AN ANALYSIS OF NEXUS BETWEEN EVOLUTION OF URBAN FORM AND ENVIRONMENTAL CHANGE

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A thesis submitted to the Department of Environmental Science, Faculty of Basic and Applied Sciences in partial fulfillment of the requirement for the award of degree of Doctor of Philosophy of International Islamic University, Islamabad.

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بسم الله الرحمن الرحيم

Dedicated to My Beloved Father

"Habib Ul Haq"

Who says at age of 85

"Parhae mera ishaq hey"

(Education is my Passion)

ACCEPTANCE BY THE VIVA VOICE COMMITTEE

This is to certify that the research work presented in this thesis, entitled **"An Analysis of Nexus Between Evolution In Urban Form And Environmental Change"** was conducted by *Mr. Naveed Ul Haq* (Registration No: 3-FBAS/PHDES/S11) under the supervision of *Prof. Dr. Muhammad Irfan Khan and Dr. Ghulam Abbas Anjum (Late).* This thesis is submitted to the Department of Environmental Science after receiving "pass" comments by two foreign evaluators and acceptance of the Doctoral Advisory Committee, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Environmental Science. No part of this thesis has been submitted anywhere else for any other degree.

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DECLARATION

I *Naveed Ul Haq*, PhD scholar in the Department of Environmental Science enrolled under registration No. 3-FBAS/PHDES/S11, hereby declare that the knowledge contributed by analyses of data collected and results derived to draw conclusion presented in this thesis titled "*An Analysis of Nexus Between Evolution In Urban Form And Environmental Change*" is my own original work and has not been submitted as research work or thesis in any form in any other university or institute in Pakistan or abroad for the award of any degree. However, two research papers on the basis of this research have been published in ISI indexed journals, as required by IIU Academic Regulations. The output from this thesis so far published are following:

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FORWARDING SHEET BY RESEARCH SUPERVISOR

The dissertation entitled **"an analysis of nexus between evolution of urban form and environmental change"** submitted by **Naveed Ul Haq** in partial fulfillment of PhD degree in Environmental Science has been completed under our guidance and supervision and has been reviews by two foreign evaluators with positive remarks. I am satisfied with the quality of student's research work and allow him to submit this thesis for further process to graduate with Doctor of Philosophy degree from Department of Environmental Science, as per IIUI rules and regulations.

Dated: October 13, 2021

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Abstract

Our cities are expanding due to continuously growing population. Thus, urban form either planned or unplanned is under metamorphosis. This research endeavor has focused on devising an urban form, which is flexible and dynamic in nature and has minimum burden on environment. To achieve this goal some parameters have been incorporated in town planning practices, which helps to draw raw material from environment in a sustainable way. In turn, it exhausts minimum quantity of raw materials. Three popular theories of urban form namely as normative theory, rationalism, and pragmatism were studied. Planned consideration of popular and historic urban forms such as European, South Korean, American and South Asian urban forms gave a perspective of relationship between urban form and environmental change. A comprehensive methodology was adopted to study the pre-60s and post-60s urban form in selected cities of Pakistan. While designing an urban form, three points namely substantiation of location, space allocation and planning standards for land uses has to be considered. Urban form of Faisalabad, Gujranwala, Multan Lahore, Islamabad and Sargodha were analyzed under these parameters. With the advancement of knowledge, we have moved from visible to nanoscale for studying and finding solutions of the environmental issues. Such arrangements will definitely help to ensure safe and green cities with less waste and minimum burden on environmental resources. Historical evolution of the human civilization is divided into different ages/eras. Studies of chronological records have exposed that there is a cause and effect relationship in urban form and environment. It is a two-way relationship, which moves, in circular form. Whereas correlation values calculated with quantitative data varied around moderate. On the other hand, qualitative data shows environmental measures have strongly influenced urban form. Hence, deduction is drawn that influence of environmental changes is strong enough but not as strong as influence of other factors. Based on the analysis, a novel "composite city planning approach" is proposed, which may provide an ultimate answer to human quest for a functional, convenient, technologically assimilated and sustainable urban form. This approach warrants for flexibility in spite of proposing predetermined urban form in a "composite Plan" and subsequent "Opus Plans". The city will contain quad-tier transportation infrastructure i.e. low flying zones, spiral public avenues, link roads, pedestrian streets;" Intermittent Zoning", "Amenity Area" providing necessities and "Facility Centre" having multi-use high-rise buildings with parking plaza. Inverse architecture for B+G+3 houses abating pedestrian streets with walking, cycling, skating

lanes will emerge an "inventive urban form". Economic, Environmental, social and institutional indicators are proposed to be examined in context of resource utilization. The indicators represent a primary tool to provide guidance for policy makers and to potentially assist in decision-making and monitoring local strategies/plans. It is hoped that this study will contribute in designing the policies, tools, and approaches essential for planning to attain the sustainable development goal 11- Sustainable Cities and Communities.

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Naveed Ul Haq

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List of Abbreviations

ADB	Asian Development Bank
C	Criteria
EIA	Environmental Impact Assessment
EU	European Union
FY	Fiscal Year
GHG	Greenhouse gas
IPPC	Intergovernmental Panel on Climate Change
MCDA	Multi-criteria Decision Analysis
MDGs	Millennium Development Goals
SDGs	Sustainable Development Goals
SMART	Simple Multi Attribute Rate Technique
UN	The United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UK	United Kingdom
USA	United States of America

CHAPTER # 1

INTRODUCTION

Human actions referred as anthropogenic activities, directly or indirectly, cause degradation in natural environment. Historically, industrial revolution has been the first ever single incidence responsible for putting extra ordinary burden on nature in terms of raw material extraction and wastes dumping.

Interaction of Pollutants in an ecosystem is now well understood but impact of these on built environment throughout their life cycle is yet rarely understood. Advancement in all branches of sciences in general and in medical sciences in particular has not only raised quality of life but also enhanced average life expectancy. All these elements have contributed to population explosion. People usually prefer to adopt urban living for better quality of life. Which has resulted into expansion of existing urban areas and establishment of new cities. New problems like ecological disturbance, greenhouse effect, ozone depletion, heat islands, urban flooding, air/soil/water pollution and indoor toxins emerged. These small-scale individual changes in environmental factors have been translated with the passage of time into mega shifts in natural environment. These are now known as climate change. Climatic changes have started causing extreme events. Such extreme events are now the major threat to the urban/built environment. To cope up with outcomes of environmental changes, urban form needs to make environmentally resilient.

Though urban areas are providing shelter to half of global population but is responsible for no less than 40% of the greenhouse gases. This level is expected to increase under current demographic trends (Rosenzweig *et al.*, 2011). In the effort to deal with the results of climate change, world is already suffering from its impacts. Moreover, there is no significant decrease either in levels of Green House Gases (GHGs) or its impacts. Studies have shown that heat waves interact non-linearly with urban heat island (UHI) in urban environment producing extreme consequences. Till 2040, death rate associated with these events is expected to be doubled (Li *et al.*, 2013).

Now, it is well established that there is a relationship between state of atmosphere and surface morphology, impervious building materials, vegetation sparseness, blue areas, transportation patterns and other features of the cities (Rafael *et al.*, 2016). All these features are landmarks of progress and there is no way to remove them in order to combat with above given phenomenon. However, efforts can be made to integrate such modifications within the urban tissue that may control the urban meteorology – a relatively

new and unexplored concept. This idea leads to the urban resilient forms. Resilience is a very broad terms and a system is called to be resilient when it holds potential for creations, innovation, opportunities and have ability to absorb shocks.

Although concept of resilience got primary concern and objectiveness while designing the cities for future. In addition, it remains the hallmark during discussions for achievement of goals of ultimate urban development. However, perception of resilience in historical cities is usually missing.

Modern cities do not have capability to preserve its identity while passing through series of morphological changes, to withstand the natural and anthropogenic disasters and even to make a comeback after complete destruction. Few examples of historical cities that have such properties are London (the great fire in 1666), the middle ages fires in Kyoto and 1923 earthquake in Tokyo. These cities can be considered as good example of resilience. In addition, other cities that have stayed alive through thick and thin of centuries can be studied as role models of city resilience. Here, the question arises about the survival of modern cities. Whether these will be able to survive through the test times like Roman cities? These questions become more important while talking about fragile structure of these cities and increasing entropy by huge and uncontrollable energy consumptions (Salat *et al.*, 2012; Salat *et al.*, 2011).

1.1 The Urban Form

Urban form stands for the physical features of area which forms built up spaces and comprise of size, density, configuration and shape of a settlement. Urban form can be dealt at multiple scale such as from street, block, neighborhood, urban and regional. It kept on changing constantly due to economic, environmental, social as well as technological developments. Policies governing housing, health, transport, settlements and economy are also contributing factors of modifying urban form (Williams, 2014). Following factors affects the urban form drastically:

Economy

All cities function with one or more economic basis. Quality of life in urban centers in addition to other factors revolves around buoyance in economy:

- Existing policies of economic management, government policies, bills and rules
- Available manpower
- Cities are more relevant to its sort of livelihood
- Restrictions and obstacles (limitations and possibilities)

- Profit and sources

Society

Livelihood in the city depends upon structure of the society:

- Urban settlements are recognized by its society
- Historical background and chronology
- Art and science
- Cosmology and way of thinking
- Ideology and philosophy
- Population
- Language
- Mentality
- Race
- Rituals and rites
- Values
- Cultural glimpses and religious traditions

Nature/Environment

Natural environment provides aesthetics in addition to enhanced livelihood in the city:

- Urban dynamics are majorly governed by the natural dynamics.
- Topography, geographical location and specification
- Ecological and climatic features
- Rain and ground water
- Wind
- Soil
- Plants
- Town space

Urban form in its simplest shape narrates physical characteristics of the city whether, regional or urban scale. Elements or components of an urban form can be described as three-dimensional configuration of stationary elements (Anderson *et al.*, 1996).

1.2 Scales of the Urban Form Components

Sharma (2014) recognized three scales of components/elements of the urban forms. These are given below:

Macro Scale

Urban space creates the city's fabric and is free of description. These are seen in two cases, either when entering a city area by plane or from high-rise strategic points. The macro scale components include:

- Skyline
- Silhouette
- Solid and Void
- Entrances and Exists

Medium Scale

Factors that can be seen and remembered are introduced at this scale. Recalling these components may cause happiness. These factors may include a transitory or a building, borderline separations of the city parts, a certain locale with definite features or an attractive community center. The medium scale components of the urban design can be marked through:

- Route
- Edge
- Node
- Land mark
- District

Micro Scale

Features that are noticed immediately after entering the city are classified under micro scale components. It may include:

- Furniture
- Elevation
- Space (Sharma, 2014)

All these components are described as morphological attributes of an urban area at all scales (Michael Jenks, 2000). As a matter of fact, features of urban components vary from a vary localized scale, such as fenestration, facades and building materials to a very broad scale such as streets patterns, their spatial layout or arrangements and housing. However, urban form can not only be characterized by the physical features but it also takes into account the non-physical ones. Density (number of people in the given unit of area) of human population is not just a tangible physical feature but it also governs social

environment and collaboration with neighborhood. Non-physical, political, economic and social processes are also manifested in physical features such as schools, parks, houses facilities and services.

The scales at which urban form can be considered or measured include the individual building, street, urban block, neighborhood and city. These levels of spatial disaggregation influence how urban form is measured, analyzed and ultimately understood. The issue of scale constitutes an underlying dimension of any examination of urban form. Measurable scale of the urban form includes urban block, streets, building and neighborhood. Spatial disaggregation affects the method of measuring urban form, it analysis and understanding. Tangible and non-tangible features of the urban form are divided into five inter-related elements of an urban form.

1.3 Elements of Urban Form

The five inter-related elements of an urban form which are considered as very vital to influence human behavior and sustainability. These include:

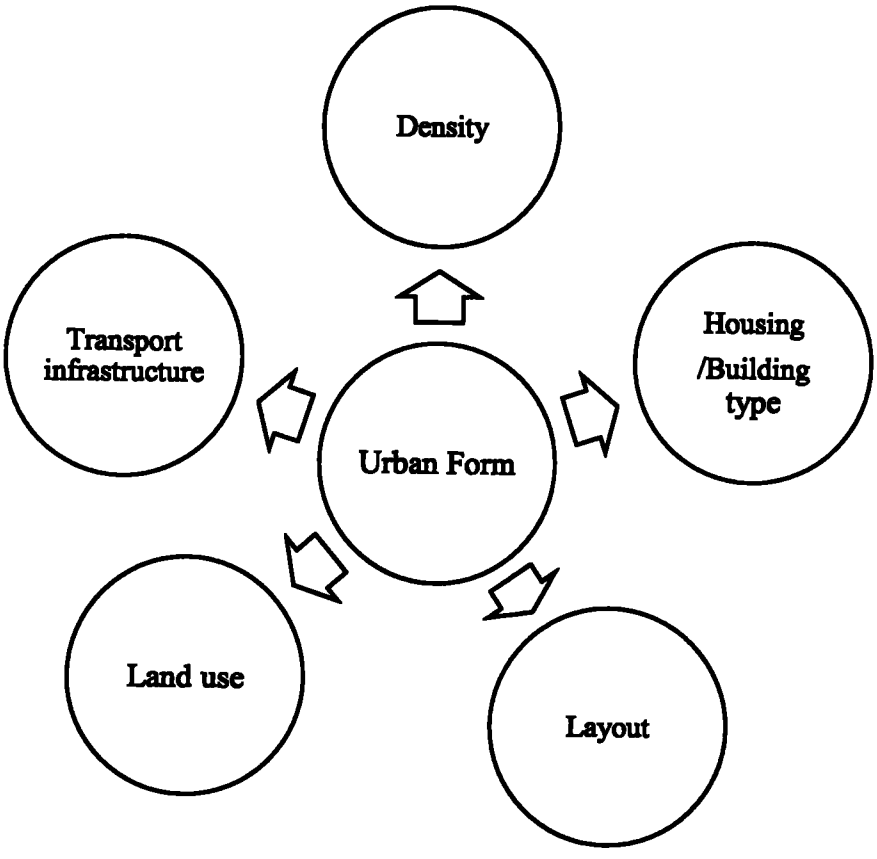

Figure 1.1:- Components of Urban Form

Density

Density of human population provides many inter-related dimensions and provides a spatial-based measure of number of residents in an area. It should be assessed subjectively. It provides social understanding of characteristics of individuals which may differ from person to person (Churchman, 1999) For example: density in Trafalgar Square of London (U.K) may be lower than the perceived one. Yet, its crowding is very high. In was Nineteenth Century when policy makers in UK started taking density into account. It was the time when the urban centers were experiencing rapid growth and poor living standard. Cultural dimensions are also attached to the density aspect of the urban form where number of people becomes relevant (Mike Jenks, 2000; Mike Jenks *et al.*, 2005). Other components of the urban form such as access and availability of services and land use also affect the density of an area. For example, a viable facility or service can serve only a particular size of population. Density can be result in competition between transportation infrastructure and accessibility to other amenities of help services. Availability/provision of the viable facilities and services is the goal of maintaining living standard in urban life. Thus, density can also serve as a tool to gauge the availability of the services and infrastructure provision, feasibility of the land use and construction and design of urban form. Critical level of density may vary with policy, planning and practices of urban design in new developments.

Land Use

In broader terms, land use stands for the multiple functions of the available environment. Predominant, land use in an urban area may be residential but a functionally viable urban form should have offices, retail, infrastructure and industrial moieties at optimum distances. Micro scale land use patterns are vital for their arrangement, because these affect the sustainability of urban form, efficiency of city center and overall quality of life of the citizens, through provision of green spaces. However, there are some socially unwanted land uses such as airports, prisons and land filled sites which are not located close to residential areas (Grant, 2005).

Urban planners in past tried to separate the land uses for potential unwanted externalities. However, they are supporting use of mixed development, for example UK policy makers favor the accessibility of the facilities and services for dwellers horizontally at ground floor level and increasingly in new city center developments, 'vertically' – within the same building. Although, patterns of land use are a dynamic phenomenon rather than stationary and largely depends upon forces of real estate market. Convenience of neighborhood is a

vital feature for the availability of the land use. Provision of facilities and services depends upon resident population and its requirements. Thus, a particular sort of land use depends upon and vary from one neighborhood to the other. Therefore, requirements of the local people and local city context matters a lot. However, spatial scale for the provision of facilities and services is not clear.

Eight neighborhood services and facilities were identified in UK context by Winter and Farthing i.e. primary school, supermarket, post offices, open spaces and newsagent. Relatively, less frequently used services includes chemist, hospitals, community centers and banks. There is extensive guideline in all countries available that which land should be used for which purpose however, there is no consensus found yet (Barton *et al.*, 2003; Dempsey, 2008).

Transport Infrastructure and Accessibility

Accessibility to the transport infrastructure is very important as it determines the comfort of reaching same building. Ease with which ident of an area can reach services/ facilities of their locale or outside their locale is determined by accessibility of transport infrastructure. Accessibility is an encrusted concept and cannot be explained by the distance alone as distance is only one contributor. Important components/features of accessible transport infrastructure include: (Liu *et al.*, 2004)

- Position of prospective destinations in relation to person's starting point.
- How well spatially distributed locations are connected to each other.
- How the local people use the transport system?

All these points are closely linked to the layout and land use, facilities, services and open spaces and extent of how well these are managed and arranged in neighborhood or city. Road and street pattern had a role in transport infrastructure and accessibility.

Road Patterns

Road networks has been recognized as vital constituent of network design problem (NDP) and is a main problem in transportation science (Zhao *et al.*, 2016). Pattern problems of road networks determines the arrangement of different elements in space along the road network. Transportation planners focuses on road pattern of a city for establishment of better settlements (Chen *et al.*, 2011; Szeto *et al.*, 2015). A rational road network plane can ensure lesser incidents of traffic jam and can contribute to the spatial agglomeration of economy but also save cost of investment. Thus, road network problems has become an

active science (M. Lee *et al.*, 2015; Parthasarathi *et al.*, 2013). Road network pattern can have different patterns;

1.3.4.1. Block or Rectangular Patterns

This pattern divides the whole area into rectangular blocks. Streets intersect block and each other at right angles. There is a main road which provides direct access to the outside of the city and is sufficiently wide. While, branched roads are comparatively narrow.

This pattern has following advantages:

a. Larger rectangular plot can be further sub-divided into smaller blocks with streets intersecting each other at right angles.
b. This pattern can be employed for city roads.
c. Maintenance and construction of the road is easier.

Major inconvenience of this pattern remain that vehicles face each other at intersections.

1.3.4.2. Star or Radial and Block Pattern

Network of roads divide the area and radiate from business hubs outwardly. Built-up terrain is planned in between the radiating roads in rectangular blocks. It reduces the congestion at bottleneck location.

a. Avoids traffic from retrieving local flow ways in the course of the incident venue that function in service of outlet traffic flow.
b. Allows Traffic can movement on if one block if facing traffic jam.
c. Proves particularly effective if two-lane gradient traffic has not to combine at downstream finish point of ramp.
d. Safety appurtenances such as guide rail transitions, crash attenuators, and post support bases have not been designed to provide adequate protection at hazardous locations from the opposite direction of travel.

1.3.4.3. Star or Radial and Circular Pattern

Main roads radiating from central business hub connects together with concentric roads. Built-up areas are planned in a curved block system in which boundaries lie on corresponding circular and adjacent radial roads. This system has following pros and cons are as follows:

i. Crashes/collisions are very common at traditional intersection having traffic signals and traffic signs at left turn, head-on collisions and right angles. These collisions

can be severe if vehicles are passing at high speed through intersections. In circular patterns, such kind of incidents can significantly be reduced as vehicles move is same direction.

ii. Rear-end crashes are also significantly reduced by installation of circular patterns.

iii. Eliminates the motivation for drives to approach green signals at high speed at abrupt breaks at red signs.

iv. Traffic flow efficiency is enhanced resulting in fuel consumption and vehicular emissions.

1.3.4.4. Star or Radial and Grid Pattern

Street configurations are enduring physical features in any urban layout which contribute in systematic planning and as a result should be examined closely. Such patterns are interconnected, thus, making north-south movements circuitous, inconvenient and indirect and where driving becomes an unlikely option and proves that interconnectedness is insufficient to assist transportation. Pros and cons of this pattern is as follows:

i. There are three way intersections which keeps traffic safe.

ii. Cut-through flow of traffic is reduced through similar means.

iii. Savannah's cellular configuration improves the flow of traffic.

iv. Unit density and land use efficacy are improved.

v. Splitter islands that separates exit and approach lanes should outspread far enough.

vi. Lighting, pavement marking and traffic signs should be sufficient so that driver may get aware, where to reduce seed.

1.3.4.5. Hexagonal Roads (Diagrammatic Support may help the reader)

Whole road network forms a hexagonal configuration i.e provided in whole area. Built-up land is touched by the three road at each corners of hexagons. These hexagons are further sub-divided into suitable sizes. Three roads meet the built-up area boundary by the sides of the hexagons.

1.3.4.6. Minimum Travel Pattern

In this type of road pattern neighborhood center, suburban center and sector centers are connected with a road that requires minimum to connect the city center. Pros and cons of this patterns are as follows:

i. These types of potentially serious crashes essentially are eliminated.

ii. Intersections are especially challenging for older drivers.

Street Patterns

Interconnectivity is a vital constituent of city/town/neighborhood. Which is achieved through street/road network. This connectivity provides road for the vehicular traffic and paths for pedestrian and cycling. Urban planning has a variety of methodologies to link neighborhoods and streets. These approaches depend upon topography, density of the area and other elements of the urban form. Streets patterns of an urban settlements are unique and consist of following features:

- A main access/link road the connects the area to freeway or highway and provides access to settlement.
- Normally, one-way-in and one-way-out roads exits for smaller settlements.
- For bigger settlements highways may connect the streets and bring better opportunities for social and economic benefits.
- By-passes are constructed for dense settlements such as Sialkot, Lahore etc.

Within the settlement there is usually a main artery serving as major transport route and signifying the social and economic centers. Whereas, open spaces and edge streets fronting reserves act as settlement boundaries and form protection zones for assets. Residential streets have limited flow of traffic. There built laneways to serve residential and commercial lots. Also, pedestrian pathways exit along all streets except highways and freeways.

Streets patters are divided into six types

i. The diamond grid pattern
ii. The rectilinear grid pattern
iii. The stem pattern
iv. The picturesque landscape pattern
v. The spider web or star pattern
vi. The curvilinear pattern

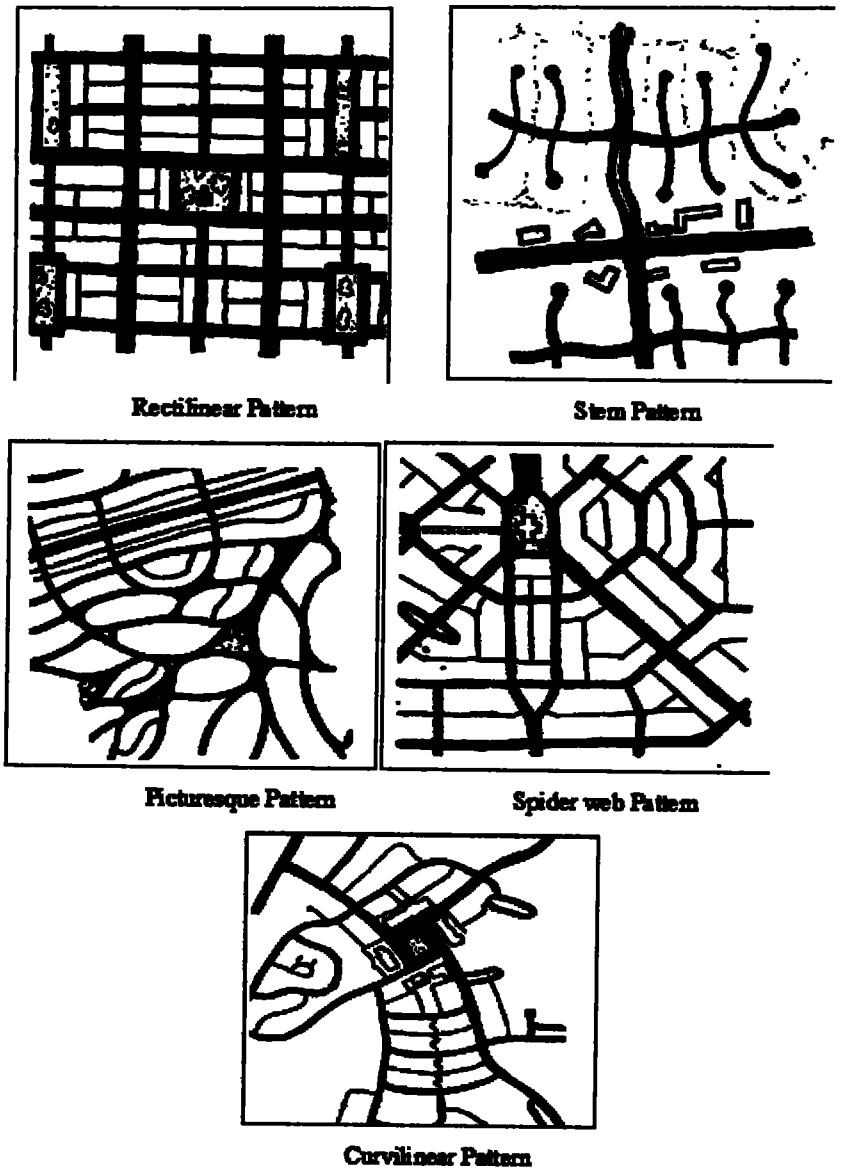

Figure 1.2:- Various Street Patterns

City Layout

Spatial arrangements and configuration are characterized by the urban layout and consist of building, blocks and streets. At street scale, we refer it to as tree like or grid patterns. Layouts play a vital role in pedestrian movement. It is crucial factor of how spaces are linked to one another. The layout controls movement and access of pedestrians no matter its permeable or not. It also influences the other features of metropolitan life such as density and land use (Hillier, 1996). Designs of today's urban area are artifacts of historical building regulations, planning and development. Functionality of a city depends upon street network defined in terms of city block size, its size and location within the city, vehicular and pedestrian connectivity. The extent and nature of routes through and between the

spaces determines the permeability and connectedness of city layout. That has an impact on how well-used and lively spaces are. Streets which are well-connected to services, facilities etc. and/or the means for the pedestrian of reaching them, are argued to be more frequently used than deserted or quiet options(Porta *et al.*, 2009).

Housing and Building Characteristics

Characteristics of both residential and other purpose building are very important in city settlements and has significant impact on daily life. Experiences of the dwellers living in detached low-density and large gardens will be distinctly different from those living in apartments of a high rises in a city center. Although, impact of building characteristics is far beyond the urban living density (Michael Jenks *et al.*, 2005). Aspects like building type, age and height may influence multiple issues like sunlight exposure during day time, building orientation and the potential for modifications, such as changes to living space to work space or individual room conversion to continue accommodating an ageing resident as in the 'lifetime homes' model. Other issues like living space in individual dwellings, types and number of certain rooms, lowest living space also have substantial effect on effectiveness of a building in relationship to it operating and life cycle energy and embodied (Dempsey *et al.*, 2010).

Integrated Elements

Integrated elements are interdependent and inter-connected. For example accessibility inside an urban area is associated with density, layout and miscellaneous uses within the settlement (Dempsey *et al.*, 2010). A neighborhood cannot be accessed without facilities and services viable to all inhabitants. Public transport channels, pedestrians and cycling are also important to access the urban services and reach outside. While constructing and planning new housing types and residential areas, size and type is dictated by the density of the area (Cutsinger *et al.*, 2005).

1.4 Importance of topic

Cities are expanding and urban form is under continuous evolution. Literature (Ewing *et al.*, 2003) review has revealed that urban forms have undergone an altogether transformation from ancient to contemporary through medieval and modern forms. Rapid industrialization, consumers' economy, energy intensive life style and growing services sector has influenced the evolution of urban forms significantly and has added more pollution than the carrying capacity of urban environment. Terms like environmentalism, sound science and stewardship have contributed in raising human consciousness for

environment but technical conversion of these into city planning theory to evolve environmentally sustainable urban form is yet due. City development is allied with enormous environmental damages. Damages of clearing of land for construction purposes are countless and basic concern of environmental degradation. Individuals and goods are required for development increases air pollution and causes larger emission of GHGs. Hydrogeocycle is altered by impervious surfaces and loss in precious biodiversity is caused either by the habitat loss or fragmentation etc.

United Nations has clearly narrated that "Hundreds of millions of people will be vulnerable to coastal flooding and related natural disasters as global warming increases. Moreover, it will be the poorest countries and people who will be most vulnerable to this threat and who will suffer the earliest and the most"(Un-Habitat, 2016). Resilience although a complex subject, however, not only mean to prepare cities to counter natural disasters but also to introduce such parameters that may lessen the impact of development on the environment. In order to make it more environmental friendly and safe for human settlements. Recognizing the role of a relationship broker between the complex hierarchy of urban tissue, social values and economy, it is need of day to incorporate environmental parameters into urban forms in order to make cities safer for our future generations.

Furthermore, the topic is important in context of Strategic Environmental Impact Assessment (SEA) of the plan for developing a new city or urban form. The research will identify the parameters that would be useful for environmentally sustainable urban planning.

1.5 Statement of the research problem/thesis statement

Urban form constitutes upon neighborhoods/housing, CBDs, parks, institutions, utilities and roads/streets/pathways. The focus of this study would be on the aspect of human settlement/housing. The urban forms would be categorized into two broader categories i.e. pre-1960s and post-1960s urban forms for the purpose of comparative study. This division of timeline is based upon two important incidents which have occurred in 1960s i.e. Rachel Louise Carson's book Silent Spring published in September 27, 1962. The book raised the concerns about environment, which ultimately resulted into global environmental movement. Afterword, in 1969, United Estates of American made Nation Environmental Policy Act. This was first practical step towards environmental consideration in development projects. Both events were result of environmental harm caused by modern day practices. In 1980s, environmental concerns deepened and

grassroots environmental conservation groups emerged in the civilized world. They were not ready to comprise on environment although progress may be halted. In late 1980s, terminology of environmental justice evolved which argues that safe and healthy environment was right of every human being. In 1992, representative of 179 nations gathered for conference of environment and development where they agreed upon eight basic guidelines to strengthen the global environmental management.

Environment is categorized as natural, manmade, physical, living environment and built environment. In this study focus is on natural environment i.e. Air, water, land, and vegetation. Sustainable Development Planning has ecological, social, physical, economic and institutional parameters. Ecological footprint is a measure of human consumption burden on nature. Which shows that humankind will have utilized all the biocapaity of planet earth and will face an ecological deficit (liquidation of ecological reserves) for remaining year. Such trends result in definite over exploitation of the natural resources causing their degradation, social injustices and huge amount of waste. An example of most advance and developed city is UK, London – the ecological footprint of the city is 120 time of area of the city. Planners are facing an enormous challenge in order to provide or formulate such conditions that may fulfill the requirements of both nature and modern life style. All these attempts ultimately contribute to make self-sufficient cities where carrying capacity of the nature may not be exceeded.

Ideas of sustainability in environmental and social perspectives have their own long lasting history. Literates of all eras, throughout the human history used to emphasize on sustainable living. However, city planning, development and regeneration have received significant influence by these sustainability movements. As urban development and urbanization causes huge environment degradation, social inequalities and injustice. Many town planning movements and theories have emerged after industrialization. The beautiful city movement, the park movement, the garden city, the utopian approach for city planning, the new town and the techno city are example of few movements, theories and attempts that emerged in previous two centuries(Caprotti, 2014).

After advent of environmental movement in 1960s, every development project is gauged at scale of Environmental Impact Assessment to know project repercussions on natural system where as Strategic Environmental Assessment is considered as more comprehensive tool for regional level development. It is almost impossible to identify and gauge the impression of multiple developmental projects on an ecosystem. Because of inherent complexity inter-connections of biotic and abiotic factors. To have such

estimations new technical evaluation tools and legal/regulatory frameworks are required to develop on the same natural system.

Post 1960s era stands for the post-modernist approaches in urban planning. Authors like Denise Scott and Robert Venturi used to criticize pre 60s approaches. A number of theories were put forward in that era related to urban form. "Pattern Theories" were proposed by Christopher Alexander. "Crime Prevention" strategies were anticipated by Oscar Newman. Donald Appleyard introduced a new pattern in streets and showed its importance in urban design. Environmental planning in urban form was signified by Lawrence Halprin. Post 1960 (Particularly 1960-61) stands as benchmark in history of town planning not only for America but also for the rest of the world. Most creative and productive theories of town planning were put forward in that time. Three greatest books of the urban form and design were published in this era. These books namely"

"The Death and Life of Great American Cities" by "Jane Jacob" (1961)

"The Image of the City" by "Kevin Lynch" (1960)

"Townscape" by "Gordon Cullen" (1961)

As far as, geographical location of Pakistan is concerned, since independence in 1947, development has been managed by municipal administrations, cantonments, and improvement trusts set up by the British. No town planning act was followed for improving the development at that time. It was not until 1960 when Municipal Administration Ordinance was passed that gave powers to the local councils for development (Groote *et al.*, 1989).

Later, the provincial government decided to augment the Tehsil Municipal Administrations (TMAs) with additional development authorities and after the approval of Development Cities Act of 1976, the improvement trusts (LTs) were reformed into Development Authorities (DAs). DAs were assigned the responsibilities of urban development, provision of infrastructural facilities and maintenance, and creation of comprehensive development plan for the cities (Ahmad, 2013 #622;(Ahmad *et al.*, 2013; Rana *et al.*, 2018). As for as environmental aspects of development is concerned, Section 8 of PEPO-1983 made for the first time in Pakistan environmental assessment compulsory for new projects.

The most important question for professionals is what will happen with city life tomorrow? Undoubtedly, with uncheck population growth, poor economy, harsh and sudden environmental changes are continuously adding to entropy. It has become extremely difficult to plan a city keeping in view future requirements. Thanks to the

continuously evolving knowledge, which is helping to understand, what is going on and where would it lead to. However, the understanding is still not complete and plausible solutions have not surfaced.

Every city is a unique world in itself and has its individual set of parameters, which vary substantially from others. Urban entities are complex in terms that they may carry extremely diverse set of elements like single small huts to sky scrapers, slum dwellers to elite's ones, from green parks to concrete jungle, from wilderness of suburbs to congested downtown. Thus, sustainability and resilience requirements may vary city-to-city and same with the parameter addressing the two issues. However, environment, society and economy are broadest terms or buzzwords, which may cover all.

Although, no set criteria have established for environmentally sustainable urban form/an "eco-city" till date. However, an ideal criterion should consider environmental, social and economic dimensions. Hence, an ultimate environmentally sustainable urban form can be that one which may fulfill following requirements:

i. Has a carefully planned urban layout.

ii. Mass transport system in which streets and roads should be designed in such a way to prioritize pedestrian movement. Cycling should be next in preference and then comes public transport. Personal vehicle should be discouraged.

iii. Ensure decent and reasonably prices housing for all ethnic and socio-economic groups.

iv. Better and enriched opportunities for women, neglected and disabled groups and for minorities to earn their livelihood.

v. Resource conservation – Apply the three R rule i.e Reduce, Reuse and recycle.

vi. System should be developed to get maximum efficiency from water, energy and non –renewable resources.

vii. Concept of urban ecology should be introduced to reinstate environmentally damaged cities.

viii. Energy sources should be shifted towards renewables.

ix. Local and organic products and agriculture should be encouraged.

x. Find local resources to sustain an independent economy.

xi. Reduce material consumption by promoting voluntary simplicity.

xii. Mass awareness for environmental, social, economic issues.

Further to it, city plans and layouts should be flexible to accommodate the changing needs and growing population. Infrastructure should be designed by keeping in view the past and present growth pattern. It should be flexible enough to get it modernize easily.

1.6 Aim and objectives of research

Following are the Aims and objectives of the research;

Aim

The aim of this research study is to explore ways and means of introducing environmental parameters more effectively in urban planning practice.

Objectives

Following three are the explicit goals of the study;

i. To evaluate and asses the pre-1960s and post-1960s urban forms in order to identify any relevance given to environmental considerations

ii. To identify the nexus between evolution of urban form and environment, if there is any.

iii. Based on the above, identify and suggest parameters for sustainable urban form.

1.7 Hypothesis

"Environmental considerations have remained in backdrop of city planning."

1.8 Contribution towards General Understanding of Theory/Practical

Some environmentally sustainable parameters for urban form would be proposed. It would support the Planning Commission's National Impact Assessment Program (NIAP), which is being carried out by the Planning Commission of Pakistan and Climate Change Division of the Government of Pakistan with cooperation of Netherlands Commission for EIA and technical assistance from IUCN-Pakistan. The outcome of the study will also be helpful in planning of new cities with environmental considerations.

Urban sprawl in Pakistan is majorly unplanned and haphazard despite the fact that the region is most vulnerable to global warming. In Pakistan, four out of ten people are living under the poverty line. Large number of people are illegal slum dwellers. These people are least prepared to but receive first and serious consequences of the nature calamities. Further to it, they are the last to recover from these shocks. Research under discussion will divide the whole resilience life cycle into social, economic and environmental resilience. That will help to add or suggest such initiatives to help the make sustainable cities.

1.9 What Constitutes an Urban Form Environmental Friendly or Sustainable?

To make an urban form environmental friendly is a very broad spectrum subject and has multiple dimensions researched by experts in variety of fields. However, the fundamental clue for the sustainability was provided by 'World commission on Environment and Development' as they defined the sustainability as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Lélé, 1991). In terms of urban planning, planners have defined sustainability as the minimization of the negative impacts of urban development on environment. Lawrence (2000) considered a broader horizon by considering not only environmental but minimization of the negative impacts (Burgueno *et al.*, 2005).

Urban development has impact on environment in a number of ways; including carbon emission, clearing of land for built-up areas, deforestation for raw materials, water usage, production and taking care of waste materials and water. Furthermore, there are a number of projects that impact the environmental performance of the urban form. These factors include its aesthetic aspects, locating construction materials, design and urban form, opportunities for rain water harvesting, recycling of waste materials and water and production of energy from renewable resources. These impacts are categorized into following modes of actions for attaining environmental sustainability in an innovative urban form. These modes are as follows:

i. Environmental footprint of the new urban settlement should be reduced in terms of GHG emission, energy, raw materials and land use and exhaust of all kind of waste materials.
ii. Ensuring healthy urban form and living environment in neighborhood i.e. improved public health, better sanitation conditions and reduced pollution.
iii. It should be resilient and adaptable to changing environmental conditions.

As described above, infrastructure is an important constituent of the urban form. Thus, an urban form to be sustainable as well as resilient selection of raw materials for the infrastructure development in very important in terms of durability and energy efficiency. Energy efficiency can be insured by designing such built up areas that may be flexible for change, durable, consuming minimum raw materials – reeling on local raw materials and most important of all energy efficient. Selected/used materials should be recyclable or

reusable. Materials used should be made available by minimum transportation and processing (Carpenter *et al.*, 2009; Willis *et al.*, 2011)

Sustainability of an urban settlement and an urban form can be determined by using the indicators of "United Nations Centre for Human Settlements". Which measure it in terms of standard of life of inhabitants, extent of use of non-renewable resources, extent of reuse and recycling, waste materials generated from consumption and production activities and overall health of the eco-system. In more recent studies, measurements of sustainable urban form have shifted towards measurements of ever increasing levels of CO2 and massive energy consumption configuration of conventional infrastructure. Scientists have asserted that any sustainable model should consume minimum energy with provide maximum output for all purposes. In an innovative urban form, basic style of infrastructure makes the artificial cooling and heating unnecessary. Thus, it was required to add sustainability and resilience concept in urban planning.

In designing an urban form, it is important to pay attention to contextual environmental hazards (potential or existing) both anthropogenic (GHGs, climate change, deforestation) as well as natural (landslides, floods and earthquakes) calamities. In developing a good urban form such measures should be taken in order to minimize the environmental hazards. Protecting natural flora and fauna, introducing resilience factor and improving quality of life are some other factors. Green network should be incorporated in urban design which includes gardens, open spaces, green corridors, wildlife habitats, woodlands and trees to develop urban ecology. This urban ecological network will not only support the natural processes but becomes essential part of the climate management plans for both mitigation and adaptation.

Habitat restoration and urban forestry are very cost effective measures for carbon sequestration. It also improves air quality but also help in runoff management. Increased vegetation helps to reduce pollutants in environment. Green area has cooling effect and help to manage urban heat islands which affects negatively both humans and vegetation. Increased vegetation regulates the surface water runoff. Thus protecting soul erosion with reduced need of piped drainages. All of these steps are important to tackle natural and anthropogenic hazards and to create a resilient and sustainable urban form.

1.10 Whether Planners Working on Environmentally Sustainable Urban Form Are Modern Friends of Utopians?

Sustainable development is buzzword of this era. When the word sustainable is attached with urban form. It has its cost in term of land allocation and land uses provisions in addition to monitory implication. Such cost may make the endeavor uneconomical in land utilization and non-prudent in decision making.

Who are the Utopians?

Utopia is a word synonymous to totalitarianism or Stalinism, in fact (Ganjavie, 2012). "To-morrow: A Peaceful Path to Reform" (1898) and its second edition "Garden Cities of Tomorrow" (1902) written by Ebenezer Howard are most influential books in last years in field of urban planning. Howard proposed plan of a "social city" and trued to bridge gap between individualism and socialism (Słodczyk, 2016). Following Jane Jacobs' famous book, it is difficult to find a scholar who wrote positively on Utopia in contemporary urban literature (Ganjavie, 2012). Cuthbert argued that even after 50 years of the creation of the urban design field, we could still hardly see any good theories produced. What we can see is mostly a generalized anarchy of creative ideas that bear little coherence, either internally or collectively (Cuthbert, 2007).

Medieval Ages Environmental Problems

Urban planning and life practices in medieval towns were not environmental friendly. Different crafts were in its primitive form and large amount of water was wasted and air pollution was exhausted. For production purposes organic and inorganic chemicals were utilized and waste was put into rivers, books and ground and surface water. Tanneries, abattoirs and breweries were producing large amount of waste including heavy metal was dumped directly into the environment. Animal and human excreta, waste water from house hold and kitchen slops was directly deposited into streets(Guillerme, 1988). Amount of animal excreta was increased due to farm keeping animals in backyards and also in streets. Cemeteries were located inside the town, consequently, wells and water table were receiving pollutants continuously. Open fire for cooking purposes in houses and for production purposes in factories was a common practice. This elevated the level of pollutants in air. There is no waste management system and vulnerability to natural and anthropogenic hazards was high. In such, unhygienic conditions chances of epidemics were very high. Epidemic breakouts were common in those days which took lives of thousands

of peoples. There wasn't any fire department to summon to a chimney fire, no police department to catch thieves, no ambulance to transport the sick. Also missing were sanitation services, a meaningful criminal-justice system, and a standing army to protect against invasion. Systems for controlling floods were not always effective; there was no provision for communal long-term storage of food as a guard against starvation, no water-purification system or reservoirs in which to store water, no protection against extreme weather.

Solutions; 1st Approach; Low Density and Zoning with Flaws

Experts of urban planning like LE Corbusier, Wright and Howard utilized their ideal city concept to portray such a world which has already been achieved its economic and political goals. Each planner advocated the beauty and rationalism of its urban design and believed that its capable to achieve the social goals as well.

Garden city movement was initiated by Sir Ebenezer Howard in 1898 in United Kingdom. Garden cities consist of proportionate areas of industry, residence and agriculture. These were supposed to be self – sufficient communities surrounded by 'greenbelts'. Ebenezer Howard founded the Welwyn and Letchworth. He introduced many features of Hygeia in his cities such as low population density and wide avenues. It was utopians approach in which environment was given predominant importance. Where men lie in harmony with nature and peace with other men.

2nd Approach Compact Development with Flaws

Compactness without proper coordination and planning process would result in overdevelopment and burden on local environment beyond carrying capacity. Dense urban growth poses multiples problems which tend to imperil sustainability of metropolitans as it can puts ginormous strain on city infrastructure and huge demand of natural resources. The increased cost of living in dense urban cores may contribute to gentrification, dispersion of low- income residents and the creation of impoverished areas with insufficient resources and infrastructure.

Tools for Environmentally Sustainable Urban Form

Relationship between built space and nature if harmonized through landscape architecture. Major purpose of which is to guarantee environmental sustainability of space for work and live. Environmentalists and urban planners are using multiple tools to make urban form sustainable. Some tools are discussed below;

i. Preservation of Wildlife Habitat

Land has to be cleared for all purposes of development such as housing, agriculture, industry etc. Removal of the existing flora is against the doctrine of sustainability. However, basic rule of the sustainability is to keep the native plant species and not to introduce invasive species. Introduction of invasive/alien species may disrupt the local ecosystem.

ii. Increase of Green Transportation

Building of green spaces would not be enough to ensure sustainability. If means of transportation and road networks and designed in such a way that they are not minimizing the air pollution and fuel consumption. The whole system will soon be collapsed. Thus, regardless of location opting for riding a bike or pedestrian movement and use of public transport always favor the sustainability despite of riding a car. There is dire need to make transportation network to make bicycle friendly and supportive for pedestrian movement. Which will significantly contribute to cut down the fuel/energy consumption and reduction in air pollution

iii. Use of Recycled and Recyclable Materials

Decreasing the waste production, sorting it out at source, recycling and its reuse always been an issue and concern of policy makers and researchers. Specially, when it come to the decor of outdoor spaces, using recycled materials can provide a sustainable solution. Now days, a bigger market is focusing and established on making utilities from recycled materials. e.g. if one can find materials from demolition sites that can compose very charming rooms. Other excellent choices are recycled components — those made from raw materials harvested and processed according to environmental laws, such as certified wood and materials made from local sources to avoid the high costs of transportation. And, to be coherent with green approaches, you should check whether the materials you initially used can be reused or recycled and assure that their recycling process won't generate even more damage to the environment.

iv. Reduction of Use of Electrical Energy

Of course, you would like to use your outdoor space for resting or social gatherings at night as well as during the daytime. And all the efforts to reduce your footprint will have been useless if, at the moment of designing the lighting system, you waste energy. The right choice is to make the place even greener by combining devices such as motion sensors,

dimmers, and LED (light-emitting diode) or other energy-saving light bulbs, such as solar powered. Although they may be still pricey, you will see a reduction in your energy bill, so your investment will have a payback.

v. Selection of Plants According to the Place

It can't deny that some exotic plant species fascinate us with their beauty, and that we would like to have them in our gardens. But, as you have already learned from the first practice, the sustainable method calls for planting native species. This can unite private spaces with some public parks that are restoring the local wildlife. Seedlings can be obtained without cost from the many non-profit organizations that distribute them as an incentive to sustainable planting. So, this step will make your garden affordable and align you with community efforts to bring natural life back to urban spaces.

- In existing urban areas particularly big city following methods for trees plantation can be adopted to control increasing temperature, heat islands and other related issues.
- Plant shady and/or fruit trees along roads wherever green strips are available.
- Replace 75% of ornamental plant, planted in green strips of the roads with shady/fruit trees.
- If green strips are not available in cross sections of road make planters for shady trees on both sides of every road at a distance of 15ft-20ft from each other
- Replace fifty percent of grasses and shrubs in parks and green strips with eatable vegetation.
- Commercial and flat building owners and users be bound to grow vertical and roof top gardens by including it in bye laws.
- For houses kitchen garden be promoted.

Removal of existing vegetation in one go for replace may further aggravate the situation in short period, so replacement must be in rational and step wise way. Native species of trees should be selected and its allelopathic evaluation should be carried out before planting.

vi. Vertical Gardens Contributing to a Healthier City

Walls are also surfaces that are increasingly becoming water absorbent through the use of vertical gardens. You might have seen versions of these living walls, some of them transformed into art panels, which promotes their use. But, nowadays, green walls are going beyond this, and are becoming a requisite for buildings and businesses to upgrade their

green certifications because vertical gardens purify the air and improve the energy efficiency of the buildings. So, you if are thinking about incorporating green walls into your construction, you should know that, although the most practical types are the ones built with the insertion of pre-grown plants into panels or trays, you can make cheaper ones by growing on-site climbing species.

The crucial point in maintaining your living walls will be to design the watering system and, although there are several solutions for that, the most common are those based on the recirculation concept, which uses water more efficiently.

vii. Increasing the Permeable Area

If you have a garden with plant beds and lawns, why not design the paths and gathering areas in a way that they can absorb the rainwater as well. Permeable pavers can make your outdoor area be as good at absorbing water as natural soil. By using permeable pavement, you will prevent storm water from being wasted through runoff – just like professionals are starting to do in larger public spaces with materials suitable to lightweight traffic, such as parking lots, bike lanes, and driveways. There is also a trend to apply permeable asphalt and concrete in heavy traffic areas.

viii. Efficient use of Water and Other Resources

Although including plants in your spaces shows that you are in tune with environmental concerns, if you adopt wasteful irrigation, you will probably have your green space classified as anti-ecological. Treating water as a resource and not as waste is an essential landscape design rule. And you can follow it by selecting the right plants for the local climate and the type of soil, in addition to storing rainwater. And, if the law where you live allows for the reuse of "greywater", you can also build a system to capture water from bathing, laundry, and dishwashers, treat it properly, and use it to irrigate your plants. Similarly, other resources should also be used efficiently.

ix. Sustainable Green Roofs

You might also be impressed by some garden roofs and consider including them in your constructions. It's no wonder; their aesthetic effect has been living in our imaginations since the Babylonians' (or "Nineveh's", according to recent research) hanging gardens were cited in history books. And, although it is still uncertain if the story about Alexander the Great being amazed by their beauty is fact or legend, it's a sure thing that a roof garden won't be sustainable if it relies on a system like the great conqueror observed. According

to some research, the aqueducts he saw may have been built for watering the legendary gardens. To make your roof a successful green space, you would rather use the Scandinavian tradition of planting hardy species, such as several kinds of grass that can thrive with low maintenance. But, if you are really interested in a more complex garden, professionals can help you make it sustainable by selecting adequate plants, calculating the roof's load, designing efficient rainwater storage and drainage systems, and analyzing whether the cost and maintenance suit your budget. Regardless of the type of garden roof you decide to have, it will improve your building's thermal performance and link it to the green surface net that is reducing the heat island effect in cities. Painting roofs white is an easy way to reflect heat and save costs in the summer. But even better is planting gardens on rooftops, bringing the green back to the urban jungle. The gardens help insulate buildings in the winter and soak up storm water, reducing water pollution from urban runoff.

From above given discussion it is evident the idea of environmental sustainiability and resilience in borrow from utopian approach. But utopian approach is impractical. Thus, few changes have to be made in order to make is practical and applicable in order to achieve the goal of sustainability.

CHAPTER # 2

LITERATURE REVIEW

This chapter briefly reviews a number of the theories for understanding urban form and the environment and then proceeds to provide a review of studies that have examined dynamics urban from and their relationship to environmental issue. It explores the ways in which planners and scientists have sought to understand the relationships among components of the city and phenonmenon of environmental changes. The review is concluded by relating urban areas design parameter to emerging work on environment and urban ecology.

2.1 Literature related to Urban Forms

Literature related to urban forms in developed countries and under developed countries is reviewed. Representative literature related to urban form evolution in developed countries i.e. Europe and under-developed countries i.e. South Korea is given below. South Korea is selected because of, firstly, it contains a variety of urban form; secondly, literature is available.

The word form has its origin in Latin word "Forma" and it is pronounced almost similar in all European's leading languages like Italian, Spanish, Polish, and in Russian. Whereas, it is pronounced as "Form" in English, French and Germany. In etymology, a western researcher Tatar Kivich has introduced an interesting approach for explaining the meaning of the word. Which is by contracting it with its opposite and by studying its various semantics. Thus, aesthetic researchers have explained at least five different meanings of this word. (i) Form is taken as the arrangement and discipline among various components of any work. (ii) Form in the meaning of what is directly perceived by senses. (iii) Form is a concept that indicates the presence of something that distinguishes it from other subjects. (iv) Form is the conceptual essence of something that is placed opposite casual features. (v) Form means contribution of the mind for understanding things. However, each of these definition requires further explanation (Sharma, 2014).

The term "Urban form" cuddles the physical characteristics of the human settlements that may include configuration, shape, size, density and can be dissected in to different levels The major elements of the urban forms are streets, blocks, plots and buildings (Kropf, 1996). The urban forms can be influenced by a majority of factors such as geography,

period of development, impact of natural environment, social, economic and political forces and trade practices.

Theoretical basis of urban form can be divided into three broader philosophical backgrounds such as normative, pragmatic and rationalism.

Normative Theory

Lynch (1981) described the normative basis as, "how to know a good city when you see ONE". Although question should be of values i.e what is conceptual framework and objective of a city design. For some people visual aesthetics are matter of concern while for others it is about fulfilment of basic requirements. However, different people have different parameters to judge aesthetics and most of people ranks high a city by this quality. Businesspersons may look as a city merely a space for a particular type of business. While some others may prefer a city that fulfill their social cultural and economic requirements. Similarly, normative theories not only have variety of normative bases but also have diversity of foci for development of urban design. Some theories may focus on society expression and deal on larger horizon while having no or very little room for aesthetics and environmental sustainability. Since others may emphasize on visual features of urban layouts and do not bother the social issues. Still other may have other issues to focus on such as traffic, resource and energy conservation or other special issues (Faludi, 2013; K. Lynch, 1984; Talen *et al.*, 2002).

Theory of Rationalism

Rationalism, in contrary argues that a person's senses is not a reliable evidence to make a judgment. Thus, one should go for the universal truths for making a decision. Which can only be gained by logical thinking. Dissimilar to the pragmatist view, rationalism embraces that opinions and decisions should not be perceived. Rather it should be conceived by practical experience if possible (Bäcklund *et al.*, 2010; Healey, 1992).

Theory of Pragmatism

Peirce, Dewey and James – American philosophers, put it forward. It accounts for the uses and real-world consequences of the plans, ideas and layouts. However, as ideas and philosophies are judged by their physical or tangible results. Their elucidations may consider "impure" by rationalist point of view. Dewey narrated it as "Action and opportunity justify themselves only to the degree in which they can render life more reasonable and increase its value" (Festenstein, 1997; Hoch, 1984).

Industrial revolution, better educational and health facilities, and population boost being the key factors in changing urban forms. New spatial structures either planned or unplanned have emerged(Ashton, 1997). All these factors along with many others are ultimately dependent upon environment either in terms of drawing raw materials, dumping waste materials, clearing of land for agricultural or residential purposes. Therefore, there emerged a need for sustainability. Urban growth negatively influences the environment in city vicinity and remotely by land conversions, consumption of natural resources, emission of pollutants in all three matrices (soil, air and water) and waste generation (Alberti *et al.*, 2003).Despite soil is a crucial land resource for many ecological processes (Brevik *et al.*, 2015; Keesstra *et al.*, 2016), soil consumption and land degradation usually reflect dispersed urbanization (Beniston, 2016). Air pollution is also a relevant outcome of discontinuous urban expansion (Trujillo-González *et al.*, 2016). Fragmentation of priority habitats is also a common process related to urban sprawl (Aguilera *et al.*, 2011), affecting both landscape structure and functions and causing a potential loss of biodiversity (Leitao *et al.*, 2002; Salvati *et al.*, 2014). Conversely, sustain-able urban form and appropriate land-use planning may contain loss of natural habitats and biodiversity. Which gave birth to number of environmental movements like romanticism and progressivism, earlier environmental movement, the beautiful city movement, the parks movement, garden cities and many others.

The patterns of rectangular squares and streets are most important patterns in a city arrangement than other components. Urban design kept on changing since establishment of first city 10,000 years ago. These changes were influenced by assemble of influences, the most valuable of which are: way of thinking, life and values, government setup, population size, building, design and paving techniques, transportation and artistic sensibility.

Many town planners argue that presence of grid is only form of design and planning. Lack of grid is considered as indication of nonexistence of planning. The pattern medieval streets which is complex in nature is neither chaotic nor random. Grid patterns are least suitable for a care free community as compared to pattern of medieval cities. As it offers easy access to city centers as well as transport, services and goods.

2.2 Urban Forms of World

Urban planners and geographers have attempted a lot to analyze, understand and classify the urban form of the world. Which allows them to understand the process of evolution of urban form. Researchers and experts of urban morphology has devised a

number of strategies to understand the urban forms in various parts of world which has been categorized under "National Geographic Standards" (Gallagher *et al.*, 2012). These strategies include descriptive models, mental maps etc. Descriptive models and mental maps help to organize data about cities. These models help to interpret the process of evolution through which cities have evolved up to its recent form. Scientist kept on following the trail of why and how urban spaces have reached to its present form and how these patterns work for purposes accomplished by and within the cities

European Urban Form

It is vital to examine the urban form in Europe because 80% of European population lives in urban areas. Moreover, after Second World War, they have very assorted history of city development. There seems to be three stringent categories of developmental school of thoughts i.e economic transition, capitalist and communist. This segregation becomes more important after 1990 (Morris, 2013). Town planning is still independent business of the individual states in European Union. That is why, sectorial policies, institutional frameworks (both govt. and non-govt.) are very different from each other. Also, the extant of coordination among all these vary to a greater degree from case to case (Albrechts *et al.*, 2003). European cities lay out are drawing much attention of the professionals due to their history and unique characters. European Union has accepted town and cities as crucial player towards sustainable development. In 1999, "Aalborg Charter of European Cities and Towns Towards sustainability" declared need for sustainable land use management techniques for designing city layouts." European Spatial Planning Observation Network" has been declared as scientific community responsible for territorial development since 2002(Morris, 2013). Impact of urban development on natural environment was stressed in a report "Thematic Strategy on the Urban Environment". Cohesion of policies with particular emphasis on managing urban growth (Kasanko *et al.*, 2006). In addition, "Leipzig Charter on Sustainable European Cities" and "The Territorial Agenda" highlighted the multiplicity of urban sprawl in Europe. "European Urban Charter II was adopted by "The council of Europe". It states that "we must organize our development around different types of urban form"(Agenda, 2007; Charter, 2007; Rodger, 1993)

South Korean Urban Forms in History

Despite of 4.5 millennia old history, clues of urban structures of Korea starts from 1st century BC. It was period of "The Three Kingdom". Which lasts 7th century AD. It was followed by "The Unified Shilla Kingdom" (7th - 10th century), "The Goryeo Dynasty"

(10th - 14th century) and "The Joseon Dynasty" (14th - 19th century). However, studies regarding urban form and archaeology are very few or entirely lacking(K.-H. Kim *et al.*, 2007).

2.2.2.1.Primeval Capital Cities

Among ancient cities, those with clues of urban form in history are described above. The urban layout of these walled capitals was in gridiron form. It consisted of sequence of squares. It consists upon sequence of 44.5 square meter blocks. She further speculated that such unit blocks were formulated from larger square of 356 square meter, framed by east-west and north south road axes (K.-J. Kim, 2012).

2.2.2.2.Medieval Era Capital Cities

After the fall of "Shilla Kingdom", Korea entered into an era of "The Three Kingdoms" (AD 892 - 936). However, reunification took place around 936 during "The Goryeo Dynasty" (AD 918 -1392). Gyeseong was the capital. However, based on its location in North Korea, studies about its urban form are lacking. Archeological records and urban layout scholars have analyzed the location of the city and available drawings(Graham, 2002). Examinations of topographical environment and location of the walls, royal palaces, gates, arterial roads and major buildings have made it clear that city comprised of three layers. i.e the outer wall (23 km in length), the inner wall (4.7 km in length) and walled royal palace. City layout was asymmetrical due to mountainous topography. Thus city site was uneven with lopsided city walls (K.-J. Kim, 2012).

There is a large number of studies on Modern urban changes in Europe. In 1970s, urban architects and designers started to take interest in concepts of metropolitan fabric as related to logical design methods. Morphology of British urban areas was introduced in South Korean architecture and town planning by Chong-Won Chu and his pupils at Seoul International University (Chu, 1996; Couch *et al.*, 2008).

2.2.2.3.Downtown areas of Seoul

Downtown areas of Seoul were once part of Hanseong (inside wall). It has received special attention for its urban morphology. Seoul was first surveyed by Japanese foreign rulers during 1912-14. Cadastral maps were sketched in a series at scale of 1:600. Each map covered 200m from couth to north and 250m from west to east. As all downtown area underwent important modification by colonial planning. While developed cadastral maps were accepted for its great morphogenetic value (J. Kim, 1997).

2.2.2.4. Colonial Urban Form

Town planners, geographers and architects have paid special attention to urban morphology of port cities originated in Colonial era. In South Korea, five port cities were opened during 19th century. These cities include Incheon, Mokpo, Busan, Masan and Gusan. Concessionary areas of Gunsan and Mokpo have received special attention by the urban morphologists (Choi *et al.*, 2017). Lee and Huh focused on grid iron urban form of Gunsan – as emerged from colonial era. They analyzed it with particular emphasis and comparison on cadastral maps. As a result of their investigation different form of plot processes and urban tissues were recorded (K.-C. Lee *et al.*, 2005). K. C Lee's work revealed that, during post-colonial era, plot processes introduced the ownership variety. And has resulted into diversity in building facades. Old urban center of Mokpo has shown another city form of colonial era. Comparison of old urban forms and cadastral maps belonging to nineteenth century helped to trace the altered trend in city landscape during 1897 – 2003 (King, 2012).

2.2.2.5. Korean Native Cities

Local cities having historical origins are subject of morphological interest substantially. Researchers have shown curiosity in urban form of Jeonju. Plot processes of downtown area were particular point of focus since 80 years. It was concluded that socio-economic circumstances and planning actions are evident by subdivision and plot amalgamation processes.

American Urban Form

Americans have long history of urban planning dated back to the 17th century. Philadelphia, Pennsylvania was planned by the William Pen in 1682 to serve as a port of river Delaware. However, his plan was not followed properly and inhabitants were densely populated around the river. Till 1701, it had become an important trade center and number of changes were mode according to Pen' plan (Weigley, 1982). Pierre L'Enfant was appointed by President George Washington in 1791 to design and select the place for the new capital. Although, his plans were not implemented till 1902 (Seale, 1986; Tyler *et al.*, 2011).

2.2.3.1. Pre-19th Century Urban Form of America

American cities of 19th centuries were in industrial phase and used to be congested, poverty stricken, ugly and had constant threats of epidemics. Urban designers and architects of that era worked to beautify the cities and resolve these issues. "City Beautiful

Movement" followed the "Park Movement" and both movements has its roots in progressive theory. Which aimed to rectify the moral ground of the society for the establishment of peaceful, flourishing and prosperous society. Frederick Law Olmsted is considered as the father of the landscape architecture in America. He started "The Park's movement" in 1840 to deal with problem of congestion in cities. Central Park of the New York was designed by the Olmsted. This movement also inspired the start of the 2nd movement "The Beautiful City Movement". This movement flourished in US during 1890s and advocated the establishment of monumental beautifying artifacts. Which is their opinion would bring harmonious order in society and help in improving lives of the poor. Ideas and urban design of this movement was essentially borrowed by the "Beaux-Arts movement" (Bradley *et al.*, 1994).

2.2.3.2. Pre – 60's Era of Urban Planning in America

First two decades of the 19th century was influenced by the "City Beautiful Movement" and "The Park Movement". Chicago plan proposed by the Daniel Burnham was also influenced by these movements and should be considered as its outgrowth.

Ideas of Garden cities was put forward by a British planner Ebenezer Howard in 1902 in his book "Garden cities of tomorrow". This idea and theory deeply influenced the American planners. Clarence Arthur Perry concept of neighborhood unit in 1920 and "New Urbanism" in 1990s – both have its roots in Garden cities movement (Hall *et al.*, 2006). Burnham was a leading American planner who proposed urban design of Chicago in 1909. It was a redevelopment plan in which Chicago city consist of 60-mile city radius. Elaborated plan for concentric and radial boulevards and parks was proposed. This plan set the standards for urban design and anticipated future requirements to control uncheck urban sprawl. Burnham's idea also helped to shape up many cities such as Washington DC - the McMillan Plan, San Francisco, Baguio in Philippines and Manila (Hines, 2008). Frederick Law Olmsted Jr – "heir apparent" of Frederick Law Olmsted was also a landscape architect. He designed the Hill Gardens – 9 miles away from Manhattan consisting of 142-acre suburban. It's often referred as first American Garden City. According to Olmsted, the main framework of any city plan is the transportation system including the street railways, the rapid transit railways, where such exist, the long-distance railways with their terminals, and the facilities for waterborne traffic (Klaus *et al.*, 2002; Sies, 2003).

After a gap of few decades' American urban form was molded by the neighborhood concept introduced by the Clarence Arthur Perry. His concept influenced the town planning

efforts worldwide. Perry believed that cities should be built (or rebuilt) to consist of an agglomeration of smaller units, typically centered on and served by an elementary school, and bounded by major roads with shopping centers at intersections (Aryal, 2008). Although, this plan was practically applied by the Clarence Stein during 1930s. Stein founded the Regional Planning Association of America. Influenced by the Ebenezer Howard, Stein planned 22 new settlements across the US. Stein and Henry Wright planned Redburn as self-sustaining community.

Frank Lloyd Wright – a greatest American Architect had a very long career of six decades i.e. 1890s-1950s. His concept of city planning "Broad Acre city" was published in 1932 and guided the American democracy towards principles of building cities (Hagan, 2007). In this concept cities were regarding as open communities/landscapes. Transportation networks consisted of broad freeways. There kept a provision for environmental friendly and pedestrian supporting streets and roads. It was many common ideas with that of garden cities. But the main difference was utility of automobiles and low inhabitant's density.

2.2.3.3. Post 1960's Era of Urban Planning in America

This was era of end of modernist approach in urban design where city renewal movement was heavily criticized. Jane Jacob - a Canadian planner, activist and writer was born in America. Her book "The Death and Life of Great American Cities" attacked the modernist approach of urban planning and effectively described how cities work. Rather than looking onto how cities should work. Modernists used the deductive approach to plan a city by rejecting human being as a multi layered complex chaos. Segregation of residential, commercial and industrial hubs destroyed the innovative economics and the communities. Whereas, Jacob advocated the mixed urban use preserving the inherent uniqueness of the neighborhood. That was quite opposite to the modernist approach. She frequently cited New York City's Greenwich Village as an example of a vibrant urban community (Jacobs, 1961).

Lynch's major contribution to the city planning is his empirical research work on how persons navigate and perceive urban land scape. He divided the physical features of an urban form into five major elements i.e.

- Path – trails, streets, sidewalks and any other ways for people's travel
- Edges – Conceptualized boundaries e.g shorelines, walls, building
- Districts – large section of an urban area identified by some character

- Nodes – Intersections, loci or focal points.
- Landmarks – Identifiable objects as reference points.

These elements acted as raw materials of a city design and finally helped to synthesized series of reports and maps. Which generated basic image on an area, general visual issues, critical or strong elements and its interrelationship (K. Lynch, 1960, 1995).

Another American town planner was William H. Whyte, who spent many year observing human beings and wrote a number of texts about human behavior, city design and planning. Utopia of decentralized suburb was criticized in his books "The Last Landscape" (Whyte, 2000).

Lawrence Halprin was an environment and architect planner. His work stretches from small water fountains to massive urban renewals. His work was result oriented as well as process oriented. He took the human scale into consideration and analyzed its social impacts. His designs were known as user's friendly.

New urbanism movement was started in 1990s and it main goal was to introduce reforms in urban planning and real estate. Peter Calthrope – a new urbanist introduced the idea of (Transit-oriented development) (TOD) in 1993 and discussed urban design at a regional scale. By the start of the new century, urban planners like Calthrope spoke about the regionalism in urban planning. Books like "The Regional City" a remarkable shift from the philosophy of "Edge Cities" discussed the network of regional geographies, green spaces and transit oriented development.

Later on, with the changing industrial, scientific and environmental circumstances concepts of sustainable design, smart growth and green infrastructure were introduced into urban design. But these cannot be stringently called urban design theory. All these ideas cover social, economic, ecological and environmental aspects that has aroused in new millennium.

South Asian Urban Form

To describe the physical form or morphology of south Asian urban form has some obvious difficulties such that it cannot be described by the western or European models. Patterns of land use, transportation networks and residential block layouts verily largely and those of western models. Thus, it is not easy to explain them and those are beyond the explanatory limits of famous patterns. However, to develop the models explaining south Asian urban form, not much effort has been made. Very few theories and assumption that have been made are culture based and not majorly applicable to those cultural boundaries

(Smailes, 1969). Some of these important works includes R.L Singh's explanation of Banares (Varansi) and Manzoor Alam's model on structure and growth of Hyderabad (Alam, 1965; R. Singh, 1973; R. L. Singh, 1955). Urban form of the south Asia can be divided into following four eras:

- Prehistoric or classical Period (initial settlements passing through Gupta era up to.
- Medieval Time (Starting from Gupta time to Mughal era i.e. 550 C.E to 1700
- British colonial Period (1700 -1947)
- Modern Period (From independence to recent time)

2.2.4.1. Prehistoric/Classical Period

Earliest urban development in Indian subcontinent started in prehistoric times. Planning efforts of that era are still distinguishable. These cities follow a Mandala city plans and are mostly related to the Hindu religion (sometimes to Buddhism). A Mandala plan geometrically represents the cosmos and extensively effect the origin of the urban planning of India. There are number of examples that seems to be inspired and have attributes of Mandala's school of thought. Cities belonging to Indus Valley civilization like Harappa and Mohenjodaro have orthogonal structures and have Mandala's Influence. But only barest ruins of these cities can be found these days with tenuous connections. Jaipur and Kathmandu valley can possibly be identified with Mandala's urban form. Jan Pieper has studies the Patan, Kathmandu and Bhaktapur belong to 12th century Hindu Malla Dynasty for Mandala's urban form (Noble, 1998; Pieper, 1975). Best existing example of the Mandala planning is Madurai city in South India."Enclosure and protection reinforces holiness, and the key movements are from the outside in, or circling the sacred enclosure in a clockwise direction"(Pieper, 1975). Jaipur was founded in late eighteenth century and has classical Mandala's urban form. However, Mandala influence is not as clearer as in Madurai.

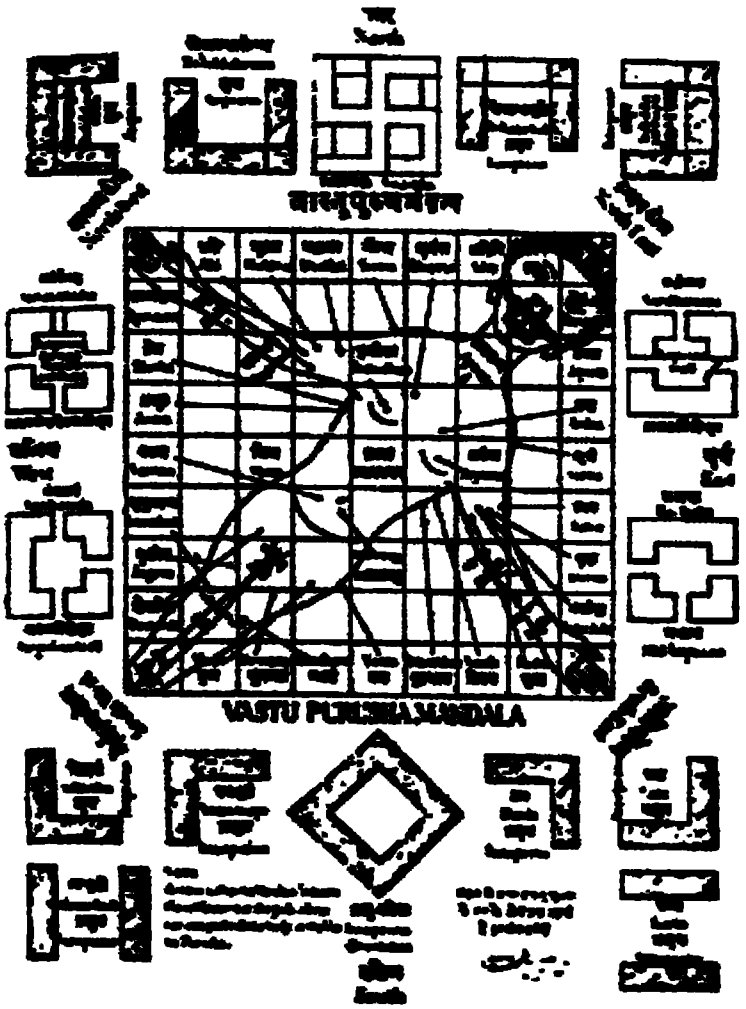

Figure 2.1:- Classical Mandala Urban Form (Nathan, 2002)

2.2.4.2.Medieval Period

Cities of the medieval era follows the pre-industrial patterns as described by the Gideon Sjoberg. Characteristics of these cities are irregular and random arrangement of the streets, crowded and less open spaces, central small bazars and squares surrounded by residences of influential and wealthy persons and municipal buildings. Peoples who have migrated from country sides and those with low income inhibits the fringes of settlements. Neighborhood was segregated according to occupation and social characteristics as residential and work places located at same place most of the time. Technological development was low with lack of vehicular transportation systems. Sub-continent cities that followed this pattern had evolved after long periods of slow evolutionary growth. Possibilities are there that there may be some conscious planning efforts in the beginning but very less was remaining of that initial efforts.

2.2.4.3. Colonial Period

Colonial city model for sub-continent is known as Dutt's 2nd urban model. But it refers to large cities such as Madras, Calcutta, Lahore, Bombay and few other cities belonging to India and Pakistan. These cities have similar urban elements which includes railway stations and colonies, cantonments. Many of the cities having colonial urban form were hill stations and showed very specific type of urban functions (Spencer *et al.*, 1948).

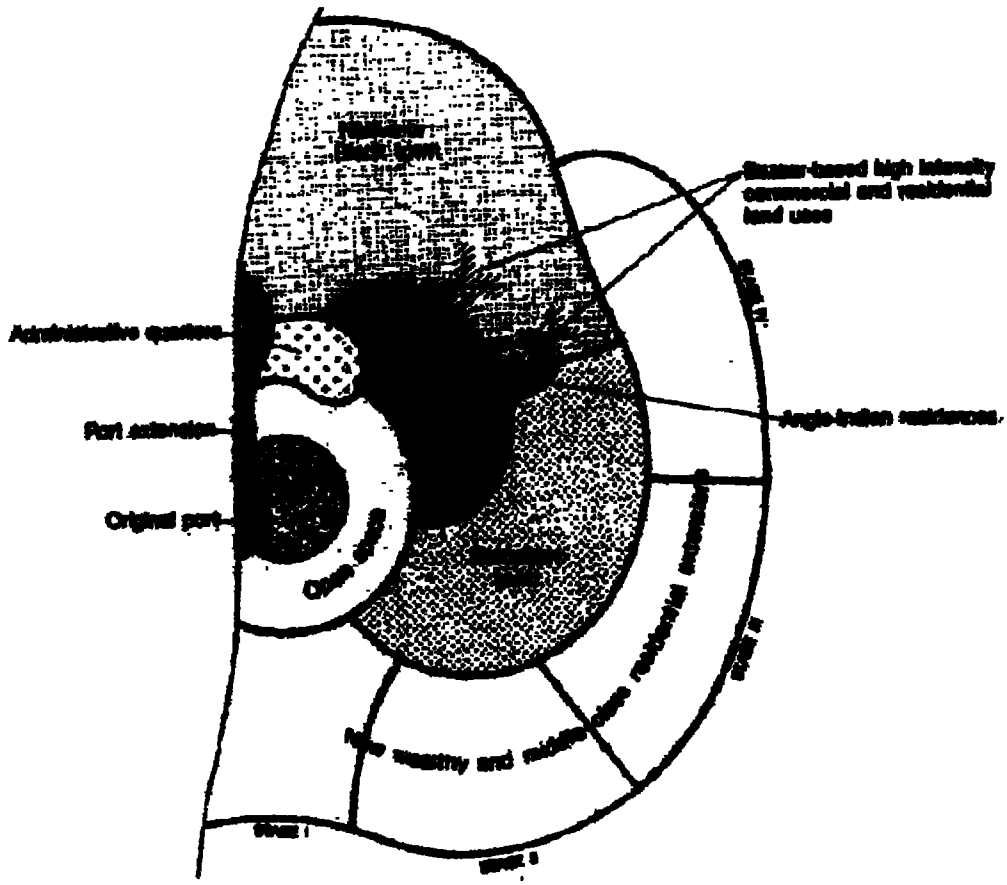

Figure 2.2:- Dutt's Model of colonial cities

Urban form of the colonial cities can be described through the descriptive models as explained by the Smailes. He elaborated the binary structure of the colonial cities and drew an interesting association between urban form, administration blocks – both military and civil and railway networks built by the British rulers during 19th century. Smailes's narration of colonial cities have excellent descriptions but graphical models depict very little about the morphological units of the city and its interrelationship. To remove the

defects of the Dutt's and Smailes' models, Nobel described other two models as follows (Noble, 1998);

a. Model One

Dual nature of colonial cities in sub-continent is depicted through model one. The native settlements, the fort used to locate on a steep eminence and used to be a dominant feature. A temple or a mosque – a secondary pivotal point used to be near a water body. Both facilities were often connected by a permanent paved bazar with shops on either sides. Main bus stop was known as *serai* and acted as traveler's shelter. Main intersection or *chawk* remained the salient feature of the colonial cities, lately. Water stood for the considerable feature of the environment which received four to five months of rainfall, yearly. Consequently, *dhobi ghats* (for washing purposes) and *shamshan ghats* (for cremation purposes) had religious aura. *Dhobi ghats* served the washing purposes of both clothes and utensils and mainly located near the worship places. *Pucca* houses (high quality) were organized in *mohallas* (neighborhood) and usually segregated on the basis of language or caste. Lower quality houses (*Kachcha*) were widely scattered throughout the settlements. Sometimes, boundaries of the cities were marked by a trench or a wall. The British ruler added Civil Stations to this bipolar model of the sub-continent cities. Which were administrative and residential centers for the rulers. These Civil Stations were located at expedient distance from main cities but separated from it through buffer areas. Structure of these stations used to be entirely different from native cities. There used to be a square or rectangular grassy ground/mall lined by the trees. Nearby, used to be a large bazar, fulfilling the retailing requirements of the Civil Stations. All administratively important building such as hospitals, churches and law courts. Gardens surrounds the Civil Stations. Homes of the upper – level administration were called bungalows that used to be two to three story mansions unlikely to the western concept of bungalows. Barracks and small houses were distributed according to the ranks. Middle – level employees from British race resided the civil lines and polices occupied the police lines similarly railway employees resided in railway lines. Railway station used to be an integral component of the Civil Station. Although road network was extended in late 19th century. Menial services providing personal to the Civil Station used to live in hutment slum. Finally, there were *dak* bungalow serving as government guest houses for travelling officials. Circuit houses is another term with varied facilities. Unmanned open spaces acted as separators between British ruler and native community and remained the vital constituent of the bipolar urban

form. These provided a number of recreational facilities. Then, there were the English clubs having ballrooms, dining rooms and card room predominantly for male Britishers but sometimes for females as well. There were botanical gardens, race courses, cricket grounds and gymkhana to provide support facilities.

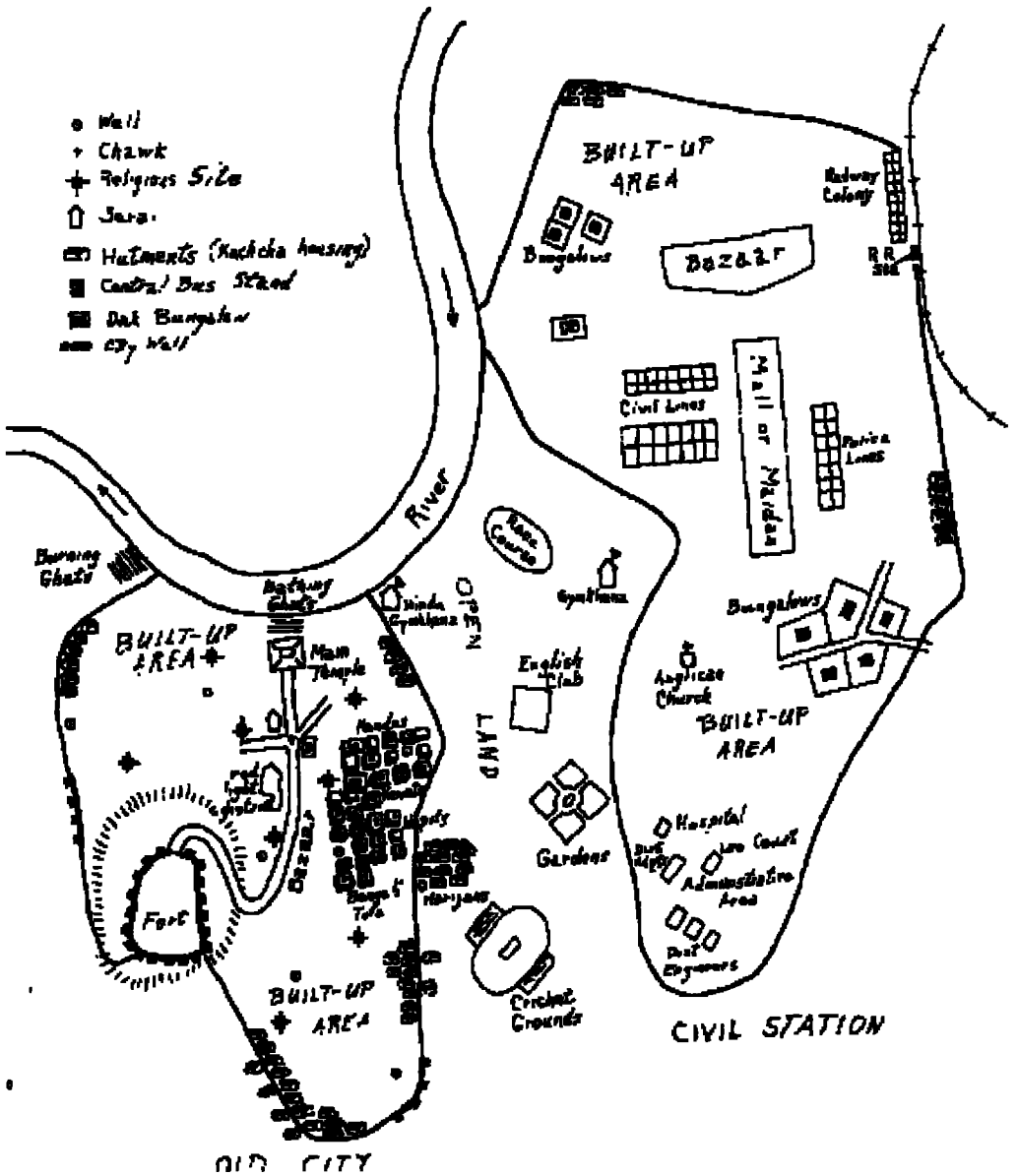

Figure 2.3:- Colonial City Model Drawn by M. Margaret Geib

b. Second Model

The 2nd model fits for the cantonments and pilgrimage oriented cities. And it does not separate the native and British parts distinctively. Temples and mosques acted as central points in most of the cities. Dharamsalas – resting places for pilgrimages were important constituent of these cities. Differentiations in land uses occurred with the increase in

population and city sizes. Small factories, warehouses and workshops arose (King, 2012). British administration has established 114 cantonments till 1863. In some instances, earlier forts of vanquished foes were occupied and, together with a surrounding territory, turned into a British military posts. Although in most of the cases newly planned cantonments were established to get maximum advantages for military. British civilian who had no obvious positions in cantonment used to live in European Towns in order to differentiate from native settlements. These European Towns were named after the British businessmen or officials. These extensions not only provided the psychological protections to the cantonments but also worked as a midway partition between British and indigenous settlements. Housing in these extensions were very much similar to those of cantonments and with block of flats.

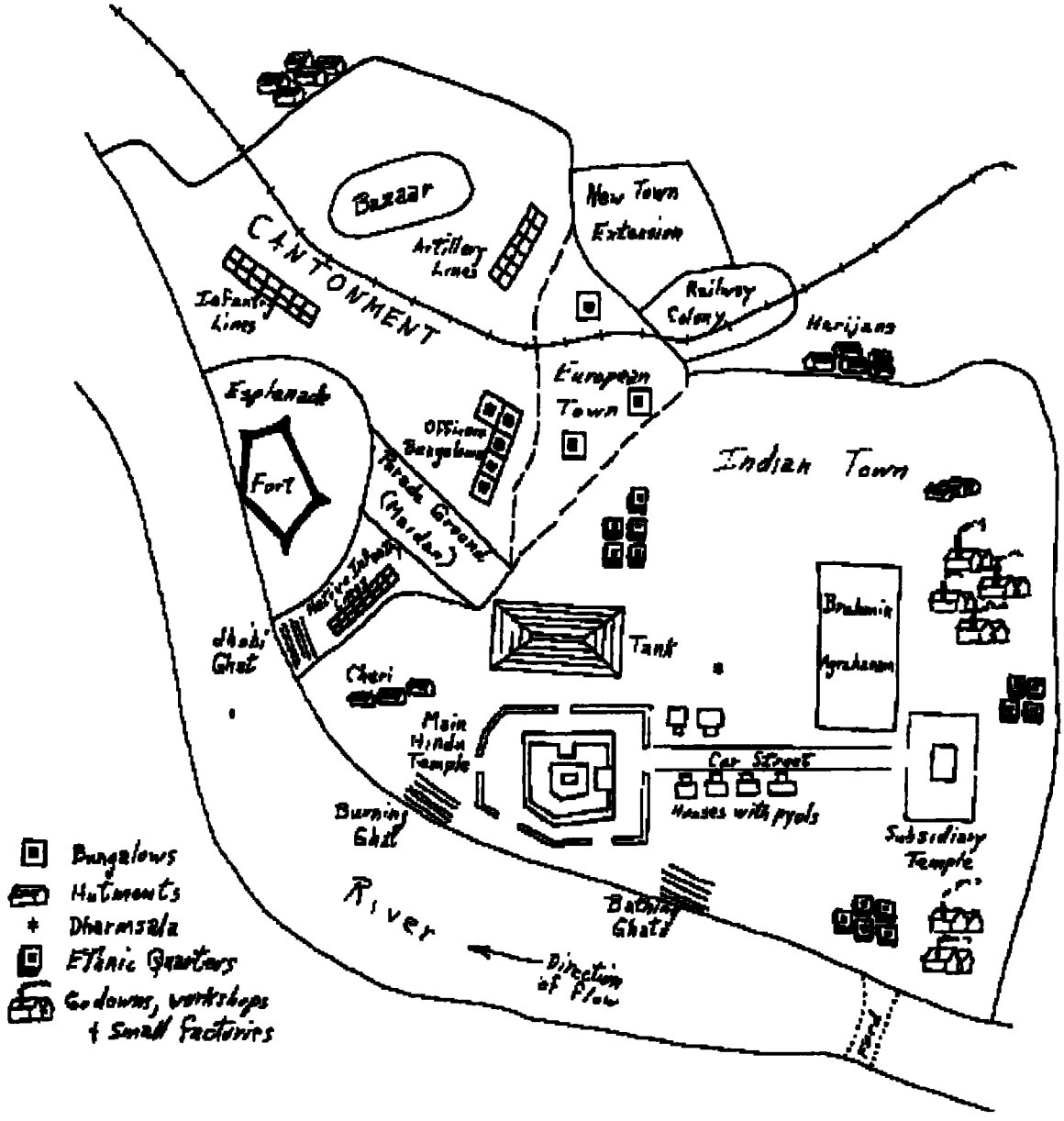

Figure 2.4:- 2nd Model Drawn by Margaret Geib

2.2.4.4. Modern Era

A very small number of town planners has made attempts to explains the modern urban form of the indo-Pak (Dutt *et al.*, 2007). One of such attempt was made by Jhoson. However, his attempt was functionally unsuccessful due to large details (Johnson, 1979). Spatial relationships were not clear and tough to identify. The author has tried to explain complete history of urbanization of India. Thus, making the model very complex. Alok singh – an Indian geographer has examined the land use designs of cities and attempted to design model buildings. But this model addresses to very small number of cities as it only refers to modern industrial cities. Singh's cities have concentric arrangements which seems to influenced by the western models. Western influence is also evident in Dutt's models – "Cities of South Asia".

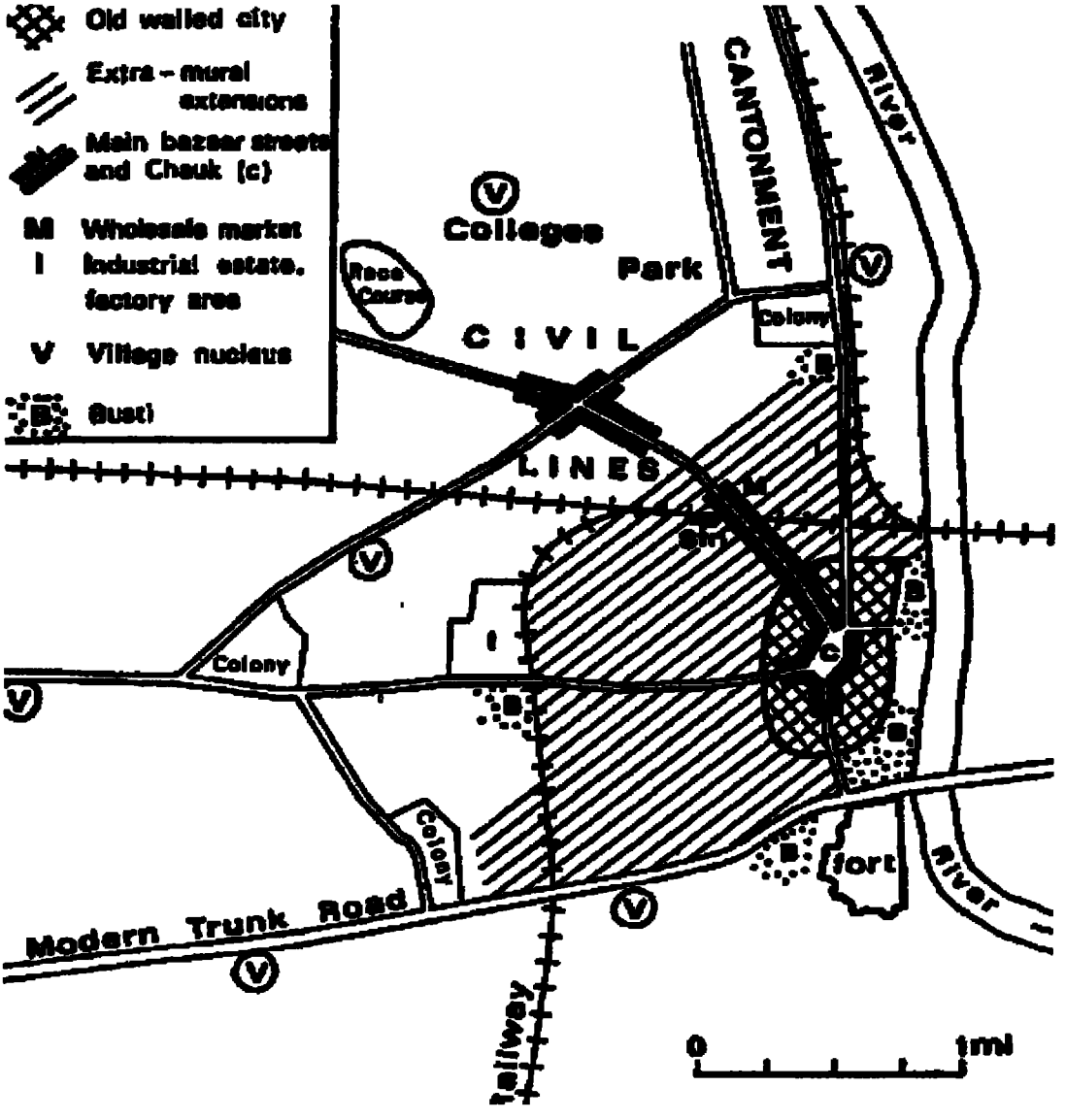

Figure 2.5:- Smailes Generalized Diagram of Colonial Cities (Smailes, 1969)

Dutt has proposed two models i.e. colonial model and bazar-based city. He has also proposed a hybrid of two models. Bazar city plan seems to fit many modern cities of Indo-Pak. But the colonial period majorly fitted to earlier period. This model consists of cultural enclaves, peripheral wedges and concentric zones. Dutt has collected three western approaches into a single morphology. Those two models are more related to the Hill stations or more specifically to the colonial cities. However, descriptive models should be used to explain the urban form of the cities of this period. Earliest descriptive models were proposed by the Smailes which effectively described the binary structure of the indo-Pak cities.

2.3 Literature Review Related to Environmental Change

Environmental changes occur due to natural and human processes and activities. Nature takes sun's energy into living systems and causes changes by recycling the materials such and oceanic, biological, geological and biogeochemical cycles. These transformations are majorly slow and have capacity to maintain the threshold capacities. On the other hand humans alters environment by transforming materials and energy into products and services to seek the human requirements and needs (Vitousek *et al.*, 1986). Thus, environmental changes under discussion are referred to disturbance or change in the environment mostly by the anthropogenic activities. Since its existence, history of mankind survival on earth can be distributed into four developmental phases i.e hunter-gatherer, early farming, early urban, and modern high-energy. Hunter gatherers used 0.0001 per cent of the available solar energy (Boyden, 1992). In early forming era, humans stated manipulating the ecological systems for its own good. Thereafter, populations grew and proliferated. Cultural development added a technological dimension to the metabolism of human populations, increasing food production on the one hand, and lengthening lifespans on the other. Civilizations also developed in parallel with the advance of military innovation, each reinforcing the other in the domination of the local environment, people or the globe (Graedel *et al.*, 1989). All these factors are contributing to unprecedented changes in the natural cycles and fluctuating their balance. Humans are consuming 40 per cent of the net primary productivity belonging to earth's whole terrestrial systems and fixing as much nitrogen and Sulphur as nature does (Stanners, 1995). 2400 years ago Plato identified the environmental degradation and wrote, "what now remains [of forested lands in Attica] is like the skeleton of a sick man, all the fat and soft earth having been wasted away, and only the bare framework of the land being left. (Critias III, section B)". However, the acuteness

of the problem aggravated only in the eighteenth century with the intensification of agriculture, demographic development and the start of industrialization. Now a day, earth's ecosystem is being affected by anthropogenic activities at an extraordinary rate. These activates includes resource consumption above threshold capacity, species loss, alteration, fragmentation or loss of habitats, changes in energy flow, interruptions in hydro geochemical and nutrient cycles and species loss.

Nature is operating through closed lope of elements each with a source and sink. Hence forming quasi-steady state of the elements – as they enter into living organisms and return to environment as they die and degraded. These cycles are essence on life on earth. Since industrial revolution, anthropogenic interruptions have elevated to such an extent that has interrupted with the nature's balance of the environment. Safely, it can also be argued that some activities such as mining and agriculture has initiated new cycles. Rest of balances are suffering in two ways. For example, in case of carbon dioxide (CO_2), carbon mono oxide (CO) and methane (CH_4). Huge amount of resources i.e. higher than their reservoir's capacity is being exhausted into environment causing acid rain, global warming and climatic changes. Similar is the case with Sulphur and phosphorous and nitrogen. Hardly, a water body can be recognized around the globe that is not affected the eutrophication (Yi *et al.*, 1992). Human activities has caused worst environmental incidents like Chernobyl nuclear incident (Denton, 1987), Bhophal methyl isocyanate escape from pesticide plant on mid night December 02, 1984 (Labib, 2015) Kuwaiti oil fires (Husain *et al.*, 1994), love canal 1987 (Fletcher, 2002), 10.8-million-gallon oil escape from ship "Exxon Valdez" on March 24, 1989 after hitting "Bligh Reef" in the "Pristine waters of Alaska's Prince William".(Gill *et al.*, 2016),Tokimura power plant incident in Tokyo (Gasparro *et al.*, 2004), the Aral sea – graveyard of ships as described by the then US secretory general Ban-Ki-Moon (S. B. Roy *et al.*, 2014), Soveso dioxin cloud (Emond *et al.*, 2016), Minamata disease from mercury poisoning in Japan (Kudo *et al.*, 1998) and three mile island (Gauld *et al.*, 2016).

All these environmental disasters and changes are leading us towards greenhouse effect, thinning of ozone layer, acid rains and much more. Atmospheric physicist and scientists have also analyzed the impact of these environmental changes on human health and settlements (Leaf, 1989).

Web of environmental changes, industrialization, economic growth, population growth and urbanization are strongly complex and interconnected. In the last 100 years' world's population is multiplying by a factor more than three, the world economy expands by more

than twenty times. As a result, fossil fuel consumption has increased thirty times to support a fifty times greater industrial production (De Sherbinin *et al.*, 2008). Industrialization, population boom and economic growth – all three requires more and more raw materials drawn from natural environment and putting and increased burden in form of waste material exhaust. Irrespective of political and geographical boundaries, once released into the environment, pollutants are transported by natural processes. Meteorological variabilities and fluctuations facilitate the dispersion of atmospheric pollutants exposing humans and ecosystems to the contaminants.

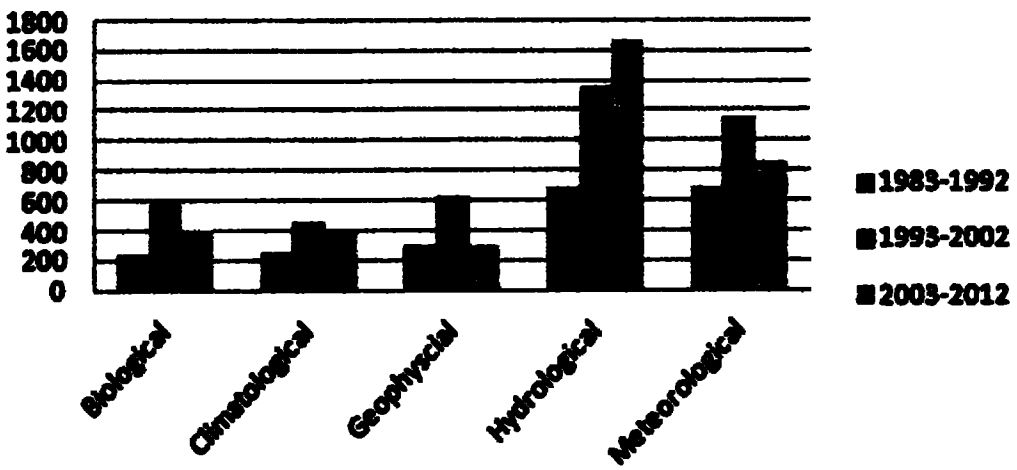

Figure 2.6:- Reported Natural Disasters

Adopted from: OFDA/CRED Data Base. www.em-dat.net

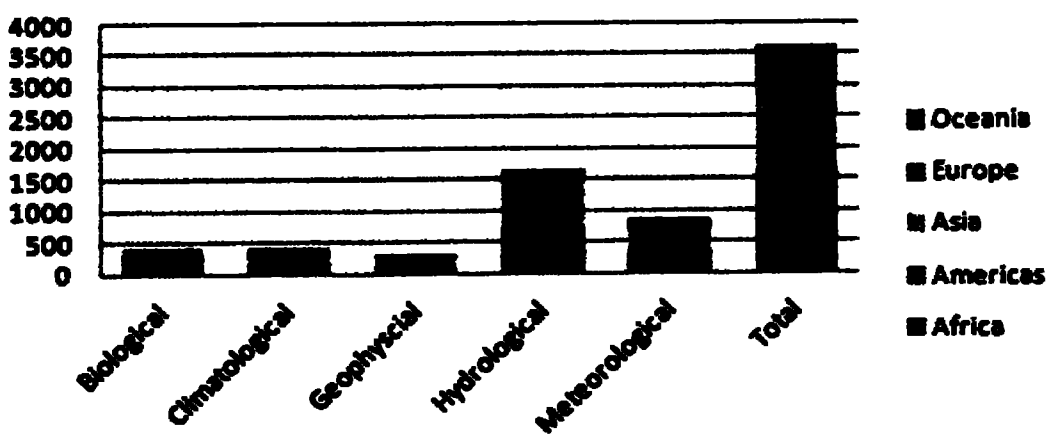

Figure 2.7:- Regional Distribution of Disaster

Adopted from: OFDA/CRED Data Base. www.em-dat.net

2.4 Inter Relationship of Urban Form and Environmental Change

Because of urbanization and prompt population growth, risk-prone and hazardous areas are getting more and more populated. The trend is same either it is a large city or a small or average sized urban area. However, each type of urban sprawl has its own disaster risks(Grimmond, 2007; Satterthwaite, 2005). An urban center with greater than 10 million individuals are called mega cities and according to UN reports there will be more than 41 mega cities by the year 2030 (Nations, 2014; Scientist, 2006). Due to their size, function and design all mega metropolis are vulnerable for natural disasters and hazards. These hazards include geological (mass movements, ground shaking earthquake), climatic events (Cold and extreme events) and wildfires. Thus, it creates necessity to plan such strategies and plan that minimize the risk in megacities. Without exception of the coastal areas climate change is supposed to adversely affect all mega cities with the rises in sea levels, accompanying costal floods, increases in the intensity and frequency of climatic events such as intense cold and hot events or intense rain and flash floods (Grimm *et al.*, 2008; Hunt *et al.*, 2011). Disaster risk reduction strategies and plans have been widely discussed in developmental studies. However, along with these strategies and plans there is sheer need of such initiatives that may reduce the frequency and intensity of these extreme events. Basic factors causing such events should be addressed particularly in urban environment. Initiatives much be taken to increase threshold levels of natural resources or to decrease the burden of raw materials extractions. Increase the threshold capacity of nature to hold waste materials or to take such steps which may lessen the burden of waste dumping. Reduce the emission of GHGs or make such arrangements which may utilize or recycle these emissions. To achieve all these goals basics theories of the ecology should be revised (Heynen, 2006; Michael Jenks, 2000; Stone *et al.*, 2010).

Metropolitan ecosystems are relatively less stable, have more non-native species, have different species structure (always changing but simplified), different underlying structure highly flexible in spatial and temporal scale) and exceptional energetics (extreme anti-entropic). Metropolitans are less stable, have unique energetics (Extreme entropy), simplified but always changing species composition, more foreign species and variable dynamic (both in spatial and temporal context). Thus, temporal and spatial heterogeneity is greater. Which give rise to complicated assortment of living things and physical patches within an infrastructure, social institutions and human organizations. Land covers are

directly affected by anthropogenic activities. Which is return affects primary productivity, biodiversity, surface runoff, pollution and soil quality. Altered air quality and land surfaces formulates microclimates and create heat islands. Increased impervious surfaces due to urbanization also affects nutrient cycles, sedimentation, fluxes of water and hydro geochemical cycle (Leopold, 1968). Jean-Marie Pelt in his book "The Re-naturalized Human" introduced a new aspect to ecology clearly different from traditional one (Pelt, 1977). Forman and Godron's in 1986 wrote book Landscape Ecology in which first distinguished urban settings and landscapes forms were introduced (Forman *et al.*, 1986). These theories and concepts kept on molding with the pace of industrialization, population explosion and rate of economic development. Today, the greatest challenge for the town planners and ecologists is to integrate the human activities into the urban ecology. In order to minimize their impact on surrounding environment without sacrificing the standards of life. Incorporating humans into ecosystems provide vital prospects for all kind of bionetworks (Alberti *et al.*, 2003). Emerging requirements introduced the different cities such as smart cities (Neirotti *et al.*, 2014), sustainable cities (de Jong *et al.*, 2015), compact cities, eco-cities, city resilience and many others. Thus, a new debate has been started to integrate modern technology based elucidation in to approaches of urban layouts, designs and planning. It can be a way to guarantee future viability and opulence of urban areas (Alawadhi *et al.*, 2012; Dirks *et al.*, 2009). Different authors have considered different set of parameters to be focused. Here is the summarized list/tables of all those parameters that have been reported in the literature so far to attain the goal of an eco/sustainable/green/compact/resilient city.

Domains considered for Eco/Green cities

"Emils Gejs" introduced the notion of "Urban Emiils."- "The Eco City". Which was one of the pioneering organization developed for eco cities. Richard Register was heading the group in Berkeley, California during 1975. Their major objective was to create equilibrium with nature by recreating the cities (Roseland, 1997). They worked with the legislative frame work of Berkeley and introduced environmental friendly initiatives such as tree plantation by the main streets, green houses powered by solar energy and boosting public transportation (Devuyst *et al.*, 2001). They started publishing a journal "Urban Ecologist" in 1987. With this initiative movement of "Urban Ecology" took another step forward(Devuyst, 2001).

In order to attain urban sustainability concept of eco-city was introduced. Which covers large number of urban-ecological plans to achieve the purpose of sustainability (Hald, 2004). A variety of social, institutional, planning and environmental policies have been proposed to achieve urban sustainability. Environmental management in an integral part of such kind of plans. It emphasis on ecological management by a set of policy tools and institutional networks. Two major domains should be kept in mind namely hard domain and soft domain for designing eco/green city (El Ghorab *et al.*, 2016). Also, Eco-city is described as "a city that provides an acceptable standard of living for its human occupants without depleting the ecosystems and biochemical cycles on which it depends" (Radovic, 2013; Wong *et al.*, 2011).

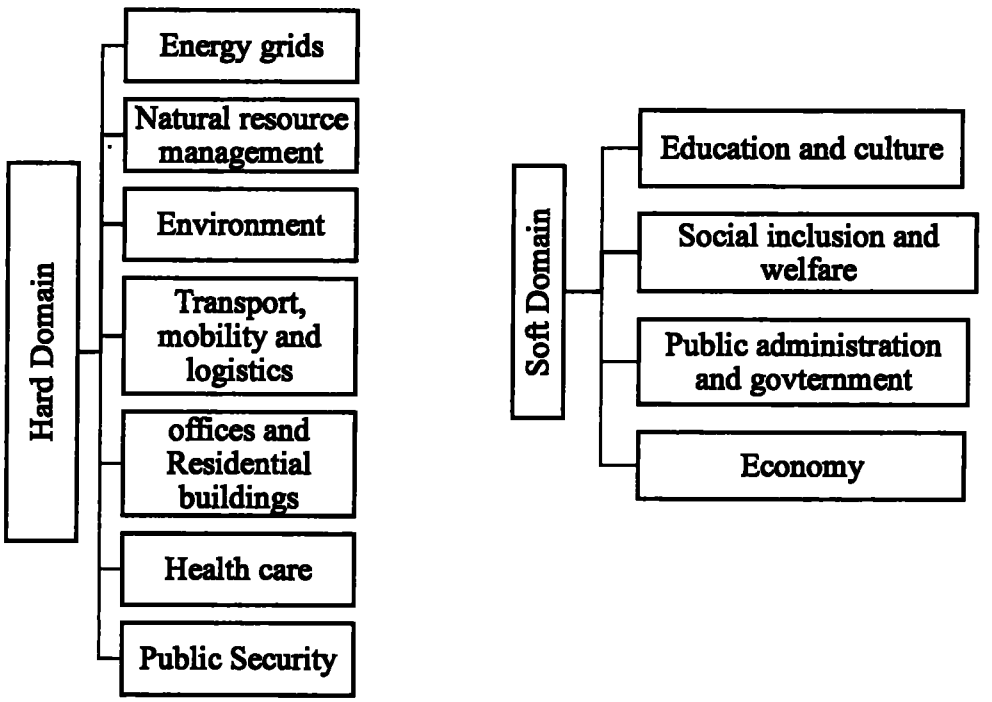

Figure 2.8:- Domains of Green/Eco City

(Joss, 2011; Roseland, 1997)

2.4.1.1. Strengths of Eco/Green Cities Concept

i. Vertical farming is held in buildings thus it occupies less room than conventional farming

ii. One square town block with a rise of 30 stories is enough to fulfill nutritional requirements of 10,000 people.

iii. Food safety, food security and food quality is assured as crops are provided indoor controlled environment

iv. Sun light is used as source of energy like conventional farming. Thus artificial means of lighting not required.

v. 97.5% on earth is saline only 0.007 % is considered safe for human consumption. Desalination plants are an important feature of the eco-cities. In order to provide freshwater to people around the world.

vi. These desalination plants also aim to provide fresh water to dry or drought stricken areas. Good example of such a plant is Kurnell Desalination. Which is location in vicinity of Sydney, Australia and has low annual rainfall. Kurnell Desalination fulfill the 15% of Sydeny's total water requirement.

2.4.1.2. Limitations of Eco/Green Cities Concept

i. Nourishing and taking care of crops in vertical building is very expensive and requires lot of money.

ii. Removal of stains and microscopic organism is work and cost intensive job.

iii. Desalination requires a lot of energy so water produced is expensive and not accessible to all.

iv. Marine flora and fauna are harmed by chemical discharge and brine of desalination plants. Which is against the philosophy of eco-cities.

v. Phytoplankton and planktons disturbed by discharges of desalination plants serves as life line bases of marine life. Thus marine food webs are disturbed vigorously. Which harms the marine life drastically.

Components of a Sustainable City

According to the Bruntdland Commission sustainability can be defined as "meeting our own needs without compromising the ability of future generations to meet their own needs". Along with environmental consideration, social and economic aspects should also kept into consideration. It has been found that sustainability challenges can be better addressed if dealt at local scale(Clark *et al.*, 2003). Climate change mitigation and adaptation is best example of such measures(Evans *et al.*, 2014). Agenda 21 was put forward by United Nations in 1992 during Earth Summit in Rio. Agenda 21 stands for a benchmark plan of sustainable strategies and developments for regional and local councils. According to Agenda 21, communities and cities have to recognize their own concerns for sustainability. Which is turn should be incorporated in their policies, plans and action of

environment, social and economic spheres to achieve the target. However, agenda 21 provides a set of indicators for effective monitoring of sustainability.

Along with the novel description of sustainability, a city is considered to be sustainable "if its conditions of production do not destroy over time the conditions of its reproduction" (Castells, 2000). More recently authors like Hiremath, Kumar, Balachandra, Murali and Bansode, have defined have categorized urban sustainability "achieving a balance between the development of the urban areas and protection of the environment with an eye to equity in income, employment, shelter, basic services, social infrastructure and transportation in the urban areas"(Joss, 2011; Tanguay *et al.*, 2010)

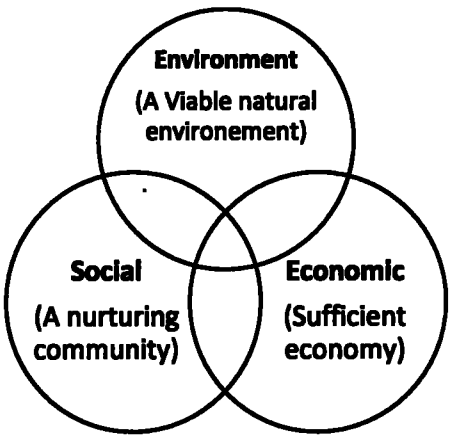

Figure 2.9:- Components of a Sustainable City

2.4.2.1. Strengths of Sustainable City Concepts

i. There is always a room for continuously increasing population by remodeling the existing cities. Due to relocation of new expansions redevelopment/remodeling becomes easy.

ii. Land can be spared for determinants such as mitigation of environmental challenges, eco-system monitoring and agriculture.

iii. Energy/fuel consumption is reduced significantly by promoting public transport, consequently air pollution is also reduced.

iv. Pedestrian are encouraged by modifying urban forms which have study, worship, workplace and recreational places at walkable distances

v. City system has to run 24x7 in order to enhance management, administration, public participation and employment opportunities.

vi. Resource conservation and waste recycling and management remains the central life of action. Services and resources are optimized by integrated and automated systems

2.4.2.2. Limitations of Sustainable Cities Concept

i. Intensive vertical development has its own environmental impacts which are more rigorous during construction phase. Thus chalking out an environmental management plan that fulfill the sustainability requirements is an uphill task.

ii. Growth potential may be restricted in case of vertical development. Whereas, cities are meant to accommodate growth potential and transform with time.

iii. Vertical development is designed for a targeted life span. After completion of lifecycle, it has to be abandoned and chances of its reuse are not clear at this stage.

iv. Transformation and remodeling of human settlement in horizontal growth is a lifelong phenomenon tested by the centuries of history. Whereas, durability and dynamicity of vertical growth has yet to be tested by the time.

v. Water and energy footprint of the vertical growth during the construction phase is much higher than traditional growth.

vi. Microclimate of the area may be altered due to vertical growth. Which is turn can affect local micro flora and fauna because significantly large surrounding area will be under wind and sun shadow.

vii. Environmental hazards (noise, air, water and soil pollution) associated with heavy and medium industrial zone makes it impossible to incorporate it in vertical development model.

viii. Chances of mass destruction are higher in case of natural calamities and other action generated disasters (Garg *et al.*, 2018).

Components of Resilient City

World "resilience" has its etymological roots in Latin word "resilio". Peter Newman (co-authored with Heather Boyer and Timothy Beatley) wrote a book "Resilient City". It was published on 9th January, 2009. Taking into account the climate change and oil peak. The etymological roots of the word "resilience" stem from the Latin word resilio. In the book "Resilient Cities" published on January 9, 2009 written by: while responding to Peak resilience refers to "equipping cities to face future shocks and stresses from climate change and depleted oil and fuel sources".

According to researchers, the concept of resilience city is a concept that has a relationship with the perception of sustainability. Also, it is based upon three dimensions i.e. adaptation, mitigation, and innovation.

The three dimensions will be explained as follows:

i. Mitigation is the reduction of risk relative to the object capacity, the object itself in accordance with its capacity.

ii. Adaptation is the self-adjustment to risk, which is adapted to the hazards and vulnerabilities that exist at the object.

iii. Innovation is the time frame to consider the implementation of new activities in the treatment of actual risk which falls outside the existing capacity on the object, such as creating new technologies to reduce disaster risk (Da Silva *et al.*, 2014; Index, 2014; Renald *et al.*, 2016)

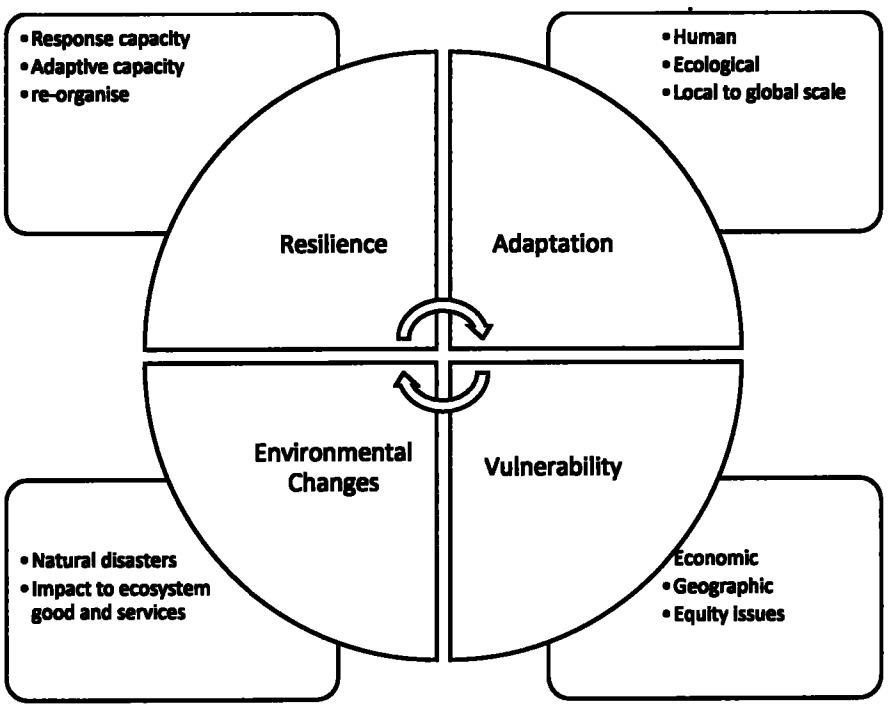

Figure 2.10:- Components of Resilient City

2.4.3.1. Strengths of Resilient Cities Concept

i. It fulfills the requirements of users, uses, public spaces and building types. It accommodates the diversity and density.

ii. Pedestrian's mode remains prime mode of transportation to ensure healthy life. Necessities of life are provided within walking distance (500 radius)

iii. Develop in a way that is transit supportive. Focus energy and resources on conserving, enhancing, and creating strong, vibrant places, which are a significant component of the neighborhood's structure and of the community's identity.

iv. Conservation of natural systems as well as climate is ensured by impact management.

v. Enhanced efficiency, safety and effectiveness of industrial and technical process and system is ensured. Manufacturing, communication, transportation and construction phases are guaranteed with minimum footprint and maximum energy efficiency.

vi. Promises self-sufficient communities. Good (growth and production) and services are available in 200 kilometer radius.

vii. Community membranes has to participate actively in development plans at all scales.

viii. Plan and design for redundancy and durability of their life safety and critical infrastructure systems. Planning and design of these systems will aim for levels of redundancy and durability that are commensurate with the increasing environmental, social, and economic stresses associated with the impacts of climate change and peak oil.

ix. Reduced service cost and minimum environmental footprint is ensured constructing urban form and building types.

x. Develop building types and urban forms with reduced servicing costs, and reduced environmental footprints.

2.4.3.2. Limitations of Resilient Cities Concept

i. Resilience and low carbon economies has to do nothing with each other. Local governments can create city resilience without eliminating their carbon budget. Mark Pelling – the creator of city resilience idea has differentiated the cities that aims for the resilience and the other that opt for transformation and beyond it (Mark Pelling, 2012).

ii. Resilience can be achieved by modifying policies, detecting present and future risks. Active institutional structure is required to support and encourage all agencies and sectors.

iii. To go beyond resilience to transformation means having adaptation policies and investments integrated with development that really meets needs (including those

of low-income groups), while also addressing mitigation and, where needed, over-large ecological footprints(M Pelling, 2011). This obviously requires fundamental changes in the supporting political and cultural systems. We are far from understanding what can support these changes at local, national and global scales.

Smart City Concept

The concept of the smart city has been introduced to highlight the importance of Information and Communication Technologies (ICTs) in the last 20 years' literature the term smart city is used to specify a city's ability to respond as promptly as possible to the needs of citizens. Quality of life and city development are profoundly influenced by the core systems of a city: transport, government services and education, public safety and health. Research has focused to study these four areas - education, health, transport, public administration - which are identified having high priority. For these areas was highlight the use of new technologies of employers (Choenni *et al.*, 2016; Dirks *et al.*, 2010; Giffinger *et al.*, 2007). Smart transportation systems are the best example of the harmony between development of city and modern technologies.

The tag "smart city" is a fuzzy concept and is used in ways that are not always consistent. There is neither a single template of framing a smart city, nor a one-size-fits-all definition of it (O'grady *et al.*, 2012). Most of the authors have agreed upon following six constituents of a smart city.

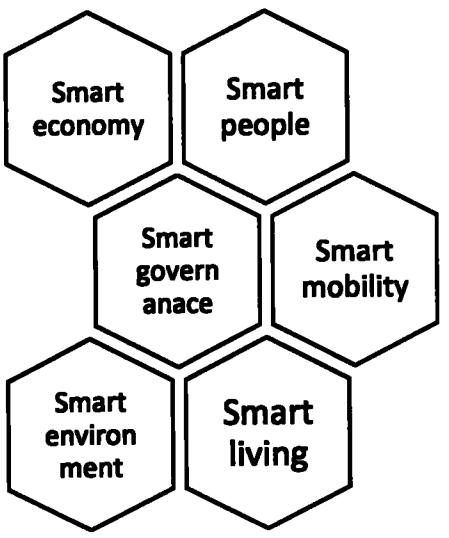

Figure 2.11:- Concept of Smart City

(Albino *et al.*, 2015; Hatzelhoffer *et al.*, 2012)

2.4.4.1.Strengths of Smart Cities

i. Smart cities have improved long term strategies and infrastructure.

ii. It ensures enhanced citizen safety and social development, e.g. elderly people can live independently and improve their standard of life.

iii. It promises better environmental benefits (Smart energy management) and economic development

iv. It minimizes energy consumption and hence CO2 emissions are minimized to achieve economic sustainability.

v. Economic Sustainability for instance: minimizing energy consuming and also minimizing CO2 emissions.

2.4.4.2. Limitations of Smart Cities

i. Technology required for smart cities is yet in it pre-commercial phase.

ii. May cause social risk e.g. elder individuals may have lack of skill to access broadband. This limitation of access may cause problems. Also, a lot of individuals may have lack of information about how to use technologies in smart cities

CHAPTER # 3

RESEARCH METHODOLOGY

This chapter provides the methodology adopted to answer the central question of research topic. The nature of topic warrants for qualitative research. Therefore, the methodology is planned and executed keeping in view requirements of qualitative research. Qualitative research writing, author makes sense step by step, not only for the data but for whole practice and experience to which it belongs. This used to be a collaborating process in which author makes a conscious effort and tries to show its role and presence. Quantitative work can be shown in the form of summaries and tables. In contrary, qualitative work contain the meaning in its complete text. Thus, its connotation lies in its reading (T. Lynch, 2001). According to Thomas and Silverman, for qualitative research most common and important data collection tools are observation, review of documents(Papers, audio, video, photographs, narrative field logs and diaries, participants notices) and interview (Thomas *et al.*, 2015). Focus group discussion is a tool employed in qualitative research to gather information on a particular topic through interview from a special group and number of peoples. Information can be collected from several individuals in one meeting. Thus, it is an efficient way of data pooling. Usually, focus groups are kept homogenous e.g a set of students, teachers, or an athletic team (Morgan, 1996).

3.1 Establishment of Data Requirement

After defining the problem implicitly and explaining background of research topic, requirement of the data to be collected from various sources will be established. The key objective of doing this practice is to define the required type and amount of data in relevance to fulfillment of study objectives.

Data Access and Collection

Data collected is of two types, which are primary as well as secondary data. Primary data will be gathered through focus group, observations and interviews. And for secondary data books, journals, periodicals and papers.

3.2 Study Design

Keeping in view afore-stated parameters, comprehensive methodology had been adopted to conduct the study. It was two pronged i.e. explanatory and conclusive research designs. Explanatory research design generated descriptive data, whereas conclusive research design led to numeral data. Major steps are depicted through following flow chart:

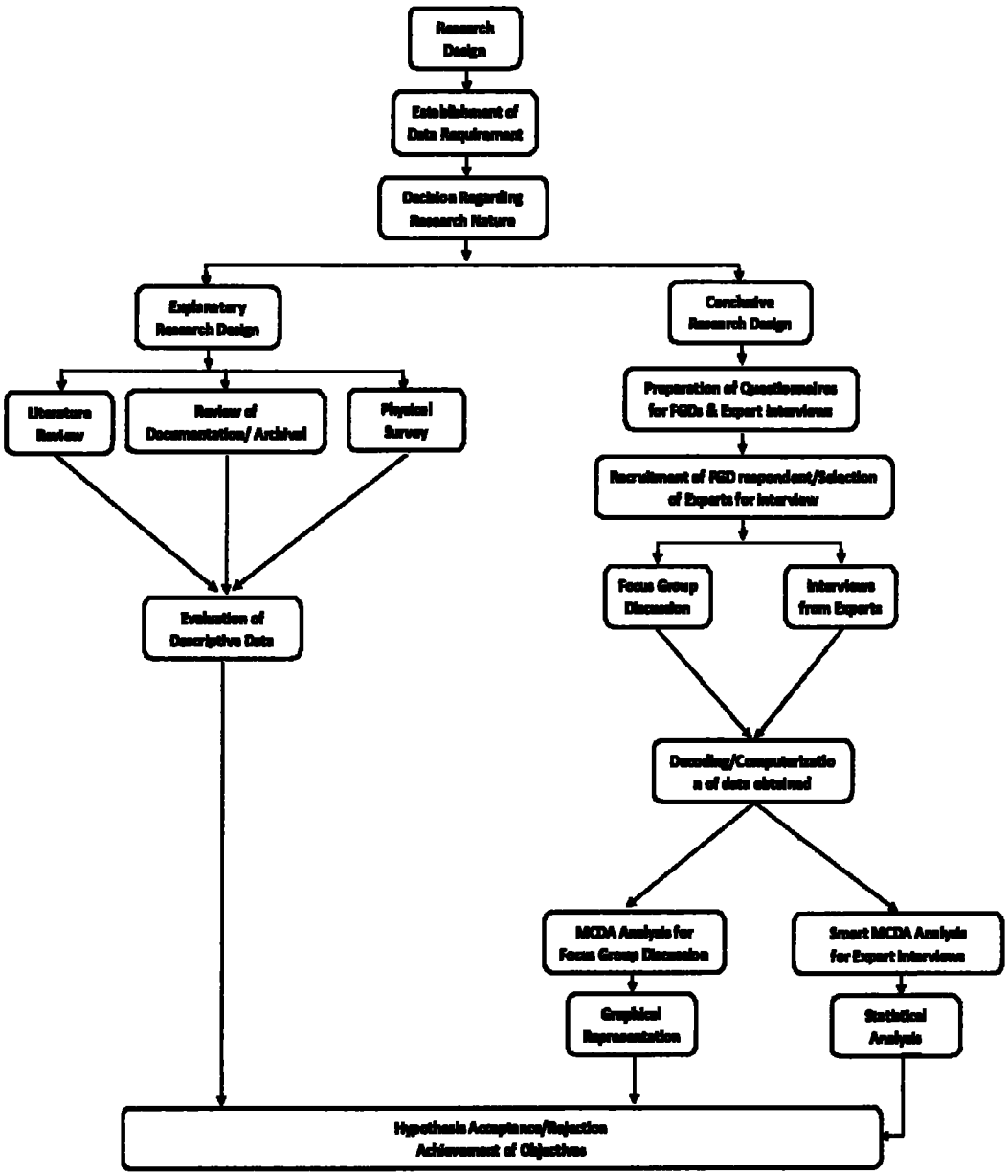

Figure 3.1:- Flow Chart of Research Design

3.3 Explanatory Research Design

It comprises of following steps:

Baseline information gathering

At first stage a desk study was conducted for thorough review of available and existent resources. This was included but not limited to books, thesis, journals, research papers, newspapers, review reports and project reports etc to establish baseline and to know latest endeavors to make urban form more harmonious with natural environment. Answer of the question whether environmental consideration is given while designing city was traced in history of urban planning.

Documentation and Archival Record

Archived land records, libraries and historical documents were thoroughly searched. Archival record was consulted to get information about the city design, trends in urban sprawl, transformation of the city shape through history. It also provided the living patterns and standard of life of the city inhabitants. It gave a glimpse about contribution of development authorities and how the cities were managed. Laws related to urban design and environment were studied in pre and post 60's eras. 60's stands as bench mark of the city transformation. As city management experienced drastic changes due to formation of developmental authorities etc. in Pakistan

3.4 Physical Surveys of Pre and Post 1960s Urban Forms in Various Parts of Pakistan

Selected cities inside were visited. In Pakistan Lahore, Multan, Rawalpindi, Faisalabad, Sargodha were visited to study pre-1960s urban form. Post-1960s urban form was studied in Islamabad which is only planned city of Pakistan.

During these visits multiple sources of evidence and data collection techniques were used. These include;

Observation

Observations were also recorded for both pre 60's and post 60's cities by personal visit. For the purpose of authentication notices, photograph and videos were taken.

Personal Communications

Individuals' thoughts and feelings are tied inherently to their communication. The cognitions people have and the emotions they feel both affect, and are affected by, social interaction. Therefore, way of personal communication is adopted instead of other methods where direct interaction is not involved

Interaction with Professionals Like Ethnographers and Historians etc

Ethnographers and historians have better understanding of human society, settlements, living patterns and interrelationship between urban sprawl and environment. Therefore, their viewpoint is collected. Furthermore, Technical notices were recorded from those professionals and/or people dealing with land records or participated in planning as well as development activities, who have seen pre 60's era.

3.5 Catalogue of Research activities and Data Collected

For cataloguing and data collection audiotaping, videotaping, photographs and handwritten notices were used. As these tools can create priceless spin-off because these

characterize literal replicas of happening's during field surveys. These tools provide selection opportunities about "what to", "when" and "why" to record. Permissions for recording and photography were taken from the participants prior to recordings. After coming back from field, data was tabulated on immediate basis as per requirement of analysis to be carried out to unveil research question.

3.6 Conclusive Research Design

Conclusive research provides such information that helps the research to draw a conclusion. It is mostly of quantitative nature i.e. to narrate in form of numbers which can be quantified as well as summarized. It tests the hypothesis and statistics is an integral part of it. Conclusive research relies on two types of data; firstly, secondary data, mostly existing databases which are to be reanalyzed to through light on some different problem rather original one for which these were constituted, secondly, primary research, i.e. data gathered specifically for current study.

Preparation of Questionnaire and Data Collection

Questionnaire/s were prepared for collection of data from primary as well as secondary sources. Questionnaire were used for collection of data from professionals and govt. functionaries regarding environmental parameters affecting urban form. Structured interviews were conducted, if required from individuals and members of focus group. Questionnaires for focus group discussion, questionnaire for expert's interview, post 60's individual's questionnaires are attached in Annexure-I.

Selection of Respondents for Research

A range of dynamics can sway the quantity of data in qualitative research. Sum of interview and cumber of participants decide the load. How many focus group discussions or interview are enough? The actual answer is "there is no rule of thumb"(Baker *et al.*, 2012). In order to be more efficient and save time focus group methodology was used in this research. Detail is given in data analysis chapter.

Recruitment of Respondents

Contributor's recruitment is important for the success of investigative study. In a conclusive research design, project may fails if there is insufficient amount of participants (McDonald *et al.*, 2006). In advance studies, the empathy of optimal enlistment methods is attaining interest and a current systematic evaluation of strategies intended to improve recruitment for "randomized controlled trials (RCTs)" identified 45 significant studies. It has classified six types of intrusion: trial design, approach for participants, obtaining

consent, financial incentives, trial coordination and training for recruiters. There can be few strategies that are found to be effective for recruitment. Which includes, reminders on telephone to non-responders, having opt-out procedures where potential participants are required to contact the trial team.

Pre-interviews

Pre-interviews may be divided into two steps i.e. planning and developing. Planning recognizes the likely participants for the interview. It determines an optimal sample size if required. It decides whether research is under national and international ethical standards of research. And developing includes; "what to say to interviewees when setting up the interview. What to say to interviewees when beginning the interview - including ensuring informed consent and confidentiality of the interviewee confidentiality of the interviewee – and what to say to and what to say to interviewees in concluding the interview. What to do during the interview (e.g. take notes, audiotape, etc.). What to do following the interview (e.g. more notes and/or check audiotape for clarity; perhaps summarize key thoughts)(Woods, 2011).

Interview Conducting Process

The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say (Steinar, 1996). A qualitative research interview seeks to cover both a factual and a meaning level, though it is usually more difficult to interview on a meaning level (Steinar, 1996). Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic. Interviews may be useful as follow-up to certain respondents to questionnaires, e.g., to further investigate their responses (McNamara, 1999).

Focused Discussion Groups

Focus Group is a type of in-depth interview accomplished in a group, whose meetings present characteristics defined with respect to the proposal, size, composition, and interview procedures. The fundamental data produced by this technique are the transcripts of the group discussions and the moderator's reflections and annotations The general characteristics of the Focus Group are people's involvement, a series of meetings, the homogeneity of participants with respect to research interests, the generation of qualitative data, and discussion focused on a topic, which is determined by the purpose of the research (Freitas *et al.*, 1998).

Individuals Interviews from Experts

Expert's opinion was obtained from 22 professionals which included environmentalists, town planner, civil engineers, members of revenue staff and academia belonged to cities under study. In order to get data/information, their opinion regarding important urban planning techniques/tool/parameters and environmental friendly indicators were obtained through questionnaire (Annex-I). List of experts interviewed is given at Annex-II.

Data tabulation

Data obtained from focus group discussion and individual experts' interview was tabulated for further analysis by giving ranks to selected category of criteria, assigning weights to sub-category and calculating scores of test questions (Faria *et al.*, 2018). These scores established the basis for data analysis.

3.7 Data Analysis

After tabulation data has been analyzed to establish expert opinion regarding different parameters and inferences had been drawn through interpretation. Thematic Analysis, Co-occurrence Analysis, Comparative Analysis had been carried out to find relationship between evolution of urban form and environmental changes. List of parameters which came under consideration is given below: -

i. Shape of Urban form (Regular/Irregular)
ii. Priority method of transportation (Pedestrian, Public transport or Car)
iii. Lifestyle choices and Social parity (Promotes voluntary simplicity)
iv. Resource Conservation (Water, energy, less materials consumption)
v. Urban Ecology
vi. Carbon Emission control and Renewable energy
vii. Self-sustenance (Agriculture, Industry, services sector, Knowledge base)

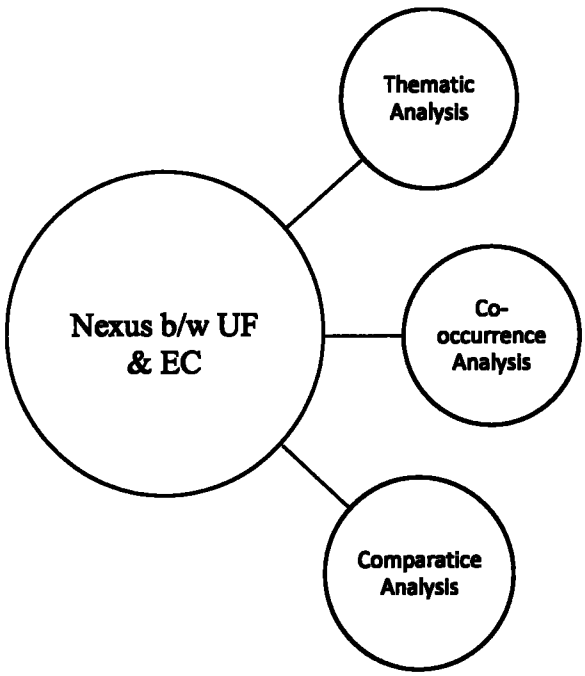

Figure 3.2:- Flow Chart for Data Analysis

3.8 Multiple Criteria Decision Analysis (MCDA)

Howard described decision analysis as balancing process for all the factors that influence a decision (Howard, 1966). Among methodological tools for assessing value quantitatively as part of a decision-making process, MCDA could be indicated as an ideal method, ordering a set of alternative options based on the degree to which a number of different objectives are achieved. One of the main aims of MCDA methods is to enable decision-makers to reach a decision by facilitating an understanding of the problem, objectives, and associated values, through organizing and synthesizing information of complex and conflicting nature. MCDA can facilitate decision-making by explicitly integrating objective measurement with value judgment while managing subjectivity in a transparent way, however it cannot act as a substitute for decision-making (Angelis *et al.*, 2017). We have used two types of MCD analysis

MCDA Analysis–Ranking Method

In MCD analysis each criterion category was ranked from 1 to n (Total number of criteria's).

Where, 1 = most important & n = least important

Each subcategory was assigned a group weightage by allocating 100 points among the *n* categories. The more important the interest, the higher its weight and vice versa. Such that sum of the scores for all test questions added up to 100. Sub interest was assigned its

own weight. Which took a value from zero to max. Weight of that group. For example, if you assigned a group weight of 15 to an interest, the sub interest in that group can range from 0 to 15. You can assign all sub criteria in that group a 15, or some a 15, some a 10, one an 8, one a zero, and so on. Calculated the sub-interest score for each option by multiplying the sub-interest rating by its weight. Summed up the sub-interest scores within each interest category to derive the interest scores. Summed the interest scores to get the total score. And ratings answer the question, "How well does each alternative satisfy the interest?" Use a 'best to worst' ranking or a numeric scale (5=excellent; 4=very good; 3=fair; 2=below average; 1=poor).

Simple Multi-Attribute Technique of MCD Analysis

The SMART technique is based on a linear additive model. This means that an overall value of a given alternative is calculated as the total sum of the performance score (value) of each criterion (attribute) multiplied with the weight of that criterion. The main stages in the analysis are;

Stage 1: Identify the decision-maker(s)

Stage 2: Identify the issue of issues: Utility depends on the context and purpose of the decision

Stage 3: Identify the alternatives: This step would identify the outcomes of possible actions, a data gathering process.

Stage 4: Identify the criteria: It is important to limit the dimensions of value

Stage 5: Assign values for each criterion: For decisions made by one person, this step is straightforward.

Stage 6: Determine the weight of each of the criteria: The most important dimension would be assigned an importance of 100

Stage 7: Calculate a weighted average of the values assigned to each alternative: This step allows normalization of the relative importance into weights summing to 1

Stage 8: Make a provisional decision (Wang et al., 2009).

3.9 Conclusion and Recommendations

During this step of the research conclusion was drawn on probity of the analysis. While concluding, concerned sections of the thesis were referred back properly for reminding the argument on basis of which conclusion is arrived at. Further evaluation and interpretation was also provided where ever required. Keeping in view the forecasted circumstance which might happen in future, pragmatic recommendations/suggestions were given. In addition,

predictions and warnings also formulated on the basis of simulated conditions concluded with thought process.

3.10 External Resources

Co-supervisor and other resources from "City and Regional Planning" Department, "University of Engineering and Technology" had been availed keeping in view the topic requirement.

CHAPTER # 4

DATA COLLECTION AND ANALYSIS

Primary and Secondary data have been collected by field work, institutional consultation, expert interview, focus group discussion and research journals, Primary data was collected from the chosen cities through questionnaire and focus group discussion Performa. While secondary data was collected from web links, historical and archived documents in the respective cities

4.1 Field Work for Primary Data Collection

Main purpose of the fieldwork is to have three dimensional verification of the theatrical notion generated by the extensive literature review in the previous sections. This verification includes; verification of location, space allocation and planning standards for land uses.

Substantiation of Location

The empathy of four Planned Development Locations (PDLs) signifies a major and extraordinary opportunity to for new strategic development in a widespread manner. To ensure that the developmental goals goes in purview with the establishment of crucial community and physical infrastructure. The target is to provide affordable and standardized housing facilities to common masses.as well as to attain long lasting sustainability for urban community. Other objectives include avoiding small housing development, which damage the charisma of well-ingrained communities. Selected or proposed location should have a good amalgam of design principles and following points.

i. Eccentric – chosen site should be logically selected and have appeal for people.
ii. Legibility – selected site should be easy to navigate and understand.
iii. Permeability – Accomplishing a design layout which has prioritize pedestrian movement. Bicycle riders, vehicular movements with renewable sources of energy and mass transport systems are next in line successively. It should have easy connectivity with adjacent places.
iv. An enunciated landscape – human scale should be considered while creating townscape parameters such as building height, massing and scale.
v. A unified landscape – Green infrastructures and spaces that are soul of development should be included in such a way that it should correspond to the landscape setting.

vi. Social Scale – Planning of the layout should provide a sagacity of perceptiveness and scale. Scale should be hominid readable and understandable

vii. Easy Surveillance – To provide security to common masses either by passive or active policing or both.

viii. Detailing, Productivity and Interest – Endorsing consistent vernacular, rhythm, richness, ornamentation and intrigue into urban environment.

ix. Quality in public territories – promoting ways and places which are safe, uncluttered and attractive.

x. Adaptability, Sustainability and Robustness – design of planned developmental location (PDL) and building layouts should aid for resource minimization from design stage to finalization.

xi. Diversity – keeping in view the local needs it should provide multiple choices of use and development.

Space Allocation

Whereas above referred defining statement to bigger territorial scale. However, in city scale the other features of term are major point of concern.

According to Kaisar and Chapin (Chapin Jr *et al.*, 1979; Kaiser *et al.*, 1995): "At territorial scales involving large land areas, there is a strong predisposition to think of land in terms of yields of raw materials required to sustain people and their activities. At these scales, 'land' is a resource and 'land use' means 'resource use'. In contrast, at the urban scale, instead of characterizing land in terms of the production potential of its soils and its sub mineral content, the emphasis is more on the use potential of the land's surface for the location of various activities". Both these authors have described three systems that has specific significance to spatial city structure. These systems are:

i. "Activity systems (the way man and his institutions such as households, firms etc. interact on a daily basis)"

ii. "Land development systems (processes that change space in a way that it can facilitate different activities)" and

iii. "Environmental systems (natural environment)".

Two categories of frame works were also identified by the same authors. While discussing the urban layouts these two frameworks should be kept in view

i. Descriptive Framework – Present the way in which things are arranged in urban areas.

ii. Explanatory Framework – ask the question why arrangement of things are the way organized in city areas

Planning Standards for land uses

In current scenarios, planning standards for design are limited as applied to different land uses. Also for endowment of facilities, expense of secondary land usage i.e parks and streets etc should have supported primary land utility. Design and planning standards at regional scale are still switching from one another. Different situations and circumstances have their own convenient standards.

Nonlinear constraint relationships present a more serious problem. Certain design standards are inherently nonlinear, and a linear approximation sometimes provides an unsatisfactory substitute. When a design model is not able to provide satisfactorily for a design standard, it loses most of its usefulness.

Aggregate land use demand requirements are determined by applying a conversion coefficient, usually designated as a design standard, to each employment and population category. Such a multiplication and summation will result in a detailed classified set of aggregate demands for residential, industrial, commercial, and other land uses. These aggregate demands provide one of the primary inputs to the third function.

4.2 Results/Data Collected from Archival Records

Historical geography and townscapes present morphological and regional characters of an area and important for analysis (Conzen, 2001). Thus, it is a common practice for the urban planner to consult archeological work and historical data such as maps, surveys and plans. Importance of the archeological data augments in the case when evident structures are not available for in situ observations (Whitehand *et al.*, 2009). In order to study the micro-morphology of the building structures additional material such as building drawing, historic photographs and evaluation done by local authorities.

Access to the Archival Data

To get complete picture of historical transformation of the selected cities, access to the archival records of the local governments, municipal councils, development authorities and other relevant departments was gained. Important documents either studied or collected included survey maps (property delineation), photographic records (pictorial evidences) and description of events and places (newspaper records, telephonic and postal directories etc.). A large amount of data was not available to copy and to reproduce due to its historical

importance. It was only available for in house study. Even then, survey of archival repositories and collection resulted in compilation of comprehensive data.

Types of Archival Data collected

Among the complied data, very brief selection is given below.

Pictorial Records

Following important pictorial records were found in archival record for selected cities.

i. Faisalabad

Snaps of area under original master plan of the which at the pattern Union Jack, an old building and a machine of textile industry is given below;

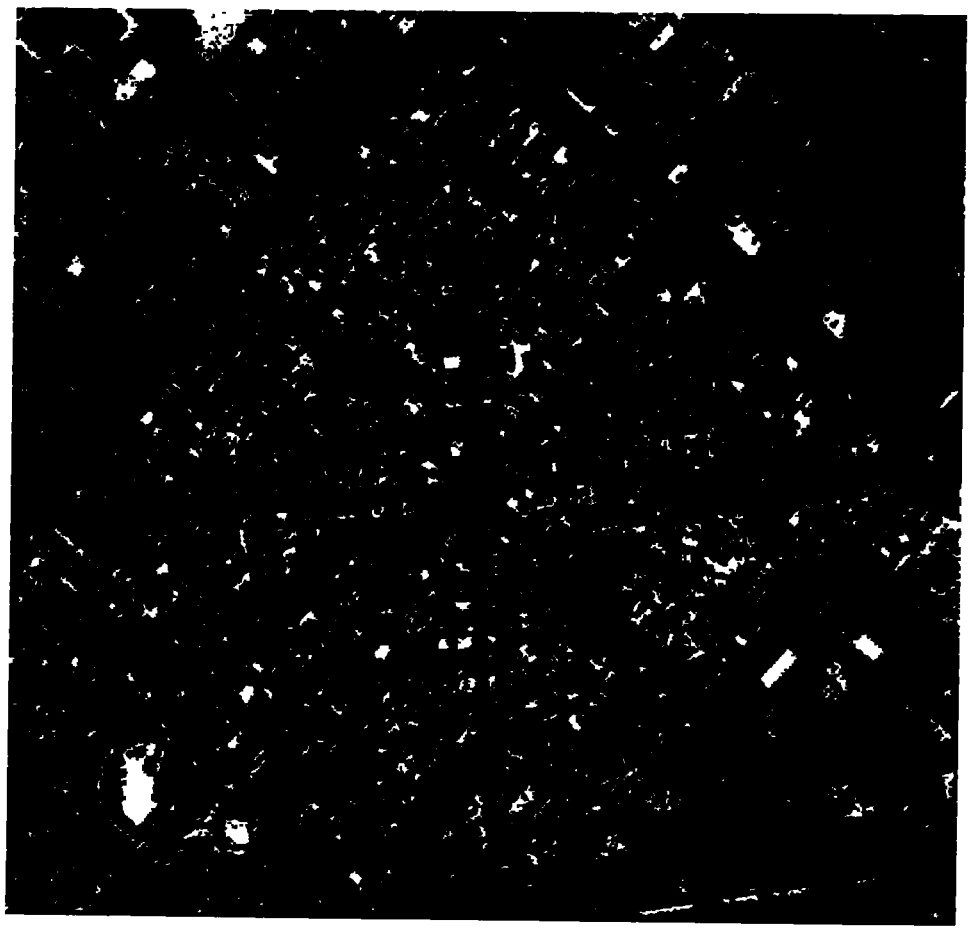

Figure 4.1:- Pre-60's Planning of Faisalabad

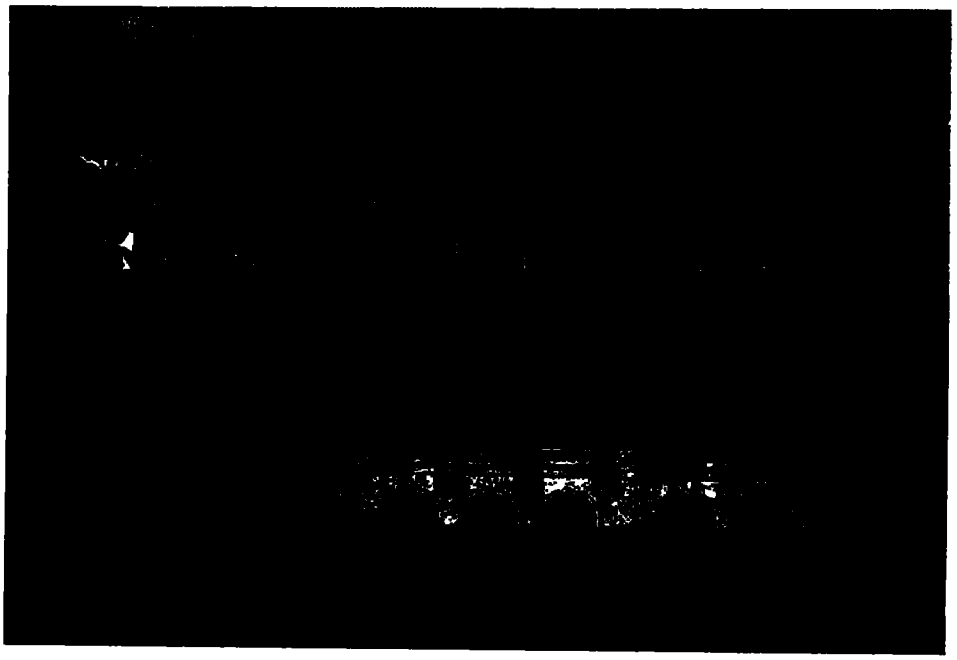

Figure 4.2:- Gurdwara school inner front. Pre 60's era

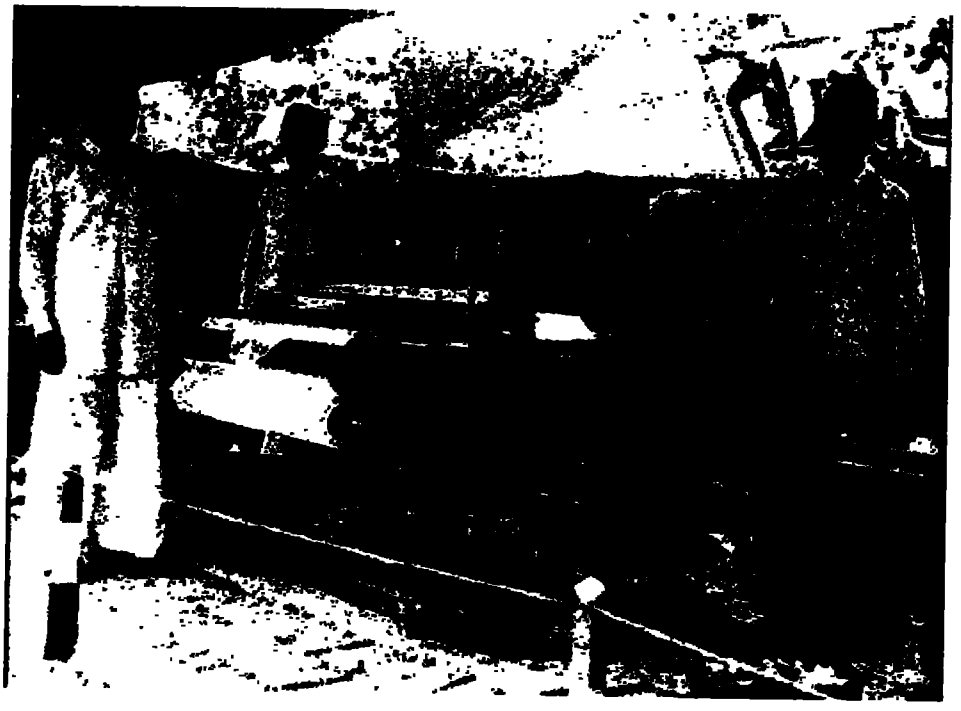

Figure 4.3:- Industrial exhibition in Faisalabad pre 60's era

ii. Lahore

Old picture of master plan, railway station building and modal town (most environmental friendly town of Lahore) are given below;

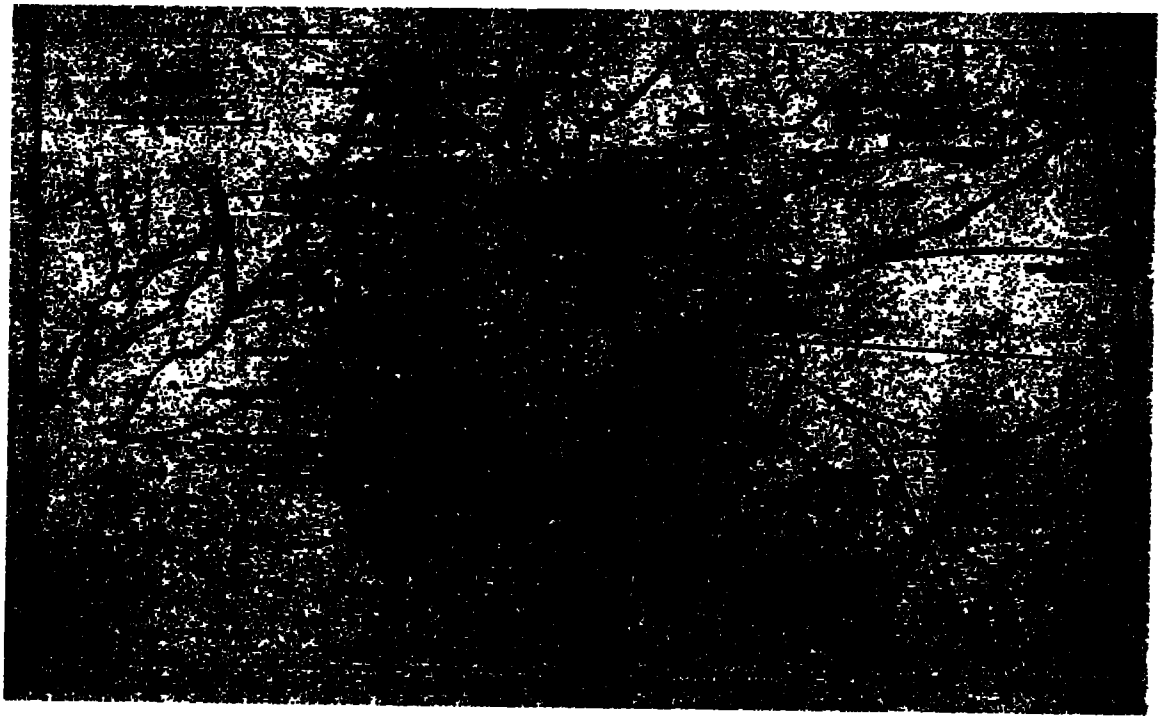

Figure 4.4:- Pre 60's Map of Lahore

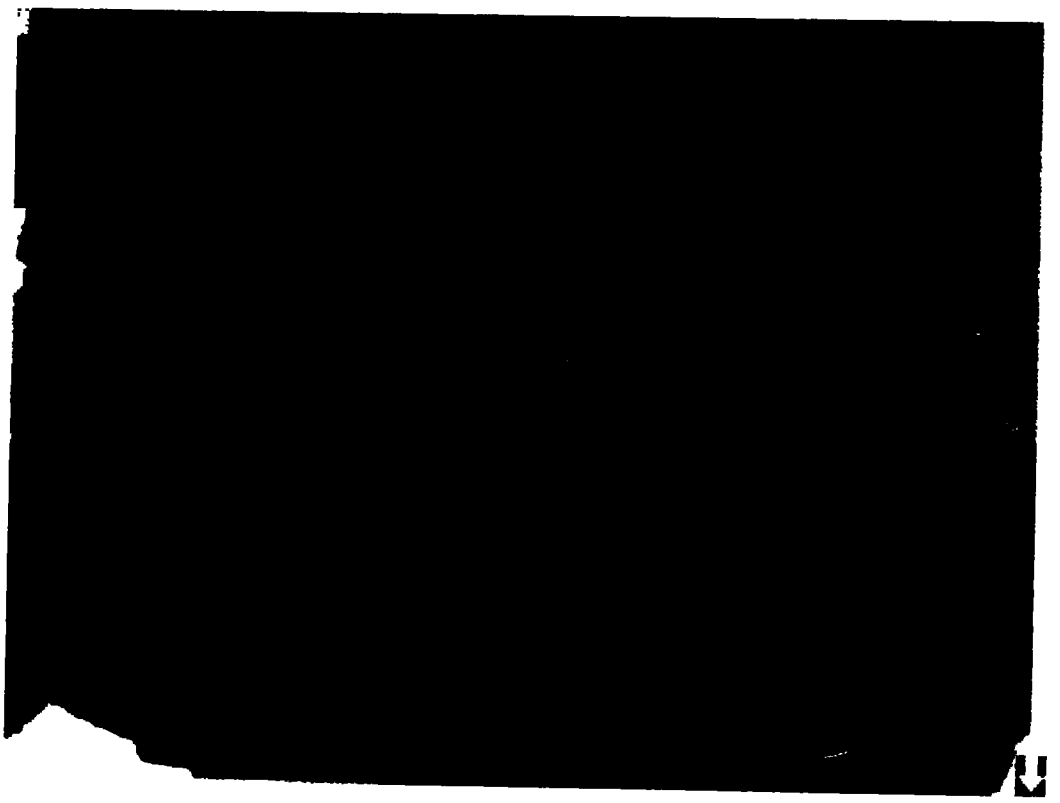

Figure 4.5:- Lahore railway station:1880 Picture by Craddok and George

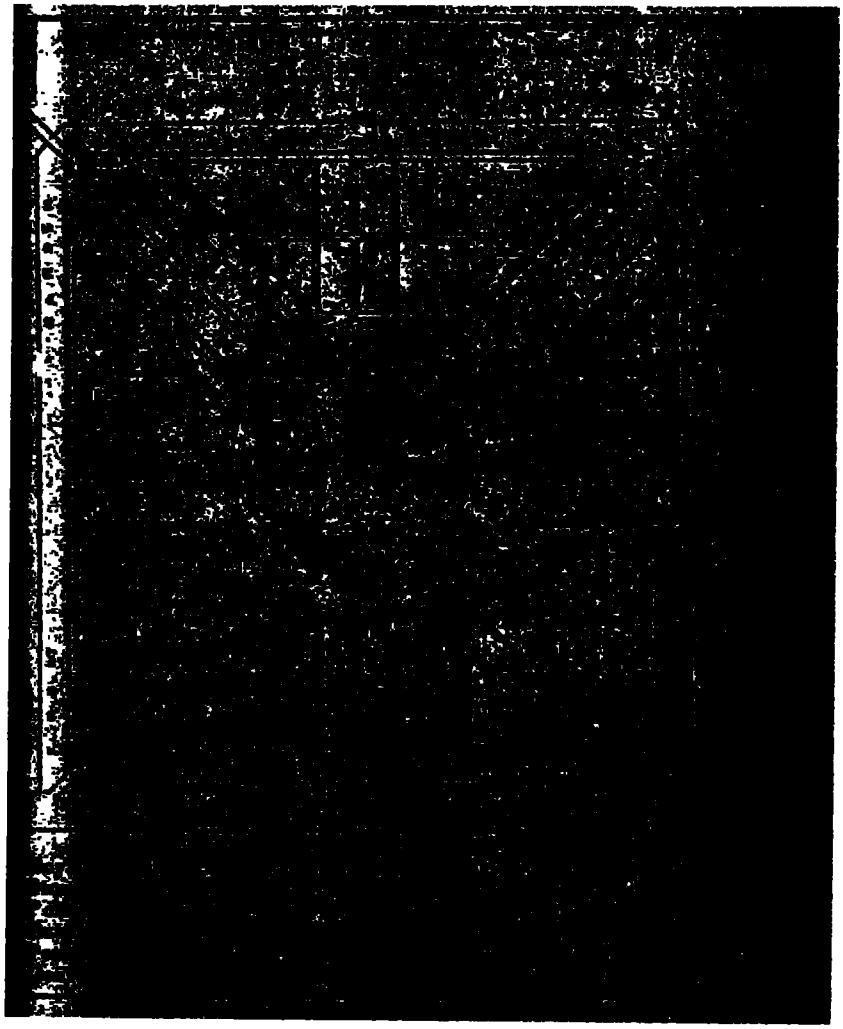

Figure 4.6:- Model Town Lahore – Pre 60's map

iii. Multan

Picture of a temple from prehistory, snap short of old Multan in the form of map and front view of railway station is given below;

Figure 4.7:- Suraj Kund Temple – Pre historic glimpse of Multan

Figure 4.8:- Pre 60's map of Multan

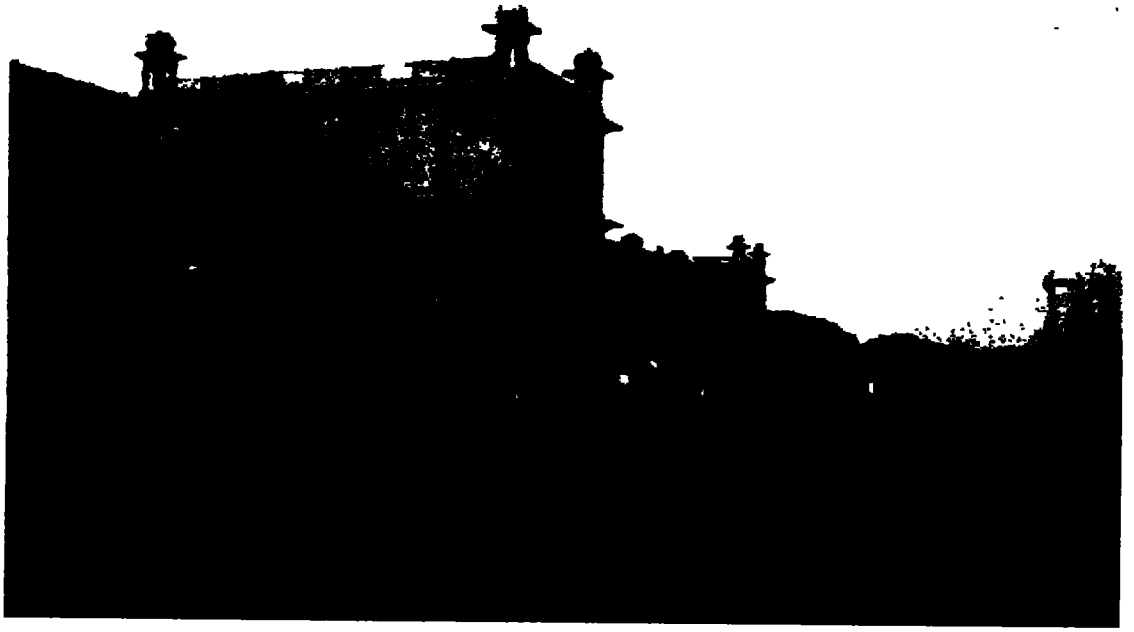

Figure 4.9:- Cantonment railway station of Multan, pre 60's era

4.3 Pre 60s and Post 60s Regulatory Frame work on Urban Forms

Archival record gave the precious details of the pre 60's and post 60's town planning and environmental legislation. These laws are very important as these governed they shape and function of the cities in their respective regimes. It helped a lot to understand the town planning rules and patterns of the pre 60's era. But also depicted the important of environmental legislation in government affairs. After a deep and extensive study of these legislation it was clearly evident that town planning and environmental legislation went through metamorphosis in critical period of 60's. And post 60's era had an entirely new set of legislation with the revised town planning rules in which environmental consideration was given due importance. Thus, the archival record helped a lot to divide this study into pre-60s and post-60's era.

Pre and Post 1960 Environmental and Town Planning Legislation

Given below is list of important environment and town planning legislation of pre and post 60's era a gathered from literature review and archival records.

4.3.1.1.Pre 1960 Legislation

Major part of the history is shared with other parts of sub-continent under British and earlier regime. Therefore, pre 60's laws were studied from sub-continent region. Majority of laws addresses the town planning. However, their sub clauses address the environmental aspects of the urban area. List of such selection laws according category is given below:

Table 4.1:- Town Planning Legislation

Sr. No.	Acts/Law	Year
City Improvement Acts		
1	Bombay Improvement Act	1898
2	Mysore Improvement Act	1903
3	Calcutta Improvement Act"	1911
4	The Land Improvement Loans Act	1883
Town Planning act		
5	Bombay Town Planning Act	1915
6	Madras Town Planning Act	1920
7	Madhya Pradesh Town Planning Act	1948
8	Jammu and Kashmir Town Planning Act	1963
Town Improvement Trust Act		
9	Bihar Town Planning and Improvement Trust Act	1951
10	Orrisa Town Planning and Improvement Trust Act	1956

Table 4.2:- Environmental Legislation

Sr. No	Environmental Legislation	Year
1	The Land Improvement Loans Act	1883
2	The Canal and Drainage Act	1873
3	The Factories Act"-	1934
4	The Factories Act	1934
5	The NWFP Hazara Forest Act"-	1936
6	The West Pakistan Prohibition of Smoking in Cinema Houses Ordinance"-	1960
7	The West Pakistan Ordinance"-	1959
8	The Kohat Marzari Control Act	1954
9	The West Pakistan Factories Canteen Rules"-	1959
10	West Pakistan Goats (Restriction) Ordinance	1959

4.3.1.2. Post 60 Environmental and Town Planning Legislation

Post 1960s laws were studied in Pakistan context. Town planning laws have environmental implications in its sub clauses. List of selective environmental and town planning laws of post 1960s era is given below:

Table 4.3:- Environmental Legislation

Sr. No	Legislation	Year
1	Indus River Water Apportionment Accord	1991
2	Statutory Notification S.R.R. 742	1993
Air Quality		
3	The Motor Vehicles Ordinance	1965 and "Rules"- 1969

4	The Baluchistan, NWFP, Punjab and Sindh Local Government Ordinance(s)"-	1979/80
5	Statutory Notification S.R.R. 742"-	1993
6	Statutory Notification S.R.R. 1023"-	1995
	Noise	
7	The West Pakistan Regulation and Control of Loudspeakers and Sound Amplifiers Ordinance"-	1965
8	The Motor Vehicle Ordinance	1965 and "Rules"- 1969"
	Toxic and Hazardous substance, solid waste and effluents	
9	The Baluchistan, NWFP, Punjab and Sindh Local""Government Ordinance(s)"	1979/80
10	Pakistan Environmental Protection Ordinance, No. XXVII	1997
11	The Agricultural Pesticides Ordinance	1971 and "Rules"- 1973
	Marine and Fisheries	
12	The West Pakistan Fisheries Ordinance	1961
13	Baluchistan Sea-Fisheries Ordinance	1970 and "Rules"- 1971
14	The NWFP Fisheries Rules	1976
15	Territorial Waters and Maritime Zones Act	1976
	Forest Conservation	
16	"The West Pakistan Firewood and Charcoal (Restrictions) Act	1964
17	The Punjab Plantation and Maintenance of Trees Act	1974
18	The Cutting of Trees (Prohibition) Act	1975
19	The NWFP Management of Protected Forests Rules	1975
20	The Baluchistan, NWFP, Punjab and Sindh Local Government Ordinance(s)"-	1979/80
21	The NWFP (Conservation and Exploitation of Certain Forests in Hazara Division) Ordinance	1980
22	The NWFP Forest Development Corporation Ordinance	1980
	Parks and wild life conservations act	
23	The Sindh Wildlife Protection Ordinance	1972 and "Rules" 1972
24	The Punjab Wildlife (Protection Preservation Conservation and Management) Act	1974 and "Rules" 1974
25	The Baluchistan Wildlife Protection Act	1974 and "Rules" 1975

26	The NWFP Wildlife (Protection Preservation Conservation and Management) Act	1975 and "Rules"- 1976
27	The Pakistan Plant Quarantine Act"-	1976
28	Islamabad Wildlife (Protection Preservation Conservation and Management) Ordinance	1979/80
29	The Baluchistan, NWFP, Punjab and Sindh Local Government Ordinance(s)-	1979/80
30	Export and Control Order"-	1982
31	Cultural Environment	
32	The Antiquities Act	1975
33	The Punjab Special Premises (Preservation) Ordinance	1985
	Live stock	
34	West Pakistan Punjab Animal Slaughter Control Act	1963
35	The Grazing of Cattle in the Protected Forests (Range Lands) Rules	1978
36	Pakistan Animal Quarantine (Import and Export of Animals and Animal Products) Ordinance	1979/80
37	The Baluchistan, NWFP, Punjab and Sindh Local Government Ordinance(s)"-	1979/80
Public Health and Safety		
38	The Baluchistan, NWFP, Punjab and Sindh Local Government Ordinance	1979/80
39	The West Pakistan Epidemic diseases Act	1979/80

Table 4.4:- Town Planning Legislation

Sr.No.	Legislation	Year
1	Land Disposal Act, Pakistan	1998
2	Local Government Ordinance	2001
3	Illegal Dispossession Act	2005
4	Local Govt. Act (which gives provincial and local govt. for legislation)	2013

4.4 Selection of Cities

Those cities were selected which have history of either before British era or developed during the British era. Furthermore, sufficient data is available for finding relevance and making comparison. These include; Faisalabad, Multan, Sargodha, Lahore (Mughal and British regime), Gujranwala, Islamabad. Although, Islamabad do not have pre 1960s history, even then it is selected being a planned city developed after timeline split of 1960s.

Faisalabad

Faisalabad is not a very old city. Its history is just dated back to a century old. This region was famous for livestock keeping. Irrigation started in 1892 by the water of Gogera and Jhang branch. In 1895, foundation of very first residential area was laid. Which has a principal objective of provision of a market. Before the establishment of the city area around the Chenab rover was called "Sandal Bar". Primeval residential area of that time was known as "Pakka Marri" or more correctly as "Pakki Maari" before the "Lyallpur" city was built. This place used to serve as junction for the caravans, travelling from Lahore to Jhang. The English voyagers of that time intended to transform this vicinity into a city. "Chanab Canal Colony" was firstly established by the English rulers. Later on, it was named "Lyallpur" after "Lt. General Sir James B Lyall" – "the then Governor of Punjab". The foundation stone of "Lyallpur" was positioned in 1896. Faisalabad is famous for its clock. Which was built on a well. In 1906, its construction was completed. "Ghulab khan" supervised the work of clock tower. His forefathers had built the famous "Taj Mahal" in Agra. While clocked was transported from Bombay. It is assumed that this clock tower was constructed in memory and to pay tribute to late queen Victoria after she died. The famous "eight bazars" were operational before the clock tower was erected. The layout of the eight bazars corresponds to the Union Jack – The British Flag. Which is believed to be planned by Desmond Yong – an architect. Although, Sir Ganga Ram – a renowned town planner/architect of that time, originally designed the city of Faisalabad. In his design "Goal Bazar" serves the purpose to connect all eight bazars to each other. Funds were raised from local Zamindars at an amount of eighteen per square of property. Municipal Committee was given the responsibility for fund raising.

4.4.1.1. Historic Town Planning Perspective

i. The then "Deputy Commissioner of Jhang" was travelling towards Lahore, in 1985. He broke his journey near the Theh of Pucca Mari'. The Deputy Commissioner after resting for a while set out for walk, along with the Tehsildar of Chiniot, towards the west and returned quite late in the evening. He spent the night and rode for Lahore on the next day morning.

ii. Six months later, on a fine morning, the then Pakka Marri witnessed some government officials pitching tents and making other camping arrangements. In the evening, there arrived the caravan of Deputy Commissioner, the Colony Assistant of Jhang and their subordinate officials. All the barren and desolate tract of land situated

to the west of Pucca Mari was surveyed and marked here and there in three days. In the beginning, there was only a few huts and cottages nestled beside the Then of Pakka Mari.

iii. It became an attractive agricultural and residential site when Chanab Canal was constructed. The proper city was founded in 1892. The Tehsildar of Chiniot, recommended to name this township after Pakka Marri but the Deputy Commissioner Jhang prevailed upon him at the name of the then Governor of the Punjab, Sir James Lyall, who let it be named after him. The famous Philanthropist, Sir Ganga Ram was assigned to draft its plan. After approval of draft Sir Ganga Ram was given five squares of lane as reward.

iv. Railway tract was laid between Lyallpur and Wazirabad. Which was fully functional in 1895. The edifice of Railway Station wanted time, therefore, a Goods train wagon served as Lyallpur Railway Station. Lyallpur was given the status of Tehsil of District Jhang and its administration carried on the tents on the old Theh (Mound) of Pucca Mari near Tariqabad.

v. Till 1902, total population of Lyallpur was greater than 4,000.

vi. Decision to establish an agrarian college was made in 1903. District Lyallpur was upgraded in 1904, which had Tehsils of "Toba-Tek-Singh","Lyallpur", and "Samundri". There was also a subtehsil Jaranwala. Later on, Jaranwala was made a tehsil.

vii. District Headquarters of Lyallpur was full functional in 1906. Commercial and residential area which were bounded the circular road started crossing it. And city experienced a spread in area and population.

viii. Town Committee was formulated in 1904. Later on in 1909, it was elevated to Municipal Committee. "Deputy Commissioner" was avowed its first chairman. Civil hospital was expanded during 1916. Whereas, number of customers in grain market were also elevated.

ix. People of Lyallpur experienced political awareness with the start of "world war II". Fiery speeches, revolutionary meetings and slogans on walls – all were part of that political awareness influence.

x. Founder of Pakistan, Quaid e Azam Muhammad Ali Jinnah visited Lyallpur in 1943. A crowd of over 2 lacs gathered to greet him and to listen his speech in famous grounds of Dhobi Ghat.

4.4.1.2. Modern Age - Pre - 1960s

i. After partition, Lyallpur shoed in rapid progress both in terms of economy and population.

ii. Until now, city was famous for grain market only. Then, with the development of industry it was also known for its commercial value.

iii. Population of the city which was only few thousands in 1901, was elevated to lacs. Educational and medical facilities also got better.

4.4.1.3. Post - 1960s

i. Faisalabad was declared as industrial zone in early 60s and grew further. This city is known as "Manchester of Pakistan" for its well established textile industry.

ii. City name was changed from "Lyallpur" to Faisalabad after name of "Shah Faisal Bin Abdul Aziz – late king of Saudi Arabia.

iii. Faisalabad was upgraded in 1985 as a division. Toba-Tek Singh, Jhang and Faisalabad became its districts.

iv. Due to presence of "University of Agriculture" and additional agri related institutes, agriculture in stride very fast.

v. Faisalabad achieved the status of city district in 2005. After that it was divided into eight towns.

4.4.1.4. Developmental Planning of Faisalabad

In 1968, first master plan of Faisalabad was prepared after independence. However, the plan was not implemented in true letter and spirit. As a result, city has to experience haphazard growth. The main reason for none or improper implementation of the master plan remains that Lyallpur Municipal Corporation had not hired any professional town planner. Whereas, Govt. officials were not capable enough to properly understand and comprehend the policy documents (Shabana *et al.*, 2015).

4.4.1.5. "Faisalabad Development Authority "(FDA)

Faisalabad Development Authority (FDA) was established in 1976. It was felt that city requires a new and innovative master plan. Formulation of the "Master Plan" was initiated in 1979. It went through number of stages and finally "Structure Plan" was formulated in 1986. Spatial strategic plan that was part of structure plan emphasized upon extension of existing trends for development and land use of that time. Infill development was also proposed within the present built up zones in order to achieve compact form of development. Linear development was allowed along the connecting roads of Faisalabad

to other cities. Radial developmental pattern was also projected for the city(Javed *et al.*, 2015).

Along with the inner civic center, secondary and tertiary metropolitan centers were proposed in order to reduce burden on "central business district". Two circular roads were suggested to deal with the traffic overcrowding in epicenter. Furthermore, external periphery of ring road a green area in belt shape having width measuring two miles was given all around of the city. In conclusion, plan emphasis was planning as well as development for expansion areas excluding nonconformities usage. However, there was no specified zoning at all (Sohail *et al.*, 2004).

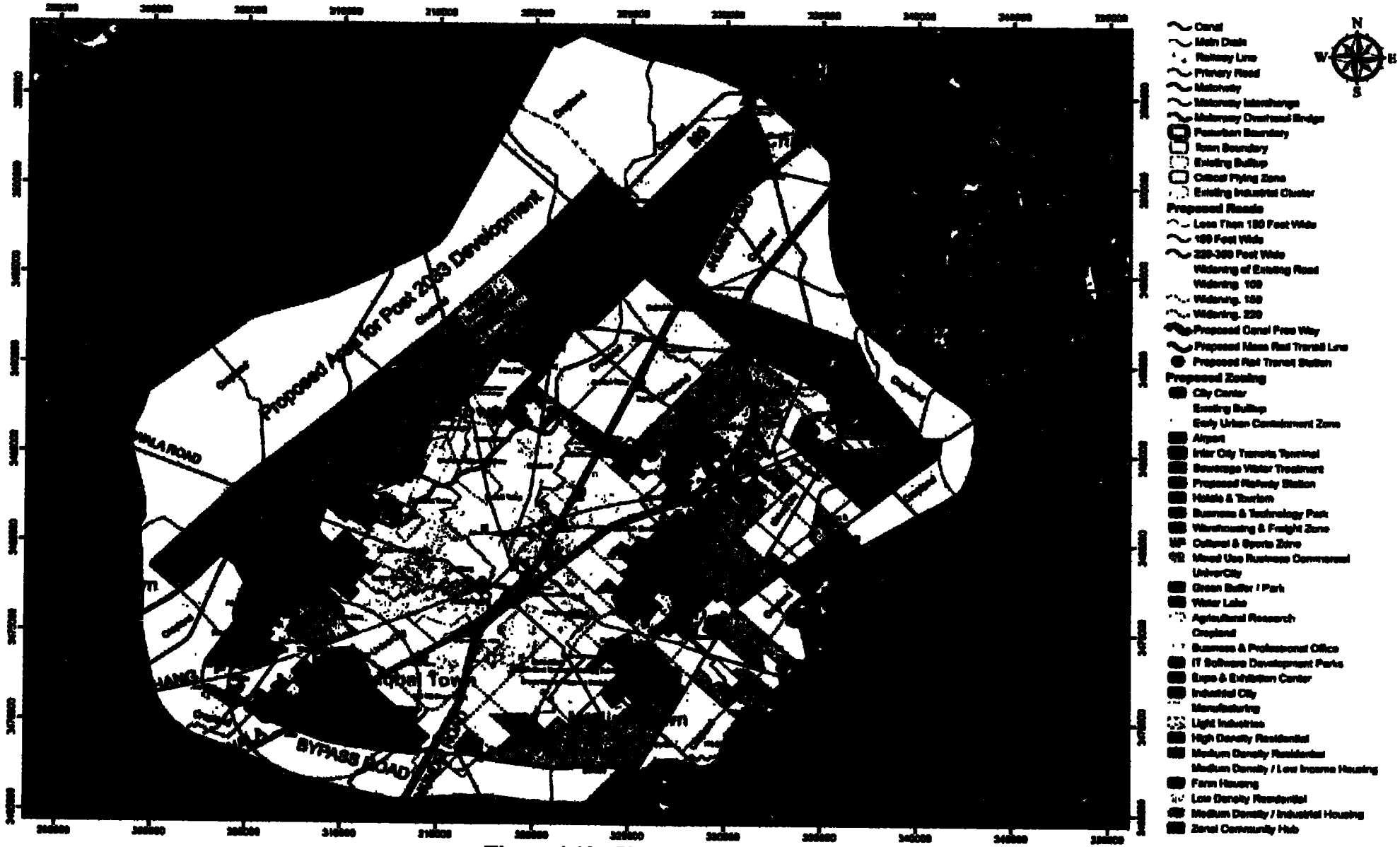

Figure 4.10:- Urban Sprawl of Faisalabad

Gujranwala

It is third largest industrial center after Karachi and Faisalabad. It was founded in Sikh and birthplace of famous Mahraja Ranjit sing. According to world's mayor's statistics it is ranked as 27th fastest growing city.

4.4.2.1.History

The origion of the city is shrouded in the mystery. However it was originally founded by the gujars. Charrat singh a sansi jut fortifies it in 1756.

Throughout it history it has passed through three major periods.

- Sikh era
- British era
- Modren era; i) Pre 1960s and Post 1960s (Sohail *et al.*, 2004)

Figure 4.11:- Walled City of Gujranwala

4.4.2.2. Sikh Era

Charat Singh and Mahan sign – the founder of the city built four towers, which fixed the boundaries of the city. Major extension took place in era of Mahraja Ranjit singh. An army commander Sardar Hari singh Nalwa built a huge mud wall around the city to protect it from foreign intruders. The grid pattern of the roads suggests that the city a well planned to provide the citizens with better amenities of life. Enclosed by the circular polygonal road – city is divided into several squares and rectangles. Primary streets and bazars intersect each other at right angle while secondary streets provide access to the residential areas. Sardar Hari sign being a great admirer of the nature built large number of garden around the city and big hawalies. In 1935 Gazette of India, it was best kept city of the country.

4.4.2.3. British Era

It came under the British rule in 1847 and British rebuilt the city according to their own rule. However, the city underwent rapid commercial development beyond the boundaries of the walled city. Colonal Clark – a deputy commissioner demolished the hawali of Sardar Hari singh and built a square bazar of 500 shops known as Ranjot Ganj. During 1914-1947, they also built darwazas like sialkoti, lahori and khayali darwaza. Marked as center of new city – a clock tower was also built. Civil lines were established for the European residents – one mile away from the original city and was manifested by the Victorian style bungalows and railway station. Many of these are still in very good condition and reveals the glory of the era (Rafique, 1997).

4.4.2.4. Modern Era

This era stretches across time line division of this study. Therefore, it is scrutinized in two halves i.e. Pre-1960s and Post-1960s.

a. Pre - 1960s

Arrival of refuges in 1947 and establishment of new settlements brought considerable changes in the urban landscape of the city. Most of the roads had been radial converging to the GT road. Satellite town had stretched to 247 acres until 1950. D-type colony was established for Kashmiri refuges. The upper Chenab canal put a limit to city expansion. Rawalpindi and Sialkot by-pass roads set a de facto boundaries of the city (Kaul, 2013; M. A. Khan, 1984; Naz).

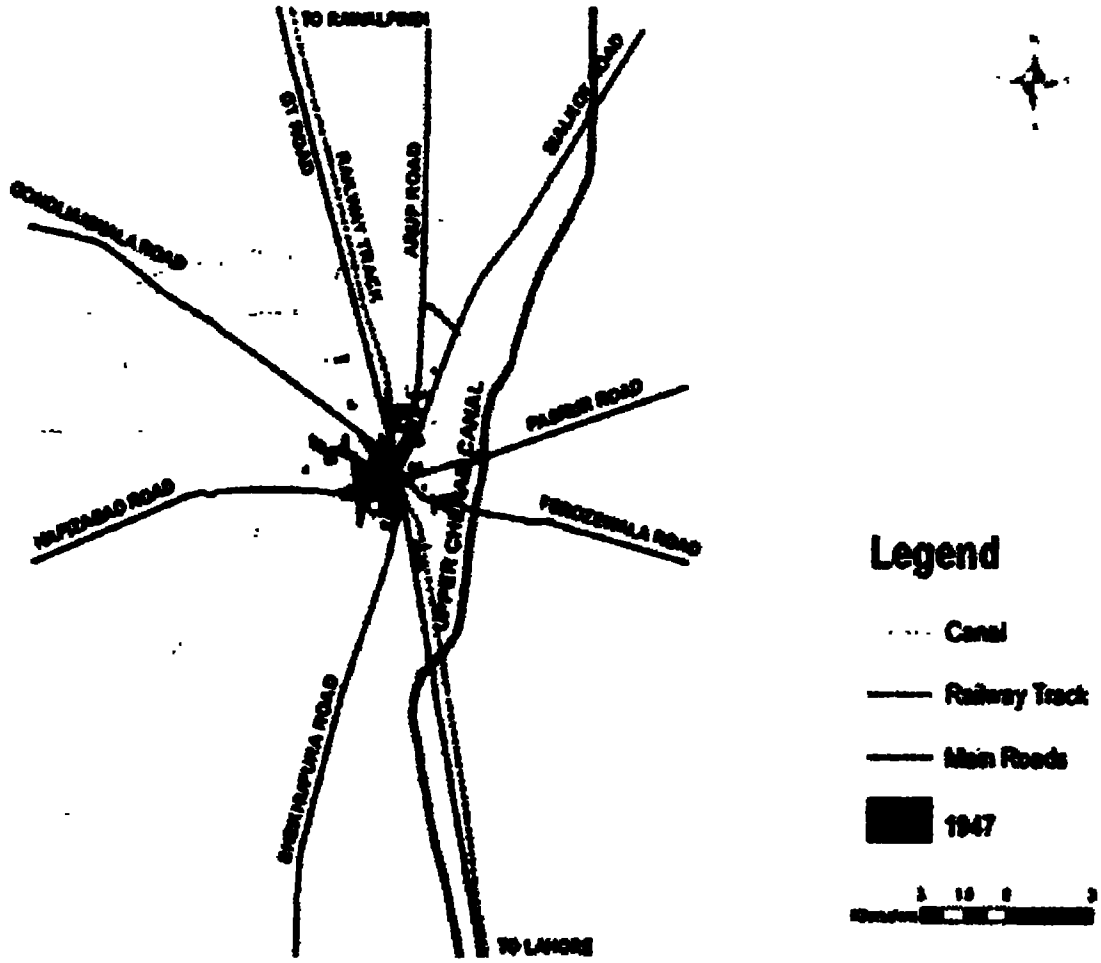

Figure 4.12:- Gujranwala During 1947

b. Post 1960s Era

An "outline development plan (OPD)" was prepared for the city in 1971 and was updated in 1985. However, most parts of the plan were not implemented. Funded by the World Bank. Urban master plan for ten cities of the Punjab was started. Feasibility studies was carried out by concerned departments. But it was also not implemented. OPD and Ten City Plan proposals for the Gujranwala are still hold good but are never implemented. Major reasons for the failure being financial limitations, institution inefficiency, and absence of comprehensive master and spatial plans. A large number of the residential areas have been established without proper planning resulting in mushroom growth and causing deterioration of the overall landscape and environmental conditions (A. Khan, 1994) (Naz).

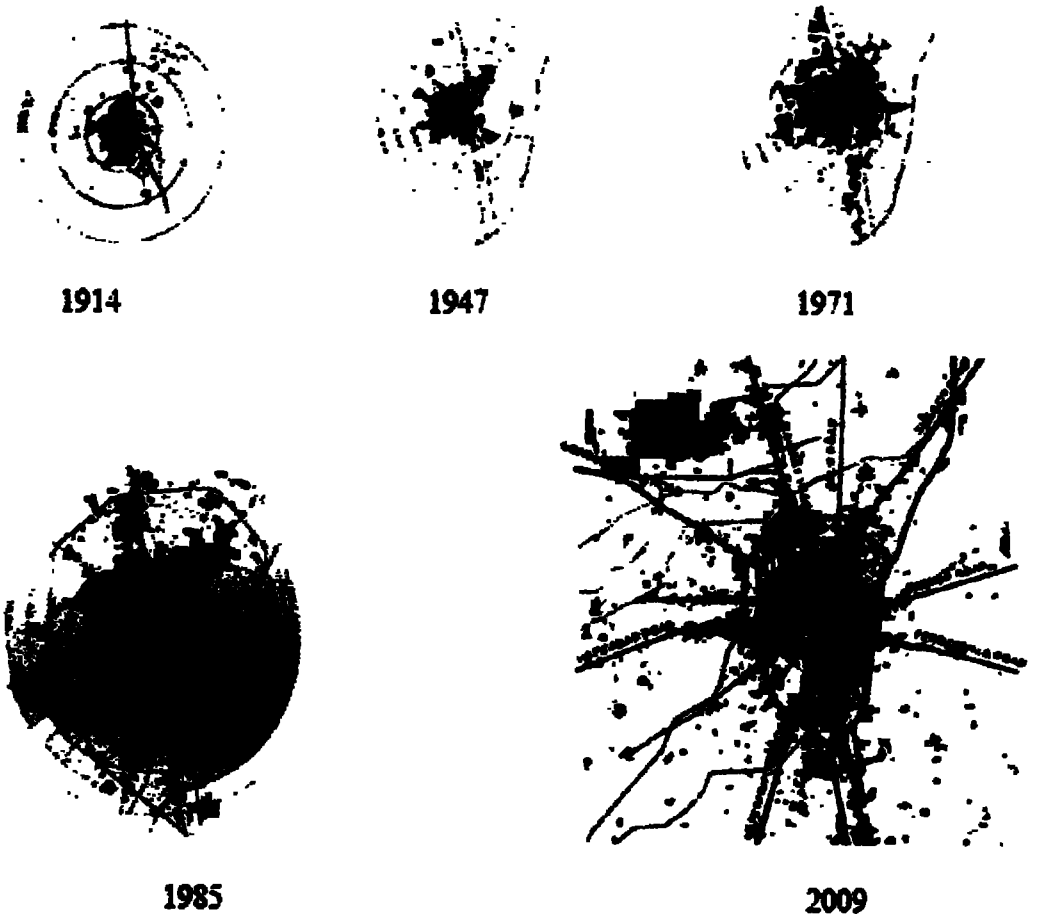

Figure 4.13:- Pre and Post-Independence Sprawl of Gujranwala City

Lahore

Lahore is known as "City of Garden". It is capital of province Punjab – largest of four provinces of Pakistan by population. Lahore itself is second largest city of the country with a total population of more than eleven million (according to 2017 census). It has its distinguished historical and cultural identity. Which attracts large number of visitors each year. The city is experiencing a spatial sprawl from eastern and southern sides. It took three design and planning efforts to take the city its current shape. All planning efforts aims to manage the promptly changing city eccentricity from industry to trade, business hub and services(W. Glover, 2008; Latif, 1892).

4.4.3.1. History of Lahore

Historically Lahore is dated back to thousands of years ago. It has seen "Hindu era", Buddhist era", "Greek times", "Muslim ages", "Sikh eons" and "British era". After passing through so many different cultural eras, it has large number of historical monuments and have become cultural hub of modern Pakistan. Historical evidences point the location of old Lahore in neighborhood of Ichhra – now, it is part of old city. However, at that time, it

was only a village. It is amused that most important edifices of Hindu's were located there. However, architectural remains of such entities have diminished. Lahore has gone through Mongol genocide and suffered massive destruction. Muslim empire was most glorious era of Lahore(Gupta, 1982).

4.4.3.2. Mughal Era

Lahore attained its zenith of its splendor during Mughal Empire. Lahore remained under Mughal umbrella for about 228 years (1524 – 1752). John Milton – An English poet was deeply inspired by the beauty of Lahore. In 1670, he wrote "Agra and Lahore – The Seat of Great Mughal". Like most famous old cities, Lahore is also situated on bank of river Ravi. Therefore, it matured culturally, economically and demographically. Lahore has two faces – old and modern Lahore. Due to spatial location of Lahore, it got an exclusive taste of communication, trade and food.

Figure 4.14:- Walled City of Lahore

(Adopted from: Marchent., 2017)

The timeworn city of Lahore is reminiscent of its historical glory, whereas, new and modern city points towards the prosperous and bright future. Old city was enclosed by the

walls in a perimeter of 1.87 square kilometers in a parallelogram shape. To protect from outer invasions and any destruction, walled city of Lahore is a little elevated. The great Mughal king Akbar built a blocked wall enclosing the city. Which aimed to protect the city from foreign intruders. The wall kept on decaying with passage of time. Until, sikh maharaja Renjeet Singh took the power. He reconstructed the wall with a ditch around. There were thirteen gateway in wall through which city can only be assessed (W. J. Glover, 2008; Walker, 1997).

4.4.3.3. British Era

Lahore is supposed to have 120,000 residents when British invaded and took control of Indo-Pak (W. J. Glover, 2008). Lahore localities mostly consist of within the "Walled City" before the British invasion. There were few settlements such as "Qila Gujar Singh" and "Mozang" on eastern and Southern sites. There also exist the leftovers of "Sikh Era" military structures, tombs and Mughal gardens on plains between these settlements (W. J. Glover, 2008). In British point of view "Walled City" of Lahore" was source and center of epidemics, disease and social discontentment. So majorly, the inner city was left alone. Moreover, all the development efforts were concentrated in suburban areas. Lahore's suburban and Punjab's countryside consist of very fertile agricultural land (W. J. Glover, 2008). Thus, the British set out "Civil Station" as their capital city, outside the "Walled City" on its southern site. Lahore's suburbs contained populous kachi abadis, deserted barracks and cantonment of previous Sikh infantry on its debris-strewn and flat land.

"Mughal-era" monuments are scattered everywhere in civil lines. All these monuments were not only reused but also vandalized. "Tomb of anarkali" is also included in the list. Which was first transformed to a clerical office. Later on, it was converted onto a church in 1851. Railway management office was established in "Dai Anga" mosque. "Tomb of Nawab Bahadur" became a storehouse and wine house was running in "tomb of Nawab Bahadur". "Civil secretariats", "accountant's general's offices", "Public works department" and municipal offices were established in older edifices.

"Lahore railway station" was built in 1857 right after "Mutiny", outside the "Walled City". Medieval castle style was adopted for the construction. Main features of these styles are thick walls, turrets, holes for directing cannons and gunfire. All these arrangements were made for the defense of the structure. Lahore's most important Govt. organizations were located in half-mile radius of civil station. Where British and native inhabitants were

allowed to mix dissimilar to military zone. "The Mall" served as epicenter of Lahore's civil management. It also is most fashionable and stylish commercial areas.

British also constructed many imported buildings. Which includes "Quaid-e-Azam Library", "Lawrence Gardens" and "neoclassical Montgomery Hall". "Lawrence Garden" got its donations from wealthy locals and British rulers. This garden has six hundred plant species. A horticulturist was sent from "London Royal Botanic Garden" for the maintenance of garden. Lahore cantonment was built on southeast side of walled city, where exit the old "Mian Mir" settlement. Unlike "The Mall" rule of racism used to apply here.

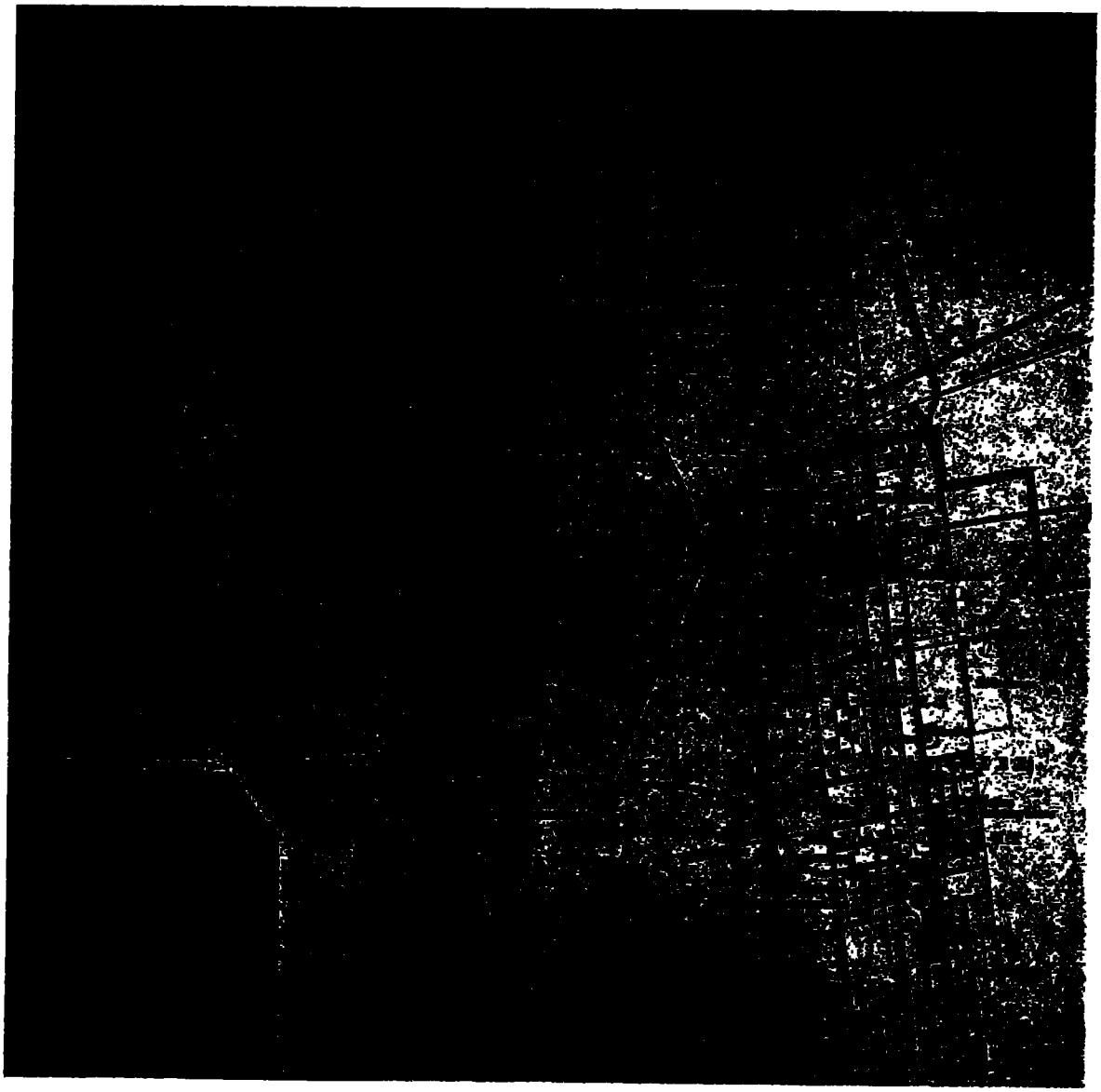

Figure 4.15:- Pre 1960s Urban Sprawl of Lahore

Adopted from (Murray, 1901)

"The Lahore Museum" and "Mayo School of Industrial Arts" reminds us the "Golden Jubilee of Queen Victoria". These buildings were built in "Indo-Saracenic" style. Other examples of this style are "The Lahore High Court", "University of the Punjab" and "Aitchison College". Majority of buildings were designed by "Sir Ganga Ram". Which is rightly called "Father of Modern Lahore".

Census was carried out in Lahore during 1901. 20,691 people were residing in walled city. While there was a total count of 200,000 people living in Lahore at that time. Lahore was center of Freedom movement. British used the Lahore jail to confine independence activists like Jatin Das. Bhagat Singh was also hanged here. "All India Muslim League: passed "The Lahore Resolution" under Jinnah' leadership in 1940. A separate country was demanded for Muslims in this revolution (Glover, 1999; W. J. Glover, 2008).

4.4.3.4.Post-independence (Pre - 1960s)

Lahore became capital of largest province of Pakistan – Punjab. After independence, a massive riot breakout among Hindus, Sikhs and Muslims. Which caused large number of deaths and massive destruction to historical building. Colonial buildings, Lahore fort and Badshahi mosque were also got hurt. However, by govt. reforms, Lahore regained its cultural and economic importance (Anjum *et al.*, 2016; Baqir, 1952; Qadeer, 1983).

4.4.3.5.Post 1960s

Events of this era related to city planning are given below;

a) Planning Efforts:

Subdivision regulations and zoning reforms were proposed in first plan proposed in 1966. Twenty-four-kilometer-long green belt around the city and satellite towns were proposed in the plans. Creations of industrial bus and growth of economic zones were particularly focused in this plan. Very little attention was given for the enforcement of this plan. However, industrial estates were established in southern side (Chunian), Kala Shah Kaku (on northern side) and at Kot Lakhpat. Idea of green belts was also failed by the perpetual urbanization(Qadeer, 1983).

b) The second plan:

"Lahore Development Authority (Alawadhi *et al.*)" played a very active role for formation and implementation of "Lahore Development Authority and Traffic Study" during 1980. Very small amount of data and land usage surveys were used for its preparation in very short time. This plan served as directorial document for LDA and serves no legal purpose. However, LDA has implemented "Structure Plan-1980", which set its

repute as a prominent authority. Preparation of 20-year plan for Lahore urban area was focusing point. Development across the Ravi rover and from southwest to southern directions were proposed in this plan. Major emphasis was on intensification of built-up land, decentralization of prevailing centers and creation of new epicenters. LDA controlled successfully housing schemes developed in private sector. It ensured primary road linkages while implementing the proposals of "Structure Plan". However, planning for development and densification of old buildups was not successful because no local plan was prepared for this purpose(Laquian, 2011).

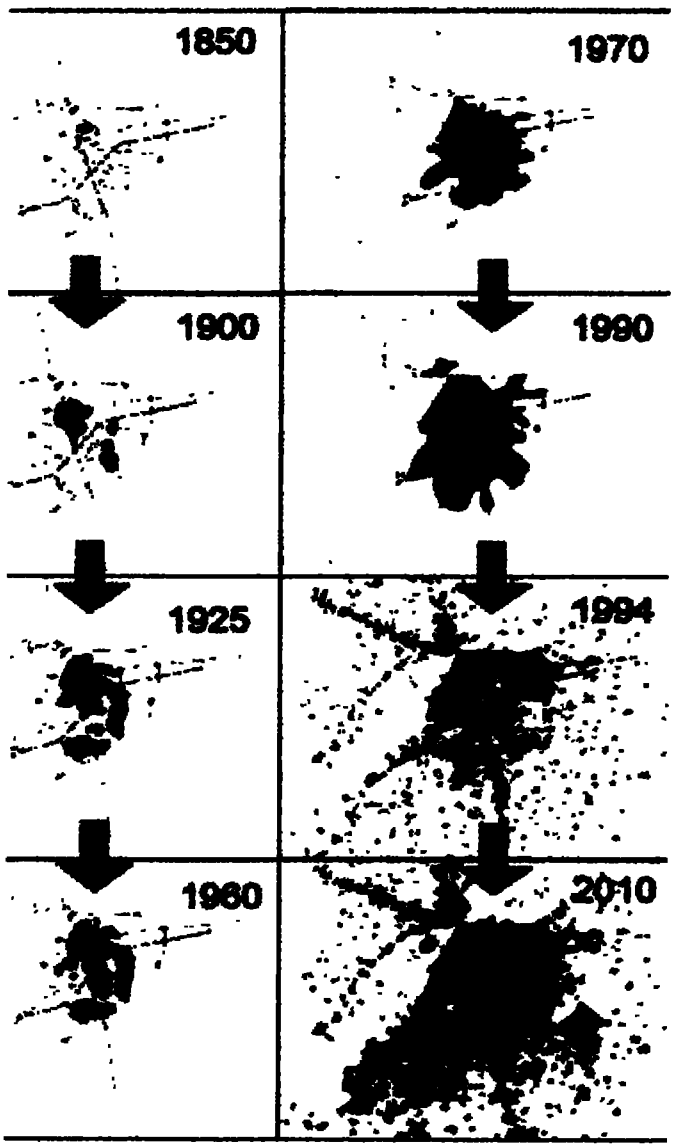

Figure 4.16:- Dimensions of Sprawl till 2010

(Ahmad *et al.*, 2013)

c) Third Plan

As the "Structure Plan-1980" was near to expire. LDA prepared an "Integrated Master Plan -2021. The task was given to NESPAK (A private consulting firm). "The integrated Master Plan" started in 1997. it got its approval in 2004 as third city plan for Lahore city. It contains plan till year 2021(Laquian, 2011).

d) Spatial Strategy:

Third plan for Lahore city was quite a comprehensive plan in comparison to two earlier plans. However, its strategy was cumbersome and problematic. This plan has ignored transforming city character from industrialized to trade and services. It over emphasized the production activities and overlooked existing and future trade and commercial trends. While devising the strategy, cantonment part was forbidden altogether which was most important for future development. And lastly, city expansion was restricted towards north because of flood danger. Developmental opportunities were sought along "Lahore By-pass" by using advanced technology and highly controlled gauges. According of above loopholes, there is need of an appropriate spatial plan for development across Ravi river, sub-centers and developmental corridors. This can be demonstrated by the fact that large number of educational bodies are either established or in process of formation at this site. IMPL has not anticipate that lot of development going on in the city. The IMPL's regulation are non-supportive to densification and infill(Bhatti *et al.*, 2015).

Multan

It is postulated that the world Multan has its roots in Sanskrit. It may possible that it was derived from pre-Islamic Hindu shrines "Mulasthana". In 19th century, Hukm Chand hypothesized that Multan was derived from name of a prehistoric Hindu tribe "Mul"(Latif, 1963)

4.4.4.1. British Raj

British had reached near Multan outskirts during December 1848. They accumulated an army of twelve thousand to triumph over the Multan city in start of 1849. The walls of "The Multan Fort" were breached on 22nd January 1849. Consequently, Mulraj along with his forces had to surrender. British had completely taken over the "Sikh Empire" during 1849 – after the "Battle of Gujrat".

British laid an enormous canal system for irrigation in "Multan region" during 1890-1920. This canal system covered southern and central expense of the province Punjab. A

large number of settlements and "Canal Villages" were constructed along these irrigated land (Awan, 1992; W. J. Glover, 2008; M. H. Raza, 1988; Riddick, 2006).

4.4.4.2.Post-independence

Muslims were in dominant majority in Multan. Thus, they supported "Pakistan Movement" and "Muslim League". As a result, Sikh and Hindu minorities had to migrate to India after creation of Pakistan. Initially, Multan was lacking in universities, industry and hospitals. Since 1947, there is a little industrial growth however, population of the city is growing continuously.

4.4.4.3.Post - 1960s Planning Efforts

In order to control ongoing development trends efforts were made during 1970. It was a fragmentary effort to control the city expansion. Due to slackness in approval, plan was not implemented until 1980. Whereas, ground realities had changed altogether after ten years. "Lahore structure Plan - 1980" was successfully implemented. So keeping in view this success story "Multan Development Authority" also get a "structure plan" done for Multan city. A consultancy firm from private sector was hired and given the task of structure plan preparation. The plan was completed in 1990. However, this plan was never approved or implemented. Besides another plan namely "Multan Master Plan" (1987-2007) got approval. This plan also expired. Then NESPAK was given the task to prepare a master plan for Multan. NESPAK prepared and submitted and submitted a "Master Plan" (2008-2028)(Kiani *et al.*, 1991; S. M. RAZA *et al.*)

4.4.4.4.Multan Master Plan (1987-2007)

This master plan had major objective to provide a broad framework for well-managed urban growth. It furnished guidelines for housing and spatial activities in Multan. Zoning plan was based upon broader land uses and transportation plan for twenty years(Ghafoor *et al.*, 2010; Rajput, 2003).

4.4.4.5.Spatial Strategy:

Amplification of prevailing areas and delivery of facilities was main focus of this plan. New growth had main thrust towards south west, north east and north. Complete provision of services and infrastructure to new settlements and partial provision to intensly populated areas was core of this plan. Cantonment was excluded from the plan like any other plan. Road networks and planned new developments were particularly emphasized.

4.4.4.6.Zoning:

A comprehensive zoning exercise was done for "Multan Master Plan". Zones were defined clearly and earmarking of non-confirming uses was performed. There are three categories in each type of zone for consistency and environmental protection. These classes include permissible uses, prohibited uses and permitted uses. In addition, the whole city was clearly divided into trade and commerce, manufacturing and industry, green belts/open spaces/recreational areas, residential, graveyard, metropolitan uses, non-conforming uses and agriculture. Zoning regulation were flexible for future development and supplementary activities in all zones.

4.4.4.7.Implementation Status:

Major projects and proposals of this plan have been executed. However, due to absence of coordination between "ex-Multan corporation" and MDA. This plan was prepared by a dedicated and focused group of "Master Plan". Which made use of both primary and secondary data. So it proved to be a practical and comprehensive plan(Ahmad *et al.*, 2013; Del Bo, 2014; ur Rahmaan, 2017).

Sargodha

Sargodha is quite an old city however; it was British invaders who established a proper town in 1903. At time of its commencement, it was a small settlement. "British Royal Air Force" constructed an airport as they found it strategically important (Cheema *et al.*, 2007; Rasul *et al.*, 2006).

4.4.5.1.Urban planning of Sargodha – Pre - 60s era

Planning efforts for Sargodha city were started in July 1957. A developmental plan was chocked out by the "Housing and Physical Planning Department" and "Govt. of Punjab". Larger scaled maps were prepared after elaborated studies and surveys for prevailing land uses. Survey accuracy was questionable point for areas that were developed without plan. However, a system of counter checking and revisions was introduced to gather all type of information from all types of areas. The investigation of collected information showed that residential buildings have occupied area i.e 1241.92 acres. Other major types of land uses may include educational institutes, railway land, Govt. offices and vacant land had 213.14, 160.74, 264 and 681.00 acres respectively. The residual area has mixed uses such as health, recreational, entertainment, commercial, worship, public utility and commercial. It is a colony town and follows well-defined patterns.

4.4.5.2.Zoning

Town is divided into square blocks. Main bazars are located on the major roads. Educational institutes, transport terminals and industrial areas are at reasonable distances and are quite accessible from residential and commercial institutes.

North eastern and north sides of Sargodha along the Mianwali road are oldest city parts having commercial areas. This area is hub of commercial accomplishments due to its easy accessibility and central location. Commercial centers and markets are economically more beneficial, so there seen a tendency to construct them by trashing residential areas. Lahore road and civil lines are areas bearing public and education institutes. Administrative officies are located in civil lines to run govt. affairs of division and district. Industrial area located majorly along Sillanwali road. According to all the signification locational aspects this area was best suited for industrial purposes.

4.4.5.3.Planning Efforts - Post 60s era

"Municipal Development Fund Company (PMDFC)" has prepared a planning report for TMA Sargodha in 2008. The main objective of this report was to assist TMA in developmental planning. They also identified the gaps in service delivery, accessed the original requirements. The report also directed towards ways and means to bridge these gaps through developmental actions. PMDFC updated the TMA's map through land utilization survey. Base map was prepared by marking industrial areas, open spaces, commercial, residential and institutional areas. A team of town planners of PMDFC and TMA's draftsmen completed the task. Middle portion of the Sargodha city has mixed land usage, according to PMDFC's report. Where, "University of Sargodha" is located in neighborhood of public residential area. Thus inhabitants, public buildings and institutions are located side by side. The most important public building includes "Deputy District officer", "Chief Engineer", "SUP engineer", "DIG", "Director of Public Relations", District Police Line", "Office of Anti-terrorism". There is a commercial market adjacent to the public buildings. There is wood market, also. Vegetable and fruit markets are located north to the bus stand. Most prominent business centers are located around or at these roads, i.e "Main Bazar", "Kachehry road", "Karkhana Bazar", "City road Faisal Bazar" "Millat Bazar", "Shaheed-e-Millat Road", "Girls College road" and "Millat Bazar Road"(S. M. RAZA *et al.*; S. M. RAZA *et al.*).

4.4.5.4. Parks

Open spaces and parks can be found in whole city in scattered form. Five major parks are; "Old Civil Lines Park", "Tekon Park", "Rehmat Park", "Jinnah Park" and "Main Water Works Mohammadi Colony Park"(S. M. RAZA *et al.*).

4.4.5.5. Educational Institutes

Eastern part of the town has many educational institutes both for boys and girls from primary to higher secondary levels. South eastern part bears the "Army cantonment". "Sargodha Air Base" is one of the vital air bases in Pakistan. So "Pak Air Force" is occupying a massive area. There are eight graveyards in city, scattered all around. City is growing towards Lahore. Most populous areas are located along Sargodha-Lahore road. World Bank funded to aid a master plan which is now almost twenty years old. Maintenance and extension of services require funding from different funding bodies. Which is in piecemeal manner. Utilities specially sewerage system requires special attention.

Islamabad (Post 1960s)

This city came in existence after 1960s as capital seat for the country. therefore, it has no history of pre-1960s era.

4.4.6.1. Islamabad: the original master plan, 1960

Need of a new capital was felt since the creation the creation of Pakistan. Thus, capital of the new state was conceived in 1959 and Greek architect and town planner - Constantinos Apostolou Doxiadis was given the responsibility for its planning. Planning process was started in 1959 and continued till 1963. Meanwhile, practical implementation was started in 1961. Following important parameters were considered during planning process(Hull, 2008).

4.4.6.2. Site Selection

Process of site selection was started on scientific basis. However, later on, it was somehow got biasness through political considerations. The points which were kept into account while selecting site includes: network connections like "Grand Trunk Road" (GT), and proposed "United Nations Trans-Asian Highway" and center of gravity. Topographical conditions such as elevation from sea level and foothill of Himalayas remained the deciding points. Vicinity to the Rawalpindi city area helped the decision making. Existing transport and road linages facilitated the development of new capital. Also, it provided accommodation to early residents and Islamabad offices (Botka, 1995; Maria *et al.*, 2006).

4.4.6.3. Dynapolis

"Dynametropolis" described the central principal of Islamabad Metropolitan. Which means it would be dynamic metropolis consisting of Islamabad, Rawalpindi and National Park. Dynamic expansion of Rawalpindi and Islamabad was proposed from southwest site. It was kept into consideration that blue area i.e backbone of principal facilities would be least affected by the adverse impacts of population and traffic (J. M. Frantzeskakis, 1995). Four main highways "Islamabad Highway", "Capital Highway", "Soan Highway", and "Murree Highway (Kashmir highway)" were proposed to connects three elements of Metropolitan (J. M. Frantzeskakis, 1995). Among these four highways, two namely Islamabad and Kashmir highways are built and fully functional till now. Doxiadis characterized Islamabad by its dynamic nature, unidirectional growth and non-existence of size. It was argued by Stephenson that original size of the city is missing in master plan as city can spread bestowing its requirements in a metropolitan dynapolis (Stephenson, 1970). Experts found this idea very advantageous for extensive planning and future of the city. Islamabad was perceived in grid-iron configuration. Each of two square kilometers sector were kept apart from each other by hierarchical principal roads. Each sector has discrete land use like educational, commercial, administrative and residential. However, town planners showed their concerns about straight highways and "Grid iron patterns". Residence is provided in "grid-iron sectors" in order of income groups in a disciplined hierarchy. There is a bigger shopping center for cluster of four communities with a grid pattern. To control the traffic, business activities were merged in epicenter of enlarged square settlement. However, authors have criticized the social structure evolving by "iron-grid patterns" and economic development.

4.4.6.4. Transport Network

Hierarchically planned road linkages serve the "grid iron patterns". These roads had a width of 300, 600 and 1200 feet. Which intersect each other at right angle. To assist the community local and collector roads were proposed. Wide "right of way" remained the strong recognizing entity of Islamabad. Authors like Botka wrote that roads of such width and hierarchy are most effective to deal with the burden of growing traffic and rapidly moving traffic as well. That's is why the road infrastructure was kept the same even in revised master plan. However, the width of the "Capital Highway" was increased from 1200 ft. to 1800 ft. high automobile density per capita was considered by the Doxiadis while planning it. Thus along a 50-100 yards' green shreds a wide road was proposed.

However, Islamabad could not get as much motorization as conceived. Highways were kept wide to act as future corridors of utilities such as high tension electricity, gas pipelines and water supplies. Plains of Pothohar region are deeply eroded by water courses. Even though, the main roads were aligned straight through these undulating plains. As Doxiadis argued that main roads by no reason can be curved. Until the type of landscape forces to do so(J. Frantzeskakis, 2009; Shabbir *et al.*, 2010).

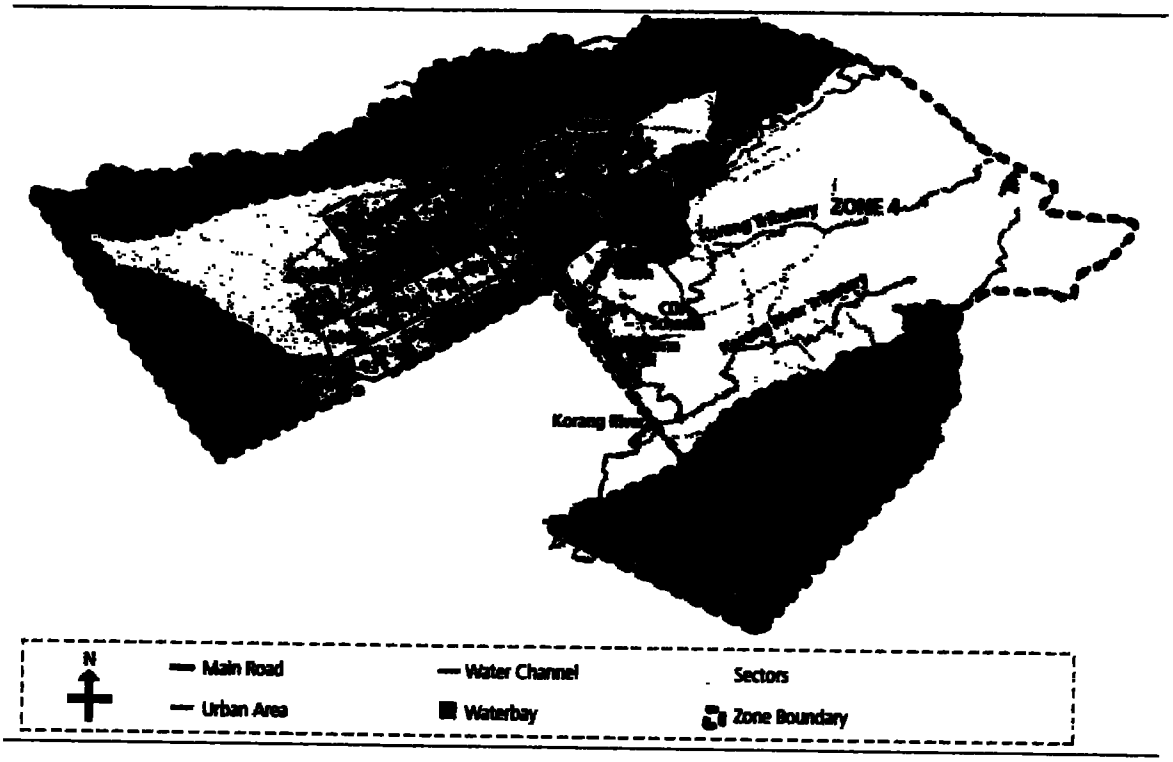

Figure 4.17:- Zoning and Master Plan of Islamabad

4.4.6.5. Economic Justification

However, there are numerous critics and opponents of the conception and creation of Islamabad. They put the basis of their arguments on the fact that Pakistan have limited natural resources and a high percentage of illiterate people. So it cannot afford such luxury (Meier, 1985). Meier compared Islamabad with Brasilia and Chandigarh in terms of capital withdrawal from country's economy. Although, Doxiadis had already proved and showed that dual functionality and investment on Karachi, creation of the new capital is more economical. He calculated per square feet overheads for Islamabad as well as for Karachi (By existing capital). "Labor-intensive" approach was adopted for construction of Islamabad city in order to make it affordable. However, this approach slowed down the construction pace due to prohibition of big and heavy construction machinery. Similarly, presentation of all social groups and cultures in capital remained point of debate.

4.4.6.6. Capital Development Authority (CDA)

For implementation of the "Master Plan", "Capital Development Authority (CDA)" was developed in place of "The National Capital Commission". CDA was given strong authority for planning and implementation. It has its extensive area of influence to control the improvements in national capital. However, only one architect, one town planner and one skilled architect-planner was hired from Pakistan is early days of development. Rest of work was completed by foreign planners and architects. At the initial stage, there was serious lack of capacity to deal with such huge metropolitan planning (Hull, 2003).

4.5 Data Analysis

The term analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data groups.

Before embarking on analysis of collected data, processing will be carried out. Processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis.

Editing to ensure that the data are accurate, consistent with others facts gathered, uniformly entered, as complete as possible and have been well arranged to facilitate coding and tabulation. (Field editing, central editing)

Coding refers to the process of assigning numerals or other symbols to answers so that response can be put into a limited number of categories or classes.

Large volume of the raw data was classified according to attributes.

Ultimately, raw data was summarized and displayed in compact form to start analysis. (Simple and complex tabulation, principles of tabulation)

4.6 Focus Group (key informants)

Members of focused group (Senior Citizens, employees of municipal corporations, retired patwari/tahseel dar, relevant professionals, NGOs, old/retired teachers having environmental know how). There were 10-16 participants in focus group discussion in each city under study. It was kept view while selecting the individuals/members for focus group that they such person be search out who have observed or seen pre-1960s era in consciousness. At least two or two such person have been assured for every group before discussion. The meeting with the respondents were arranged with the help of town officers planning and coordination, local friends, Faisalabad Industrial Estate Management Company, district environment departments and revenue staff.

4.6.1 Group Discussion

Group discussion is conducted in five selected cities. The discussion is conducted in context of already prepared questionnaire (Annex-I). Outcome of group discussion is summarized in the tabular form and is given city wise in the table below;

Table 4.5:- Focus Group Discussion

Q. No.	Outcome of Group Discussion
	Faisalabad
Q 1	Well- planned, union Jack shaped, located within the circular roads, residential and commercial places located in and around the eight bazars.
Q 2	City was designed in such a way to provide citizens a better life style and all necessities of life
Q 3	Yes, it was enough. Govt. buildings, public places and parks provided shelter in extreme conditions.
Q 4	Solid waste management was done by the municipality and waste water was collected by the sewage system.
Q 5	Yes, people were well-aware of importance of cleanliness and pollution. That's why factories and commercial areas were out of residential areas
Q 6	There wasn't any well-defined mechanism however people were well aware of importance of natural resources and they wasn't used up to exhaustive limit
	Gujranwala
Q 1	Grid pattern roads, town enclosed within circular roads with several polygonal square and rectangular blocks. Large Hawalies and garden of sikh era. Commercial places and agricultural land away but accessible from residential areas
Q 2	Situated along the river, ground water and river water available, good road infrastructure and accessibility to other parts of country by rail, gardens and parks served well purpose, open and recreational places.
Q 3	Yes, infrastructure had the capability to serve this purpose
Q 4	It seems that people were not much aware and factories were built adjacent to the hawalies. While were later on demolished by the British rulers

Q 5	People were great admirers of nature so they preserved it well by building parts admired by the English poets
Q 6	Small amount of inhabitants and large amount of natural resources could not let the sense of preserving natural resources prevail.
	Lahore
Q 1	Wall city with good road infrastructure since old time, railway accessibility to other areas in British era. Symbol of glory, famous commercial places lies anar kali, named as city of Gardens
Q 2	It remained city of the rulers throughout its history so water supply, sewage, security arrangements and recreational places were good and updated in every era.
Q 3	City infrastructure was huge and magnificent and had ability to provide shelter to its residents in case of nature disasters.
Q 4	Solid waste management and waste water disposal had proper arrangements
Q 5	Environmental pollutants were well catered for by building gardens, keepings factories out of city
Q 6	No there wasn't any defined mechanism
	Multan
Q 1	Multan has its roots in pre-historic civilizations like Harappa, which is known for highly well development infrastructures. Open drains made of small bricks. Streets lights in the form of lamps (Dia). Roads were of bricks. Ravi and chanab were also used for transportation e.g wood was brought from upper areas through these rivers. Thus, city was well provided with all these amenities
Q 2	These facilities like gardens e.g Hazori bagh, Aam/Khas bagh, Bhangi system for cleanliness, mashki system for water supply and sprinkling, small sewerage ducts made of small bricks at human scale, were not only very good but also ahead of time of that era
Q 3	Infrastructure wasn't that much heavy to take care of natural disaster
Q 4	Waste water disposal and waste management were well development from Harappa
Q 5	It lacked industries for a long time. So people were not much aware of pollutants

Q 6	It used to be a river town. So most of the people were farmers. Preserving nature to get more raw material was a usual habit
Sargodha	
Q 1	Efforts were made to plan the city. But it was neither fully prepared not implemented
Q 2	Infrastructure facilities were insufficient
Q 3	Infrastructure was very poor and unable to with stand any harsh conditions.
Q 4	No such mechanisms existed at all.
Q 5	There was very little knowledge of environmental pollutants.
Q 6	There was no concept of nature's carrying or threshold capacities. However, natural resource consumption was within optimum limits due to small population

4.7 Expert's Opinion

Expert's opinion was obtained on two pre-existing approaches (master plan and structure plan) and newly conceived approach for city designing to establish the level of importance given to the environmental aspects. Experts from field of urban planning, environment and academia were approached with a structured interview performa to get their opinion.

4.8 Brief Explanation on MCD Analysis

Decision making in environmental sustainability and urban planning is complex and time consuming due to involvement of large number to factors and stakeholders affecting the scenario. The situation becomes even more complex when dealing with the all the sustainability dimensions and urban resilience that may be result of a newly proposed urban form such as described in this research endeavor. Thus, the final destination is to achieve urban resilience and sustainability by balancing the environment, social and economic phenomenon's through newly proposed urban form. In general, goal is always to choose the best suitable option among the available ones (Moffett *et al.*, 2006).

The rational decision making (DM) is helpful when applied to energy system or applied to management systems. However, it does not work when dealing with the complex

situations described above. Multi criteria decision analysis (MCDA) comes to rescue in such a tricky situation. MCDA is known as a tool in urban planning as well as in environmental sustainability to address and formalize the issues being faced in achieving objectives of competing decisions. Decision makers and researchers have used it for a long time. MCDA supports the evaluation of integrated sustainability. Most recently researchers have used it health technology assessment systems (Marsh *et al.*, 2018), combined GIS and MCDA tool for land sustainability (Jelokhani-Niaraki *et al.*, 2018), cycling path planning (Terh *et al.*, 2018), in knowledge based economics (Carayannis *et al.*, 2018), combined cognitive mapping and MCDA approach for improving quality of life in urban areas (Faria *et al.*, 2018). Till 2018, almost 100 multiple methodologies have been reported in literature. However, the most frequently employed ones in field of urban resilience, environmental sustainability and city planning are given below (Guarini *et al.*, 2018).

Table 4.6:- Types of MCDA Analysis

Sr. No.	Method	Reference
1	Multi-attribute utility theory (MAUT)	(Greco *et al.*, 2016)
2	Elimination Et Choix Traduisant la REalitè (ELECTRE)	(B. Roy, 1968)
3	Measuring Attractiveness by a Categorical Based Evaluation (MACBETH)	(Costa *et al.*, 1994)
4	MCDA Ranking Method	(Triantaphyllou *et al.*, 2005)
5	Analytic Hierarchy Process (AHP)	(Saaty, 1977)
6	Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE)	(Brans *et al.*, 1985)
7	Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)	(Yoon *et al.*, 1995)
8	MCDA-SMART	(Lootsma, 1993)
9	Analytic Network Process (ANP)	(Saaty, 2013)

4.8.1 What is MCDA?

It is a decision support methodology for operational evaluation of the complex problem. Which may involve conflicting objectives like large and different sort of information vs data multi perceptiveness and interests; accounts for multifaceted and

evolving socio-economic vs biophysical systems. Decision makers face difficulties while dealing with large and complex information with certainty and reliability. It helps to recognize ultimate option or to short-list limited quantity of options for subsequent comprehensive appraisal, or merely to distinguish suitable from undesirable possibilities. There are number of MCDA techniques available in literature and their number is still growing due to following factors:

i. **Decision Category:** there is variety of decisions that suits the broad horizon of multi criteria analysis.
ii. **Time:** Time available for the analysis may be different.
iii. **Data:** Variable nature and amount of data required for analysis.
iv. **Analytical Skills:** required to support the decision may be different
v. **Social and Cultural Requirements**: may vary a lot from community to community.

4.8.2 Why to Use MCDA Analysis

In this research endeavor MCD technique was chosen due to following reasons:

i. Easy to use
ii. Data requirements are not uneven with the significance of the subject being measured.
iii. Logical soundness
iv. Internal consistency
v. Availability of software where required
vi. Convenience of audit trail
vii. Manpower and time requirements for the analysis are realistic

4.8.3 Salient Features of MCD Analysis

Vital characteristics of the MCDA technique that makes it a methodology of choice are as follows;

- MCDA finds the preference between objectives identified by the decision maker and extent up to which it has achieved the objectives.
- Identification of criteria and objectives may provide sufficient information in simpler scenarios. However, in complex situations MCDA provides a number of data aggregation options for calculation of overall performance.
- MCA central theme is the emphasis of decision-making-team on judgement, in establishing criteria and objectives, estimating the relative importance of weights and,

to some extent, the contribution of every option to each of performance criterion in judging.

- In principle, foundation of MCDA lies in objectives, assessments and weights, criteria chosen by decision maker. However, it creates degree of structure, openness of classes and analysis of decision that is beyond the practical limits of decision maker.
- One major drawback of the MCDA is that it cannot show that which action can aid or detracts to welfare of the objective.

4.8.4 MCD Analysis Vs informal judgment

A comparison of multi criteria decision analysis (MCDA) and informal judgment is given below. Rather MCDA has following advantages over other methods without analysis:

i. MCD analysis is explicit and open.

ii. Decision makers can choose criteria and objectives for analysis and can be changed if felt inappropriate.

iii. Techniques are developed to establish weights and scores which are very explicit. These techniques are amendable and can be cross referenced.

iv. Measurement of performance is not left to decision makers only but also sub-contracted to experts of that field.

v. It can be used as tool of communication between wider community and decision makers.

vi. Audit trail can be tracked through weights and score.

4.8.5 Technique of MCD Analysis

Different types of MCDA may have variation in method of analysis. However, broader technique of MCD analysis consist of following components:

4.8.5.1 The Performance Matrix

Consequence table or performance matrix is standard feature of MCD analysis. An option is described in a row whereas column designates the performance of the options against each criterion. Individual performance evaluation is often done through numerical, bullet score points or color coding. Performance matrix can be the concluding product in basic practice of MCDA. Decision makers, then are left with task related to assessing extent to which the objectives have met by given entries in afore-stated matrix. Which provides speedy and effective processing of data. But it could lead to inappropriate ranking options

due to unjustified assumption utility. Basic information matrix is used to transform in consistent numerical while using more sophisticated MCDA techniques.

4.8.5.2 Weighting and Scoring

Numerical analysis is applied on performance matrix which usually consists of following two stages;

i. Scoring

Numerical value is assigned to outcomes of each possibility. Which depends on strength of likeliness scale for every option each criterion. More preferred possibility scores secure greater scores on scale. While less preferred ones score lesser. Normally, a scale of 0 to 100 is used. Whereas, 0 is least preferred option and 100 is most preferred one. All the other options assumed will lie between 0 to 100.

ii. Weighting

Weights in numerical form are allocated to define, relative valuations for shift for every criterion between top to bottom of chosen scale

4.8.5.3 Statistical Analysis

Appropriate statistical techniques are used to study the correlation between parameters to arrive at conclusion. This conclusion will formulate the basis for decision making.

4.9 MCD Analysis

Multi–criteria decision (MCD) analysis was performed for the selected cities as described in methodology. The table is given below:

Table 4.7:- Multi Criteria Decision Analysis Table

				Total Score				
				Faisalabad	Gujranwala	Lahore	Multan	Sargodha
				2141	1177	1467	2018	677
				Ratings				
Interests and Sub-Interests	Rank	Group Weight	Sub-Criteria Weight	Faisalabad	Gujranwala	Lahore	Multan	Sargodha
1. Importance of Urban form of city	3	11						
Street Patterns			11	5	5	5	4	1
Width of Streets			11	5	5	5	4	2
Green Spaces			9	5	5	5	3	1
Placement of land uses, residential, commercial			6	5	4	5	3	1
2. Adequate Infrastructure	4	15						
water supply facility for all			15	4	5	5	5	1
Passable road network			14	5	4	5	5	1
Security arrangements			13	3	3	5	5	1
Public Places			10	2	1	4	5	1
Recreational areas			9	2	1	5	5	1
Efficient sewage treatment system			14	3	2	5	5	1
3. Infrastructure capable to provide shelter	6	7						
too hot summer			7	3	2	4	1	1
too cold winter			7	3	2	4	1	1
wind storms			4	2	2	3	1	1
Fire incidents			6	1	1	1	1	1
Thunderstorms			5	1	2	3	1	1
Floods			7	1	2	4	1	1
Heavy rains			7	4	2	5	1	1
4. Mechanism of solid waste management	5	33						
Generation (solid waste)			30	4	3	3	4	1
Storage			25	5	1	2	4	1
Collection			29	5	1	4	4	1
segregation and storage			27	3	1	1	3	1
transfer and transport			23	4	1	3	4	1
Disposal			33	5	3	2	3	1

Score				
Faisalabad	Gujranwala	Lahore	Multan	Sargodha
185	179	185	133	48
55	55	55	44	11
55	55	55	44	22
45	45	45	27	9
30	24	30	18	6
249	217	365	375	75
60	75	75	75	15
70	56	70	70	14
39	39	65	65	13
20	10	40	50	10
18	9	45	45	9
42	28	70	70	14
96	80	152	43	43
21	14	28	7	7
21	14	28	7	7
8	8	12	4	4
6	6	6	6	6
5	10	15	5	5
7	14	28	7	7
28	14	35	7	7
1250	562	785	1100	372
120	90	90	120	30
125	25	50	100	25
145	29	116	116	29
81	27	27	81	27
92	23	69	92	23
165	99	66	99	33

Reuse			31	1	1	1	1	1	31	31	31	31	31
Landfills			33	2	1	3	4	1	66	33	99	132	33
energy generation			24	1	1	1	1	1	24	24	24	24	24
efficient collection system (from point to Generation)			32	5	3	4	4	1	160	96	128	128	32
primary treatments: Mechanical processes, Remove larger solids, 20-30% of BOD and 50-60% of suspended solids			30	3	1	1	3	1	90	30	30	90	30
secondary treatments: biological treatment involving microbes, removes dissolved organic matter, 85% of BOD and suspended solids			32	4	1	1	2	1	128	32	32	64	32
Tertiary treatment disinfection with chlorine and UV treatment, Wetlands, removes 90% of all impurities			23	1	1	1	1	1	23	23	23	23	23
5. Awareness about environmental pollution	2	13							138	46	174	46	46
Air Pollution (Smoke, smog, particulate matter, aerosols)			13	3	1	4	1	1	39	13	52	13	13
Soil pollution: Oil and fuel dumping, nuclear waste, Direct discharge of industrial waste to soil, Discharge of sewage and spills, landfill and illegal dumping, coal ash, electronic waste, ammunitions and agents of war			12	3	1	4	1	1	36	12	48	12	12
Water Pollution: surface water pollution, Ground water Pollution, Microbial pollution, Oxygen Depletion Pollution, Nutrient Pollution, Suspended matter pollution, chemical pollution			11	3	1	4	1	1	33	11	44	11	11
People response to all kind of pollutants			10	3	1	3	1	1	30	10	30	10	10
6. With drawl of raw materials from nature (keeping in view nature's threshold and exhaustible capacities)	1	21							223	93	171	321	93
Exploitation of fresh water resources for domestic, industrial and agricultural resources		5	20	3	1	2	4	1	60	20	40	80	20
Profiteering from nonrenewable hydrocarbon fuels		5	19	1	1	2	4	1	19	19	38	76	19
Deforestation for fuel, agriculture, residential and industrial purposes		5	21	3	1	2	3	1	63	21	42	63	21
Loss of soil structure due to salinity, water logging, excessive animal tapping & grazing and inappropriate agricultural practices		4	18	2	1	2	4	1	36	18	36	72	18
Level of people awareness about above criteria and sub-criteria		2	15	3	1	1	2	1	45	15	15	30	15

Faisalabad attained the highest total score followed by the Gujranwala, Lahore, Multan and Sargodha as shown in Figure 4.18. As per survey data, withdrawal of the raw materials from the nature keeping in view of its threshold and exhaustible capacities were ranked highest. Whereas, infrastructure capable to provide shelter was ranked least. Mechanism of solid waste management attained the highest group weight as evident from its proportionate share in bars of the graph.

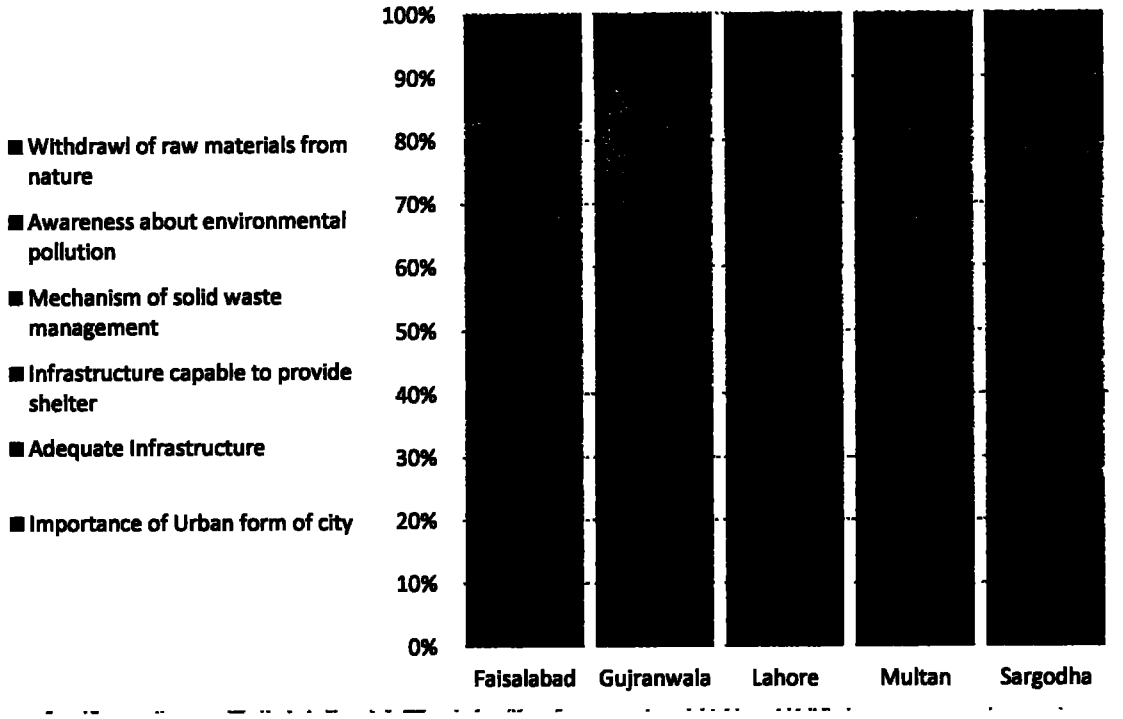

Figure 4.18:- Analysis of Pre 60's urban form by ranking method

A well-planned city is considered that one which is fully prepared for the future problems, social and economic impacts. Evident from the above analysis and history, Faisalabad is most well-planned city of pre – 60's era providing a better living style to its residents. Study has revealed that there found a nexus between changes in urban form (economic, agricultural, residential and cultural zones) and environment for the city even after end of colonial era. The city also had centralization of functions and facilities.

It is claimed in hypothesis that environmental consideration has remained in backdrop of city planning. In table 4.7, indicators given at serial no. five and six depict the environmental consideration in back drop of city planning. Score for serial no. five varies from 174 for Lahore to 46 for both Gujranwala and Multan. Score for serial no six varies from 321 for Multan to 93 for both Gujranwala and Sargodha. These result manifests that there have remained environmental considerations in back drop of city planning. However,

level of considerations has varied keeping in view importance of the city for the state or region. Highest values are attained by the Lahore and Multan as these were most important cities of respective regions. Faisalabad despite of being most well planned city could not get the maximum value for these indicators as it was not most important city of region because of Lahore.

4.10 SMART-MCD Analysis for Focus Group Discussion (FGD)

Results of focused group discussion are also analyzed by using Simple Multi-Attribute Rating Technique of MCD analysis in addition to ranking method. This analysis includes significance and existing ranking of urban infrastructure and environmental options which is shown in Table 4.8.

4.11 SMART-MCD Analysis for Experts Opinion

Results of Experts Opinion are analyzed by using Simple Multi-Attribute Rating Technique of MCD analysis. This analysis includes significance and existing ranking of Master Plan, Structure Plan and Proposed Urban Plan which is shown in Table 4.10.

Table 4.8:- The Significance and Existing Ranking of Urban Infrastructure and Environmental Options through SMART-MCDA

Technical Criteria		Significance Ranking (%)	Existing Ranking (%)					
			Faisalabad	Gujranwala	Lahore	Multan	Sargodha	Islamabad
Urban form of the city	C1	95	75	70	90	65	65	85
Infrastructure adequate to people's requirements	C2	85	70	65	85	70	65	80
Infrastructure capable to provide shelter in extreme events	C3	80	60	55	90	55	50	75
Mechanism of solid waste management and waste water disposal	C4	80	75	45	95	55	60	80
Realization of environmental contaminants in people	C5	75	70	65	95	70	65	95
Extraction of raw materials from nature	C6	95	60	65	70	55	55	40

Table 4.9:- Pearson's correlation of Urban Form and Environmental Change

Cities	Pearson Correlation value
Faisalabad	-0.09
Gujranwala	0.52
Lahore	-0.7*
Multan	-0.16
Sargodha	0.001
Islamabad	-0.60

(*** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$) (Very weak= 0.00-0.19, Weak= 0.20-0.39, Moderate= 0.40-0.59, Strong= 0.60-0.79, Very strong= 0.80-1.0)

The relationship between environmental change and evolution in urban form is circulation in its naute. Simple multi attribute rating technique (SMART) was used to analyze the data. Pearson's correlation was applied to find two-way relationship between environmental change and evolution in urban form. Values of correlation varied around moderate and have insignificant *p* values. Whereas, qualitative information portrays the different story. Data collected from focus groups and interviews revealed that pollution control measures like daily sprinkling water, washing of open drains, pavement of drains, thick walls for temperature controls, sewerage ducts made of small bricks, land reservation for tree plantation (Baghat/gardens), tree plantation campaign, consciousness about health and safety, daily street cleaning, door to door collection of mela (human excreta) and taking it to safe dumping sites on animal driven carts has remained at top priority of the city planners as well as managers (table 4.13). Which shows environmental measures have strongly influenced the urban form. Hence, deduction can by drawn by comparing and evaluating the qualitative and quantitative data that influence of environmental changes is strong enough but not as strong as the influence of other factors like rapid population growth, technological advancement, transportation means etc. Subsequently, doctrine of development led growth over shadowed the environmental consideration. In many cases, cities were designed with proper environmental considerations e.g. original part of Faisalabad, old city Multan, British era development of Lahore but subsequent population explosion and rapid requirement of development muddled the original urban form.

Table 4.10:- The Significance and Existing Ranking of Master Plan, Structure Plan and Proposed Urban Plan Through SMART-MCDA

Technical Criteria		Significance Ranking (%)	Existing Ranking		
			Master Plan (MP)	Structure Plan (St. P)	Proposed Urban Plan
Transportation system	C1	90	10	30	80
Urban and environmental bye laws	C2	80	20	40	85
Type of Zoning	C3	85	40	40	90
Acceptable to nature urban plan	C4	90	40	60	60
Main skeleton/arteries of the city	C5	80	30	60	72
Environmental & urban sustainability for welfare society	C6	75	60	65	80
Least carbon emitting urban form	C7	90	30	40	80
Natural resource conservation	C8	95	25	50	80
Solid Waste Management	C9	75	70	70	80
Sustainability dynamics	C10	80	60	60	80
Contents and benchmarks of MDG's	C11	70	40	40	70
Extent of address environmental Pollutants (air, soil, water)	C12	85	30	50	80
Responsive to treat environmental pollutants	C13	80	20	30	80

Data obtained from expert's opinion was analyzed through Simple Multi-Attribute Rating Technique (SMART) in table 4.10. Pearson's correlation was used to find the relationship. Values of correlation for Master and Structure plans with proposed urban plan are given in table 4.11.

Table 4.11:- Pearson's Correlation of Master Plan, Structure Plan with Proposed Urban Plan

Plans	Pearson's Correlation value
Master Plan	-0.52*
Structure Plan	-0.24

(*** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$) (Very weak= 0.00-0.19, Weak= 0.20-0.39, Moderate= 0.40-0.59, Strong= 0.60-0.79, Very strong= 0.80-1.0)

Those parameters which got more than 70% weightage from experts were picked for further analysis. In this way generic set of parameters for an environmental friendly urban form has been established. In the light of this set of parameters, new approach namely "Composite City Approach" for urban planning is devised.

CHAPTER # 5

CONCLUSION

This chapter encircles the outcomes of literature review and field work. Chronological scrutiny of literature review proved a circular relationship between urban form and environmental change. Primary data obtained from the field work was used after its analysis to prove the hypothesis.

5.1. Outcomes from Town planning Theories and Existing Sustainable City Models

So far, three theories of urban forms have been proposed yet. Normative theory as described by the Lynch is "how to know a good city when you see one". Theory of rationalism relies on the universal truths to make a decision". Whereas, pragmatics judge the plans and ideas by their physical or tangible consequences. The huge amount of literature is available on historical urban form in different eras. European historical urban form is unique due to its history and characteristics. South Korean urban form is dated back to 1st century BC. Archeological records of the "Shila Kingdom", era of "The three Kingdoms" and "Goryeo Dynasty" are interesting due to its location, topographical environment and three-layered cities. Humans/population growth has direct relationship with environment. As population is increasing, more land is cleared for shelter, raw materials are drawn and more waste is exhausted to nature. Thus, with the modifying need, there is also a transformation in urban form. Study of historical urban form has revealed that it kept on adapting corresponding to the environmental changes.

All the attempts made so far to make the cities urban friendly (as discussed in section 2.5 of the literature review) are handy capped. Because these attempts are dealing the software side of urban planning. These models add some environmental measures on existing city design approaches. Eco city adds vertical gardens to existing urban form. In sustainable cities approach major emphasis is to form own priorities at local level regarding integration of economic, social as well as environmental spheres in planning. Resilient city concept argues for equipping cities to neutralize future stresses and shocks erupted from changing climate. Smart city concept focuses on use of information and communication technologies to enhance capability to respond upcoming events. In nut shell none of the above-mentioned endeavor focuses on to improve the urban form of the city so that

resilience, efficiency, sustainability and resource conservation emerge from components of the urban form.

Analysis of primary data had shown that well planned cities like Faisalabad were more environmentally sustainable and showed resilience to some extent. Whereas, cities with haphazard growth were unable to fulfill the requirements of their inhabitants in terms of raw materials, clean environment, protection from natural calamities and hygiene.

5.2. Hypothesis - Environmental considerations have remained in the backdrop of City Planning

While evaluating different periods of history, it is observed that measuring scale has been changed throughout the history time to time. Firstly, things were measured in the light of observation. If the difference between the first observation and subsequent observations were given bad feelings the variation was considered as negative change and in case of vice versa variation was considered a positive change. This scale of measurement is name as visible scale. Early human settlements subjugated the natural resources and subsequent over extraction resulted in distortion of vistas. This visible scale deformation of nature was also realized and responded in city planning practice in the form of Patrick Geddes's "Regional Planning and Design with Nature"; Daniel Burnham's "The City Beautiful Movement" and "The Parks Movement" by Frederick Law Olmstead. Design with nature can safely be called as origin of sustainable urban development.

With the passage of time when human started the strong judgment by close observation, sniffing, feeling and estimating. In this way, sound judgment leads to establish a standardized scale to measure environmental anomalies, which is named as Sagacious Scale in this study. With the advent of industrialization typology of damage to the environment started changing. In addition to mere removal of trees and vegetation, burden of industrial effluents, smoke and noise had also started contributing to the environmental pollution. Masses and professionals started realizing that pungent industrial effluents were polluting the water streams by close observation and sniffing of smell. Inconvenience of noise from industry was talk of the town in industrial areas. Heat islands in the urban areas were felt. Judgments were made that unhealthy conditions due to presence of industry in urban area was causing the epidemics. Which resulted in "The Municipal Health Movement" by Benjamin Ward Richardson and "Garden Cities" by Ebenezer Howard.

In the course of development, transition from classical to sophisticated instrumentation was designated as micro-scale. Discovery of microscope provided an insight into pollutants and made it happen to device pollution control technologies.

Ensuing mechanized industry and mining paved the path for exploitation of natural resources beyond carrying capacity of the planet. The consequential chemical processes adversely affected the surrounding. Rachel Carson is considered as sphere head of this micro scale environmental movement. Its planning response is being observed in the form of "Eco-Cities" and reduced carbon emission techniques (Carson, 2009). The notion of the "Eco-City" is developed by the organization of "Urban Development". Which remains the pioneer in focusing on "Eco-City" development projects (Joss, 2010). The organization was founded in Berkeley, California during 1975. Its creator Richard Register put forward the idea to restructure and modernize the cities that have balance in nature. They worked on tree plantation along main street sides and energy supplies to houses by solar systems and encourages mass transport systems. They operated within "Berkeley Legal System" to get authorization of environment friendly rules and regulations. "Urban Ecology" is another step forward in the movement. A scientific journal titled "Urban Ecologist" started its publications in 1987 (Roseland, 1997).

The movement has a melodramatic boost in 2001, by the "John Howkins", publication, "The Creative Economy" and "Roachard Florid's", "The Rise of the Creative Class". The movement experienced a global restructuring after the book. Florid's book introduced the clever slogans like "talent, technology, tolerance". Motivating indicators like "bohemian index" or the "gay index" shock the basis of traditional urban and environmental planning. Notably, it linked three areas: "A Creative Class", "A Novel Idea", "The Creative Economy" and conditions of the cities, which will appeal "the creative class". Florid established that variety of lifestyle features, such as entertainment, urban infrastructure, diversity and tolerance, crop out the economic development.

Highly sophisticated technologies have made possible to work at nano-scale. Nanotechnology is the buzzword of the day without detection and estimation of potential nano-pollution and town planners have to respond it with preemptive approach. The dream of "Smart Cities" is the future of urban centers. "Smart Cities" will be using advanced, assimilated materials, networks, electronics and sensors which all will be interfaced to computer systems. These computerized arrangements would have decision-making algorithms, tracking systems and databases. All these arrangements will help to ensure secure and safe ecologically green cities as all water, transportation and power systems will

be centralized and connected by computerized systems. Discussion above proves the hypothesis and invalidates the null hypothesis. Environmental considerations remained contacted to urban planning one way or the other throughout the evolution of city planning.

Historical records are evident that environment is affected when human start to make settlements and towns developed emerge as areas with intensive footprints. Therefore, the environmental considerations have remained related with city planning in the form of circular evolution. The relationship is narrated below;

5.2.1. Historical Evolution of Human Civilization

Evolution of human civilization from -3000 years to -1000 years in the form of timeline is given in the figure below;

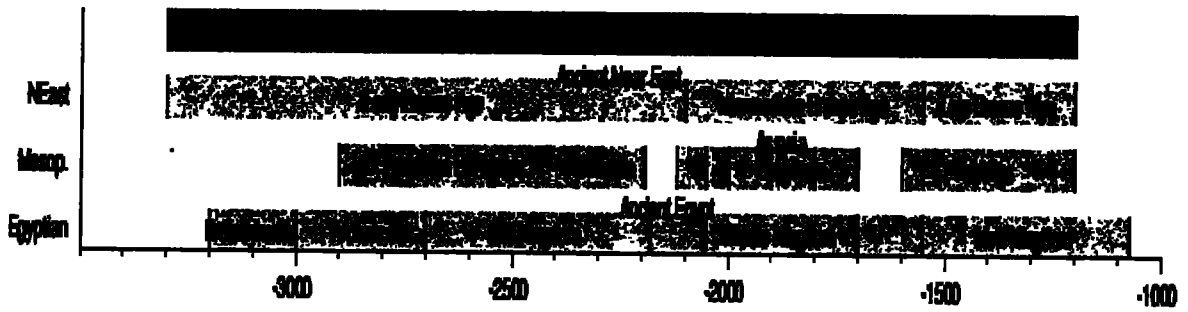

Figure 5.1:- Different Eras in Human History

Paleolithic era

Early stage of "The Stone Age", "Pleistocene epochs" and "Late Pliocene" are referred to as "Paleolithic era". It was first appeared in Africa and is featured by the sturdy development of stone gears. Other important features of this age is bone artifacts, antlers, engravings and paintings on rock shelters as well as caves walls. This era is divided into three stages: Lower, middle and upper Paleolithic (Christian *et al.*, 2014).

Mesolithic

It is an intermediate age between Paleolithic stage and Neolithic times. Mesolithic period is marked as transition phase between two ages. It is featured by hunting adaptation, fishing and collecting from the lakes, seashores and forests (Kozlowski, 2009).

Neolithic

Last stage of "Stone Age" is known as Neolithic. This era is characterized by the animal domestication, planned agriculture and manufacture of textiles and poetry. This era began in 9000 b.c. and ended up in 8000 b.c. It is marked as beginning of the bronze age (Hurwit, 1999).

Microlith

Geometric shaped platelets made of stones were first appeared in microlith era. These blades used to mount on wooden logs or used individually (Gordon, 1938).

Bronze Age

Bronze usage, early characters in urban civilization and proto-writings are remarkable features of "Bronze age". Among the three era system i.e "Stone-Bronze-Iron" system. Bronze age is middle in chronological order. The "three age system" was introduced by "Christian Jurgensen Thomsom" for classification of ancient times. In this era urban centers surrounded by politically attached communities had been developed. Civilizations had developed craft and trade. Agriculture had become economic base of that era. Dams were found at numerous places showing a well-developed "Water Management System" (Dickinson *et al.*, 1994).

Indus Valley timeline

Evolution of human civilization in Indus Valley in the form of timeline is given in the figure below;

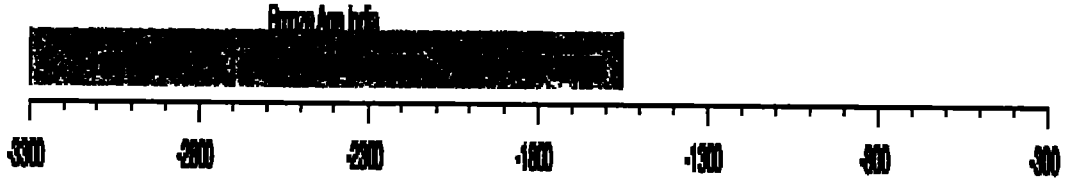

Figure 5.2:- Time Line of Indus Valley Civilization

Iron Age

Evolution of human civilization in the form of timeline is given in the figure below;

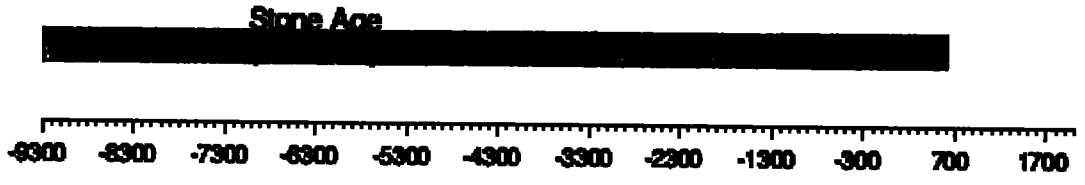

Figure 5.3:- Iron Age in History

This is the period of mankind history after the "Stone age" and Bronze Age". Remarkable feature of this period is formation and use of iron made weapons.

i. **Ancient Near East** During late 2nd millennium BC iron was discovered in Balkans, Caucasus and Anatolia. Smiting and smelting techniques were discovered and were marked as start of Iron Age in this part of world.

ii. **Europe** Iron age may have started in Europe from Caucasus and gradually spread west and southwards. It may have started in eleventh century BC and lasts for next 500 years.

iii. **Asia** Iron usage in China dated back to 600 BC.

iv. **Central Asia** Between ten and seventh century BC, utility of iron particularly in weapons started in area of Xinjian (Indo-European Saka). Oldest ruminants were found in "cemetery site of Chawuhukou"

v. **North Asia** Excavated artifacts have shown that Pazyryk is an archeological iron age culture. There were found mummified humans in Sibarian permafrost of "Mountain Atlay".

vi. **Indian subcontinent** Antiquity of metallurgy is dated back to second millennium BC. Ancient sites of India such as Lahuradewa, Malhar, and Raja Nala ka Tila had iron artifacts of 1800-1200 BC. Smelting of iron was extensively practiced in India after of start of "Indian iron age", as believed by the Rakesh Tewari [24].

5.2.2. Roots of the Environmentalism and Measurement Scales

During the study roots of the environmentalism were outlined in history. It is transpired while going through historical records that period of 1960s which is considered as advent of environmentalism is in fact reinvigoration of environmental movement because of measurement scale change.

Natural resources by human were vanquished for the first time in history for establishment of early human settlements. Over extraction from specific locations resulted into distortion of vistas. This visible scale deformation of nature was realized and was measured at visible scale.

Industrialization in the end of 18th century brought revolution in human life but with offshoots like noise, smoke, effluents and epidemics. These were realized and by measured wise judgment. This measurement method is given the name of sagacious scale in this study. Subsequent advancement makes it possible to work at micro scale. Extensive use of chemicals in Industrial processes as raw materials as well as finished product and ultimate exhaust these in open environment started generating toxic pollutants. Consumerism and mechanized extraction paved the path for exploitation of natural resources beyond carrying capacity of the planet. This pollution and over exploitation was recognized as environmental degradation and given the name of micro scale environmental movement in this study. Racheal Carson is considered as sphere head of this movement.

Highly sophisticated technologies have made possible to work at nano scale. Nano technology is the buzz word of the day. The detection and estimation of potential nano pollution is need of the hour.

There exist cause and effect relationship between urban form and environment. However, this relationship is two ways. Therefore, it is called as circular evolution. In the evolutionary history of the human race, humans used to live in jungles, hunt wild animals and eat fruits. They were inhabitants of caves. Incidental discovery of the fire remains the hallmark of shift towards civilization. Food insecurity and fear of wild animals forced then for planned agriculture and secured living in forms of houses and human dwellings.

They had started living in the form of small groups, started systemized farming, and systemized hunting. As inhabitant of cave and in personal capacity, a man was hunter of an animal or harvesting some fruits and vegetables or cutting small trees or bushes for clothing and shelter. Tribes, families and groups gave them strength, increased their food requirements and urge for food security for future. Thus, they started hunting more animals, clearing forest for farming and shelter and molding environmental conditions according to their requirements. Which created an appreciable difference to views and vistas of their natural surroundings. For establishment of early human settlements, natural resources were subjugated and subsequent over extraction resulted into distortion of vistas.

In present study, total time period under discussion was divided in to pre-60s and post 60s era. It was established that environmental considerations arouse in pre-historic era along with formation of the human settlements and kept on evolving depending upon available technologies and type of problem. Pre-60s witnessed the ascend of environmental movements as a solution to environmental problems of industrial revolution. These environmental movements kept on evolving along with the advancement in science and technology.

In nut shell, there has been found nexus between environmental change and urban form. However, definition of the environmental concerns kept on changing historically in every era in context of available scale of measurements.

5.3. Composite Approach for City Planning – A Paradigm Shift

In order to carve out environment friendly urban forms, such standards are required which increase number of trees as compared to existing ones by introducing new/improved urban ecology. An urban form that facilitates a life style leading to low carbon budget and encourages bicycles and pedestrians instead of hydrocarbons dependent vehicles. It should

discourage concrete jungle of buildings rather have more spaces for natural features like lakes, vistas, vegetation and sceneries.

The basic concept behind the Composite City Approach is that it warrants for flexibility despite of giving a pre-determined urban form to the city. Though, it sounds against the phenomenon of compactness, never the less, flexibility is ensured by formulating "Composite Plan". The plan will be considered alternate to the Master Plan., To achieve the goals of Composite Plan, action area plans with nomenclature of "Opus Plan" will be prepared, subsequently.

5.3.1. Composite Plan

The Composite Plan will act like the master plan. This plan will decide the future shape of an urban settlement. This plan will be formulated by following key steps:

i. Definition of goals and objectives
ii. Baseline studies (land uses, socioeconomic, traffic, industrial environmental conditions, community facilities, utilities & services,)
iii. Re-evaluation of goals and objectives
iv. Composite Plan

Composite plan consists of following elements:

i. Opus Plans
ii. Zoning and Sub-Division Plan
iii. Urban Ecology Plan
iv. Community participation Plan
v. Regulations and building by laws
vi. Implementation framework
vii. Stakeholder response
viii. Monitoring and feedback

The Composite Plan will give a "Spiral" shape to main body of city with alternate intermittent zones at nodes. The final form of the composite plan will feature Quad-tier transportation infrastructure, which will ensure the smooth connectivity between Intermittent Zones, Amenity Area and Facility Centre.

5.3.2. Why Spiral?

As mentioned earlier that Composite Plan will be developed upon a central artery, which will be planned in a Spiral shape to the city. The question arises that why Spiral? To

answer this question, we have to look back at the city approaches taken up in past. Listed down are the major city developing trends adopted in past.

i. Radio Centric City
ii. The Grid Iron City
iii. The Linear City
iv. Irregular City

And then there are some models which also theorize the city development approaches. These models include

i. Concentric Zone Model
ii. Sector Model
iii. Multiple Nuclei Model

All these city development approaches have their pros and cons. But here we are aiming for the ultimate sustainability of city. This can be attained if lesson is learnt from the mistakes committed in past. Hence, focus will be on the loopholes which are identified in above listed city approaches.

Radio Centric City are characterized by central traffic congestion causing flow problems in local traffic and difficult building sites. The Grid Iron City requires flow hierarchies, is limited to suitable terrain, has many intersections, quite monotonous and lacking aesthetics. Islamabad is an example of Grid Iron city. However, it is highly livable city but it requires clover leaf junction after every two kilometers to ensure the smooth circulation of traffic. Developing such junctions after every two kilometers is very costly and is not economically viable in long-term. The Linear City has exposure to easy blockage and gives less options for traffic circulations. Irregular city ensures aesthetics but it is not friendly in terms of free movement as there will always be the fear of getting lost. Concentric zone modal may restrict the development of certain models and is defied by commuter villages lying in the commuter zone. Causes the decentralization of the economic hub. The sector model was proposed for early cities of 20th century and does not take into account cars which are easiest way of commuting. While the Multiple Nuclei model neglects the abrupt divisions between zones and may not be totally applicable to oriental cities with specific background culture, politics and economics.

The spiral city has been proposed after learning lessons from these mistakes. The spiral city pattern will not address these loopholes but will also include the pros of these past approaches. The amalgam of benefits forms new spiral pattern and lessons learned from

past practices will surely produce such city which will not only promise highest quality of living but will also be sustainable.

5.3.3. Shape of the City

After discussing the pros and cons of past city approaches, the question is "What will be the shape of the city which will be developed on Composite Approach?" The answer is that the city shape will depend upon the natural topography of the city's location. The spiral main artery will be there and the shape of this spiral artery will also depend upon the topography and the natural features present in the location. The spiral can be continuous, semi continuous and may be irregular. For example; In case of plain and mountainous topography, the shape of city spiral will be linear and constant in plain region but the spiral curve will transform accordingly. The end result will be an amalgam of regular and irregular spirals.

The overall layout of the city may look irregular depending upon the natural topography but this irregular shaped city will have predetermined urban form. Which means irregular but planned as well as compact urban form. Through this approach, an irregular shape is given proper name of "Spiral Approach" same as the appropriate names given to the regular shapes.

5.3.4. Extension of Spiral

Another answer to the question "Why spiral?" is that extension of spiral is practically very easy. As the main hierarchy of the city will be spiral therefore in case of future extension of the city, the spiral will take the appropriate form according to the topography of future available land. This extension may change the shape of city in future. For example; if a city was built on plain topography and was exhibiting linear spiral then in case of future extension, the city hierarchy may not remain uniform due to the presence of hilly area which will deform the uniform spiral crests and troughs.

5.3.5. Opus Plan

The Opus Plan will be formulated to achieve the goals described in the Composite Plan and will function as "Action Area Plan". The Opus Plans will be prepared and enforced in the subsequent intermittent zones. The sole purpose of the Opus Plan will be to set down the framework for the sustainable, phased and managed development of the intermittent zone to ensure goals of composite plans.

5.3.6. City Skeleton

The Composite City Approach purposes a unique and innovative structure of the city unlike other development plans. By implementing the composite city approach, the city will metamorphose into a unique and aesthetic Spiral form. The shape of the spiral will depend upon the natural topography of the city terrain. The city will contain quad-tier transportation infrastructure which will characterize a main spiral artery which will be accompanied by alternate intermittent zones on each side.

The nodal point of the zone and the spiral artery will serve as the location of the "Facility Centre" having multi-use high rise buildings with the parking plaza. Each intermittent zone will feature "Amenity Area" which will be connected to the main spiral artery via vehicular road. Each zone will feature spiral public walkways to enable circulation for the local dwellers.

5.3.7. Transportation Network

The city will contain quad-tier transportation infrastructure i.e. low flying zones, spiral public avenues, link roads and pedestrian streets. There will be one main spiral artery circulating through the center of the city. The connectivity of the zones with the main artery will be ensured via single vehicular road which will be accompanied by a horizontal escalator. Within the zones, pedestrian movement will be maximized through spiral public walkways.

5.3.8. Inverse Architecture

Within the residential zones, the innovative concept of flying zones will be implemented. The housing units will have double storey with car porch on third floor. This proposition of car porch on the third floor will justify the concept of low flying zones. The city exhibiting the Composite Approach will not be having normal vehicles but instead it will have Flying Cars as major commuter source. Yes! you read it right, "Flying Cars".

The concept of flying cars was first originated in 2006 by some young and ambitious graduates of MIT. As of now, the concept of flying cars is not just a theory but it has evolved into reality in the form of futuristic flying car goes by the name of "Terrafugia". The Composite Approach will revolutionize the transportation system by creating new dimension of personal freedom for the dwellers. To avoid any unfortunate event by usage of these flying cars, at first this service will not be used in bulk but will only be used as public transport in the form of Taxis.

These futuristic cars are able to take off vertically hence eradicating the need for the runway. The introduction of Terrafugia in the community will considerably reduce the harmful impacts of vehicular emissions on public health. As mentioned earlier that car porch will be designed on the third floor of the dwelling unit therefore any vehicular emission will be dispersed on a higher altitude without coming directly in contact with the dwellers. The dwelling units will have lifts which will be used to gain access to car porches. Introduction of lift will ease the mobility of elders and disables.

5.3.9. Supporting Road Infrastructure

The overall commuting system proposed in Composite City Approach will promote pedestrian movement. The nodal points of the intermittent zones serving as the Facility Centers will have multi story parking plazas. The dwellers of the residential zones will park their cars in the parking plazas and will cover the rest of the distance from the parking lot to dwelling unit on foot. The distance between the parking plaza and the residential zone will be maintained at standard of 10 minutes. This 10-minute walk from the parking plaza to housing unit will be encouraged by designing beautiful and aesthetic spiral walkways. Moreover, for enhanced circulation within the zones, cycling lanes will be provided. Dwellers can use their own cycles and also to encourage this cyclic maneuvering, cycles equipped with trackers will be placed at cycle stands under the contract by a company which can be used by paying a certain amount of fare.

The concept of effortless movement will be molded into reality by the provision of the horizontal escalators along the secondary lane connecting the main spiral artery. The street width will be kept enough to allow the movement of two vehicles in a single lane in case of emergency situations.

5.3.10. Zoning

Instead of going for typical zoning as proposed by the city approaches mentioned in 2.2, the Composite City Approach preaches the concept of the Intermittent Zoning. As mentioned earlier that the major skeleton of the city will be spiral based, therefore, each crest and trough of the spiral will accommodate an Intermittent Zone.

As the name clarifies that Composite City featuring intermittent zoning will have zones designed at gradual intervals. The residential and non-residential zones will be placed at respective crests and troughs of the main spiral artery. The reason behind the intermittent residential and non-residential zones is to promote easy accessibility for the city dwellers.

5.3.11. Residential Zones

Unlike previous zoning practices, in Composite approach, there will no clear cut categorization of zones. The concept of heterogeneous zoning will be followed. This means that zones will be intermingled with each other. A residential zone will be surrounded by the zones of multiple nature. The residential zone will be centered with zones of multiple nature surrounding it. The idea behind this is that the people will not have to a whole new zone for daily routine.

Software (Policies and management tools) used to control environmental pollution in cities are like new soft wares run on old hard wares. Which may address an area of concern but prove to be burden on other aspects of city life. New proposed urban form will increase the bio-capacity of the urban form. Proposed green spaces would not be like the green spaces proposed by the "Friends of Utopians". Rather it will along with other measures (Section 1.13) help to control the ecological footprint of consumption to avert the local overshoot. Thus, space utilization will remain economized despite inclusion of environmental friendly measures.

Rather than improving city infrastructure investment is being made on technology. The technology is replaced by the new one in very short period. Which may become an economic burden. Better to invest major part of resources on improvement of urban form components and city infrastructure upgrading to make it more resilient instead of making the cities mere technology ridden (section 2.11).

The city will contain quad-tier transportation infrastructure i.e. low flying zones, spiral public avenues, link roads, pedestrian streets;" Intermittent Zoning", "Amenity Area" providing necessities and "Facility Centre" having multi-use high-rise buildings with parking plaza. Inverse architecture for B+G+3 house abating pedestrian streets with walking, cycling, skating lanes will emerge an "inventive urban form". Economic, Environmental, social and institutional indicators are proposed to be examined in context of resource utilization. The indicators represent a primary tool to provide guidance for policy makers and to potentially assist in decision-making and monitoring local strategies/plans. The outcome of the study will contribute to the design of policies, tools, and approaches essential for planning to attain the goal of sustainable development and the social cohesion of metropolitan regions.

5.4. Recommendation

i. The New urban form which has been devised (section 5.3) here requires advanced level research on its every component in order to test and gauge its level of environment friendliness.

ii. Research on investment on improvement of urban form will have better value of money than the investment on mere incorporating the technology in the city.

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Annex-1

Questionnaire for Expert Opinion
For PhD Research
An Analysis of Nexuses between Evolution in Urban Form and Environmental Change

Study Introduction; People has to adopt urban living for batter life style. Which has resulted into expansion of existing urban areas and establishment of new cities. New problems like ecological disturbance, greenhouse effect, ozone depletion, heat islands, urban flooding, air/soil/water pollution, indoor toxins emerged. Whereas, small-scale individual changes in environmental factors have been translated with the passage of time into mega shifts in natural environment. Followings are the objectives of the study:

iv. To evaluate and asses the pre-1960s and post-1960s urban forms in order to identify any relevance given to environmental considerations
v. To identify the nexus between evolution of urban form and environment, if there is any.
vi. Based on the above, identify and suggest parameters for sustainable urban form.

The Hypothesis of the research is; Environmental Considerations have remained in backdrop of city planning.

Rational for the questions;

First question is about type of transportation system required for environmental friendly urban planning. Second question deals with the law and policy for a desirable city design. Third, fourth and fifth address the development, structure and component of an innovative urban form.

Whereas, question six to thirteen highlights the important aspects of the environmental dynamic. It aims to inquire the environmental know how of the people. Identifies the important and most concerning areas of environment. It also categorizes the responsibilities of masses and individuals for development of better/welfare community.

Questionnaire

Part 1: information about focus group
Serial no:
Name, profession and experience of the participant:

_____
_____
_____
_____
_____

Place of Meeting:_____
_____

Date of Meeting:_____
_____

Part 2: Questions

Note; Please rank the option by giving percentage out of hundred to each option.

Q 1: what sort of transportation systems be device for an environmental friendly urban form? (Contribution of transportation system to make the urban form EF = _____ %)

a. Current conventional patterns with batter arrangements.
b. Conventional pedestrian streets and precincts should be incorporated in current patterns
c. Four tear transportation system with spiral arteries.

Q2: which sort of bye laws be batter for an environmental friendly urban form? (Contribution of bye laws to make the urban form EF = _____ %)

a. Architecture in vogue with batter arrangements.
b. Conventional mutual architect which has been consider as weather resistant
c. Inverse architecture

Q3: Which option of zoning is more environmental friendly? (Contribution of Zoning system to make the urban form EF = _____ %)

a. Rigid zoning e.g. Islamabad.
b. Without zoning e.g. Lahore.
c. Purposed intermittent zoning

Q4: Which sort of plan can be more practical/acceptable/result oriented? (Contribution of urban plan to make the urban form EF = _____ %)

a. Master planning
b. Structure planning
c. Need for some innovation

Q5: Pattern of main skeleton/arteries (main road network) of the city? (Contribution of transportation system to make the urban form EF = _____ %)

a. Regular plan
b. Geometrical shape
c. Irregular streets
d. Some patterns can/can't be regular but gives convenience e.g. spiral.

Q6: which one is most important for development of a welfare society? (Importance of environmental sustainability and urban form to make the urban form EF = _____ %)

a. Environmental sustainability
b. Urban form
c. Both a & b
d. Any other?

Q7: In above given urban form, which one do you think would be least carbon emitting urban form? (Contribution of transportation system to make the urban form EF = _____ %)

a. Conventional Urban form
b. Conventional urban form with modification
c. Any other

Q8: Natural resource conservation is important to what extent? (Contribution of natural resource conservation to make the urban form EF = _____ %)

a. Most important
b. Not important at all
c. Important but there are other (economy, agriculture etc) factors that's counts for

Q9: Are you aware of 4R's (Reduce, reuse, recycle, recover) of solid waste management? Contribution of solid waste management to make the urban form EF = _____ %)

a. I know it
b. 2. I know it to some extent.
c. I don't know.

Q10 which one is most important to you out of sustainability dynamics given below? (contribution of sustainability dynamics to make the urban form EF = _____ %)

a. Environment
b. Energy
c. Economy
d. Society

Q11: Do you agree with contents and benchmarks of MDG's (Millennium Development Goals)? (Contribution of MDG's to make the urban form EF = _____ %)

a. Yes, I agree.
b. To some extent
c. I don't agree
d. I don't know about MDGs

Q12: how would your categories extent of pollutant in soil, water and air. (Contribution of environmental pollutant to distort the urban form's environmental friendliness = _____ %)

a. Good
b. Average
c. Poor
d. Very poor

Q13: Who's prime responsibility does you think is to treatment environmental pollutants? (Contribution of treating environmental contaminants to make the urban form environmental friendly = _____ %)

a. Individuals
b. Government.
c. Government and individuals
d. Any other

Questionnaire for Focus Group Discussion
For PhD research
An Analysis of Nexuses between Evolution in Urban Form and Environmental Change

Study Introduction; People has to adopt urban living for batter life style. Which has resulted into expansion of existing urban areas and establishment of new cities. New problems like ecological disturbance, greenhouse effect, ozone depletion, heat islands, urban flooding, air/soil/water pollution, indoor toxins emerged. Whereas, small scale individual changes in environmental factors have been translated with the passage of time into mega shifts in natural environment. Followings are the objectives of the study:

vii. To evaluate and asses the pre-1960s and post-1960s urban forms in order to identify any relevance given to environmental considerations

viii. To identify the nexus between evolution of urban form and environment, if there is any.

ix. Based on the above, identify and suggest parameters for sustainable urban form.

The Hypothesis of the research is; Environmental Considerations have remained in backdrop of city planning.

Rational for the questions; First question is about the urban form. Second question is to know the soundness of the urban form. Third and fourth question will reveal about environmental consideration in the urban form. Last two questions are about environmental sensitization and regulatory framework if there was any.

Questionnaire

Part 1: information about focus group
Serial no:
Name, profession and experience of the participants:

_____

Place of Meeting: _____

Date of Meeting: _____

Part 2: Questions

Q 1: What is your views about urban form of the city for example street patterns, width of streets, placement of different land uses like residential, commercial, work place, open spaces?

_____

Q 2: Do you think infrastructure (water supply, roads, sewage, security arrangements, public places, recreational facilities including parks etc) of the city was adequate to fulfil the needs of the residents in all season?

Q 3: Was infrastructure capable to provide shelter in extreme events like too hot summer, too cold winter, fire incidences, heavy rains, thunderstorms, floods, wind storms?

Q 4: What was mechanism of solid waste management and waste water disposal?

Q 5: Was there realization about environmental pollutants like dust or smoke in air, contamination is water and soil? In case of such pollution how people and city authorities used to react?

Q 6: It is established from literature review that raw materials were extracted from jungle and skins, furs extracted from animals to fulfill human needs. Was there any arrangement or mechanism to given due chance and time to get replenished the nature?

Note: This Performa had been designed to study pre 1960s urban form.

Questionnaire for Expert Opinion
For PhD Research
An Analysis of Nexuses between Evolution in Urban Form and Environmental Change

Study Introduction; People has to adopt urban living for batter life style. Which has resulted into expansion of existing urban areas and establishment of new cities. New problems like ecological disturbance, greenhouse effect, ozone depletion, heat islands, urban flooding, air/soil/water pollution, indoor toxins emerged. Whereas, small-scale individual changes in environmental factors have been translated with the passage of time into mega shifts in natural environment. Followings are the objectives of the study:

i. To evaluate and asses the post-1960s urban forms in order to identify any relevance given to environmental considerations
ii. To identify the nexus between evolution of urban form and environment, if there is any.
iii. Based on the above, identify and suggest parameters for sustainable urban form.

The Hypothesis of the research is; Environmental Considerations have remained in backdrop of city planning.

Rational for the questions; First question is about the urban form. Second question is to know the soundness of the urban form. Third and fourth question will reveal about environmental consideration in the urban form. Last two questions are about environmental sensitization and regulatory framework if there was any.

Questionnaire

Part 1: information about expert
Serial no:
Name, profession and experience of the participants:

_____
_____
_____
_____
_____

Place of Meeting:_____
_____

Date of Meeting:_____
_____

Part 2: Questions

Q 1: How environmental changes have influenced the urban form (on street patterns, width of streets, placement of different land uses like residential, commercial, work place, open spaces) of city? **(Contribution of transportation system to make the urban form EF =** _____ **%)**

_____
_____

_____
_____
_____

Q 2: How environmental changes have influenced the infrastructure (water supply, roads, sewage, security arrangements, public places, recreational facilities including parks etc) of the city? **(Contribution of transportation system to make the urban form EF = _____ %)**

Q 3: How environmental changes have influenced the capacity and capability of infrastructure to provide shelter in extreme events (like too hot summer, too cold winter, fire incidences, heavy rains, thunderstorms, floods, wind storms)? **(Contribution of transportation system to make the urban form EF = _____ %)**

Q 4: How environmental changes have influenced the mechanism of solid waste management and wastewater disposal? **(Contribution of transportation system to make the urban form EF = _____ %)**

Q 5: How environmental changes have influenced the realization about environmental pollutants like dust or smoke in air, contamination is water and soil? In case of such pollution how people and city authorities used to react? **(Contribution of transportation system to make the urban form EF = _____ %)**

Q 6: How environmental change has influenced (stopped) the use of raw material extracted from nature? **(Contribution of transportation system to make the urban form EF = _____ %)**

Note: This Performa had been designed to study post 1960s urban form.

Annex-II

List of Respondents

Sr. No.	Respondent Name	Designation	Organization
1.	Tauqeer Iqbal	TOPNC	Tehsil Silan wali
2.	Muhammad Hayat	TOPNC	Tehsil Sargodha
3.	Muhammad Nawaz	Putwari	Tehsil Sargodha
4.	Khurshid Ahmad	TOPNC	Tehsil Shujabad
5.	Awais Serwar	TOPNC	Tehsil Multan
6.	Zia Bukhari	Tehsildar	Tehsil Multan
7.	Muhammad Arshad	Manager Technical	FIEDMC
8.	Nazir Ahmad	DG Land	FIEDMC
9.	Farooq Ahmad	TOPNC	Tehsil Faisalabad
10.	Ejaz Ahmad Sheikh	Director Urban Planning	CDA, Islamabad
11.	Ammara Waheed	Environmentalist	Elan Partners ISB
12.	Ghizwan Shamshad	Director Environment	CDA, Islamabad
13.	Dr. Abdul Waheed	Asstt Professor	NUST, Islamabad
14.	Mubror Hussain	Visiting Faculty	IIUI, Islamabad
15.	Muhammad Arshad Chuhan	Project Director	Housing Foundation
16.	Rizwan Ur Rehman	Manager Planning	Urban Unit Lahore
17.	Muhammad Asad Doger	Dy. Director Planning	LDA, Lahore
18.	Muhammad Azhar	Director Planning	LDA, Lahore
19.	Dr. Fareeha Tariq	Assitt Professor	UMT, Lahore
20.	Muhammad Adnan	TOPNC	Tehsil Gujranwala
21.	Muhammad Nazar	Dy. Director	EPA Gujranwala
22.	Umar Daraz	Inspector	EPA Gujranwala