DENSITY, DESIGN AND THEIR IMPACT ON URBAN FABRIC

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Abstract

Urban consolidation has become one of the prime objectives of metropolitan planning across the world. It is based on the desire to increase population densities within existing built-up areas in cities through relaxation of regulations controlling building heights and bulk. There is a need to evaluate density and design and its impact on urban fabric to create good and feasible development.

It is often assumed that high densities are inherently evil and that low densities are good. It is quite likely that living conditions in high-density residential developments is better than in the low-density areas. In the older areas of cities in many countries, despite high densities, living environment is often quite good. However, effects of high density could be negative that can give rise to unpleasant interferences but it can also be very positive leading to social cohesion.

Planning can influence urban development through layout of services and other practices followed in design and subdivision. The economy in the planning of housing development considerably depends on judicious choices of these variables. High densities bring down total cost as well as cost of land per unit. However, design parameters such plot coverage, height, proportion of area under roads, open spaces etc also affect cost and the environment of residential development, over and above the density effects.

This study discusses mutual relationships of density and design and their impact on urban fabric. It provides some guidelines for the planning of residential areas. It attempts to identify the relationships between density and design as well as density, design and urban fabric. No attempt has been made to suggest specific standards for density or other aspects of design.

1. Introduction

Density is relevant to 'environmental quality, transportation system, physical infrastructure and urban form, social factors and economic factors' (Churchman 1999, 398). Growth of the urban areas in the last few decades has led to a number of physical problems. Many factors are responsible for this unprecedented growth of urban centres all over the world, which has contributed to acute shortage of building space and increase in the price of land. The cost of land and infrastructure is increasing continuously. In spite of this, planners are generally concerned with low density with implicit assumptions about its effect on the living environment. It is often assumed that high densities are inherently evil and low densities are inherently good. Often density is confused with building type planners often assume, for example, that detached housing has lower density than attached housing types. While this is normally true it is not always the case. A high-rise tower with large number of units set on a park-like site may have lower density than a set of detached houses on small plots (Forsyth 2003). Finally, some people associate

higher densities with some social and economic characteristics such as renter, low-income households, and high crime neighborhoods. Peoples' perception towards high density is linked with the notion that they are not good places to live. High density urban development is not necessarily undesirable if it is properly planned and managed. It is quite likely that in spite of high densities living conditions can be better than in the low density areas. In the older areas of Indian cities, despite high densities, living environment is often quite good. Effect of high density can be negative and give rise to unpleasant interferences but it also can be very positive and give rise to social cohesion. However, the problems typically associated with density are not necessarily caused by high densities but by poorly designed development.

Spiralling land prices in urban areas in many countries have tipped the balance in favour of intensive multi-storey developments. To regulate the nature of such high density developments planning authorities formulate design parameters such as density standards, coverage, floor space indices and the controls that influence design and cost of housing.

Cost and environment of urban land development is greatly influenced by the nature of planning, layout of services and practices followed in the design and sub-divisions. Economy in planning of housing developments considerably depend on judicious choices of these variables. High densities bring down the total cost as well as land cost per unit. However, other design parameters such as plot coverage, height, proportion of area under roads, open spaces etc also affect the cost and environment of residential developments over and above the density effects.

With ever increasing demands for housing in urban centres, effective utilisation of land is assuming greater importance. Due to growing pressure on land, optimisation of residential densities has become necessary. Although dwelling size, its shape and the nature of grouping are fairly crucial in determination of densities, choice of layout also deserves prime consideration. A proper choice of dwelling size, nature of their grouping and number of storeys and due regard to design and construction practices can help to achieve quality built environments.

This study discuss the mutual relationships between density and design parameters and their impact on urban fabric. First part of the paper gives an overview of density, design and relationship between density and design. Second part of the paper outlines what is urban fabric and impact of design and density on urban fabric. Final section concludes with how density, design and urban fabric are complementary to each other.

2. Density and Design

Design plays a crucial role in the successful development of a specific density. The arrangement, location, views and sequences of well designed medium density housing can function better than a poorly designed low density development.

Both density and design plays very critical role in creating built environment. However, density itself cannot create good or bad environment because density is only a measurement, not an independent factor, that could create good or bad urban fabric/built environment (Alexander 1993, Forsyth 2003). Indeed it is design that is responsible for creating good or bad urban fabric. Density is only one of the elements or parameters of design out of many design parameters such as floor space index, plot coverage, mass, volume etc. Therefore density could not guide the form of built development. First part of the section gives overview of density, second parts explains urban fabric and last part describes the role of density and design in creating sustainable urban fabric.

1. Density

Concept of the urban density is very old it has been applied ever since the Garden City movement in England and the early modernists in Germany (Pont and Haupt 2007). Density has different implications to professionals in different disciplines such as planners, economists, community organisations, psychologists and ecologists. For example, a psychologist or a sociologist may concentrate on the effects of perceived density on mental well-being. Density is a term that represents the relationship between a given physical area and the number of people who inhabit or use the area. It is expressed as a ratio of population or number of dwelling units to area (Forsyth et al, 2007; Forsyth, 2003, Holden & Norland 2005, Montgomery et al 2003, Churchman 1999, Cuthbert 2006, Magri 1994). Population density is not a practical measurement because it will be lower with small households such as empty nesters than with large families with several children (Forsyth et al 2003). The most widely used method to determine the density is dwelling unit per hectare (Pont and Haupt 2007). Another area of confusion is the issue of crowding, a perception that there are too many people (Churchman 1999, p390). Churchman says that ‘density is an objective, quantitative, and neutral term’. It is neutral in the sense that one cannot know immediately whether a given level of density is positive or negative. In housing studies, however, crowding is generally measured as number of people per room, per bedroom, or square foot. Obviously density and crowding are not the same and are not even always related. It is possible to achieve very high

densities with spacious apartments with no crowding, and conversely it is possible a detached farm house is crowded in terms of having many people per room.

Much of the literature on density by professions outside of planning focus less on the actual quantitative measure and more on the perception of density by the people who encounter it. This builds on the notion of perceived density as examined by Rapoport (1982) which looked at how different environmental, cultural and social factors could influence in both positive and negative sense, the perception of different densities by different people. Jensen (1966) argues that same housing density could be accepted differently in different parts of the world based on cultural and societal norms of the particular counties or place.

Unfortunately, planners and researchers often refer to density in relative terms such as high or medium density without specific numbers. Notion of high and medium density is relative and it varies from place to place. Same density can be perceived and evaluated in very different ways by different people under different circumstances in different cultures and countries. For example, density of 40 dwelling units per hectare is considered to be high density in Australia whereas the same density is in India is considered as very low density. While people often talk about low, medium and high densities there is no agreed standard of what constitutes high, medium and low densities. High density in Minneapolis in the U.S. might be considered as medium or even low density in Paris and Singapore.

There is no one conventional measure of density between or within countries or even within a region. Different countries have different approaches to measure density: it varies from density measured as population per hectare to dwelling units (DU) per hectare. DU sounds much better because it is constant whereas population is variable and it is based on household size. Gross and net residential density is typically expressed as dwelling units per hectare. Floor area ratio is a more precise way of measuring commercial or mixed-use density.

Net residential density includes the area occupied by the housing itself, any services and facilities for its immediate benefit, private gardens, communal gardens, children play areas and incidental open spaces. It includes parking spaces, access roads within the site and half the width of surrounding roads. Small scale facilities such as a local shopping or a community centre may also be included (Forsyth et al 2006; 2003, Montgomery et al 2003, Burton 2000, Cuthbert 2006, Jensen 1966, Magri 1994).

Gross residential density (neighbourhood density) includes, in addition to the above, open spaces serving a wider area and other landscaped areas, primary schools, local health centres, distributor roads and transport networks, small scale

employment, services and mixed use. It does not normally include large industrial and commercial areas or major roads and transport interchanges (Forsyth et al 2007; Forsyth 2003, Montgomery et al 2003, Burton 2000, Cuthbert 2006, Jensen 1966, Magri 1994).

The difference between net density and gross density plays an important role in projecting future land needs. Net density refers to the actual lots used for development after road allowance, parkland and other non-development lands are excluded from calculation. Typically, at least 33% of land is devoted to these uses. A gross residential density of 25 du/ha would be roughly equivalent to a net density of 37.5 du/ha as the following example illustrates.

2. Design

Design could be viewed as an activity that translates an idea into a blueprint and vision for any urban, rural and regional areas or for different land uses. The important part is the translation of the idea though design's ability. Design does not have to be new, different or impressive to be successful, as long as it is fulfilling a need and is a functional, as stated by Wright ‘form follows function’. Indeed design methods do lead to innovative and interesting places.

Design not only look at the aesthetic aspects of the built environment but it is a problem-solving activity. Indeed design is a ‘functionalism’ or ‘form follow function’ approach. Jones (2001) argues that design is a functionalist approach: “the functionalist approach suggests that if we analyse the problems that the design sets out to address in sufficient details and in scientific manner, a spatial solution will emerge from this analysis or ‘programme”. It suggests that design is a linear process, which if carried out with sufficient rigour, will lead to a single, optimum solution” (Jones 2001, 51). Both design elements and functions have impact on built environment. Design have many elements such as plot coverage, floor space index, set backs, mass, height etc which helps to create various urban fabric with same density. Functions of the design also play a crucial role in creating a urban fabric such as how the streets are laid out, land is subdivided, buildings are arranged and detailed, where trees are planted, where the sidewalks lead.

3. Relationship between density and design

There is a strong relationship between density and design. Density is a measurement but design is a tool, which creates urban fabric. Therefore both density and design play an important role to create desirable urban fabric in various cultural contexts. This section is divided into three parts. A first part argues effect on

variations in design and density, second part explains the Impact of design parameters and last part describes impact of layout pattern.

Campoli and MacLean (2007) argue that for many people density is associated with ugliness, congestion and crowding, even if it can be shown to people that well designed higher density can achieve good built environment and could save land, energy, infrastructure cost and the overall cost of the housing development. They argue that many people have problem of visualizing density or distinguishing quantitative and qualitative character of density. Forsyth et al (2007) argues that higher density has many advantages in terms of efficient use of infrastructure, housing affordability, energy efficiency, vibrant street life that improves social interaction. However she says that density alone is not sufficient to create a good urban environment and it requires appropriate design. Montgomery, Saunders and Chortis (2003, p1) say that 'issues relating to urban form and density continue to fuel worldwide debate' .

1. The effect on variations in design and density

The effects of variation in the basic relationship between different factors like total living rate, floor space rate, floor space index, plot coverage, communal services index and number of storeys determine the total land requirements for housing. These variables in total determine housing density and plot size.

Dutta and Garg (1967) and Sinha (1982) argue that increases in density can only result from substantial decreases in the total living space. Even at low floor space rate, high densities cannot be obtained until total living space rate falls. This study also showed that variation in the communal services index can have a substantial effect on densities, particularly where total living space rates and floor space rates are low and number of floor increase. However at low floor space rates (such as 20 sq ft per person) the effect of building height on density is negligible. At medium floor space rates (e.g. 80 sq ft per person) the effect of building height becomes more marked but it is still not significant until the total living space rates fall below 350 sq ft. At higher floor space rate (e.g. 200 sq ft per person) the effect of building height on density becomes dominant when the total living space rate falls below 750 sq ft.

The point that clearly emerges from the Dutta and Garg's (1971) study is the importance of the total living space rate and it is perhaps the most significant aspect of housing density.

2. Impact of design parameter

Dutta and Garg (1971) in their study refer to the mutual impact of land use, coverage, floor space index, open space per dwelling on density. These allocations influence the net and gross residential densities. Increase in residential densities bring down the plot area of dwellings and mainly result in high rise development. At a particular density, the extent of land coverage and the type of open spaces greatly influence the quality of environment.

Nature of grouping of buildings and number of storeys also influence residential densities. These values increase with increasing number of storeys in continuous row of dwelling or where no additional side open space is allowed. In the case of high rise apartment they tend to fall after recording small increase. However, the number of storeys giving maximum density varies with the nature and size of the dwelling units. Floor space index values behave similar to that of density. In a continuous row of dwellings it shows constant increase with the number of storeys. Irrespective of grouping in a row the land coverage reduces at a diminishing rate with increasing number of storeys. Number of dwellings placed in a row influences only the rate at which land coverage diminishes. Overall high rise development does not become economical, after certain height if a small number of dwellings are grouped in row.

Open space per dwelling remains constant for a particular dwelling size and location even with varying number of storeys for a continuous row of dwellings. With other grouping it uniformly increases and greater rates are achieved in shorter row than the longer row. In row type housing open space per dwelling can be determined by multiplying the area of dwelling with the factor for the required for open space. The study concludes that apart from dwelling size, its shape, orientation, and grouping the layout deserves prime consideration in determining densities.

3. Impact of layout pattern

Other studies by Datta and Garg (1971) and Sinha (1982) analyse the impact of different layout patterns on housing densities. Size, shape, and nature of grouping give diverse configurations of buildings and directly influence the choice of layout and resulting densities.

Squares and rectangular blocks are relatively efficient whereas layouts with irregular and spread out blocks consume relatively more land. Densities vary with the size and number of dwellings in a block, number of blocks forming the pattern, and the spacing between the blocks. A comparative study of ‘T’, and ‘U’ pattern formed with three blocks demonstrate that the density of ‘T’ pattern progressively increases with

the number of dwelling in cluster. 'H' pattern gives highest density values in medium range cluster, but density reduce with the increasing size of the cluster with large number of units. 'U' pattern makes relatively highest density and 'T' pattern usually low. Four blocks of 'U' pattern can achieve higher density in large cluster, and falls appreciably with 'X' pattern. 'H' pattern formed with five blocks obtains highest values for a clustering large number of dwellings. Finally this study concludes that net area density rise with the increase of number of units in cluster. This study throws some light on the behaviour of certain parameters that influence the nature of housing development.

Quite often, in residential area planning, blocks consisting of single row of dwellings is provided. However, in low income group housing doubly loaded blocks are also adopted. Relatively higher densities can be achieved with such blocks than blocks with single rows. Higher densities between 68% and 87% of net area densities are possible with doubly loaded blocks as compared to 52% to 78% obtained from single block. Relative increase in density varies between 13% and 57%. However, in most cases about 20% to 25% more densities can be achieved with doubly loaded blocks. If higher floor area ratio is allowed doubly loaded blocks can result in higher densities. This section demonstrates that it is design rather than density matters in creating better built environments.

Even though high-rise buildings are generally associated with high residential density there is no basic relationship between the two. For example the two neighbourhoods depicted in Figure 1 have exactly the same density but they look very different at night and day. Although they both have the same density they are not necessarily perceived to be equally dense. What really matters is how the layout is laid out. Layout plays very important role in creating urban fabric and living environment.

Figure 1. Impact of design on built environment Source: Lincoln Land Policy Institute

3. Density design and urban fabric

Both density and design play important role in creating urban fabric. First part of the section explains what urban fabric is and second discuss the impact of density and design on urban fabric.

1. Urban fabric

It is generally assumed that urban fabric is nothing more than the physical arrangement of various activities, architectural forms to suit land use regulation (Greene 1992). There are various schools of thought: some authors discuss design of urban fabric in physical and environmental terms (Cullen 1961, Levy 1998, Lynch 1960, Trancik 1986), whereas others argue that creation of urban fabric is the linkage between psychological, sociological and philosophical aspects (Rapoport 1982, Alexander 1987). Some consider it as an interplay between environment and social factors (Barnett 1982, Lawson 1980). In spite of great concerns for creating sustainable and lively neighbourhoods (urban fabric) there is not enough comprehensible and consistent terminology in a framework both planners and public can use to communicate ideas about neighbourhood design (Greene 1992).

For most researchers in urban morphology urban form means the form of urban fabric. Paradoxically, the concept urban fabric has never been clearly defined. This is despite the fact that in most research on urban form the same elements are identified and analysed, either separately or in relation to each other (Levy 1999). In this paper the urban fabric is defined as the physical form of towns and cities.

Figure 2 illustrates how design plays an important role to create various urban fabrics for the same activity or use. Forms of commercial streets from various cities reflect various urban fabrics even though the activity is same. However this difference is also due to use of different design parameters and the context and culture of places.

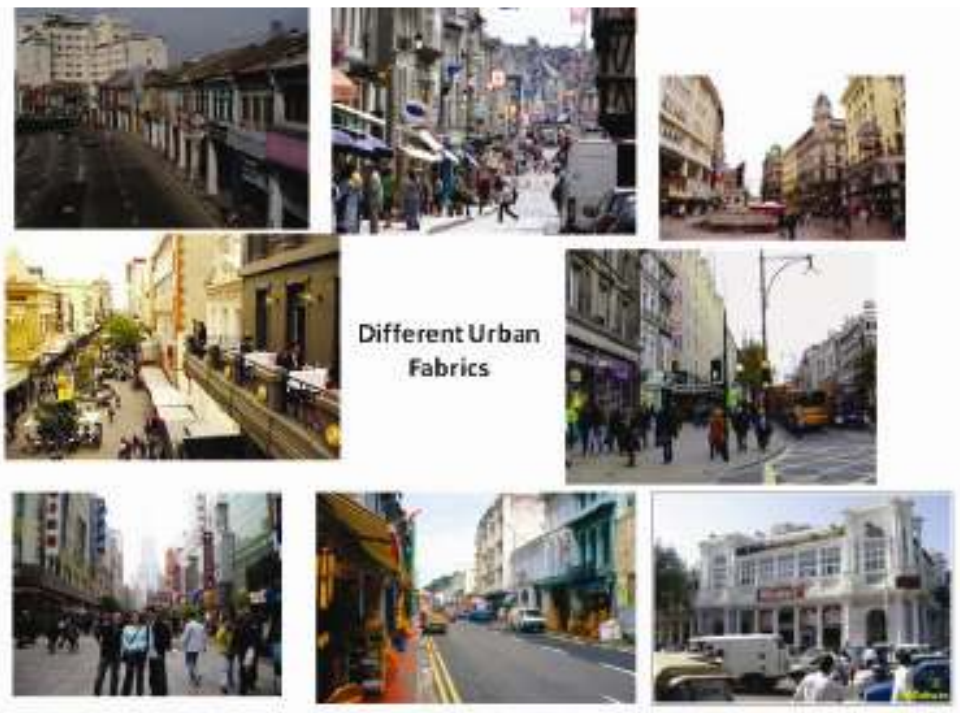

Figure 2. Impact of design and cultural context on urban fabric
Source: Authors

the classification of lots, the typology of constructed spaces or the identification of types of urban spaces and squares, typology of open spaces or the identification of types of urban spaces and squares and provision of public realm and density.

Modern cities has undergone radical changes in physical form, not only due to their expansion but also through internal physical transformations. These have created entirely new kinds of fabric. A shift has occurred from a closed fabric, including central business districts and outlying suburbs in which the link between the different elements (plots, street, constructed space and open space) formed a system (system of urban architecture), to a peri-urban fabric which is open and fragmented with autonomous and atomized elements which do not relate to each other. The shift has been accompanied by significant changes in scale with the appearance of imposing mega structures and relationships between buildings that are now only functional. The aerial photograph of Pittsburgh in Figure 3 depicts design elements that impact on the urban fabric.

Figure 3: Old Neighbourhood in Pittsburgh, Pennsylvania
Source: http://www.airphotona.com

This aerial photograph of a neighbourhood in Pittsburgh shows most of the buildings are three-story row houses, a building type which lends it medium to high densities. Variety of land uses exist here including houses, apartments, churches and shops. All streets are interconnected and have sidewalks, and parking is limited to curb side spaces. Whereas the aerial photograph of a housing development near Denver in Figure 4 shows many of the characteristics of automobile-oriented development. There is only one land use present here: single family houses. Shops, workplaces, and schools can only be accessed by a lengthy drive. Houses are placed at the centre of large lots, and large areas are taken by roads and driveways resulting in a low density. he creation of the urban fabric.

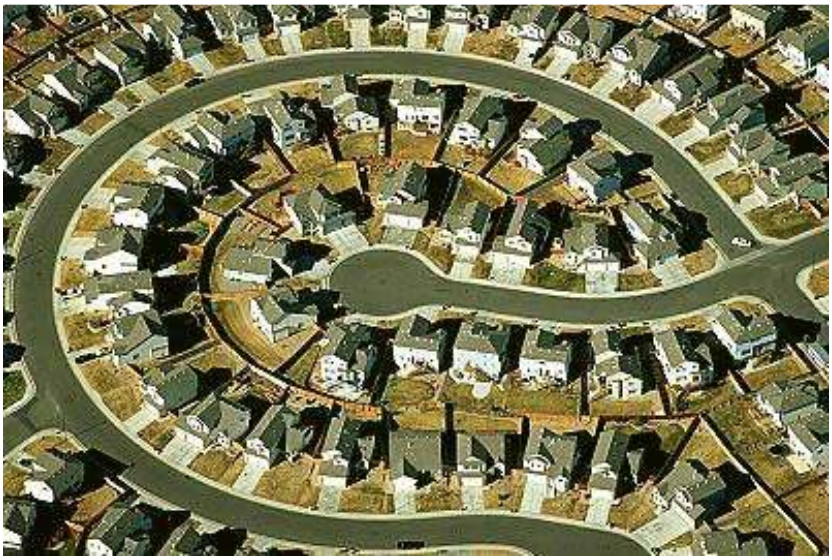

Figure 4: Denver, Colorado, United States
Source: http://www.airphotona.com

Another example show how the urban fabric varies from one example to another and how living environments is different for different types of layout pattern. Figure 5 depicts that even though density for all four lay outs is 25 dwelling unit per hectare yet urban form varies drastically from one place to another due to design parameters as it results in different types of built environments.

These examples show how the image of urban fabric varies from one plot to another and how the living environment is different for different types of layout. Another example from Singapore and Delhi (Figure 6) also demonstrate that even though density in both examples is more or less the same the urban environment is very different because of different design approaches followed in Singapore and Delhi.

Figure 5. Examples of different built environment with same density: (1) A mix of single and multi-family homes on small lots, Newport Beach, CA, (2) Side-yard houses on long and narrow lots, Charleston, SC (3) Town houses and large single-family homes converted to apartments, Sandusky, OH (4) Multi-family development, Tampa, FL.
Source: Lincoln Land Policy Institute

Figure 6. Impact of design parameters on urban fabric
Source:http://www.db.com/careers/en/images/India_(Delhi)_iStock_000001307820Small_rdax_500x3 35.jpg

Another example shown in Figure 7 depicts that even though the design approach is same for the two developments density varies significantly. These two examples have similar urban form but density is very different: 45 du/ha in Gractengordel in Amsterdam (left), where as it is 85 du/ha in De Pijp in Amsterdam (right). However this difference in density is due to number of amenities and workplaces and size of dwelling units. Thus there is no direct relationship between density and urban fabric.

Figure 7. Density design and urban fabric Source:http://www.europeanbeerguide.net and http://www.amsterdamimage.com

Pont and Haupt argue that density alone merely reflects the intensity not the urban form. However when density is seen with other design elements such as floor space index, floor space index, open space ratio, and network density it will impact on urban form and will be able to differentiate urban for more efficiently (Pont and Haupt 2007). . Therefore high density urban development is not necessarily undesirable if it is properly designed, planned and managed.

4. Conclusions

To achieve high density, placing houses closer together is important, and building vertically is also important. A two-story house provides the same living space with half the footprint. Given our desire for large homes arranging single-story houses in a compact layout pattern does not provided a good deal of density. Even at modest densities it consumes unreasonable amount of open space. Building up rather than building out not only allows higher densities but also offers opportunities to create significant green spaces and public realm.

What determines whether a place seems too dense? One important characteristic is the overall settlement pattern. If there is little variation - an even wash of development from one corner of town to the other, or the same shape blocks or building type repeated relentlessly will feel crowded even if it has a low density.

Contrast and diversity at the neighbourhood as well as the regional level are vital components of successful density.

There is a clearly a need for a better understanding of the role of these elements, particularly in the context sustainability. In this regard, there is a need to establish how urban form and density may be managed to successfully address both ecological and liveability criteria and the result could then be used in an assessment of the degree to which cities meet environmental performance and liveability standards.

Perceived density and crowding are based on the principle that the same density can be perceived and evaluated in many different ways by different people under different circumstances in different cultures, context and countries. However, a high density urban fabric could be more sustainable and lively than low density developments because of different design approach. Therefore we need not be afraid of higher-density developments because if designed well, it can provide great economic, social and environmental benefits.

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