INDICATOR BASED PLANNING OF A HOUSING SCHEME USING GEO-SPATIAL TECHNOLOGY: A CASE STUDY OF KAHNA STATION IN THE LAHORE METROPOLITAN AREA

S. Dar,, A. Rahman I.Ahmad

Department of Geography, Government College University, Lahore, Department of City and Regional Planning & Department of Civil Engineering, University of Engineering and Technology, Lahore, Department of City and Regional Planning, Lahore College for Women University, Lahore

ABSTRACT: Inadequate housing supply has been a major problem in fast growing cities of developing countries like Lahore in Pakistan. To reduce the housing backlog, a plan for a sustainable housing scheme that can be feasibly implemented in Lahore has been proposed. A suitable site was selected near Kahna Station, Lahore. Base maps were developed and comprehensive field inventory exercise was done using geo-spatial technologies. During these surveys, the soil and water samples collected from the site were analyzed to determine the aptness of the site for the construction of a housing scheme. In order to achieve the objective of sustainability, seven variables, i.e. socio-ecology, water conservation, air quality, resource conservation, controlling heat island effect, walkability and livability. Most of the plots (38%) account for five marlas and second highest numbers of plots are accommodated (19%) 3 marlas dwellings. This study attempts to use standard urban design concepts and fuse them with state-of-the-art techniques like GIS.

Key words: Urban planning, sustainable development, GIS mapping, human ecology

INTRODUCTION

Cunningham (2004) defined urban planning as to design and arrange the components of urban and rural centers in a way that optimizes the quality and productivity of life. Whereas Berg (1990) explained sustainable planning as relatively a new concept which persuades planners and the planning agencies to make smart choices in order to establish healthy and self-sufficient communities that impose minimal environmental degradation. Brundt land Commission (1987) pointed out that the think-tanks across the world define sustainability as a kind of development that ensures fulfilment of today's needs without compromising the resources for future generations.One very significant urban design concept, in the history of urban planning, is the 'Radburn plan', named so because it was implemented in Radburn, New Jersey. The Radburn plan focussed on 'superblocks', approximately 30 to 50 acres large, encompassing vast green spaces in the middle. The green spaces paved pedestrian pathways to schools, shopping centres and other civic facilities. Lee &Stabin (2001) also declared Radburn plan as unique that introduced the concept of 'neighbourhoods', where all the fundamental facilities of life were available within half a mile only.

Zaman and Baloch (2011) described the case study area; Lahore as lying between 31^{o}-15' and 31^{o}- 42' north latitude, and between 74^{o} – 01' and 74^{o} – 39' east longitude, Lahore is positioned on the left bank of the River Ravi. Following independence, Lahore was proliferated by an ever-increasing population causing an acute dearth of housing units in the city. The issue continued to exacerbate on the account of an unchecked population growth. The prevalent housing backlog and the recurring practice of developing unsustainable housing schemes in Lahore are the two reasons that triggered this research study.In 2010, the total population of Lahore had scaled up to9 million. The average population density of Lahore that was 640 km^2 back in 1951 had increased up to 4,983 km^2 in 2010. A multitude of private housing schemes sprung during 1980s lead to mass-scale urbanization in the south of Lahore. The east of the city remains exempted from dense urbanization, thanks to the Indian border at the eastern periphery, while the spread of River Ravi towards the north and the west of Lahore has relatively impeded the city's expansion towards these directions. The expansion of the city has taken place along three main highways; namely Ferozepur Road, Multan Road and G T (Grand Trunk) Road.According to a survey conducted by NESPAK (2005), the total built-up area of Lahore Metropolitan Area (LMA) was about 20 percent out of which only about 10 percent was residential.Recent data collected from LDA suggests that the residential sector comprises of 254 approved housing schemesin urban Lahore. The emerging housing schemes show an inclination towards the incorporation of T-intersections and horizontal development. However, lack of planning on the part of developers render these emerging housing schemes less effective and unsustainable.NESPAK (2005) study showed that the Housing Census conducted in the year

1998 indicated the per annum demand of housing in LMA to be 30,000 units, with the annual supply of formal housing being 2500 plots, which meant that Lahore was subjected to a housing backlog of approximately 154,000 units.The situation is far worse for the underprivileged sections of the society which lack the capacity to meet the expenses of the costly new developments. Hence, they seek to colonize slums and squatters that add to the issues of the city.

MATERIALS AND METHODS

A site was selected in the locality of Village Kachha, 1.3 km away from Kahna Station towards the South of District Lahore. The site has an altitude of approximately 50 m above mean sea level. The proposed scheme lies between 312427.1-N and 741836.6-E. The site is located about 1.3 km from the Kahna Railway line and 1 km from Kharie Distributary. The route of Kahna railway line is from Lahore to Karachi as shown in figure-1.The study area site is located in a pre-dominantly residential area with scores of housing schemes located in the region. No industrial unit or industrial activity is found within a distance of 2 km. The study area site is bordered by 'Millat Housing scheme' towards the north, which is halfway through construction. Another notable housing scheme that falls within the site's vicinity is 'Green Town'. A WAPDA grid station is located near the Village Kachha. The area falls under the 'Nishtar Town', one of the 9 towns of Lahore.The site was chosen based on its suitability for the construction of the proposed housing scheme. The site can also be accessed through public transport conveniently. What makes this site most suitable for a residential settlement is the availability of basic infrastructure and utility services, such as; line and wireless communication, electricity supply and sewage disposal. The main road adjacent to the project site is 'Kachha Road' which is 66 ft wide as shown in figure-2. Along the course of the Ferozepur Road, Kachha road can be accessed by means of taking a turn close to the WAPDA Grid Station. The selected site is at a distance of approximately 6 km from the Ferozepur Road. The selected site falls under the category of seismic zone-I. Moreover, the site is not susceptible to flooding. The survey of the site was conducted on 15th April, 2011.

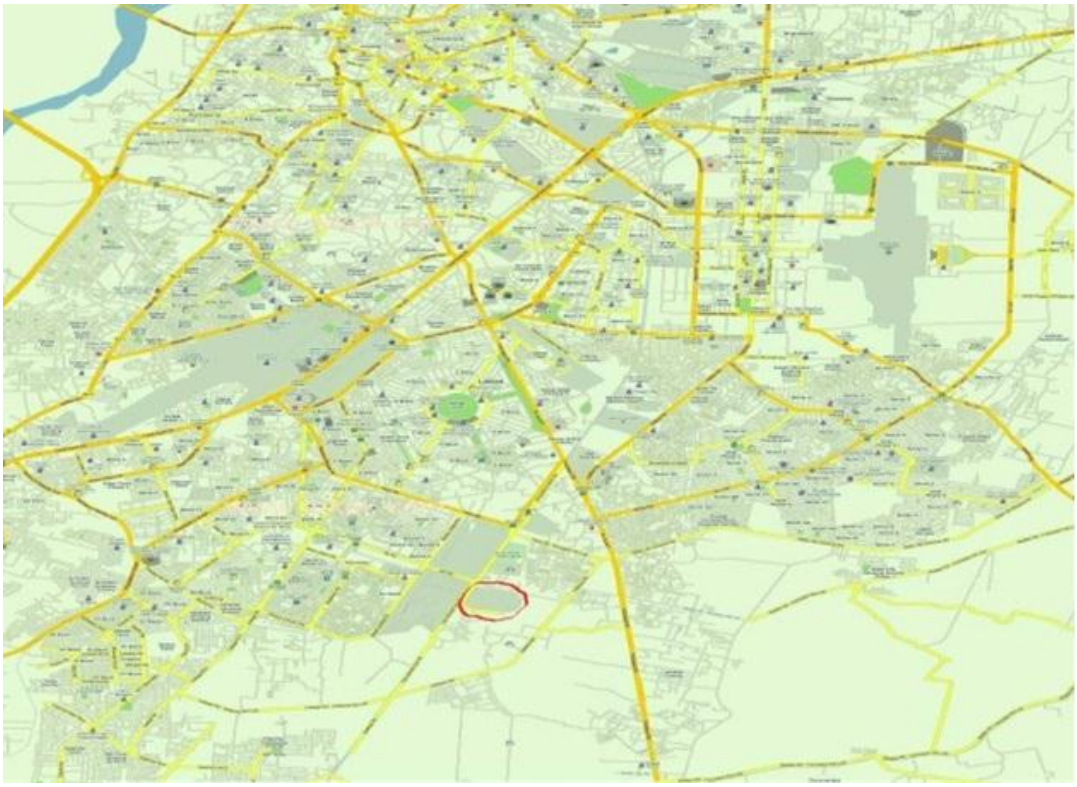

Figure-1: Map Showing the Case Study area

The actual planning of the scheme was completed using AUTOCAD 2009 and ArcGIS 9.3.In order to achieve the objective of sustainability; seven variables were incorporated in the proposed housing plan. These included human ecology, walkability, water conservation, air quality, resource conservation, controlling urban heat island and liveability. A field survey of the study area site was conducted using Global

Positioning System (GPS) followed by the collection of water and soil samples. The image of the site of interest was downloaded from Google Earth and geo-referenced using ArcGIS 9.3. Soil samples were collected from the site and analysis was done in Soil Survey of Pakistan. The water sample was collected from a nearby hand-pump in a distilled plastic bottle and the sample was tested in lab at the Sustainable Development Study Centre (SDSC) in Government College University (GCU), Lahore. The analysis was doneto check different parameters for the suitability of drinking water for human-use. The texture of soil was identified to be very fine sandy loam which is deemed suitable for the construction purposes.Data relevant to the requirements and standards for a residential housing scheme and the prevalent urban planning trends was collected from Punjab Housing and Town Planning Agency (PHATA), City and Regional Planning Department of UET, Soil Survey Department of Pakistan, Meteorological Department, Lahore Department Authority (LDA).

Figure-2: Image of the Selected Case Study area

The scheme offers plots scaling from 1 Kanal to 3 Marlas. This implies that the scheme will serve to different socio-economic classes of Lahore; ranging from upper class, upper middle class, lower middle class to lower class. The total area of the site is 132 acres, 53.4185hectors or 5749920 square feet. The dimensions of the site are given in figure-3.

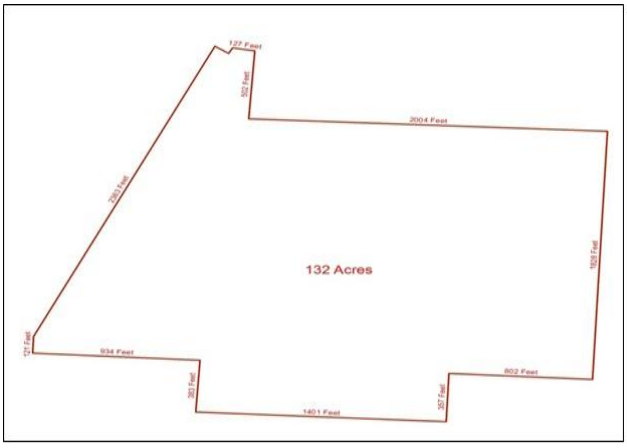

Figure-3: Area and Dimensions of the Study Area Site

RESULTS AND DISCUSSIONS

The scheme has been orderly divided into 7 sectors, which are represented by the successive alphabetical letters, that is; Sectors A, B, C, D, E, F and sector G. All the sectors bear a rectangular orientation. Each sector has been assigned its own theme-cum playing park, water filtration plant and a general market placed around the respective intersection. The intersections are in the form of roundabouts, which ensure both safety and efficiency. The principal thought behind the arrangement of the scheme is to create ‘systems’ within a ‘system’ so that the community can sustain itself. The scheme has a ‘square’ at its core which has been proposed to be the focal point of all the communal activities. This can be attributed as the ‘major’ system functioning within the community. Each sector with its own small, commercial and recreational center represents a ‘sub-system’ within the major system. The main boulevard leads directly to the ‘square’. The square comprises of an extensive park, a commercial centre, a school and a mosque located in the centre of the park.

Figure-4: Sector-wise Plan of Proposed Housing Scheme

The residential streets are mostly 40ft wide with proposed sidewalks and greenbelts. A few residential streets have been kept 30 ft wide while the roads around the T-junctions are 50 ft wide. The total distance from one end to the other of the scheme is approximately 1 km only, which can be conveniently covered within 10 minutes on foot. The 'square' is at a distance of 500 m from every sector which renders it readily accessible by a 5 minute walk. Furthermore, all the basic amenities have been placed at a 5 minute walking distance within every sector to cut short people's reliance on cars to meet their everyday requirements. Besides, one plot has been set aside as the 'garbage collection point' for the proper management of solid waste while an additional plot has been dedicated for 'graveyard'.As shown in figure-4 the sector A comprises of 1 Kanal and 10 Marla plots only. 1 Kanal plots have been placed along the main road, embodying an L-shaped orientation whereas the 10 Marla plots have been placed at the interior of the sector. The total area of the sector A is 22 acres. At its centre, there is a T-junction which encloses a theme-cum playing park. In addition, a water filtration plant and a general market have also been placed along the intersection. The total piece of land dedicated to the park and other amenities is about 3.55 Kanal. The total number of houses within this sector is given as $1\ Kanal\ plots\ are\ 119$ and $10\ Marla\ plots\ are\ 48$. The total numbers of $plots\ are\ 167$.The composition of the sector B is quite similar to that of the sector A, except for that, the total number of plots in this sector is 145, out of which 91 are 1 Kanal and 54 are 10 Marla houses. This sector covers a total area of 21 acres.The sectors C and D consist of 10 Marla plots only. The total area of each of these sectors is 7 acres. Since the composition of both the sectors is the same, the calculations of only one of them are given as $10\ Marla\ plots\ in\ Sector\ C\ are\ 88$ and $10\ Marla\ plots\ in\ Sector\ D\ are\ 88$.The sectors E and F have been placed at the rear of the scheme. They are composed of 10 and 5 Marla plots. Both the sectors have been allotted green spaces of the size 3.55 Kanal each, along with the provision of facilities similar to those provided in other sectors. Two units of 10 Marla (each with 12 plots) and two units of 5 Marla plots (1 with 16 plots and the other one with 12 plots) have been positioned along the main road. In this way, people belonging to varying socio-economic backgrounds will have the prospect of buying a plot facing the main road. The sector E covers a total area of 18 acres, while sector F covers 20 acres of the total area. Since the composition of both the sectors is the same, the calculations of only one of them are given as $10\ Marla\ plots\ are\ 71$ and $5\ Marla\ plots\ are\ 282$ and the

total numbers of plots are 353. The sector G is exclusively dedicated to 3 Marla plots where the provision of all those facilities being offered in other sectors, has also been ensured. The green patch, in this sector, has a size of 2.3 Kanal while the total area of the sector is 12 acres. The *total number of 3 Marla plots are 278.*

Figure-5(a): Proposed Plan of Housing Scheme using Auto CAD

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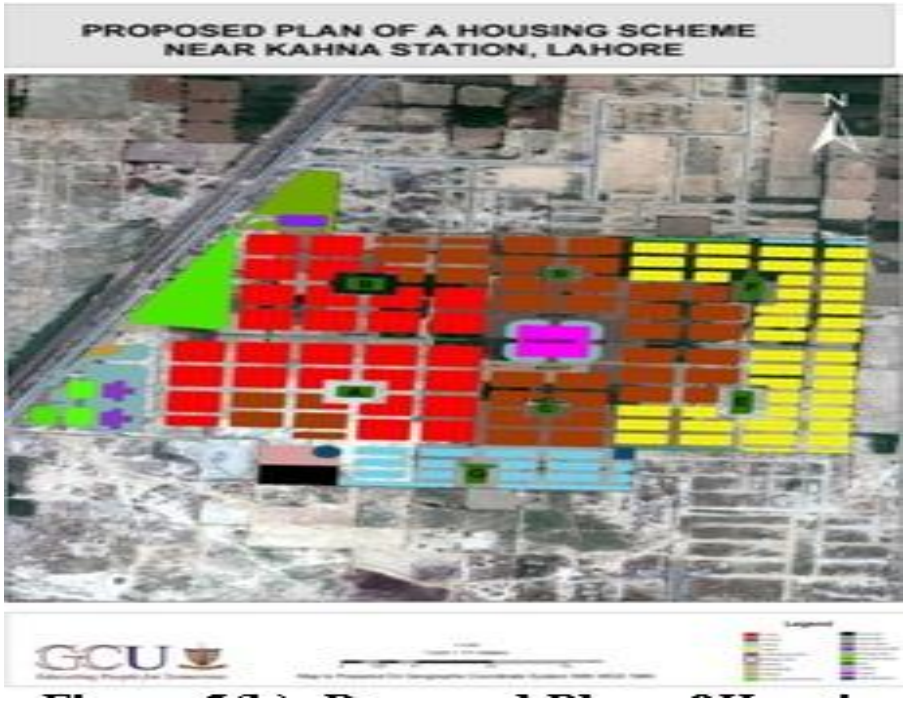

Figure-5(b): Proposed Plan of Housing Scheme using GIS

In figure-5 (a&b) the square, encompassing a total area of 15 Kanal, represents the central junction of the scheme and is located on the main boulevard. It has been proposed to serve as the nucleus of the key mercantile and pertinent communal activities. The rationale behind establishing the square at the core of the scheme is to make multi-faceted amenities accessible at a walking distance, to all the residents equally. Alongside the commercial facilities, the square is also proposed to provide public services such a primary-level hospital and a school. Keeping this in perspective, ample parking spaces have been allotted at the four peripheral corners of the square to accommodate the influx of the car fleet. The commercial centre will generate employment opportunities for numerous people.The square encloses an extensive play-field with a mosque at its heart. The play-field is proposed to be furnished with playing equipment for the children, benches, water cooler, established jogging tracks, water ponds and an artificial lake. The artificial lake will not only help in balancing the water cycle but also add to the visual attractiveness of the site. In addition, a well-built cinema, an exquisite restaurant, a first-class gym and an a la beauty salon are also proposed within the square.At the entrance of the scheme, a water fountain and a beautifully landscaped theme park has been proposed to enhance the aesthetic appeal of the project site. It extends over an area of 174848 sq. ft (4 acres). Indigenous plantation along with the exotic species of small animals and birds will add to the biodiversity on the site. The main boulevard is kept 108 ft. wide which narrows down to the width of 80 ft. towards the eastern side of the square. This is because the intensity of the traffic would decrease past the square, and a width equal to 80 ft. would be sufficient to accommodate the traffic. A 4ft. wide greenbelt in the middle of the road will separate the 'incoming' and 'outgoing' traffic. The width of roads for both incoming and outgoing traffic has been proposed to be 24 ft each. An 8 ft wide green belt and a 6 ft wide footpath will be erected on both sides of the road.

An administrative block has been located in immediate proximity to the entrance gate, covering an area of 2, 68000 sq.ft. It will consist of post office, banks, fire brigade, security, horticulture society, electricity, telephone and cable connection and maintenance and society office. An open marriage hall with a capacity of 400 people has been located near the main gate, along the administrative block.An 11 Kanal plot has been assigned to grave yard towards the south of the scheme. A 40 ft. wide road along the administrative block has been dedicated to grant direct access from the main gate to the graveyard.Adjacent to grave yard, a plot measuring 11 Kanal has been left vacant to be utilized as a 'garbage collection point'.

Achieving sustainability objectives: A concise analysis of how the design of this scheme meets the pre-selected variables of sustainability is as follows:

Human Ecology: The green spaces would serve as venues where people will be able to get together and establish close associations. It also helps in alleviating the disparity of resource distribution among different segments of the society.

Water Conservation: Green spaces play an integral role in the recharging of the groundwater. The concrete roads and pavements stall the penetration of water through the ground. It is expected that the abundant green areas provided in the scheme will help recouping the water cycle and in maintaining the appropriate level of water table.

Air Quality: Trees and plants clean the air by the absorption of pollutants. Thick plantation proposed in the scheme would function as air filters, replenishing oxygen for living organisms.

Reduction of Urban Heat Island: Greenery produces a cooling effect which helps in reducing the heat and subsequently the urban heat island effect.

Walkability: The placement of all the public and recreational amenities at a walking distance of 5 minutes has been used as a tool to motivate people to switch from their cars to walking. This shall yield two-fold benefits. One, ensure physical fitness of the people and the second; reduce carbon emissions due to less car-use.

Resource Conservation: The solid waste strategy of the society regarding waste segregation to promote the culture of recycling and composting will help in conserving abundant resources.

Liveability: The vibrant lifestyle, facilitating adequate recreational and interacting opportunities, offered within the scheme yields a livable and thriving society. The residents will be offered equal prospects to live a healthy and prosperous life, while playing their bit in the development of a sustainable society.

The highest number of plots belong to the category of 5 Marla followed by 10 Marla, 3 Marla and finally 1 Kanal plots. This fulfils one of the objectives of the study; to facilitate lower and middle income classes with dwelling units that fall within their buying capacities. The 5 Marla plots account for 38% of the total plots, which is more than the %age (20%) set by the government. Large sized plots for grave yard and dumping waste have also been set aside. Besides, the provision of essential utility and civic services has been ensured. All these features of the scheme correspond to the planning standards set for private housing schemes.The land-use classification of the proposed scheme conforms to the standards published by the

Government of Punjab for private housing schemes. The total cost of the proposed study project is estimated as

$$Total\ Area\ of\ the\ scheme = 132\ acres$$
$$1\ acre = 8\ Kanals = 132\ x8 = 1056\ Kanals$$
$$Development\ Cost\ per\ Kanal = 300000$$
$$Total\ Cost\ of\ Development = 1056\ x\ 300000$$
$$= 316800000 = 316.8\ million$$
$$Price\ per\ Marla = Rs.15{,}000\ Development\ Cost + 35{,}000\ Civic\ and\ other\ facilities\ cost$$
$$= Rs.50{,}000$$

Hence, the proposed plan indicates that it is possible to create a sustainable and vibrant community even under economic and social limitations.

The primary objective of the research was to weigh up a sustainable proposal suited to Lahore's profile.The site selected for the proposed project near Kachha road has been validated to be suitable for a residential scheme since the profile of the soil has been tested to be apt for construction purposes. The quality of water, in the vicinity of the project site, is also fit for drinking and domestic purposes. The location of the site is such that, this scheme will serve as an intermediary society for the residents of Lahore and Kasur. Lahore, being a heart of industrial, commercial and educational prospects, draws countless people from its adjoining areas including Kasur to reap benefits of these opportunities. Most of these people have to commute daily from their native areas to Lahore. The development of this housing scheme will facilitate the people coming from Kasur and other adjoining areas to gain residence along with their families on the southern side of Lahore. This would achieve multi-fold advantages. Firstly, the time spent in commuting will be saved and can be utilized for other constructive purposes. This will also help lessen the fatigue and the physical exertion inflicted by long-hours travelling. It will also help in cutting down the fuel consumption. In addition, it is a well-established fact that people belonging to lower income classes prefer living in areas which are closer to industrial or commercial zones. Hence, this scheme would provide a prospect to all those seeking occupational or educational opportunities to settle down in the rapidly developing area of Lahore.

Owing to its non-inter-connectedness, an absolute cul-de-sac plan was not deemed the best pattern for the proposed scheme. The inter-connectedness and the accessibility to alternative routes makes grid pattern, the most ancient urban concept, a viable option. In the final lay-out, the scheme has been orderly divided into different sectors. This makes it easier to find one's way through the scheme and search for the desired house. The fact that all the houses in the scheme are almost at a distance of a 500 m to the square, resonates with the idea of Radburn where the focal educational and commercial centres were proposed to be placed at a distance of approximately 1 mile from all the houses (even though the commercial centre was displaced from the centre to the entrance later). The scheme has been designed such as to place all the routine commodities and other human needs within the convenient access of the people, so that they don't have to travel long distances beyond the confines of the scheme in the pursuit of their everyday needs. The planning of the site has been done keeping the three principles of sustainability.In the scheme, the principle of responsibility has been achieved through a comprehensive solid waste management strategy which obligates all the houses to segregate their wastes within their houses. In addition, people are encouraged to 'walk' through walkways, parks and closely located amenities. A number of community programs such as composting and urban farming are have been proposed to engage people voluntarily in the sustainability movement.The goal of equity, in the proposed scheme, has been realized by ensuring the availability of small plots that would fall within the buying capacity of the common man. The most important aspect of the scheme is the provision of equal opportunities to all residents irrespective of their status. The third principle is regarding the environmental stewardship. This goal has been attempted to achieve by the provision ample green spaces which play a significant role in protecting the natural integrity of the environment.

The modern urban planning has gone well-beyond mere physical planning and management of the land use. It has now become a much more comprehensive practice which involves social, environmental, economic, and cultural aspects of the society as well as the input of the community to envision the establishment of a fulfilling life form on a designated piece of land. These innovations instigated the allocation of abundant hospitable green spaces within the scheme to only endorse a sense of neighbourhood but to also to improve the quality of environment in different ways. These green spaces can render multi-fold purposes. Model Town Park is an excellent example of a multi-purpose park in the Lahore's set-up where all kinds of people come to unwind themselves. A similar kind of approach has been adopted in the proposed housing scheme. Model Town Society, on the whole, is generally regarded as one of the well-built schemes of Lahore with each of its block having; a separate commercial area, park, school, mosque and other amenities.

Recommendations: In order to establish a sustainable community in Lahore, it is recommended that the following two aspects should be taken into account:-

1. Planning: It is possible to render any environment conducive to sustainability through appropriate planning. The profile of Lahore is suitable for the development of sustainable communities. However, the planning strategies currently in practice need to be reformed. One way of making the planning strategies more effective is by means of 'charrette'.

All the acknowledged sustainable cities worldwide incorporate charrette as a tool in urban planning. A charrette is, indeed, a form of meeting where stakeholders and other involved citizens are welcomed to incorporate their ideas and vision regarding the future of the city, to the proposals drafted by an interdisciplinary team of experts such as psychologists, traffic engineers, architects etc. This leads to city designs that are far more creative and practical.

2. A Monitoring System:The step subsequent to suitable planning should be the setting-up of a monitoring system. The purpose of this system would be to keep tabs on the activities being carried out within a built environment and to take instant action against those that are inflicting adverse impacts on the people as well as on the surrounding environment. The proposed monitoring system should keep a check on population growth, building bye-laws, concentration of air pollutants, traffic flow and health of plantation.

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