		101-167 persons per hectare	
Form	low/mid rise-high density		mid rise-low density	
Housing typology	**THEN**	**NOW**	**THEN**	**NOW**
	Courtyard/ verandah type based on the community profession	Live-work units with floor wise segregation of residential and commercial usage.	low-density, suburban scale, with tree-lined streets, parks and residential bungalows(single storeyed mostly)	Most bungalow plots converted to multi storied apartments (G+3, G+4) by private developers.
Current status	Ground+3 floors to G+6while only G+1 is permitted, with bare minimum access and very poor natural light and ventilation, for both buildings and the streets.		Stagnant or negative rate of population growth as area is already saturated.	
	PSU / INDUSTRIAL TOWNSHIPS		**BDA PLANNED LAYOUTS**	
Type	Planned Townships for Public sector industries and central government establishments:		Planned settlement	
Landuse	Residential		Mixed residential	
Density	Low density with vast open spaces, all amenities:		Variable depending on age, location in city structure, Maturity:	
Form	low rise-low density		mid/high rise-high density	
Housing typology	**THEN**	**NOW**	**THEN**	**NOW**
	Walk up apartments + individual (detached/ semi detached/ row) houses based on institutional hierarchy.	Maintenance dependent on status of mother institution. Some are in neglect/dilapidation	Plotted/ semi detached houses, well planned open spaces and amenities. Height based on abutting road width(generally not more than 3)	Plotted houses being converted into multifamily apartments with height up to G+5.
Current status	The erstwhile peripheral townships are now placed in prime areas of the cities forming pockets of sterilised low key development amidst rapidly growing surroundings.		Illegal construction is rampant as developers try to squeeze out maximum value of land.	

Tab. 1 – A brief description of various Planned residential areas in Bengaluru city. SOURCE: Krishnamurthy, S., 2016, Rajagopal, C. , 2008, Author

20th century. Post-independence saw rapid development in the city as many Public sector enterprises such as ITI, BEL, BHEL, HAL etc set up base in the city attracting a cosmopolitan set of residents from all parts of the country. The industrial link with a well-educated population paved the way for Bengaluru becoming the silicon valley of India in the post liberalization era of 1990s. The city continues to expand in all directions today as it faces a huge influx of migrants from rural as well as other urban centres. The city offers a wide range of residential options to its residents in form of planned residential layouts, each with its unique, identifiable housing typology. Krishnamurthy, S., 2016, Rajagopal, C., 2008 have clearly illustrated the transformations that the traditional planned layouts of Bengaluru have undergone over the past 40 years.

Bengaluru has developed in concentric rings, with its ring roads acting as growth stimulators. The master plan identifies densification of residential areas as a major objective. The Bengaluru master plan 2015 envisioned accommodating around 8.8 million people (3.25% current annual growth rate) by allowing urban development to the extent of the proposed Peripheral Road. Densification in various parts of the city is linked to land value and infrastructure availability. Being highly contextual, densification patterns are not uniform throughout the city. While the core areas of the city are now completely saturated and have turned to predominant commercial use, the peripheral areas of the city continue to face issues in accessibility and infrastructure provision. At this juncture, the intermediate areas of the city with their high real estate value and attractive location in the city structure become the centre of residential growth and development. The assurance of high rental income as well as sale value is gradually transforming these erstwhile Low rises (maximum G+2) medium density residential zones into midrise (more than G+3) high density zones. Here, we observe the phenomenon of unplanned, incremental transformation of housing typologies where unregulated, gradual construction aims for almost 100% ground coverage putting high pressure on public utilities and space availability per capita. This unplanned incremental transformation in urban form and typology is not isolated, as it has its bearing on the quality of life offered to the residents as well.

4. Empirical studies from 4 residential neighbourhoods in Bengaluru

A study of 4 neighbourhoods in Bengaluru was carried out to study and illustrate the transformation in urban form and housing typologies in the residential areas of the city. Though municipal wards are purely administrative constructs, the availability of ward wise census data necessitated selection of wards as neighbourhood. Bengaluru wards vary in size and service provision based on their location in the city structure. High density Non slum wards with area varying from 0.7 to 1 sq.km were taken into consideration while ensuring homogeneity in size and service provision. The number of buildings higher than G+3 per unit area was taken as a surrogate indicator of urban form in the wards. Finally, wards were selected in pairs on the basis of the density of G+3 buildings.

- Group 1: (High population density-Low density of Buildings more than G+3) - Mattikere & Kammanahalli
- Group 2: (High population density- High density of Buildings more than G+3) - Mahalakshmipuram & Gurappanapalya

A variety of housing typologies are observed in the study cases. It is interesting to note that most of the typologies seen today are mutations in the original single detached dwelling unit typology which were constructed in the planned neighbourhoods. Visual and household surveys were carried out to study and analyse the organic transformations in housing typologies in the study areas. Household surveys using structured questionnaire was done to collect data regarding the housing typologies from the selected case study areas. Random sample survey was utilized for the above.

The data collected through the visual and physical surveys shows that existing neighbourhoods in Bengaluru are witnessing a massive

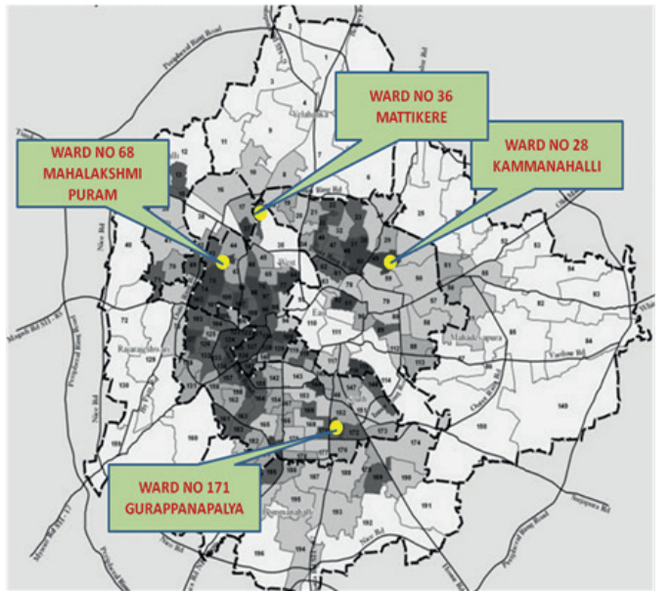


Fig. 1 – Selected study cases. SOURCE: Author

Urban form	Ownership	Landuse	Spatial/ housing related
Plot size	**Sole/ rental/builder floor/ mixed**	**Residential**	**Plan type**
Ground coverage	**No of years of residence**	**Mixed with dominant residential**	**Age of the house**
Building height		**Mixed with Dominant commercial**	**No of households accommodated within plot**
Street character			**Access to Open space within the plot**
			Built up area

Tab. 2 – Parameters on which data was collected from the selected study cases

	Confidence level	**95%**
	Confidence Interval	**5.8**

S.no	Study area	Area (sq.m)	Population density (persons per sq.km)	Population size (Total no. of Households)	Sample size (no. of households selected for survey)	Percentage of population taken for sampling
1	**Gurappanapalya**	**0.7**	**699.8**	**10513**	**67**	**0.63**
2	**Mahalakshmipuram**	**0.9**	**495.7**	**11563**	**75**	**0.64**
3	**Mattikere**	**0.9**	**411.5**	**9592**	**70**	**0.73**
4	**Kammanahalli**	**1**	**470.7**	**11479**	**73**	**0.64**
	Total			**43147**	**285**	**0.66**

Tab. 3 – Sample design for Household surveys in selected study cases

transformation in urban form and typology. It is interesting to note that the highest number of houses older than 15 years is seen in Mattikere while Mahalakshmipuram shows the highest number of newly constructed houses. Mattikere, along with Mahalakshmipuram also has the highest number of houses with area more than 1500 sqft. A glance at the tenure data visualization reveals that rental housing holds the sway over owner occupied housing in 3 of the 4 selected study cases. Visual and historical data surveys carried out within the neighbourhoods indicate that Single detached residences with front and back yards are gradually being converted into multi storied small or large apartments with heights upto G+3 or more. Figure 3 clearly depicts the changing residential skyline in the selected study cases.

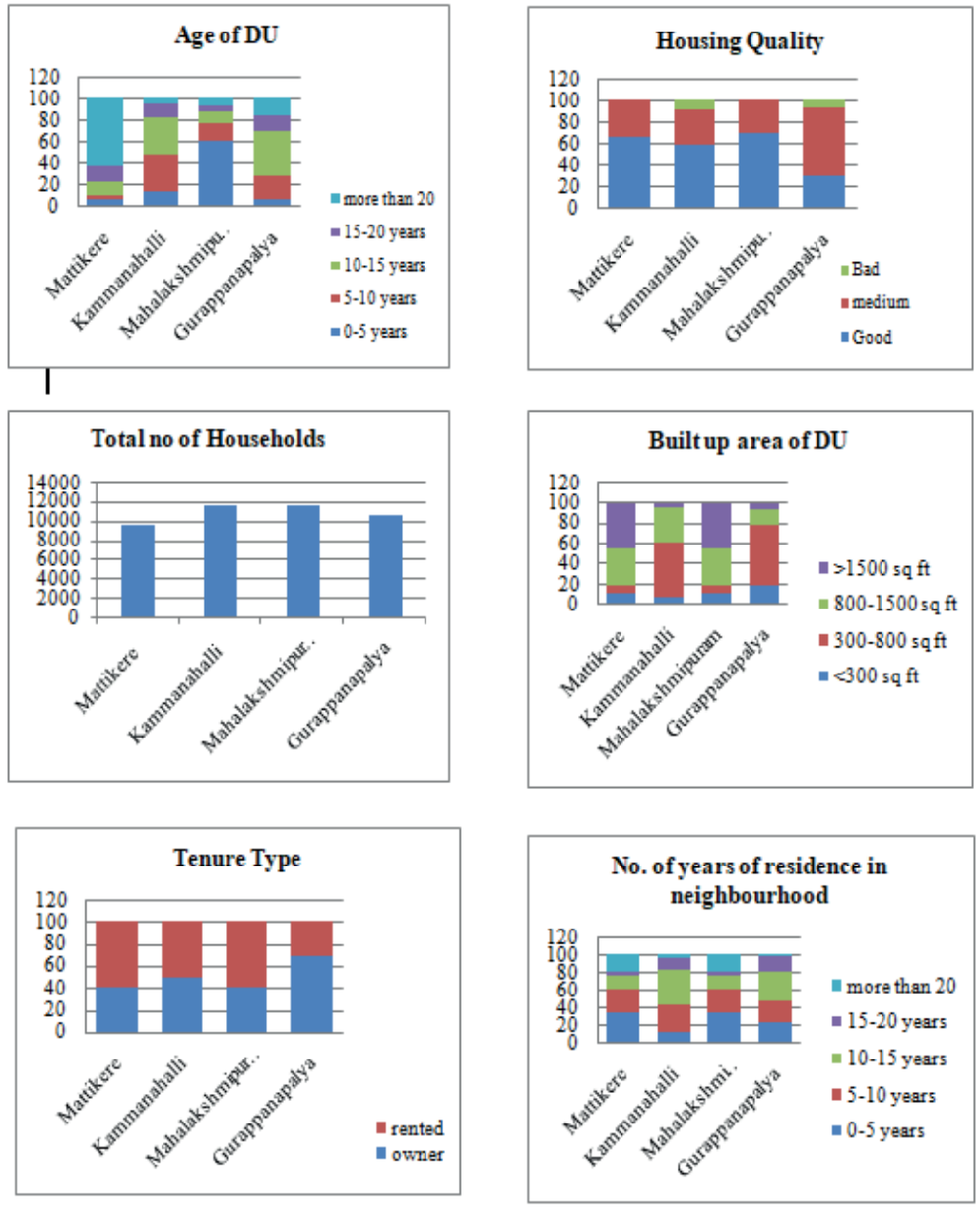
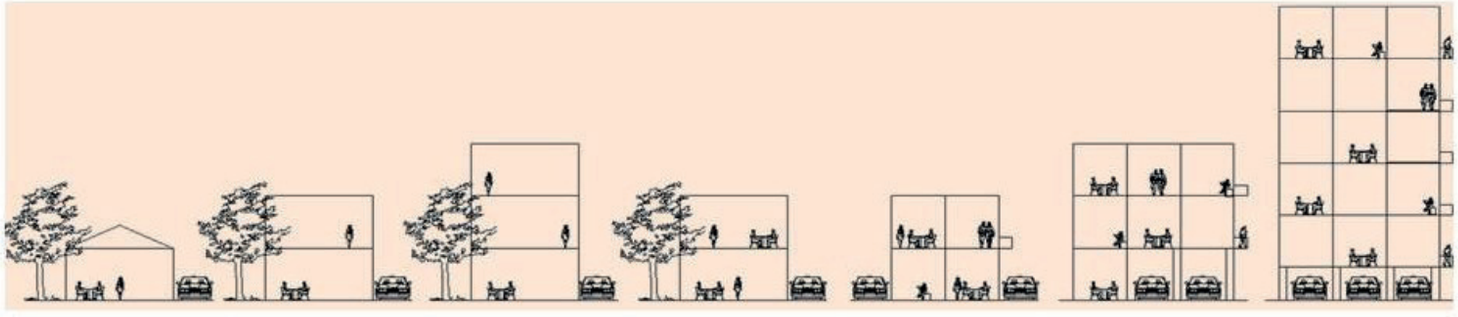


Fig. 2 – Housing characteristics in the selected study cases



Single detached	G+1 detached	Mid rise detached	Stacked	Small apartment	Large apartment-mid rise	Large apartment-High rise
Single Family dwelling			*Multi Family dwelling*			

Fig. 3 – Evolution of housing typologies in Bengaluru. Source- Author

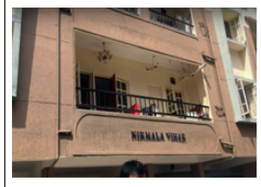
Case wise data in form of images of buildings arranged as per their age gives us a glimpse of the changes in typology, building height, occupancy and form as seen in the 4 neighbourhoods.

Fig. 4 – Transformation in Housing typologies as seen in Mattikere. Source- Author

0-5 years	5-10 years	10-15 years	15-20 years
			
Plot size- 85 sq.m	Plot size-470 sq.m	Plot size- 120 sq.m	Plot size-176 sq.m
No of DUs-04	No of DUs- 02	No of DUs- 01	No of DUs-01
BUA of each DU- 30 sq.m	BUA of each DU- 200 sqm	BUA of each DU- 200 sq.m	BUA of each DU- 170 sqm
No of storeys- G+3	No of storeys- G+2	No of storeys-02	No of storeys-02
Ownership- rental	Ownership- sole with rental	Ownership- sole	Ownership- sole

>20 years
Plot size-85 sq.m
No of DUs-03
BUA of each DU- 85 sq.m
No of storeys-02
Ownership- Builder floor

Fig. 5 – Transformation in Housing typologies as seen in Kammanahalli. Source- Author

0-5 years	5-10 years	10-15 years	15-20 years
			
Plot size- 80 sq.m	Plot size-160 sq.m	Plot size- 220 sq.m	Plot size-120 sq.m
No of DUs-10	No of DUs- 03	No of DUs- 08	No of DUs-01
BUA of each DU- 120 sq.m	BUA of each DU- 150 sq.m	BUA of each DU- 200 sq.m	BUA of each DU- 140 sqm
No of storeys- G+4	No of storeys- G+2	No of storeys-04	No of storeys-02
Ownership- sole flat with power of attorney	Ownership- sole with rental	Ownership- sole	Ownership- sole

>20 years
Plot size- 120 sq.m
No of DUs-01
BUA of each DU- 190 sq.m
No of storeys-02
Ownership- sole

The visual survey of Mattikere confirms the household survey data were we observe that several of the older residences in the LIG and MIG areas remain as single storeyed or G+1 without much additions or alterations by the residents. Residences along the main streets of Mattikere have built up to G+1 or G+2 and are being used to gain rental income through mixed use. Such mixed use residences with shops on the ground floor are seen as a popular typology around the main public square- Netaji circle in Mattikere. Few of the detached single storeyed houses have been converted to G+3 multifamily small and large apartments. A similar trend is seen in Kammanahalli as well. However, most of the houses in Kammanahalli are observed to be new constructions being double or triple storeys high. We observe dense mushrooming of mixed residential blocks on the main streets where ground floor is converted to busy shop fronts. In Mahalakshmipuram, A small portion of the neighbourhood continues to be a low rise-low density settlement with large plot sizes and ample open spaces in form of front gardens and backyards.

Most of the neighbourhood have gradually transformed into a high-density mid-rise settlement characterized by midrise large apartments. Detached dwellings have been replaced with multifamily apartment dwellings with G+3 or more storeys. In Gurappanapalya, The main street has mixed use buildings where the lower floor is given for shops or small offices. The smaller plot sizes with almost 100% ground coverage rise into G+4 or G+5 storeys high residential structures with two or more families are accommodated on every floor. High density becomes fairly perceptible both visually and in the concentration of buildings as the area as the streets are filled with High rise large apartments with mixed use on the ground floor.

Fig. 6 – Transformation in Housing typologies as seen in Mahalakshmipuram & Gurappanapalya. Source- Author

5. Neighbourhood Quality Index: A tool to evaluate quality of Life

A Neighbourhood Quality Index (Sonal S, Kumar S, 2020) is proposed as a composite index that aggregates the structural, social infrastructural and socio interactive characteristics of the neighbourhood.

Neighbourhood Quality Index= ∑ (Pi X Wi).....Eq. 1
Where, Pi- Normalized value of neighbourhood quality parameter
Wi- Normalized weightage of neighbourhood Quality parameters based on its relative contribution towards overall satisfaction with neighbourhood.

A set of 38 indicators of neighbourhood quality of life selected from literature and run through expert opinion survey to filter down the number of indicators. A total of 52 expert opinion surveys were conducted amongst urban planning and architecture professionals who are familiar with Bengaluru city and its urban issues. SPSS was used to generate a correlation matrix where it was seen that several correlations in the matrix were above the minimal thumb rule value of ±0.3 and above. The results of KMO and Bartlett test for sampling adequacy revealed a KMO measure of 0.55 and significance <0.05 which verified the adequacy of the data for proceeding with factor analysis. Factor analysis was further carried out using the principal components analysis method. The analysis revealed that a total of 3 factors (components) account for around 69.612% of variance in the data. The above factor analysis gave us the indicators which are deemed necessary for defining neighborhood quality. Based on the authors' understanding each of the factors has been allocated a name viz. Access to Space, Community Linkage, Urban Form.

Tab. 4 – Neighbourhood Quality factors using Principal component analysis in SPSS

Access to space	Community Linkage	Urban form
Access to play spaces	No of social contacts in the area	Spatial layout
Average residential floor area per person	Perception of Neighbourhood convenience	Built open relationship
Perception of Neighbourhood attractiveness	Participation in community activities	

In order to assess the selected parameters and their relative contribution towards overall satisfaction drawn from the neighbourhood we need to carry out multivariate analysis and data modelling. The model proposes that Overall satisfaction with neighbourhood is a function of the neighbourhood quality parameters. Here, the Dependent variable is Overall satisfaction with neighbourhood derived from Household survey data. Neighbourhood quality parameters from Household survey data constitute the Independent variables. Artificial Neural networks analysis was employed to verify the validity of the proposed model. The ANN analysis studies the underlying data structure and derives the structural relationship for use in predictive modelling. A total of 239 x 7=1673 data points were input the neighbourhood quality parameters. The

ANN analysis is a two stage analysis where it was reported that the model was able to predict with an accuracy of 84.8% in the training phase. In the testing phase, the model achieved an accuracy of prediction amounting to 76.7%. The ANN analysis also generates normalized importance for the independent parameters based on their relative contribution towards the Dependent variable. These values may be used as weightages for formation of Neighbourhood Quality Index. The artificial neural networks analysis carried out here helps us to assign weightages to the parameters of neighbourhood quality.

Tab. 5 – Weightages of Neighbourhood Quality Parameters based on ANN analysis on SPSS

Independent Variable Importance			Parameters
	Importance	Normalized Importance	
x1	0.152	47.6%	No of social contacts
x2	0.074	23.3%	Participation in community activities
x3	0.086	26.9%	Access to play spaces
x4	0.130	40.7%	Average ground coverage
x5	0.090	28.1%	Living space (average floor area per person)
x6	0.319	100.0%	Perception of neighborhood convenience
x7	0.151	47.3%	Perception of neighborhood attractiveness

Subsequently Neighbourhood quality indices were calculated for all the 4 selected study cases. A Min-max normalization, scheme was used to rescale the data to the range in [0, 1]. As described earlier, the neighbourhood quality index is conceptualized as a weighted aggregate of individual parameters. The weights were multiplied with the actual parameter values to calculate the overall NQI for each of the selected study cases. The table below shows the weighted parameter as well as the aggregate NQI values calculated for the study cases.

Tab. 6 – Calculation of Neighbourhood Quality Indices for selected study cases

Parameter	P1'	P2'	P3'	P4'	P5'	P6'	P7'	NQI
Weighted Parameter value	***pi x wi***	***pi x wi***	***pi x wi***	***pi x wi***	***pi x wi***	***pi x wi***	***pi x wi***	***∑(pi x wi)***
Mattikere	**0.15**	**0.074**	**0.044**	**0.04**	**0.08**	**0**	**0.129**	**0.52**
Kammanahalli	**0.00**	**0.040**	**0.000**	**0.11**	**0.005**	**0.31857**	**0**	**0.47**
Gurappanapalya	**0.05**	**0.000**	**0.086**	**0.13**	**0.000**	**0.14158**	**0**	**0.41**
Mahalakshmipuram	**0.09**	**0.072**	**0.080**	**0.00**	**0.090**	**0.17698**	**0.150**	**0.66**

6. Inter-relationship between Neighbourhood quality of life and housing typology characteristics

Conventional urban planning wisdom suggests that at the dwelling unit level, built up area, ownership, build quality, time of residence and open space availability within plot are few factors that impact the quality of life offered by the neighbourhood to its

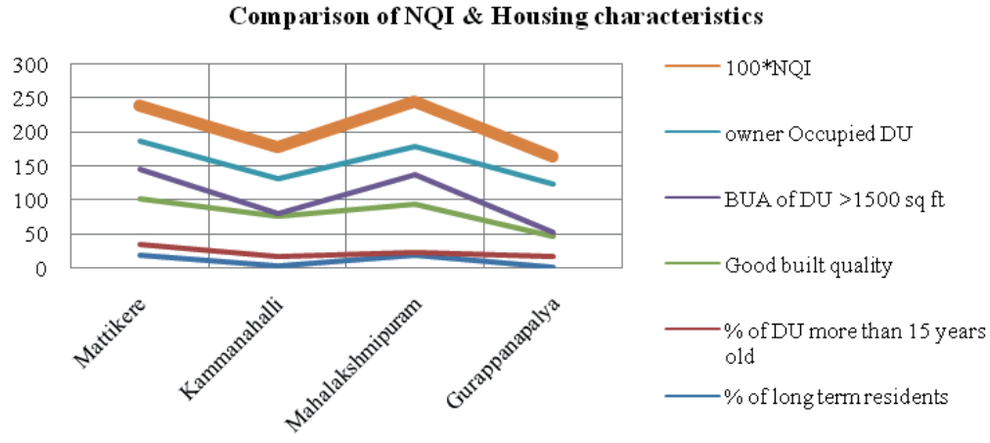


Fig. 7 – Analysis of Housing characteristics for selected study cases

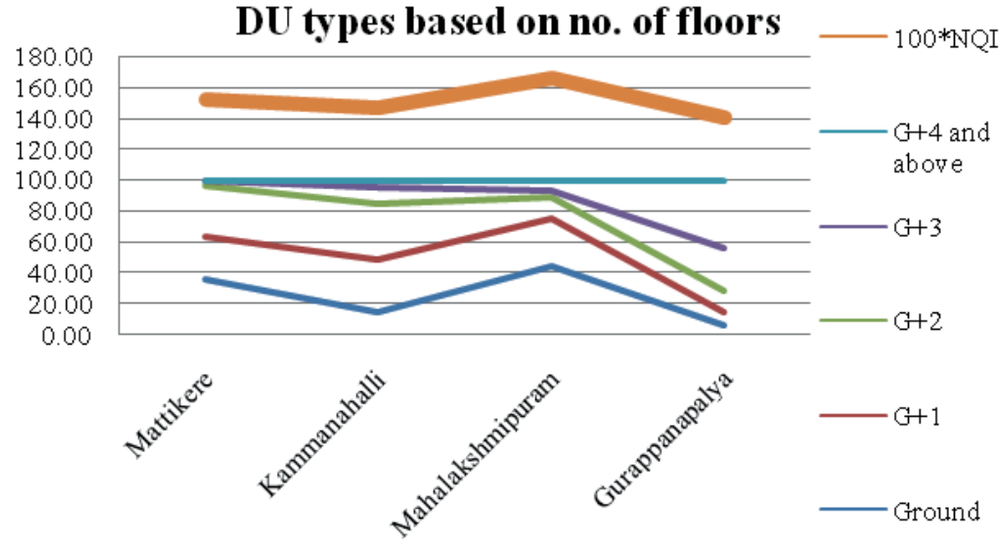


Fig. 8 – Analysis of NQI based on no. of floors

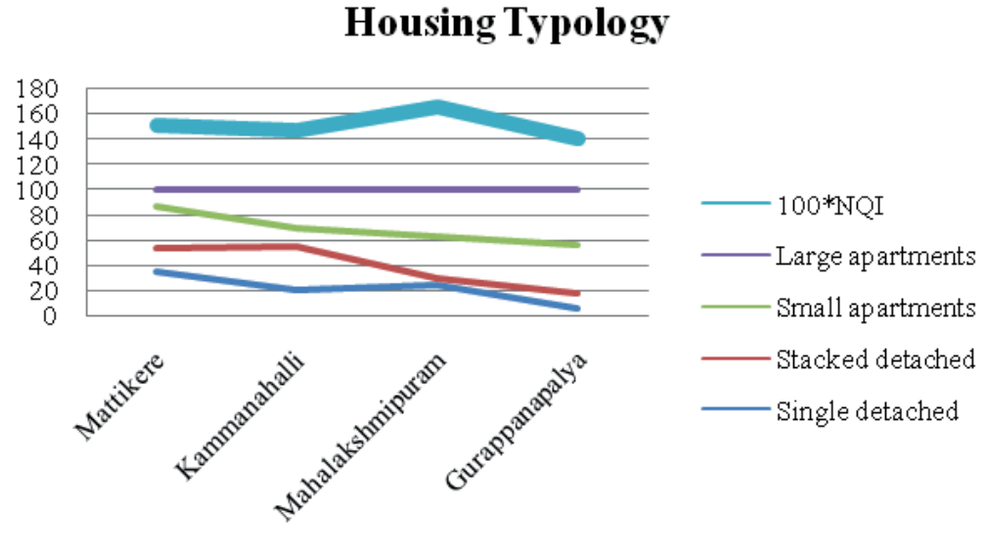


Fig. 9 –Analysis of Housing typology for selected study cases

residents. A glance at our high performing wards Mahalakshmipuram and Mattikere shows that larger built-up area per person as well as availability of open space within the plot are definitely advantageous when it comes to scoring higher in the residents' satisfaction levels. Furthermore, long term occupancy by owners and better built quality for dwellings is clearly indicated when we look at Mahalakshmipuram as the highest performing ward.

The graphical data analysis of Housing typologies with the Neighbourhood Quality index confirmed that while Single detached housing typology shows mild concurrency with NQI, amongst the newer typologies, Mid rise housing type (up to G+2) shows concurrency with NQI.

7. Inter-relationship between Neighbourhood quality of life and housing typology characteristics

Urban density is the macro level manifestation of housing typology and urban form. We can observe from the calculated NQI values that Mahalakshmipuram has the Highest Neighbourhood quality Index flowed by Mattikere. Kammanahalli and Gurappanapalya show a much lower value of NQI with Gurappanapalya being the lowest amongst the 4 selected study cases. The graph also makes it amply clear that Neighbourhood quality Index is not necessarily concurrent with population density. It suggests the possibility of the fact that neighbourhoods can show high quality of life despite high physical (population or built) density. This strategic finding was further corroborated through correlation analysis using SPSS. Spearman's correlation analysis was employed to measure of the strength of association between the variables. Spearman's coefficient is a nonparametric (distribution-free) rank statistic proposed by Charles Spearman that measures of a monotonic association between variables.

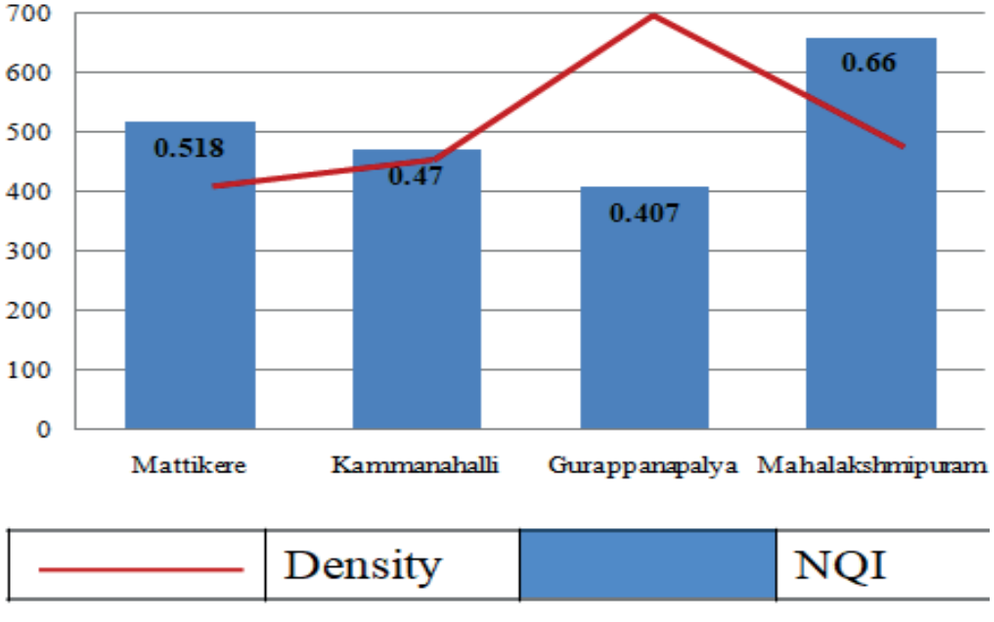


Fig. 10 – Population Density overlaid on NQI. SOURCE- Author

			Gross population density**1**(D1)	Net population density**2**(D2)	Built density of >G+3 buildings(D3)	Perceived density(D4)
Spearman's rho	NQI	Correlation Coefficient	-.400	-.400	-.200	-.800
		Sig. (2-tailed)	.600	.600	.800	.200
		N	4	4	4	4

Tab. 7 – Spearman's Correlation analysis between density types and Neighbourhood Quality Index on SPSS

Spearman's correlation analysis confirms that Physical density types (D1, D2 and D3) bear no significant correlation with Neighbourhood quality. Interestingly, Perceived density (D4) shows considerable correlation with Neighbourhood Quality Index.

8. Results and Discussions

i. Urban Form transformations- catalysts and impacts: In all the four study cases, it is observed that very few single detached houses survive. The main streets including the primary and secondary streets of the neighbourhoods are the zones of maximum transformation. An attractive location along with rising land value is an active catalyst which converts the erstwhile single detached low-rise homes into high rise apartments. Even though there is a trend towards multifamily dwelling for maximum utilization of land, the same has been unable to translate into large apartment buildings. Presence of multiple landowners along with difficulties in land assembly is probably the reason behind this phenomenon. However, the individual owners are swiftly converting their low-rise houses into multifamily dwellings. In most cases the ownership continues to remain with the original landowner and the dwelling units are utilized to gain rental income. In several cases the units are being sold as builder floors or using a power of attorney where independent registration is not possible. Several dwellings have been converted into mixed use buildings where the ground and first floor are used for commercial purposes while the residential usage is limited to the upper floors. Mixed use is usually beneficial to the neighbourhoods. However, the invasion of residential colonies by commercial usages often creates an environment which is unsuitable for living.

Rising land value and an attractive location in the city structure has pushed up the scope of rental income as well as the sale value of the dwelling units. Most of such transformed dwellings are being used either for rental purpose or are registered as flats or builder floors. Unfortunately, the surge in population and built form is not complemented by the physical and social infrastructure available in the neighbourhood. The neighbourhoods gradually begin to bear the brunt of these unplanned transformations in form of lack of parking space, crunch of basic facilities and resources as well as an overall degradation in the visual character of the neighbourhood. The stages of transformation in urban form and typology along with their resultant impacts are shown in the table below.

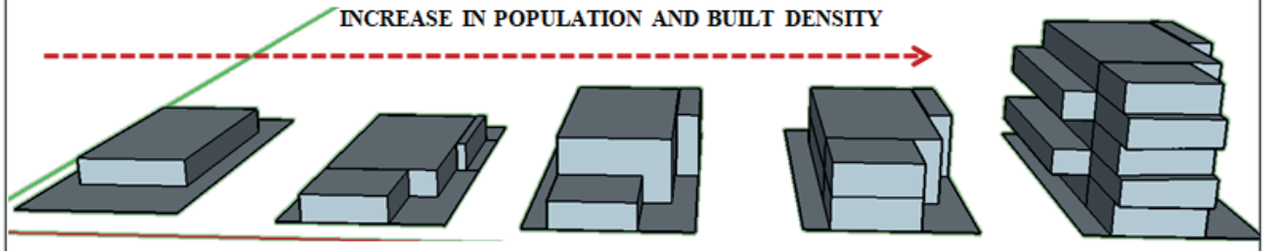
	Detached residence as single family dwelling	Detached dwelling with transformations to increase available space, extension in ground coverage; additional storeys added; ; Gradual decrease in open space within plot as ground coverage increases ; Rental space created on upper floor		**Small/ Large Apartment:** Transformations to accommodate multiple households per floor; ground coverage close to 100%; Mostly used for rental/ builder floor sale.	
					
No of floors	01	01	02	02	G+4
Setbacks	Front, back and side	Front & one side	Front & one side	Front & one side	nil
No of dwelling units	01	01	01	02/ 03	9-10
Ground coverage	70%	80%	80%	80%	95%
Parking space within site	yes	yes	yes	Yes; insufficient	No
Ownership type	Freehold, owner as resident	Freehold, owner as resident	Freehold, owner as resident	Owner + rental	Rental/ builder floors

Fig. 11 – Transformation in urban form in urban residential neighbourhoods in intermediate city areas of Bengaluru. SOURCE- Author

The unplanned transformation of detached low-rise houses to increase available space leads to extension in ground coverage and addition of several storeys. Gradual decrease in open space within plot is imminent as the ground coverage increases. Furthermore, unregulated ownership division in form of builder floors/ power of attorney cases may be pointed out as a major reason contributing towards poor maintenance of buildings along with gaps in revenue gain to the urban local bodies.

At the neighbourhood scale, such transformations result in creation of a sense of visual clutter and overall reduction in open space availability. The ultimate impact of this kind of transformation is that the piece of land which housed one or two families a few years back is now home to over 8 to 10 families. This exponential growth in population and pressure on public utilities is barely matched by the service provisions from the urban local bodies. It is quite common to find households dependent of private water tankers, frequent jostling for on street parking and mounds of uncollected garbage in the street clearings. All of this points towards a gross inability of the planning authorities to deal with the transforming housing typologies and urban form. The unplanned transformations point at a systemic issue where urban form is gradually mutating to the

dictates of the real estate market. At the same time, this also calls for a renewed enquiry into the issue of quality of life being offered by the neighbourhoods to their residents.

ii. The density- Quality of life conundrum: The analysis clearly points out that it is not the actual density, rather the perception of density, i.e how dense an area feels, which impacts the neighbourhood quality of life for a residential neighbourhood in the urban Indian scenario. The study confirms our initial assessment of cultural acceptance of high density in the context of Indian cities. It further illustrates that the negative impacts of dense residential typologies may be possibly tempered down if we are able to control the perceived density in the neighbourhood.

In order to substantiate the findings, physical surveys were carried out to identify characteristics that tone down the perceived density of high performing neighbourhoods. Some of the density management aspects which can be emulated from Mattikere and Mahalakshmipuram include:

a. Access to formal and informal public spaces-The availability of planned and incidental/ informal public spaces within neighbourhoods seems to be a prime factor in modulating the perceived density of the area. Despite high population density, availability of publicly accessible open space in form of parks, playground, public squares, civic spaces etc compensates for the space crunch faced by the residents in the private realm.

b. Street design and maintenance- Well designed street layout helps in limiting the vehicular flow to the peripheral zones of the neighbourhood. This allows the local roads to convert into informal public spaces which can be used for recreation and social interaction by residents during some hours in a day. Basic level of maintenance, appropriate infrastructure, a sense of hygiene and cleanliness become some of the factors which encourage people to come out of their homes and utilize these incidental public spaces, thereby lowering the perception of density and crowding in the neighbourhood.

c. Residential compatible mixed use- Instances of residential compatible mixed use such as small retail shops, cafes etc gives an opportunity to the residents to access and utilize spaces beyond their own private realm within the neighbourhood.

d. Community linkage- It is observed in Mattikere and Mahalakshmipuram that a largely homogeneous community which has common interests and activities tends to work better when viewed from the angle of perception of density. There are instances where large gatherings for community linked activities such as festivals etc are viewed as a component of neighbourhood vibrancy rather than the negative connotations usually attached to crowding in public spaces. The community make up is often a decisive factor in delineating the fine line between crowding and vibrancy within the neighbourhood.

As seen in the case of Bengaluru, incremental gradual increase in density has become a feature of most existing neighbourhoods in response to the dictates of the housing market. The above listed factors can become active initiatives in the local area level planning process for densifying urban residential areas in Asian cities. The study

gives a fresh impetus to the compact city paradigm (Grant, 2006, Talen, 2005) while suggesting effective measures to ensure that neighbourhood quality is not compromised in intermediate city areas despite densification.

Endnotes

1. Gross Residential Density– It is the number of housing units divided by gross residential area. Gross residential area includes all facilities at the neighborhood level like parks, collector road and school, school. GRD is generally expressed in units per hectare.
2. Net residential density- It is a measure of housing density expressed as dwelling units per hectare. The net residential area includes only residential plot area (including access roads & incidental open spaces).
3. Perceived density– The perception of crowding in a neighbourhood as compared to other neighbourhoods in the city is termed as Perceived density. The definition given by Eidlin E., 2010 is used to calculate this metric.

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