

Revisiting Density Concepts for City Planning and Its Implications for Dhaka City

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Abstract

Density of urban areas plays a crucial role in planning and managing the urban development both at the city and neighborhood levels, which subsequently affects the livability. Density describes the number of people in a given area and is usually expressed as the number of people per acre or dwelling units per acre. This paper explores various concepts of density and its application in urban planning across various cities in the world and recommends for density implications in city planning for Dhaka city as well. There are huge variations in density in various cities around the world and therefore both the form and style of urban development varies drastically across the globe. Density zoning has been incorporated in the Detailed Area Plan (DAP), 2016-2035 for Dhaka city aiming to reduce pressure of population as well as ensure balanced development to make the city livable and sustainable. In addition to density considerations, carrying capacity of an urban area is an important indicator for measuring livability and sustainability of development of an area. This paper reveals that most of the wards of Dhaka city have exceeded its carrying capacity to a great extent impacting livability of the city and suggesting for density planning for the city to increase the livability and functionality of the city. This study recommends for mid-rise residential developments for Dhaka city, which is desirable for residential living that creates better communities, neighborhoods and societies.

Introduction

Density in a spatial sense is a numerical measure of the number of people residing, or the extent of building development in a given area (Cheng, 2010). Generally in urban planning, density is a concept to describe, predict and control the use of land (Berghauser and Haupt, 2007; DETR, 1998 as cited in Satu, 2014). Therefore, density becomes a very important issue for the technical and financial assessment of the distribution and consumption of land, infrastructure and public services in residential areas. In this sense, the density of urban areas plays a crucial role in planning and managing the urban development both at the city and neighborhood levels, which subsequently affects the livability. This paper explores various concepts of density and its application in urban

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planning across various cities in the world and recommends for density implications in city planning for Dhaka city as well.

Concepts of Density: Density describes the number of people in a given area and is usually expressed as the number of people per hectare (p/ha) or dwelling units per hectare (du/ha). It can also be expressed in other area units, such as square kilometers or acres (UN Habitat, 2013). Density is understood from two perspectives: perceived density and physical density. Perceived density is largely influenced by the socio-cultural norms and the individual cognitive attributes (Alexander, 1993 as cited in Satu, 2014). In contrast, physical density is influenced by different factors, such as by transport infrastructure, planning policy and regulations, building design etc. (Acioly and Davidson, 1996). The physical density is an objective, quantitative and neutral spatial indicator and can be expressed as population density and building density. The numerators may be the number of persons, families, households, habitable rooms, bedrooms, housing units or dwelling units or floor area depending on the context (Forsyth, 2003).

Residential Density: Residential density is the ratio of number of dwellings per unit of land area. According to “Landcom Residential Density Guide” (2011), residential density can be measured in five ways: site, net, gross, urban and metropolitan. All five residential density measures are calculated using the same basic ratio formula: the number of dwellings divided by the area of land they occupy. Among these five residential densities, gross and net residential density is the most well used method in the field of density study.

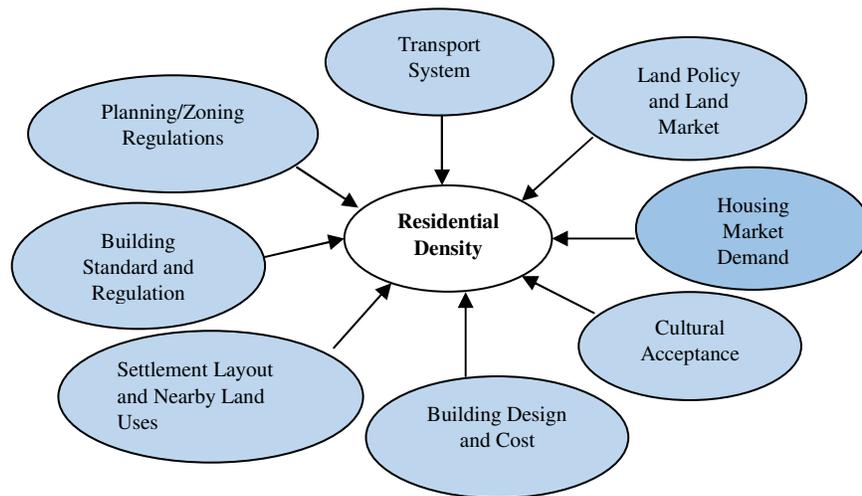
Gross Residential Density (GRD) is the measure of housing density grossly. Gross Residential Density includes residential uses, local roads plus local non-residential land uses, such as parks and schools. It can be calculated as:

$$GRD \text{ (Dwellings or Lots/Acre)} = \text{Number of Dwelling or Lots} \div \text{Total Site Area (Acre)}$$

Net Residential Density (NRD) is a measure of housing density expressed as dwellings or lots per acre. Net Residential Density includes the residential component plus local roads. It can be calculated as:

$$NRD \text{ (Dwellings or Lots/Acre)} = \text{Number of Dwellings or Lots} \div \text{Developable Land (Acre)}$$

Factors Influencing Residential Density: A number of factors may influence the residential density. Of the many factors influencing residential density, some can be dealt with directly, and some indirectly; but there are others over which very little action is possible. While planning policies and regulations, land policy, transport system, housing market demand are some of the important factors which influence the physical density; culture exerts influence on the perception of the density. Figure 1 presents some of the most important factors influencing residential density of an area.



Source: Modified by the authors, 2018 from Acioly et.al. (1996)

Figure 1: Factors influencing residential density of an area

Variation of Density across Countries and Cities of the World

Density varies across the countries and cities all over the world. Some countries and cities have higher densities, while some have low densities. Density in a city is not constant and the average might be different from the density in a particular district or area. For example, the average gross density of New York City in the United States is 32 p/ha, but in Manhattan, a New York City borough, it is around 215 p/ha (UN Habitat, 2013). Table 1 and Table 2 present variation of population density across different countries and cities respectively.

Table 1: Population density of some countries

Sl.	Country	Population	Area (km ²)	Density (Population per km ²)
1.	Singapore	5,535,000	719	7698
2.	Hong Kong	7,234,800	1,104	6553
3.	Bahrain	1,404,900	750	1873
4.	Bangladesh	161,609,000	147,570	1095
5.	Taiwan	23,361,147	36,190	646
6.	Mauritius	1,288,000	2,040	631
7.	Lebanon	6,237,738	10,452	597
8.	South Korea	51,529,338	99,720	517
9.	Rwanda	11,262,564	26,338	428
10.	Netherlands	17,071,100	41,526	411
11.	India	1,326,801,576	3,287,263	404
12.	Haiti	10,413,211	27,750	375

Sl.	Country	Population	Area (km ²)	Density (Population per km ²)
13.	Belgium	11,239,755	30,528	368
14.	Burundi	10,114,505	27,834	363
15.	Philippines	102,078,300	300,076	340

Source: Citymayors (n.d.)

Table 2: Population density in selected cities

Rank	City/Urban Area	Country	Population	Built-up Area (in sq km)	Density (people per ha)
1.	Dhaka	Bangladesh	9,196,964	165.63	555.30
2.	Hong Kong	China	5,179,089	97.63	530.50
3.	Mumbai	India	16,161,758	370.90	435.70
4.	Saidpur	Bangladesh	233,478	7.59	307.40
5.	Rajshahi	Bangladesh	599,525	20.26	295.90
6.	Milano	Italy	17,335,085	635.17	273.8
7.	Casablanca	Morocco	3,004,505	114.31	262.80
8.	Cairo	Egypt	13,083,621	569.17	229.90
9.	Baku	Azerbaijan	2,067,017	90.15	229.30
10.	Addis Ababa	Ethiopia	2,510,904	118.65	211.60
11.	Seoul	South Korea	14,546,082	706.14	206.00
12.	Ho Chi Minh City	Vietnam	4,309,449	210.33	204.90
13.	Singapore	Singapore	4,3097,97	245.24	175.70
14.	Mexico City	Mexico	17,224,096	1058.53	162.70
15.	Santiago	Chile	5,337,512	438.51	121.70
16.	Bangkok	Thailand	9,761,697	1025.93	95.10
17.	Kigali	Rwanda	354,273	45.02	78.70
18.	Beijing	China	11,866,211	1576.38	75.30
19.	Paris	France	9,519,527	1482.08	64.20
20.	Los Angeles	US	13,218,754	3850.89	34.30

Source: UN Habitat, 2013

Density Standard: Variation across Countries and Cities

Although high and low density is commonly used terms in density studies, it is difficult to define the degree of density such as 'high density' or 'low density'. 'High density' is not an absolute concept, but a relative one. The meaning of high density is a matter of perception; it is subjective and depends upon the society or individual's judgment against specific norms (Cheng, 2010). It is argued that what is considered high density in

one country may not be thought of as high in another (Jenks, 2000). It is argued that there is no ideal standard or most appropriate density (Acioly and Davidson, 1996).

Worldwide, there are huge variations in density, and therefore both the form and style of urban development varies drastically across the globe. For example, in the UK, at the neighborhood level, residential development with less than 20 dwellings per net hectare is considered low density; between 30 to 40 dwellings per net hectare is considered medium density; and higher than 60 dwellings per net hectare is considered high density (TCPA, 2003). In the US, low density refers to 25 to 40 dwellings per net hectare; medium density refers to 40 to 60 dwellings per net hectare; and high density refers to development with higher than approximately 110 dwellings per net hectare (Nipun, 2015). In India, extremely low density refers to 100 or less than 100 persons per sq km, low density refers to 101 to 250 persons per sq km, moderate density refers to 251 to 500 persons per sq km and high density refers to 501 to 1000 persons per sq km (<http://www.yourarticlelibrary.com>).

Not only countries, but also cities have tried to set density standard for its jurisdiction in order to make the cities livable. Planning Strategy for Metropolitan Adelaide defines four types of densities for its jurisdiction. Table 3 shows residential density, as defined in the Planning Strategy for Metropolitan Adelaide.

Table 3: Density standard for Metropolitan Adelaide

	Approx Gross Density	Approx Net Density
Very Low	Less than 11 dwelling per ha	Less than 17 dwelling per ha
Low	11-22 dwelling per ha	17-33 dwelling per ha
Medium	23-45 dwelling per ha	34-67 dwelling per ha
High	Greater than 45 dwelling per ha	Greater than 67 dwelling per ha

Source: [http:// VVI_Adelaide_Australia_Understanding_residential_densities_handbook.pdf](http://VVI_Adelaide_Australia_Understanding_residential_densities_handbook.pdf)

Since density plays an important role in the decision-making process in planning, architecture and urban design, the positive and negative consequences associated with high density are hotly debated throughout the world (Boyko and Cooper, 1961).

Density Concept in Bangladesh

Density is not a very recent concept in Bangladesh. Its early use was observed in “*Paurashava Ordinance 1977*” to delineate urban areas and rural areas of the country. According to this ordinance, areas having population density not less than 2000 per sq mile were to be considered as urban areas. This ordinance was amended in 2009 and titled “*Local Government (Paurashava) Act 2009*”. This act also uses the concept of density to delineate urban and rural areas of the country. According to this act, areas having population density not less than 1500 per sq km are to be considered as urban areas. Even along with other considerations, the concept of density is also used to declare an area as “*City Corporation*” according to “*Local Government (City Corporation) Act 2009*”.

Now-a-days, the concept of density is used to control the growth cities of the country. For this purpose, the development authorities of the country i.e. Rajdhani Unnayan

Kortipakha (RAJUK), Chittagong Development Authority (CDA), Khulna Development Authority (KDA), Rajshahi Town Development Authority (RTDA) and Cox's Bazar Development Authority address density issue as a growth management tool. RAJUK prepared a master plan for Dhaka City in titled "Dhaka Metropolitan Development Plan (DMDP) 1995 -2015". DMDP had three components, namely "Structure Plan 1995", "Urban Area Plan 1995" and "Detailed Area Plan (DAP) 2010". There was no population policy or density policy in the "Structure Plan" for RAJUK to follow. In the "Urban Area Plan", the development intensity was controlled through restricting the building height, which was an inefficient measure of density control for a rapidly growing city like Dhaka (Satu, 2014). For residential areas, the "Detailed Area Plan" proposes a maximum net density of 86,450 persons per sq. km (350ppa). It shows that the gross density will be lower and may be close to maximum 30,875 persons per sq. km or 125 ppa (DAP, 2010, p. 39). Like RAJUK, other development authorities have also addressed density issues in their master plan in order to make their cities livable.

There are certain planning acts and regulations which guide the development of urban areas of the country and thus influence population distribution both directly and indirectly. The Building Construction Rules 1996 sought to control development plot-by-plot and case-by-case. This rule controlled the building density by imposing conditions on setbacks, site coverage, and height of building. By restricting the height of a building, this rule influenced the density of an area and above all manages the growth of the city in some way (Satu, 2014). Private Residential Land Development Rules (PRLDR) 2004 proposes a maximum gross density of 86,450 persons per sq. km. (350 ppa) for private residential projects. According to PRLDR, to initiate the land development for housing project by private developers, the land area should be at least two hectares within the Dhaka City Corporation (DCC) and at least four hectares if the site is outside the jurisdiction of DCC. Dhaka Metropolitan Building Construction Rules 2008 superseded the earlier set of building construction rules issued in 1996 for the Dhaka metro and provided more authority to RAJUK. One of the most significant improvements is the introduction of plot ratio (PR). To control the density and manage the growth of the city, it provides rules on building coverage area, allowable floor space in relation to the building height, i.e. floor area ratio (FAR), road width and plot size (Nipun, 2015).

Density and Quality of Built Environment

In social science, the term "Built Environment" refers to the human-made surroundings that provide the setting for human activity, ranging in scale from buildings to parks. It has been defined as the human-made space in which people live, work and recreate on a day-to-day basis. The built environment encompasses places and spaces created or modified by people including buildings, parks and transportation systems. In recent years, public health research has expanded the definition of "Built Environment" to include healthy food access, community gardens, mental health, walkability and bike ability (<http://en.m.wikipedia.org>). Again, the US Centers for Disease Control and Prevention (CDC) defined "Built Environment" as encompasses all human formed, developed or structured areas. This includes buildings, transportation systems and urban form and the various ways they interact (<http://www.sciencedirect.com>).

Quality of built environment depends on many factors. Among these factors, one of the most important factors is density. Always high density creates negative impacts of built

environment quality. Some of the mentionable impacts of high density on built environment quality of an area are as follows:

Hampering Privacy, Circulation of Air and Access of Sunlight: High density requires more structures for accommodation and other purposes. So, in a densely populated area, building area developed haphazardly without following planning rules and regulations. As a result of deviations or violation of planning standards, the distance between buildings are becoming minimal and consequently privacy, safety, circulation of air and access of sunlight etc. is greatly hampering.

Housing Problems: There may be significant effect of high density on the rising prices (house rent) and the depreciation of building structure. It may create effects on the difficulty of inferred housing.

Decrease of Open Spaces: Open spaces especially parks and playgrounds being the major components of built environment are considered as lungs of any residential area. If a residential area is densely populated, then to mitigate the housing demand of growing population, the demand for residential development becomes high. Then the pressure on the land becomes intense and open spaces, like parks and playgrounds are gradually replaced by buildings.

Transportation Related Impacts: There is impact of high density on roads and traffic accidents as the increasing population increases the number of cars with the roads remaining the same. Besides, high density has significant impact on the use of alternative means of transport. Due to high density, some serious complications in the accessibility of the residential areas can be created. The changes occurring in accessibility due to growing density in the residential areas may create complexity in the accessibility, shrinking of local access roads, degradation of local access roads quality, formation of dead end roads within the residential area, etc.

Increase of Crime: There is considerable empirical evidence that crime is highly concentrated in particular places, especially places with high density and among particular groups of people. Usually theft, hijack, smuggling, drug addiction or drug abuse, antisocial activities, etc. are more in a densely area due to various reasons. So, crime rate is comparatively higher in the area with high density, which reduces safety and security condition of that area and ultimately this hampers the built environment quality of the area.

Health Problems: Due to high density, the dwellers of residential areas may suffer from different diseases, like asthma, respiratory illness, cardio vascular illness, etc. The reasons behind these health problems in the densely residential areas are crowded buildings, more people living in small space, inadequate access of sunlight, lack of ventilation, etc.

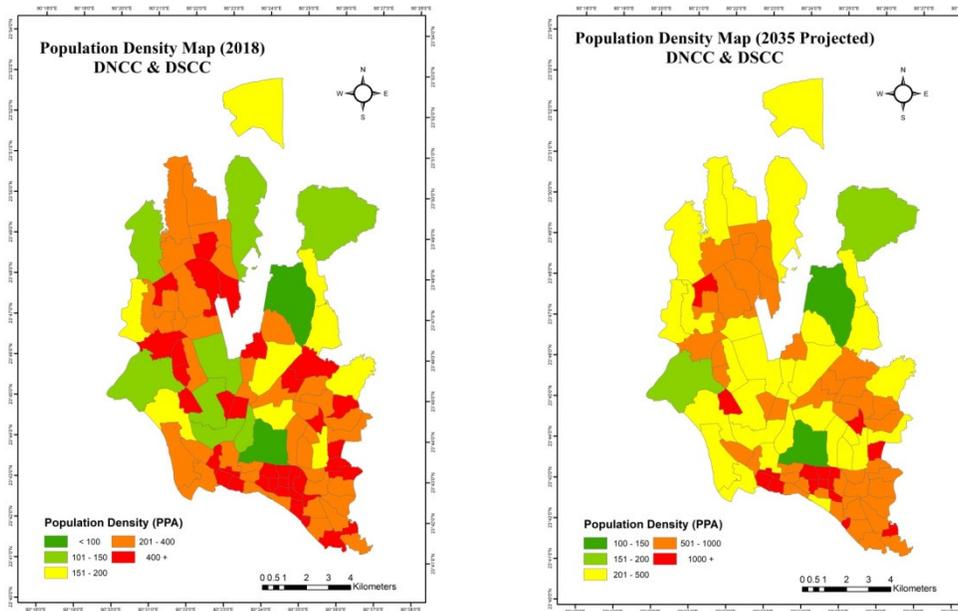
Density Implications in Physical Planning for Dhaka City

Density zoning has been incorporated in the Detailed Area Plan (DAP), 2016-2035, aiming to reduce pressure of population in the core area of Dhaka to make it livable. Under density zoning, there will be a process of identifying area-wise population density, the usage of land as per population density and putting emphasis on providing civic amenities.

Density zoning is a tool to regulate the development intensity of any specific area. Usually, it is applied in residential and mixed use areas. Currently, DAP and Building Construction regulations, such as Dhaka Imarat Nirman Bidhimala, 2008 are used to control the development activities in Dhaka Metropolitan area. Current practice of FAR is not so effective to control the population density in residential area. As there is no fixed or standard size of residential apartment in our country, number of dwelling unit varies according to plot size and FAR. However, FAR does not have any direct role to control the population density maintaining its environment properly in residential area. Besides, current FAR value is flat, at times higher than required and used equally within Dhaka Metropolitan Area, which does not consider local character, existing potentials and scenario etc.

Density Scenario for Dhaka City

Dhaka Structure Plan (DSP) 2016-35 advocates for gross density of 300 pph (120 ppa). However, current density of Central Urban Area (CUA) of Dhaka city is 325 ppa and according to DSP, projected density of Dhaka in 2035 is 434 ppa. Based on these realities, planning for Dhaka city should be done to limit density within the acceptable norms and standards. DSP suggests to cut down the limit of PRLDR density from current standard of 350 ppa and prescribed density by DSP for areas outside central Dhaka is 120 ppa. Current gross, gross Residential and net Residential density of DNCC area is 188 ppa, 284 ppa and 393 ppa respectively. On the other hand, current gross, gross residential and net residential density of DSCC Area is 144 ppa, 351 ppa and 500 ppa respectively.



Population Density in 2018 (Trend Analysis)

Population Density in 2035 (Projected)

Figure 2: Population Density (Projected) at ward levels in Dhaka City for 2018 and 2035

According to 'Density Zoning Report' for Dhaka City (RAJUK, 2018), carrying capacity of Dhaka has come to an optimum point reflected by the current unlivability of Dhaka city supported by the ranking of Dhaka city in various global indexes of unlivable and polluted cities. There are still some parts of core Dhaka city area, where gross density is comparatively lower than other parts of the Core areas of Dhaka city. However, these areas act as balancing or buffering areas in the composite planning structure of Dhaka city. Based on these premises, it would be suicidal to significantly increase the density of those parts of the city area. Therefore, intensification of density in those parts of the city might further paralyze the Dhaka city and aggravate the traffic, built environment and ecological problems in the Dhaka city.

Population Carrying Capacity Analysis for Density Zoning

The population carrying capacity of a ward means the maximum level of population whom the ward can properly support with its existing basic infrastructure and service availability. When the population size of a ward exceeds its population carrying capacity, the ward population faces limitations of infrastructure and services in that ward and at the next step the living condition of the people of that ward begins being poor. The population carrying capacity of a ward can be determined through its allowable population density and its area i.e. Population Carrying Capacity = Area * Allowable Population Density

Analysis of Population Carrying Capacity in Terms of Existing Population

Carrying capacity of an urban area is an important indicator for measuring livability and sustainability of development of an area. For the purpose of density planning of Dhaka city, carrying capacity analysis has been carried out by RAJUK in order to determine the optimum level of population that urban areas are able to carry without showing negative consequences of urbanization and development on built and natural environment (RAJUK, 2019). Population carrying capacity has been analyzed based on current population size (population in 2018) of wards in different parts of Dhaka city, derived from the 2011 census population of the wards considering a population growth rate 3.7% depending on 2001 and 2011 census data.

Carrying Capacity Analysis of Dhaka City (Dhaka North and South City Corporation Areas)

Carrying capacity analysis of Dhaka city corporation areas (Both DNCC and DSCC) have revealed that 90 percent of the wards of Dhaka city have exceeded its carrying capacity assuming the density of 150 ppa, whereas 81 percent of the wards have exceeded carrying capacity assuming density of 200 ppa. It is noteworthy that 63 percent of wards already have the density of 400 ppa or more at present (Table 4) and most of the wards have exceeded their population carrying capacity¹ (Figure 3).

¹ Population Carrying Capacity ratios greater than one delineates that current population has exceeded the maximum carrying capacity of the ward.

Table 4: Present population density in the wards of Dhaka City

Density (ppa)	No of Wards	Percent of Wards
<150	10	11
150-200	9	10
200-250	9	10
250-300	6	7
300-400	22	24
400 +	36	39

Source: Prepared by Authors

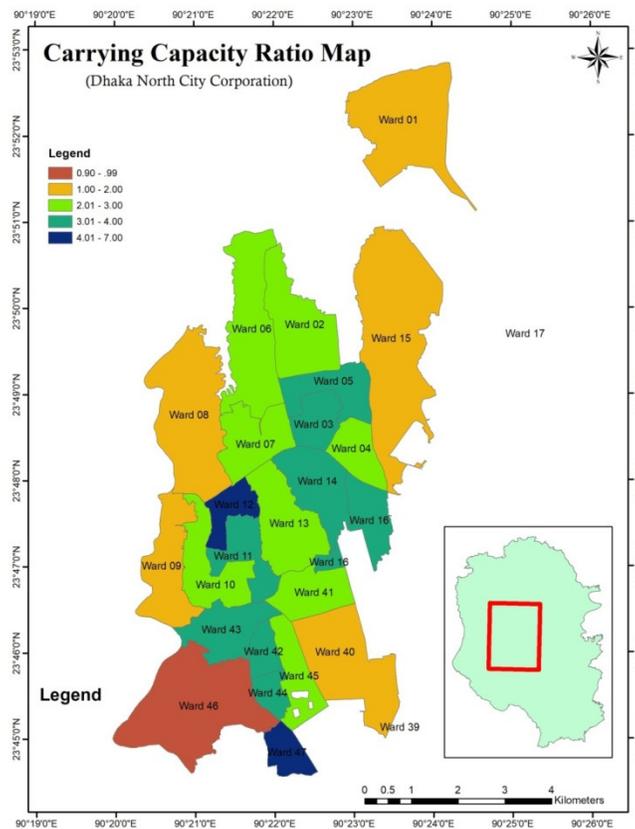


Figure 3: Carrying Capacity Analysis of DNCC

Recommendations on Density Zoning Guidelines for Dhaka City

Determining the optimum and sustainable height for buildings is quite critical for building communities in the residential areas. According to the findings of this study, mid-rise developments is desirable for community living which creates better communities, neighborhoods and societies and this type of mid-rise developments generally encourages building height within 4 to 6 stories. In addition, various researches

around the world find that building height ranging from 4 to 8 stories are most economical and affordable as per square feet construction cost increases, whenever storey height exceeds more than 8. Therefore, high rise developments increases per square feet cost of floor area and this type of development does not increase the density as it is perceived due to large amount of common space to be required for high rise construction and most importantly become unaffordable to greater sections of society.

Moreover, high rise development is designed in city states like Hong Kong, Singapore which are land scarce country and very developed country as well with very high per capita income. These examples should not be readily imitated for a country like Bangladesh as though it is a densely populated country, but not a land scarce tiny city state. Bangladesh is still a developing country with limited housing affordability of majority of people. For a developing country like Bangladesh and for a city like Dhaka where majority of population belongs to middle income, lower middle income and lower income category, very high rise developments should be discouraged because of various factors pertaining to high rise building, such as lack of affordability of majority of population, developing isolation, does not help to create vibrant communities, not fitted in human scale, does not yet readily fit in our culture and society. Such development creates social tension, anxiety and crime. Most of the Cities in the world, for example, London, Athens, even Delhi do not encourage high rise development for residential living. New urbanism thoughts encourage creating vibrant communities and societies which cannot be achieved in high rise developments.

Carrying capacity of an area decreases if it is developed in an unplanned manner or the quality and services of existing infrastructure deteriorate significantly and if the level of affordability of people and the municipal authority is very low. Once cities reach a certain population and spatial size, agglomeration benefits may decrease. The association between income and city size becomes negative once a threshold population of around seven million (70 lakhs) is reached (OECD, 2006). This is because diseconomies of scale, such as excessive extension and congestion, may outweigh agglomeration advantages. Studies show that a person's tolerance level for travelling is around one hour per day. This "travel-time" tolerance multiplied by the speed of the mode of transport is used to determine an efficient spatial size of a city (Marchetti, C. 1994). Based on this premise, it is recommended that size of a city should be within half hour ride in one way and one hour ride for both ways. This explains why cities may become dysfunctional beyond a certain size.

Based on the above premises, Carrying capacity of an urban area would be determined based on maximum level of allowable density for the concerned area. Desirable residential density for an urban area is 120 persons per acre according to planning considerations (Lehmann, S.; *Future Cities and Environment*, 2016). For the case of central or core urban areas of Dhaka city, density limit should be within 150 – 200 persons per acre and 100 – 120 ppa for outer urban areas. Based on the existing planning context and due to the fact that Dhaka city has already exceeded its carrying capacity, midrise development is recommended for central urban area of Dhaka city limiting the height within 8 stories. For the case of public housing projects, maximum building height

can be suggested to 10 stories. Maximum building height for rural settlement zone and growth management area can be 3 stories. Restricting building height within 3 storeys in growth management area will limit the value of land and developability of land. The land conversion from agriculture to residential use might be discouraged and stopped as well, due to low level of return from this conversion.

Concluding Remarks

Density planning is an important tool and technique to limit the growth of city and it helps to control the growth of a city according to its carrying capacity. For a city like Dhaka, which is quite unlivable considering the traffic, environment and other built environment related factors, density planning should be done to limit its population for better planning for various services and facilities. Future success of investments in mega projects for Dhaka city depends on population projection and density planning for the city as well. In order to achieve the goals of sustainability and better human living, density considerations should be given due priority by planners and policy makers based on the planning, economic and social contexts of the city. Hence density planning measures should be applied for Dhaka city appropriately to ensure planned and sustainable development of the city.

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