REPUBLIC OF TÜRKİYE

YILDIZ TECHNICAL UNIVERSITY

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

A METHODOLOGY PROPOSAL FOR PHASING OF URBAN REGENERATION PROJECTS: LAHORE CASE

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MASTER OF SCIENCE THESIS

Department of City and Regional Planning

Urban Conservation and Planning Program

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A thesis submitted by Muhammad AHSAN in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE is approved by the committee on 16.06.2023 in Department of City and Regional Planning, Urban Conservation and Planning Program.

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Muhammad AHSAN

Signature

This study is self-financed and has not been supported by any funding agency.

Dedicated to my family.

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LIST OF ABBREVIATIONS

ASS	Average Stress Score
AWI	Average Weightage Index
BD	Building Density
CSS	Cumulative Stress Score
CWI	Cumulative Weightage Index
FAR	Floor Area Ratio
GIS	Geographic Information System
IDW	Inverse Distance Weightage
LDA	Lahore Development Authority
MDG	Millennium Development Goals
ME	Mean Error
MSE	Mean Square Error
PKR	Pakistani Rupees
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
QOL	Quality of Life
QOP	Quality of Place
RI	Road Infrastructure
RMSE	Root Mean Square Error
SDG	Sustainable Development Goals
SS	Social Services
TOD	Transit Oriented Development
UF	Urban Furniture
UN Habitat	United Nation Habitat

US	Utilities Services
UTPs	Urban Transformation Projects
WCL	Walled City of Lahore
WCLA	Walled City of Lahore Authority
WHO	World Health Organization
WI	Weightage Index

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ABSTRACT

A METHODOLOGY PROPOSAL FOR PHASING OF URBAN REGENERATION PROJECTS: LAHORE CASE

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Since the 1980s, urban regeneration has focused on revitalizing the dilapidated and unhealthy illegal settlements to make them livable, sustainable, and economically viable. The spatial extent of regeneration projects varies from a small building or a street to a neighborhood or large urban block. To avoid technical and financial issues, large and complex regeneration projects are being implemented in multiple phases. In the scientific literature, few studies have formulated quantitative based methodological frameworks that focus on ranking the different project sites, however it lacks to provide a comprehensive framework which can be utilized for zoning the complex and large-scale regeneration projects into multiple phases for its multiphase implementation. Therefore, in order to bridge this gap, this research study aims to formulate a comprehensive framework which will act as an efficient tool to divide the large-scale regeneration project areas into multiple phases, based on multi-indicator analysis, for the effective multiphase project implementation. The proposed comprehensive framework comprises three main stages: pre-

requisites, operationalization, and finalization. To understand the implementation mechanism of this proposed framework, Bao wala (a large scale) informal settlement from Lahore metropolitan area in Pakistan has been selected as case study area. Following that, sample size of the settlement was calculated by using Slovin's formula. The socio-economic survey of the settlement was conducted based on random and proportionate sampling techniques. To conduct socio-economic surveys, a structured questionnaire was prepared. For multi-indicator analysis, five leading indicators including building densities, utilities services, road infrastructure, urban furniture, and social services were selected which were further divided into twenty-nine-sub indicators. Regression analysis was applied to understand the relationship between dependent and perceived variables, at the same time stress score was calculated from analyzed data multiplied by the weightage index to quantify the cumulative stress score. On the synthesized quantitative and spatial data, IDW (Inverse Distance Weighted) analysis technique was applied for zoning Bao wala settlement area into multiple phases. The primary result of this study shows that respondents have expressed extreme dissatisfaction with the provision and maintenance of all services in the locality, whereas, out of 29, twenty-five perceived indicators have significant impact on the quality of life of the settlement. Based on cumulative stress score coupled with IDW analysis, Bao wala settlement has been zoned into three, four and five phases, based on which the project can be implemented in short-, mid- and long-term time spans. The fundamental results illustrate that with the help of proposed framework of this study, any case study area be zoned into multiple phases based on their spatial extent, complexity, and necessity of number of phases.

Keywords: Urban regeneration, multiphase project implementation, slums, proposed framework, Lahore.

ÖZET

KENTSEL YENILEME PROJELERININ ETAPLAMASINA YÖNELIK YENI BIR YÖNTEM ÖNERISI: LAHOR ÖRNEĞI

Muhammad AHSAN

Sehir Bölge Planlama Bölümü

Yüksek Lisans Tezi

Danışman: Prof. Dr. Buket Ayşegül ÖZBAKIR ACIMERT

1980'lerden bu yana, Kentsel dönüşüm stratejisi, harap olmuş ve sağlıksız kaçak yapılaşma alanları yaşanabilir, sürdürülebilir ve ekonomik olarak uygulanabilir kılmak için yeniden canlandırmaya odaklanmıştır. Yenileme projelerinin mekansal kapsamı, küçük bir binadan veya bir sokaktan bir mahalleye veya büyük kentsel adalara kadar değişir. Teknik ve mali sorunlardan kaçınmak için, büyük ve karmaşık yenileme projeleri birden fazla aşamada uygulanmaktadır. Bilimsel literatürde, farklı proje alanlarını sıralamaya odaklanan kantitatif tabanlı metodolojik çerçeve formüle eden çok az çalışma vardır, ancak bu, karmaşık ve büyük ölçekli yenileme projelerini çok aşamalı olarak birden çok aşamaya bölmek için kullanılabilecek kapsamlı bir çerçeve sağlamaktan yoksundur. Bu nedenle, bu boşluğu kapatmak için, bu araştırma çalışması, etkili çok aşamalı proje için, çok göstergeli analize dayalı olarak, büyük ölçekli yenileme proje alanlarını birden fazla aşamaya bölmek için etkili bir araç olarak hareket edecek kapsamlı bir çerçeve formüle etmeyi amaçlamaktadır. Önerilen kapsamlı çerçeve üç ana aşamadan

oluşur: ön koşullar, operasyonelleştirme ve sonuçlandırma. Pakistan'ın Lahor Metropolitan Alan Sınırları içerisinde Bao wala isminde büyük ölçekli bir kaçak yerleşim alanı vaka çalışması olarak belirlenmiştir. Ardından Slovin formülü kullanılarak yerleşimin örneklem büyüklüğü hesaplanmıştır. Tesadüfi ve orantılı örnekleme tekniğine dayalı olarak, yapılandırılmış anket formu üzerinden yerleşim yerinin sosyo-ekonomik araştırması yapılmıştır. Çoklu gösterge analizi için, bina yoğunlukları, altyapı hizmetleri, yol altyapısı, kent mobilyaları ve sosyal hizmetler dahil olmak üzere yirmi dokuz alt göstergeye ayrılan beş öncü gösterge seçilmiştir. Bağımlı ve algılanan değişkenler arasındaki ilişkiyi anlamak için regresyon analizi uygulanmış, analiz edilen verilerden stres puanı hesaplanmış ve kümülatif stres puanını ölçmek için ağırlık indeksi ile çarpılmıştır. Sentezlenen nicel ve mekansal veriler üzerinde, Bao wala yerleşim alanını birden fazla aşamaya bölmek için IDW analiz tekniği uygulanmıştır. Bu çalışmanın birincil sonucu, yanıt verenlerin bölgedeki tüm hizmetlerin sağlanması ve sürdürülmesinden aşırı memnuniyetsizlik ifade ettiğini, oysa algılanan 29 göstergeden yirmi beşinin yerleşimin yaşam kalitesi üzerinde önemli bir etkiye sahip olduğunu göstermektedir. IDW analiziyle birleştirilmiş kümülatif stres puanına dayalı olarak Bao wala yerleşimi , projenin kısa, orta ve uzun vadeli zaman dilimlerinde uygulanabileceği temel alınarak üç, dört ve beş aşamaya ayrılmıştır . Temel sonuçlar, bu çalışmanın önerilen çerçevesinin yardımıyla, herhangi bir vaka çalışması alanının, uzamsal kapsamlarına, karmaşıklıklarına ve aşama sayısının gerekliliğine dayalı olarak birden fazla aşamaya bölünebileceğini göstermektedir.

Anahtar Kelimeler: Kentsel dönüşüm, çok aşamalı proje uygulaması, gecekondular, önerilen çerçeve, Lahor.

1
INTRODUCTION

1.1 Introduction

In the 21st century, both the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) have aimed to create societies that are more sustainable, equitable, and prosperous while enhancing the access to education, healthcare, and clean water, promoting sustainable development practices and reducing poverty and inequality. However, in the real time scenario, rather having inclusive cities, two distinctive kinds of human settlements prevail in the cities of developing and under-developed countries. The first kind of human settlements have modern planned housing and robust buildings (Buys et al., 2021), access to safe drinkable water, proper sanitation, sewer and waste disposal facilities (Marzouk & Othman, 2020), integrated road network and accessibility to public transport (Budi Utami & Susetyo, 2017), access to education and leisure activities, adequate public spaces and community facilities, sufficient availability of parks and open spaces (Aulia & Suryani, 2021), secure livings, and inclusiveness (UN Habitat, 2010) etc. In the scientific literature, these settlements as often known as planned settlement (Budi Utami & Susetyo, 2017), master planned communities (Alidoust & Bosman, 2017; Buys et al., 2021), new town (Keeton & Nijhuis, 2019), or gated communities (Grant & Mittelsteadt, 2004; Jacob & Chander, 2020) etc. However, another segment of society possesses the fragile housing structure (Mohana Gayatheri & Chennakrishnan, 2019), bad quality of drinkable water, poor sanitation and sewer facilities, open disposal of solid waste management (Ray, 2017; UN-Habitat, 2004), inadequate open spaces (Taher & Ibrahim, 2014), least access to education, health and other communal services (Joulaei et al., 2014; Ray, 2017), unpaved roads and lack of street infrastructure (Ray, 2017), minimal security, and lack of security of tenure (UN-Habitat, 2004) etc. In the wide range of literature, these communities are often defined as informal settlements (Arefi, 2018; Arif et al., 2022), slums (UN-Habitat, 2004), squatter settlements (Taher & Ibrahim, 2014; Ulack, 1978), shanty towns (Ni et al., 2015), unplanned or spontaneous settlement (Aditantri et al., 2019), dilapidated communities (Arefi,

2018), or self-help settlements (Ward, 2015). These settlements also have the indigenous names in various countries across the world. In Latin Amercia, such settlements are named as barrios pirates; in Brazil called as favelas; in Türkiye as gecekondu; in Argentina labelled as villas miseries; in Peru as Pueblos jóvenes; and in Venezuela known as ranchos; and in South Africa as bidonville; however, in the global south these settlements are attributed as kampung in Indonesia; jhuggis, jhonpri or bustees in India and katchi abadies in the context of Pakistan (Arif et al., 2022; Payne, 2014).

Empirical evidence from literature has disclosed that an extensive share of the world's population continues to live in slums, served with dilapidated facilities. According to an estimate of UN Habitat report, in 2015, about 25% (one quarter) of world's population was inhabited in slums which is approximate to one billion slum inhabitants (UN-Habitat, 2020); however, this proportion has continued to aggravate further. Across the world, just in past 3 decades (since 1990), 213 million dwellers have further been added to the slum's population (United Nations Habitat, 2015). It is estimated that, based on the persistent proliferation of informal settlements, the number of people living in slums will nearly be 2 billion by 2030 and 3 billion by 2050 (UN-Habitat, 2020).

In the one billion inhabitants of world's slum population, a predominant proportion of 881 million population lives in informal settlements of developing world, which was escalated from 689 and 791 million residents in 1990 and 2000, respectively (United Nations Habitat, 2015). Important thing to mention here is that about 50% of world's slums dwellers are still residing in the Asia-Pacific region of global south (Arif et al., 2022; UN-Habitat, 2004). Just in Asia, 30% of urban population is living in slums and informal areas; however, in Africa, this proportion is even worse, where more than half of urban population (61.7%) is residing in slums, which is estimated to escalate from 400 million to 1.2 billion by 2050 (United Nations Habitat, 2015).

This vast expansion of informal areas on the globe is often depicted as a shelter crisis (Lombard, 2014). Among many reasons, behind the creation and escalation of informal settlements in the global south, few significant explanations are mentioned here. Rural to urban migration in the developing world sparked due to expeditious evolution of cities (Guo & Qiao, 2020). This phenomenon has lessened

the access to adequate urban housing for labor class, resultantly they tend to move to informal areas to seek unauthorized shelter near to the employment opportunities (Ahsan, 2019). Secondly the economic boom in the cities has also triggered the migration effect (Black et al., 2011) which forced poor people to live in dilapidated areas. Furthermore, rapid urbanization helped the slum areas to grow faster due to immense economic, physical, and social inequalities (Jorgenson et al., 2010).

Over the times, governmental institutes have adopted several distinct strategies to enhance the living standard of the population living in slums and informal settlements, which is considered as a response to urban informality. In the infancy, site clearance policy was adopted by the government institutes in which the informal and slum areas was demolished and the property right was again transferred to the original landlords (Jones, 2010). This policy depicted the complete ignorance of such areas in the governmental upgrading plans and treated as never served areas. However, considering the challenges of worldwide urban housing, the governments and other affiliated institutes started to acknowledge the existence and importance of informal settlements. Distinct approaches were adopted by government institutes in different time eras with unique aim to objectives, such as, Reconstruction in 1950s, Revitalization in 1960s, Renewal in 1970s, Redevelopment in 1980s and Regeneration in 1990s (Roberts, 2017).

To avoid future problems with immediate effects, urban regeneration as a strategic activity was started to be utilized in the 1990s. At the start, primitive focus of urban regeneration strategy was to enhance the physical attributes of built environment, however the approach changed with time and social, environmental, and economical attributes are also incorporated (Smith, 2012). This strategy mainly focusses on setting the priorities that need to be achieved in a particular set of time and resources.

With its potential to resolve the factual problems, urban regeneration strategy is being implemented on varied set of spatial scales, starting from a street or a neighborhood to a large town or a city (Grodach & Ehrenfeucht, 2015). Bigger the spatial extent of urban regeneration project has benefitted larger communities; however, it also makes it a bit complex and complicated. Large scale complex and complicated regeneration projects faced some technical, legal, and to a larger extent financial problems, as the regeneration intervention increases the availability of

financial resources started to shrink (Cilona & Granata, 2015a; Moore-Cherry & Vinci, 2012). Therefore, in the implementation framework of several regeneration projects, the project site has been divided into numerous phases for the multiphase implementation of such projects (few exemplary international and national regeneration projects are discussed in the literature review chapter). However, the implementation mechanism of large-scale regeneration projects are silent on the methodological part that how several phases are derived to achieve multiphase implementation strategy. Moreover, in the scientific literature, no scientific study has been conducted which primarily describes the framework of phasing the regeneration project site for its multiphase implementation.

Therefore, to bridge this research gap, this study is intended to formulate a holistic framework which will help the project implementing agencies and authorities to phase out the complex, significant and complicated regeneration projects into several phases, based on multi-indicator analysis, for its multiphase implementation.

1.2 Problem Statement / Justification

Since the free developable land, particularly at the outskirts of urban fringe areas, has become the scare resource, the urban development policies have been shifted from converting green spaces into concrete places toward urban regeneration of brownfield areas with the focus to resuscitate the dilapidated and decaying communities (Pizzol et al., 2016). In the historical ages, such deteriorated communities, particularly consisting of slums and squatter settlements, were either ignored or demolished in the urban development plans (Jones, 2010) however the worldwide housing challenges acknowledge their existence to meet the housing backlog. Therefore, to revive the social, economic, environmental, and physical dimension of such deteriorated areas, urban regeneration has become an important strategy with the aim to alleviate the poverty and build sustainable environment in the locality to enhance economic structure and quality of life (Loftman & Nevin, 1995). Urban regeneration projects are being implemented on both small and large spatial scales, however the diverse problems associated with the implementation of complex and large-scale urban regeneration projects has caused multiple difficulties for governmental institutions. Among many other obstacles, insufficient

technical and financial resources are prominent causes which instigated the issues in the implementation of urban regeneration project (Korkmaz, 2015).

In the back times, policy makers, urban planners and investors etc. faced hurdles in selecting an appropriate project site for urban regeneration projects. To overcome this issue multiple quantitative methodological frameworks have been formulated such as hesitant fuzzy linguistic TOPSIS methodology used by Oztaysi et al., (2016) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) used by Cilona & Granata (2015) and Juan et al., (2010). These frameworks are particularly focused on ranking the different alternative project sites, to select an appropriate project area for regeneration projects (discussed in detailed in literature review section). However, scientific literature lacks to provide a comprehensive framework which can be utilized to phase the complex and large-scale regeneration projects for its multiphase implementation. The traditional practices of subdividing the project area into multiple phases are being carried out without any comprehensive framework. In the project carried out by Walled City of Lahore Authority (WCLA) of Pakistan, the project area was divided into several phases based on traditional approach, starting phasing from one side to other, which completely ignored the intensity of problems and issued in particular area which needs to be prioritized first. To have a practical understanding of the problem statement in an effective manner, a hypothetical scenario is demonstrated in Figure 1.1 which is conceived from the study of Oztaysi et al., (2016). In the study of Oztaysi et al., (2016), Istanbul metropolitan is selected as case study area and four different Urban Transformation Projects (UTPs) alternatives are ranked which includes Galata, Tarlabasi, Fener - Balat –Ayvansaray and Esenler. These alternatives were ranked based on multi-indicator analysis and results depicted the Esenler as best alternatives project site for regeneration project, followed by Tarlabas¸ Galata and Balat (illustrated in Figure 1.2). However, it is essential to mention that the Esenler project area is comprised of 447,000 population and extended on a large geographical extent (Population, 2021), therefore, for an efficient implementation of urban transformation project in Esenler, the area is further needed to be subdivided into multiple phases, which is not elucidated in this study.

With the primitive aim to fill the research gap discussed in previous sections, this research work is intended to formulize a comprehensive framework which will provide a detail methodology for subdividing the project area into multiple phases for the multiphase implementation of urban regeneration project. Furthermore, besides formulating the quantitative framework, this study will also syndicate the quantitative and spatial analytical techniques (by using Geographic Information System (GIS) and other remote sensing applications) to not only empirically phase the project areas but also to delineate its spatial boundaries.

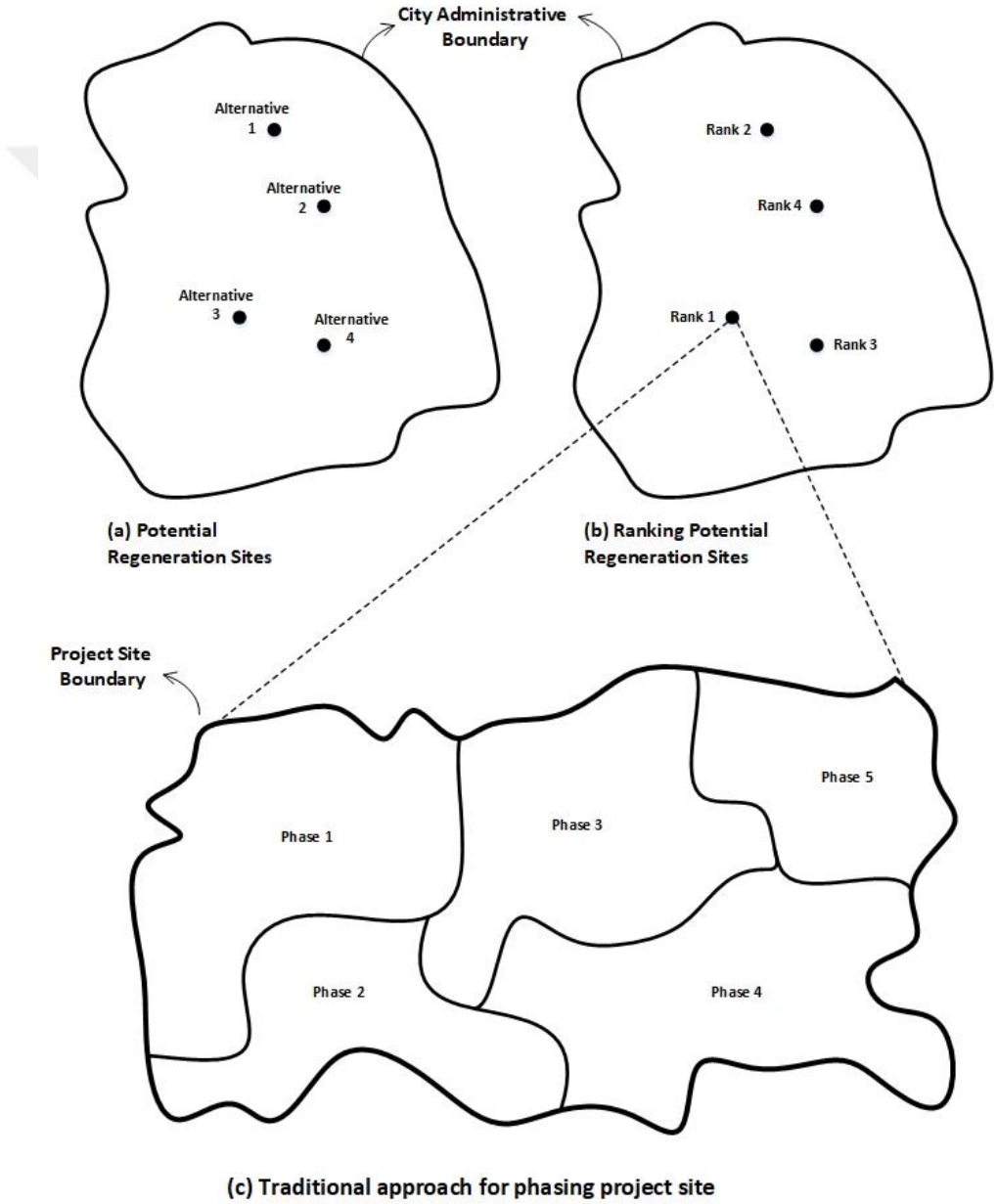

Figure 1.1 Hypothetical scenario of problem statement

Source: Author

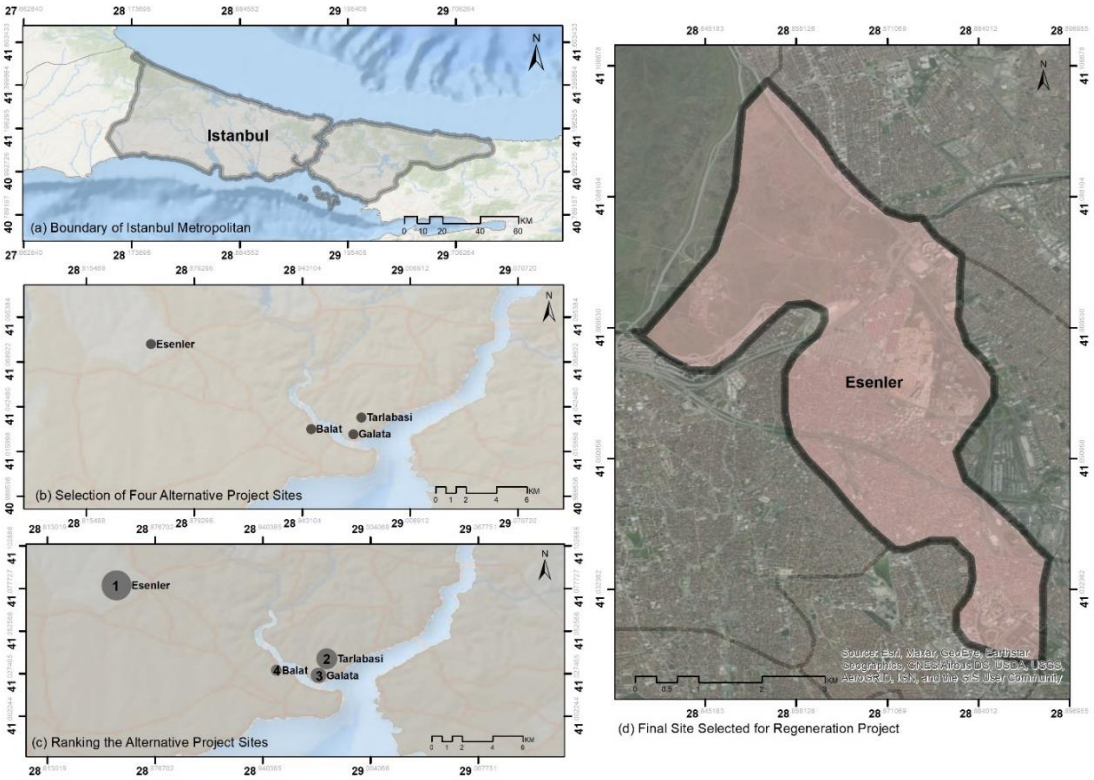

Figure 1.2 Ranking alternative project sites in Istanbul

Source: Illustrated by author (retrieved from (Oztaysi et al., 2016))

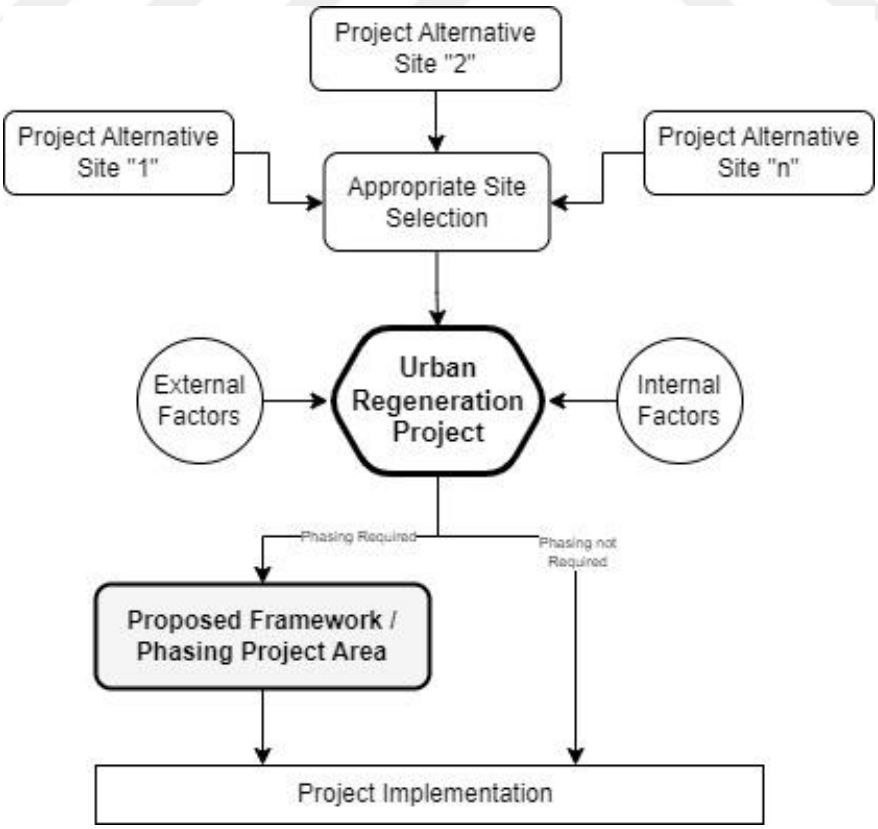

Figure 1.3 Conceptual research framework

1.3 Aim of the Thesis

The primitive aim of this research study is to develop a comprehensive framework which will act as an efficient tool to divide the large-scale regeneration project area into multiple phases, based on multi-indicator analysis, for the effective multiphase project implementation.

1.4 Research Objectives

This research study intends to elucidate the following research objectives:

1. Primitive research objective of this study is to develop a comprehensive framework that can be effectively utilized for subdividing the complicated and large-scale regeneration project areas into multiple phases for its multiphase implementation.
2. As this framework will phase out the project areas based on multi-indicator analysis, therefore the second objective of this study is to select, scrutinize, and determine the potential indicators which affects the quality of space and inhabitants of slums and squatter, particularly in global south.
3. The final objective of this research study is concerned with applying the developed framework to understand how this will be practically applicable in real time scenario.

1.5 Research Questions

This study is intended to answer the following research questions:

1. This study aims to develop a framework to phase the regeneration project areas, therefore the main research question of this study is to understand that
    a. What will be the salient features of the formulated comprehensive framework?
    b. How an effective framework be a helpful tool in multiphase implementation of regeneration projects by splitting the project area into numerous phases?
    c. What will be the applicability criteria / limitations of the developed framework?

2. The developed framework of this study seeks to phase out the project areas based on multi-indicator analysis. Therefore, it is essential to know that in current ages
    a. Which several indicators and how their correlation affects the quality of space and inhabitants of dilapidated illegal settlements?
    b. How will these several indicators, within the developed framework, be selected, scrutinized, and finalized for the regeneration of slums and squatter settlements?
3. When comprehensive framework will be developed, it is crucial to explain that
    a. How will this framework be practically implemented in a case study area?

1.6 Structure of the Thesis

The structure of this study is following:

First Chapter of this research elaborate about the background of the study and provide comprehensive justification and rationale for conducting this study. Furthermore, research aims, objectives and questions are also mentioned in this chapter. This chapter also describes the methodological steps, flow diagram and timeline of this study along with the methods and analysis used in this research.

The second chapter of this thesis provide comprehensive overview of the scientific literature including the brief introduction of urban regeneration along with its historical evolution, summary of past studies focusing on ranking alternative project sites, description of national and international regeneration project implemented in multiple phases, and the gap identified from this literature review.

The third chapter of this thesis describes the proposed comprehensive framework in this study along with its features and limitations.

The fourth chapter describes the characteristics and features of selected case study settlement in the research besides the selection rationale. Furthermore, this chapter also provides information about the data collection of this study including indicators identification and their description, preparation of base map of case study area, type, and categories of explanatory variables of structured questionnaire,

Likert scale and its elucidation, sample size calculation, socio-economic surveys and methods used in data analysis.

The fifth chapter describes the accomplished results including respondents' characteristics besides spatial and quantitative analysis of case study area. It also describes the results of calculation of stress score and IDW analysis.

Chapter six of this study provides a comprehensive conclusion of this research besides limitations and future recommendations.

1.7 Research Limitations

This research study is executed during the period of August 2021 and August 2022. In this study extensive land use and socio-economic surveys of the inhabitants of selected case study area was conducted in February 2022. As the socio-economic surveys were conducted during Covid 19 period, a bit reluctancy or hesitation was felt in the behaviors of interviewee while answering the questions, which might have affected the sampling technique or may lead to insufficient results. However, this limitation was mitigated by adopting certain measures against covid 19 which also included the proper vaccination and regular PCR test of surveyors. Also, sufficient social distance was maintained during surveys to gain adequate confidence of inhabitants in order to attain the factual data. By adopting all the mentioned measures, this limitation was mitigated till the negligence level.

1.8 Research Methodology and Time Frame

In this section, the detailed methodology that was adopted to conduct this research study is explained briefly. The comprehensive methodological flowchart and research timelines are illustrated in Figure 1.4 and Figure 1.5, respectively.

To conduct this research study, a mixed methodological approach of quantitative and qualitative analysis techniques has been used. To achieve the perceived results, the research methodology has been divided into six different stages. The first stage consists of determining the problem statement, research objectives and questions, and research limitations of this study. Moreover, a detailed literature review has been conducted in which the basic concepts of urban regeneration and its evolution over time have been explored. Moreover, past studies that help to rank the different

project alternative sites are also discussed. Furthermore, the national and international case studies of multiphase regeneration project implementation are also reviewed and discussed briefly in section 2.3.

Based on the identified gap from the literature, in the 2nd stage, a comprehensive framework for zoning the regeneration project area into multiple phases has been proposed. Furthermore, the salient features and applicability criteria of this proposed framework has also been discussed. The third stage of this research consists of determining the case study area, to implement the formulized framework as a real time project. The selected case study of this research study is the Bao Wala informal settlement from Lahore metropolitan city. After determining the spatial extent of the selected case study area, a GIS based base map of the settlement has been prepared based on which the land use analysis is conducted. Moreover, the indicators affecting the quality of space of informal settlements have also been determined in this stage. Following this, a comprehensive questionnaire has been prepared based on structured and semi structured questions. Additionally, the variable types and ranking scale are also defined in this stage. To conduct the socio-economic surveys of the selected case study settlement, sample size has been calculated with the help of Slovin's formula, which is explained in the section 4.4.5.

Stage four of this study has been divided into two parts. The first part is related to data collection and analysis based on socio-economic surveys in the selected case study area. After conducting the socio-economic surveys, the collected data is organized, and the errors have been removed. The second part of this stage is related to performing the multiple quantitative analysis techniques to calculate the effective and unbiased results. In this research descriptive analysis techniques are used to analyze the socio-economic profile of the respondents, public perceptions regarding the contemporary services in the settlement. After that, regression analysis was performed to determine the relationship of dependent and independent variables. Based on the quantitative analysis, the stress score of respective indicators was calculated. To calculate the cumulative stress score of respective indicators, a weightage index was multiplied with their average stress score. The weightage index has been determined based on interviews of professionals and experts in the field of urban regeneration. These interviews were conducted based on snowball sampling technique.

After performing the quantitative analysis, the next step was to integrate the quantitative and spatial data which was performed in stage five. On the synthesized quantitative and spatial data, interpolation techniques can be applied to calculate the values of unknown location however in this research IDW (Inverse Distance Weighted) analysis technique to calculate the values of unsampled location, ultimately for zoning the case study area of Bao wala settlement into multiple phases. The selection rationale of IDW analysis has been explained in 4.4.7. Later on, in the last stage of this study, the research findings have been determined along with the compilation and finalization of the thesis.

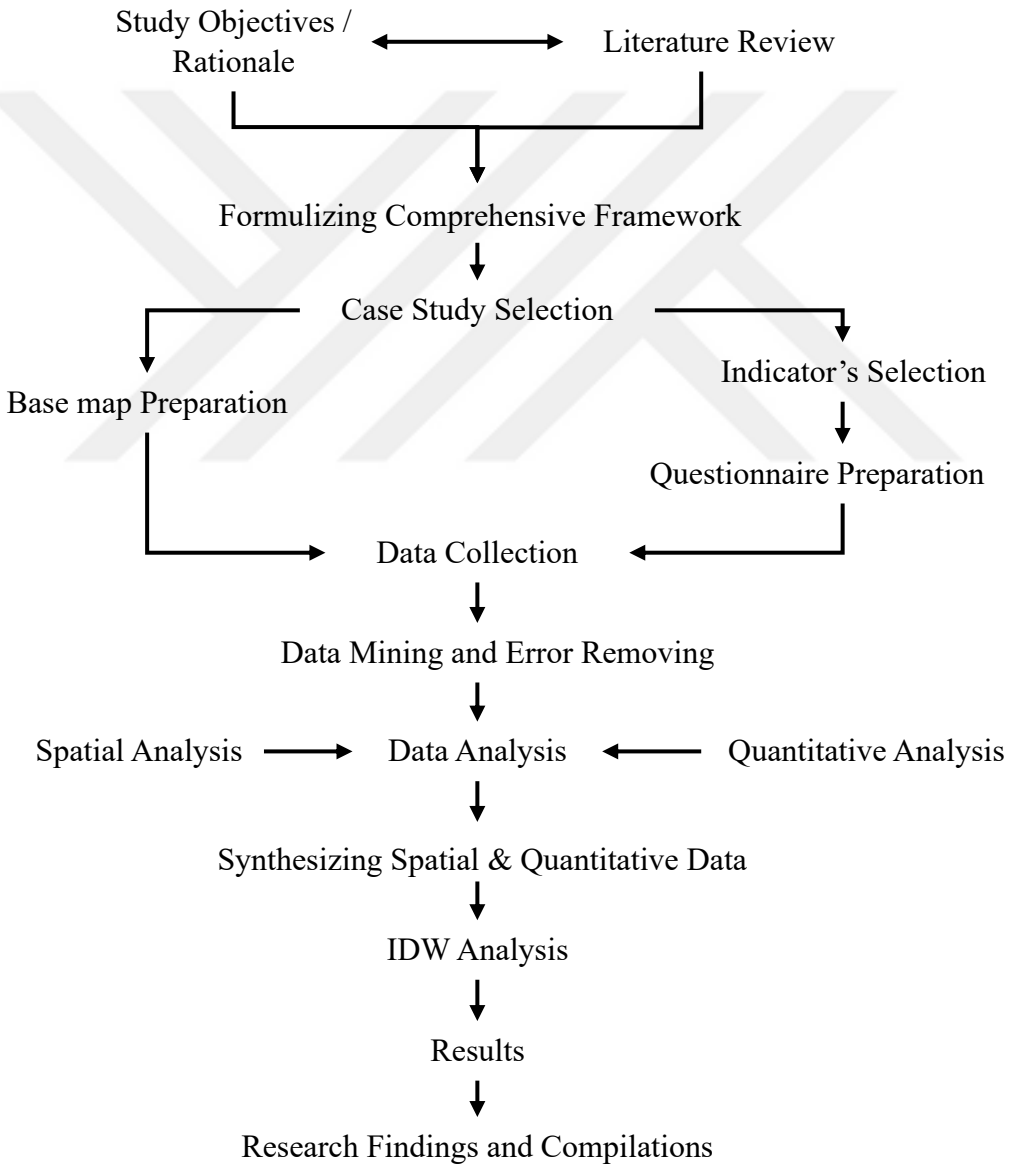

Figure 1.4 Methodological flow diagram of the research

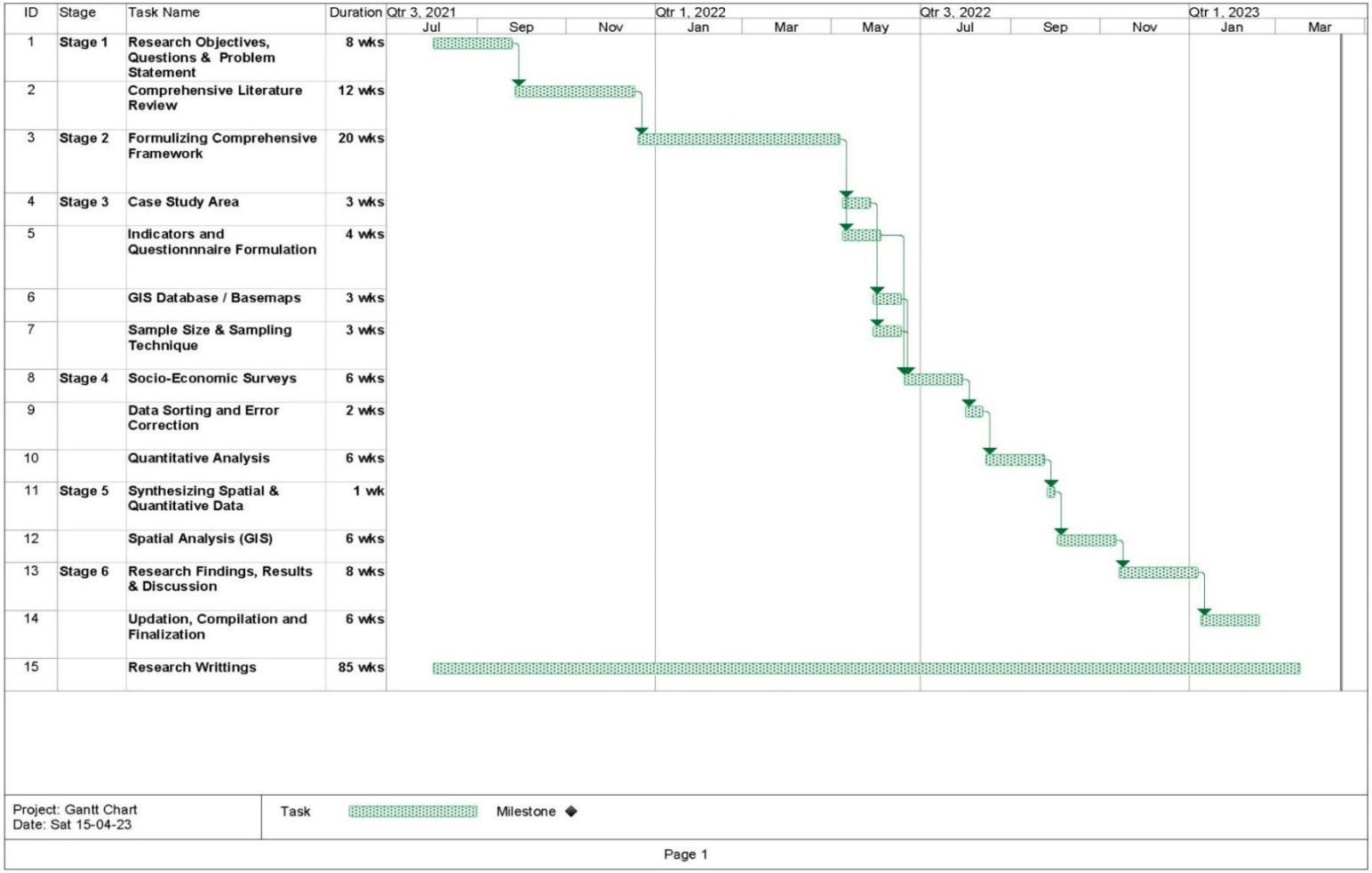

Figure 1.5 Research timelines

2
LITERATURE REVIEW

2.1 Understanding Urban Regeneration

The definition of urban regeneration has changed with the passage of time, as it has been defined by numerous scholars in different ways based on various perspectives. In general, regeneration verb defined by oxford dictionary refers to "the process of making an area, institution, etc. develop and grow strong again" (Angus Stevenson, 2010). This simplest definition of regeneration is concentrating on the physical transformation of the area, from deprecated to a robust place. Whereas, in the actual scenarios, regeneration includes more than just physical transformation. In one scientific study, authors define urban regeneration as a synonym to the physical as well as economic revitalization of declined areas. It includes the transformation of different parts of urban areas to make them more attractive for inward private investment (Loftman & Nevin, 1995). However, Akkar (2006) has enhanced the definition of urban regeneration by adding one more dimension to it. He defines urban regeneration as a fundamental solution to physical, economic, and social challenges of old parts of the cities.

The attributes of urban regeneration not only emphasis on the reuse of physical structure of built environment to gain more investment for the consolidation of an area but also refers to understand the oxidization process of decayed parts of the inner-city areas and what is trying to be achieved and how (Lichfield, 1992). It refers to a process in the community in terms of enhancing employment, quality of life, consumption, and investment.

One of the holistic definitions of urban regeneration has illustrated as a

"comprehensive and integrated vision and action which seeks to resolve urban problems and bring about a lasting improvement in the economic, physical, social and environmental condition of an area that has been subject to change or offers opportunities for improvement" (Roberts, 2017).

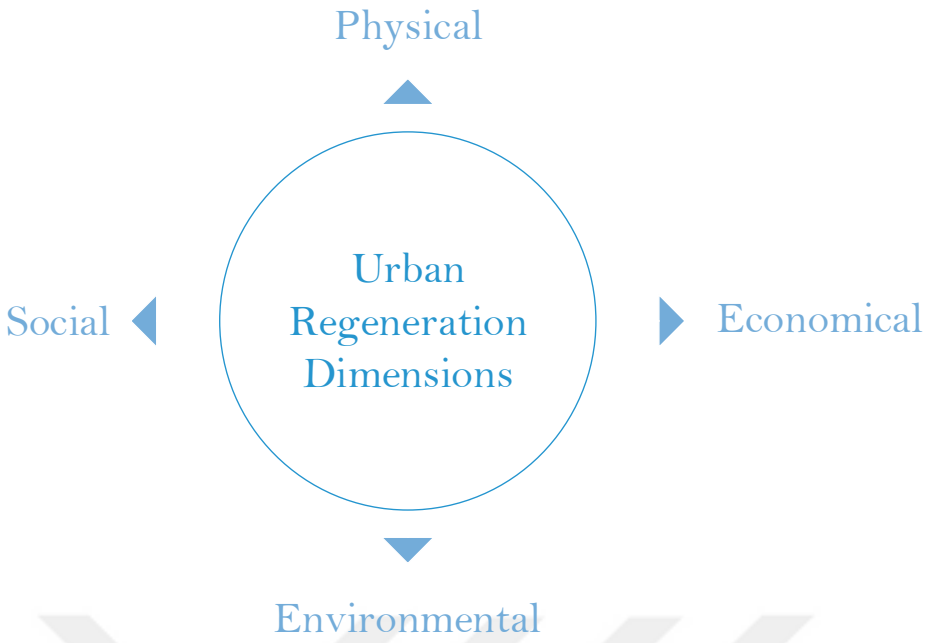

Figure 2.1 Urban regeneration dimensions

Source: Xiang et al., (2020)

Urban regeneration has also been explained as a comprehensive strategy, to resolve urban problems, that encompasses three primitive objectives (also called as three e's) that includes equity, economy, and environment. These three e's help in urban regeneration to lessen disparity, uphold economic keenness and safeguard the features of environment (Kocabas & Gibson, 2001).

In contracts to the positive dimensions of urban regeneration, some scholars have also criticized the strategies. Hausner elucidated the weakness of tactics to regeneration that are disintegrated, ad hoc, short-term and project based deprived of comprehensive strategic framework of city-wide development (Hausner, 1993). Tallon (2013) has supported the arguments of Hausner and explained that urban regeneration works in a fragmented manner and often fail to resolve all the problems. But Donnison has called urban regeneration as an innovative strategy to tackle the challenges of rotten areas in a coordinated manner (Donnison, 1993).

Urban regeneration is a comprehensive strategy that is different from urban redevelopment, rehabilitation, and renewal. Urban redevelopments focus on the destruction of old areas to build the new structure while rehabilitation is concentrated on social inclusion and renewal seeks to accomplish the physical

changes. However, urban regeneration concentrates on all perspectives including environmental, social, physical, and economical.

2.1.1 Historical Perspective

This section provides a brief overview of the evolution of the various approaches and strategies that have been used to revitalize dilapidated towns and communities throughout history. Roberts (2017) has summarized these approaches in five distinct categories, based on their purposes, orientation, kay actors and stakeholders, and on their economic focus.

In the early 1950s, during the postwar period, repairing and rebuilding the architecture of towns and cities, which had been neglected for years, took precedence. This rehabilitation operation was regarded as a national priority. During the 1940s and 1950s, emphasis was on rebuilding, repair, and elimination of physical problems from the past. The government-driven aims of “slum clearance and reconstruction”, with enthusiastic support from local governments and the private sector alike, led to the embracing of "high-rise housing and industrialized building techniques" (Couch, 1990).

The earlier concepts were continuing to be used during the 1960s, including the initial initiatives to "rehabilitate" grumpier areas of cities in order to make them more livable and economically sustainable. During this time, rehabilitation efforts at the regional level were concentrated with a balanced partnership of public and private parties. This was the first instance in which a change in urban policy was observed with a focus on restoring the run-down urban areas.

The understanding of this inner-city transition was further developed in the 1970s, a decade in which the insitue "renewal" of neighborhoods took place as a result of the expanding participation of the private sector in urban transformation (Bennett & Reed, 1999). This time is mostly identified with the emergence of initiatives based on a succession of measures to assure greater coordination across previously distinct social, economic, and physical policy strands.

During the 1980s, previously tried initiatives were pursued with significant modifications and alterations in which flagship projects, large development and rehabilitation plans were sought. These methods primarily sought to increase economic competitiveness through the "redevelopment" of least economically

productive urban areas, an endeavor in which the private sector played a significant role and state governments provided resources (Turok, 1987).

Table 2.1 The historical evolution of urban regeneration

STRATEGIES	1950s RECONSTRUCTION	1960s REVITALIZATION	1970s RENEWAL	1980s REDEVELOPMENT	1990s REGENERATION
MAJOR STRATEGY AND ORIENTATION	Reconstruction and extension of older areas of towns and cities often based on a "masterplan"; suburban growth	Continuation of 1950s theme; suburban and peripheral growth; some early attempts at rehabilitation	Focus on insitu renewal and neighborhood schemes; still development at periphery	Many major schemes of development and redevelopment; flagship projects; out of town projects	Move towards a more comprehensive form of policy and practice; more emphasis on integrated treatments
KEY ACTOR AND STAKEHOLDERS	National and local government; private sector developers and contractors.	Move towards a greater balance between public and private sectors	Growing role of private sector and decentralization in local government	Emphasis on private sector and special agencies; growth of partnerships	Partnership the dominant approach
SPECIAL LEVEL OF ACTIVITY	Emphasis on local and site level	Regional level of activity emerged	Regional and local levels initially; later more local emphasis	In early 1980s focus on site; later emphasis on local level	Reintroduction of strategy perspective; growth of regional activity
ECONOMIC FOCUS	Public sector investment with some private sector involvement	Continuing from 1950s with growing influence of private investment	Resource constraints in public sector and growth of private investment	Private sector dominant with selective public funds	Greater balance between public, private and voluntary funding

Source: Roberts (2017)

In the 1990s, the emphasis switched to the "regeneration" of degraded urban neighborhoods in terms of improving their physical, economic, environmental, and social elements (Adair et al., 2000). This new policy posture aimed at comprehensive and integrated improvement of areas, which was complemented by substantial collaboration between public authorities and commercial institutions. The formulation of this new strategy placed a strong emphasis on environmental goals of sustainable development, as well as other views (Ploegmakers & Beckers, 2015). However, urban regeneration is currently focused on addressing challenges related to economic and employment transformation, social exclusion, economic competitiveness, community concerns, new land and property needs, unoccupied and deteriorating urban areas, and sustainable development (Roberts, 2017; Turok, 2004).

2.1.2 Urban Regeneration concept in Different Regions

Urban regeneration is a concept that can be defined and understood in different ways across regions. Such as the American urban regeneration policies typically involves efforts to revitalize urban areas facing decline, disinvestment, or blight (Davidson & Lees, 2005). It often focuses on physical redevelopment, including the renovation or repurposing of buildings, infrastructure improvements, and the creation of mixed-use spaces. Economic revitalization, community engagement, and the promotion of cultural and creative industries are also important aspects of urban regeneration in these regions (Kanai & Cazar, 2009). However, in Europe, urban regeneration emphasizes preserving and enhancing the historical, cultural, and architectural heritage of urban areas (García, 2004). It involves the revitalization of historic buildings, public spaces, and neighborhoods while promoting sustainable development practices (Alpopi & Manole, 2013).

Urban regeneration policies in Asia are heavily influenced by rapid urbanization and population growth. It focuses on accommodating increasing urban populations, upgrading infrastructure, and addressing challenges related to housing, transportation, and environmental sustainability (Joo & Park, 2017; Steinberg, 2011; Yuen, 2013). In addition to physical redevelopment, Asian regions often prioritize economic growth, technology integration, and the creation of smart cities as part of their urban regeneration strategies (Butsch et al., 2017). However, in the Global South, urban regeneration involves efforts to address socio-economic disparities, informality, and inadequate infrastructure (Opoku & Akotia, 2020). It aims to improve the quality of life for marginalized communities, promote social inclusion, and provide basic services and amenities. Participatory approaches, community empowerment, and sustainable development practices are key elements of urban regeneration in the Global South (Kayembe, 2021).

It's important to note that these definitions are general and regional tendencies, and the actual approaches and priorities within urban regeneration can vary within each region. The specific characteristics, challenges, and goals of individual cities or countries within these regions also influence the way urban regeneration is conceptualized and implemented.

2.2 Past Studies on Ranking Project Alternatives

Multifaced urban regeneration projects encompassed with social, economic, environmental, and physical perspectives are being implemented to revive the decayed parts of the inner-city areas. The practices of urban regeneration projects are being increased over the times due to its beneficial effects (Cin & Egercioğlu, 2016), however the problems are associated with the regeneration projects hindered its efficiency.

The best advantages of urban regeneration projects can be gained when an appropriate project site is selected for the implementation of that project. Often policy makers, investors and implementor confront the issues in efficient site selection and further subdivision of selected site in urban regeneration project. Therefore, multiple studies have been conducted to formulize the effective methodology for ranking different project sites in regeneration projects, however, no such study has focused on the phasing the selected project site.

Oztaysi et al., (2016) has conducted a study on multi criteria prioritization of urban transformation project. Istanbul metropolitan city has been selected as a case study area for conducting this study as this city is prone to multiple problems such as floods, earthquakes, and other risks. In this study, four different Urban Transformation Projects (UTPs) alternatives have been ranked which includes Galata, Tarlabasi, Fener - Balat –Ayvansaray and Esenler. The ranking of these alternatives was based on physical, social-cultural, disaster risk, economic, and environmental indicators which was further divided into subcategories. Oztaysi et al., (2016) has used hesitant fuzzy linguistic TOPSIS methodology to rank these UTPs alternatives, which helps in multicriteria decision making process. The results obtained in this research has ranked Esenler as best alternatives, followed by Tarlabas¸ Galata and Balat, for resources allocation by municipalities to execute urban transformation projects. However, based on the data of state institute of statistics of Türkiye, Esenler possess the population of around 447,000 and expanded on large-scale geographical area of 18 km2 with the population density of 24,840/km² (Population, 2021). Therefore, for an efficient implementation of urban transformation project in Esenler, the area needs to be subdivided into multiple phases which has not been addressed in this respective study.

In the above-mentioned research, 4 case study areas including Galata, Tarlabasi, Fener - Balat –Ayvansaray and Esenler have been ranked based on comprehensive indicators but it is important to mention that all the above case study areas are distinct from each other in term of their historical background, evolutionary process, population demographic characteristics, urban fabrication etc.

Another study conducted by Juan et al., (2010) focus on the provision of systematic approach to the policy makers, decision makers and developers to review their decision on site selection process for urban renewal project, that can further be utilized for new projects as well. The author has used diamond model, proposed by Porter (1998), to determine evaluation criteria for determining urban renewal projects quality. And then the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method has been used to ascertain the priority of the project sites. This study has proposed three stage comprehensive approach that helps the decision makers and investors to prioritize the project sites for making the investment. Meanwhile, this study hasn't addressed the subdivision of selected projects sites into multiple phases.

A study conducted by Cilona & Granata (2015) is closely related to the subject that is being conducted in this research. This study focusses on the multi-criteria prioritization for multiphases implementation of urban regeneration project. This study also defines that simultaneous implementation of several subprojects delineated in a regeneration project is not possible due to financial and other problems. In this study, four different subprojects have been defined based on the subject areas; such as subproject 1 is related to road conditions including accessibility and mobility etc., subproject 2 is concerned with eco-sustainability and environmental renewal, subproject 3 is related to port infrastructures and marine works and subproject 4 is associated with tourist equipment, fishing and sailing sports. To prioritize these subject areas, nine different qualitative and quantitative indicators have been formulated which then ranked from 0 to 10 (0 being lowest and 10 as highest). At the final stages, PROMETHEE method has been utilized for the prioritization of subprojects and to rank the set of alternatives, to reach at the conclusion.

2.3 Case Studies of Multiphase Project Implementation

Throughout the world, different regeneration projects with distinct goals were devised and carried out in order to enhance the standard of space, place, and life of inhabitants of different informal settlements. However, for the efficient execution of large-scale and complex regeneration projects, the project areas are phased out into several phases. This section discusses a few exemplary projects from the globe that were initiated and completed in numerous phases.

2.3.1 Anderston Regeneration Project

In collaboration with Glasgow City Center, the Scottish Government along with Sanctuary (Scotland) Housing Association initiated a significant inner-city residential renewal project which is named as the Anderston regeneration project. This multiyear redevelopment project, which started in 2008 but ended in 2018, comprised on five phases and intends to build more than 500 new homes within the contemporary development. The location of this regeneration project is situated on the western outskirts of Glasgow's downtown, on the north bank of the river Clyde (James & Tolson, 2020).

Being a large-scale urban regeneration project located inside a metropolis city, the spatial extent of Anderston project is comprised on two different urban districts instead of a single unified location. The master plan of this project was developed based on a phased scheme to totally upgrade the contemporary housing stock (which is illustrated in Figure 2.2). The Anderston Renewal Proposal intended to enhance living standards by replacing congested, damp dwellings with contemporary ones while also developing designs to support and foster community cohesion.

The Anderston regeneration project was phased out in 5 different phases to be completed in different time frames. The first and second phase of the Anderston regeneration projects, which comprised of housing units, were finished in 2011 and 2012, respectively, adding significantly to the existing development. However, both parts of phase three (3A and 3B), were built over a large span of time which was finished in 2015 (CCG, 2022b). Furthermore, the completion of Phases 4 and 5, which consists of apartment buildings with a total of seven stories

and adds 206 additional dwellings units to the current construction stock, took place in 2018 (CCG, 2022a).

Figure 2.2 Phased out comprehensive master plan of Anderston Regeneration Project

Source: James & Tolson (2020)

Figure 2.3 Phase wise completion of Anderston Regeneration project

Source: James & Tolson (2020)

2.3.2 Thamesmead

Thamesmead, a site located in the Southeastern side of the London metropolis has undergone the extensive urban regeneration project. The geographical expanse of Thamesmead that was distributed over a broaden urban area was divided into 7 distinct phases to carry out the regeneration project (illustrated in Figure 2.4). Thamesmead's prospective was achieved through the use of a "whole place strategy," which holistically integrated the local administration, economic investment, and rehabilitation efforts of inhabitants. Thamesmead has a space of about 760 hectares. The goals of this initiative were fixing up old residences, enhancing communal places, constructing new residence units, maintaining parks and rivers, fostering cultural festivals, and assisting the neighborhood. With the goal of creating better living environments, the Thamesmead revitalization plan was introduced in 2018 and is expected to be completed in the future (Peabody, 2018).

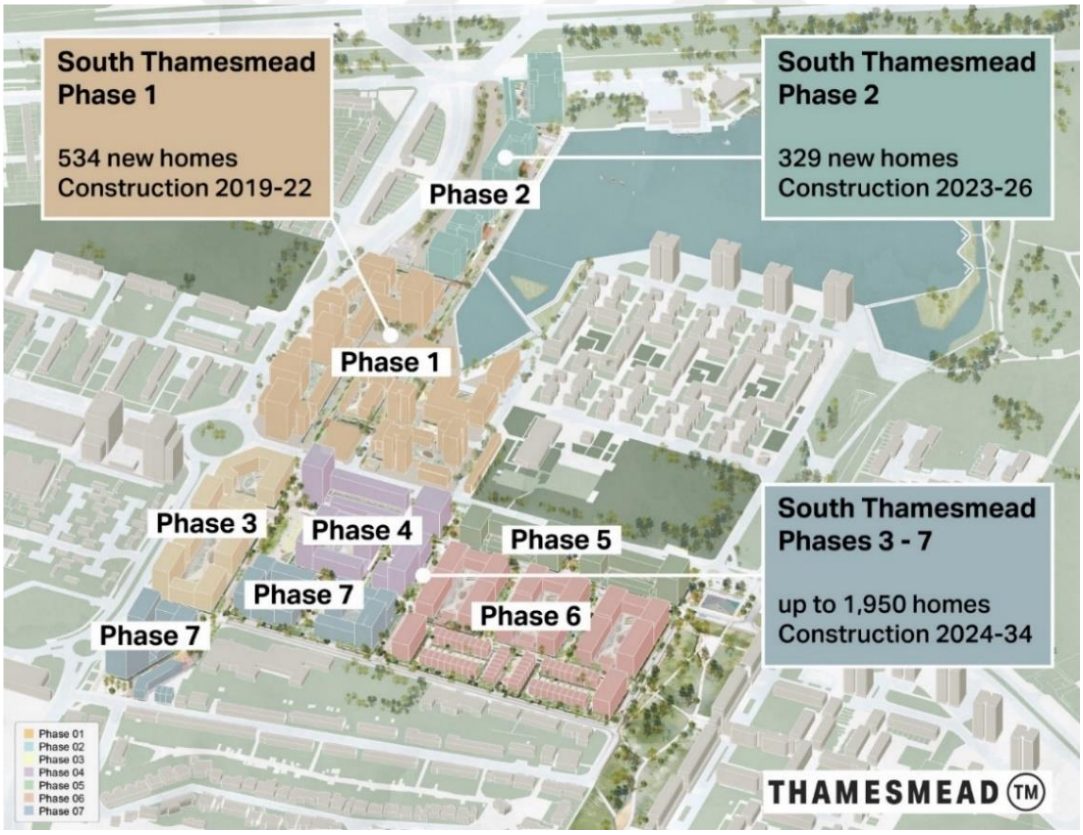

Figure 2.4 Phased based plan of Thamesmead regeneration project

Source: Peabody (2018)

2.3.3 Elephant Park Regeneration

Elephant Park in central London is experiencing a regeneration project which commenced in 2010 and is based on a participation model between the local Council and inhabitants to improve the mixed-use development. The Elephant Park regeneration project, which has a £2.3 billion budget, aims to construct about 3,000 new dwelling units in the neighborhood. The Elephant Park redevelopment project, which will give new houses, job prospects, and economic benefits linked with a pleasant and leisurely lifestyle, is being phased out over five stages (shown in Figure 2.5) and is anticipated to be finished by 2025 (Lendlease, 2018, 2022).

Figure 2.5 Comprehensive plan of Elephant Park regeneration project comprised on different phases

Source: Lendlease (2018)

2.3.4 Woodberry Down

One of the greatest mass housing developments, Woodberry Down was erected following World War Two, but it undergoes from lack of economic investment, and structural degradation and was followed by high levels of criminal activity and anti-social behavior. The estate's dwelling units were to be demolished and rebuilt in 1999, according to Hackney Council. Work started in 2009 after an original concept plan which was created in 2005. The main stakeholder of Woodberry regeneration project is Hackney Council, which entails tearing down 1,981 houses and erecting 5,561 new ones. The project area of Woodberry regeneration covers 64 acres in total. Over the course of 8 phases (shown in Figure 2.6) and a 20-year span, 1,980

residences will be demolished and over 5,500 will be rebuilt (Architects, 2022; Wilson & Carr, 2014).

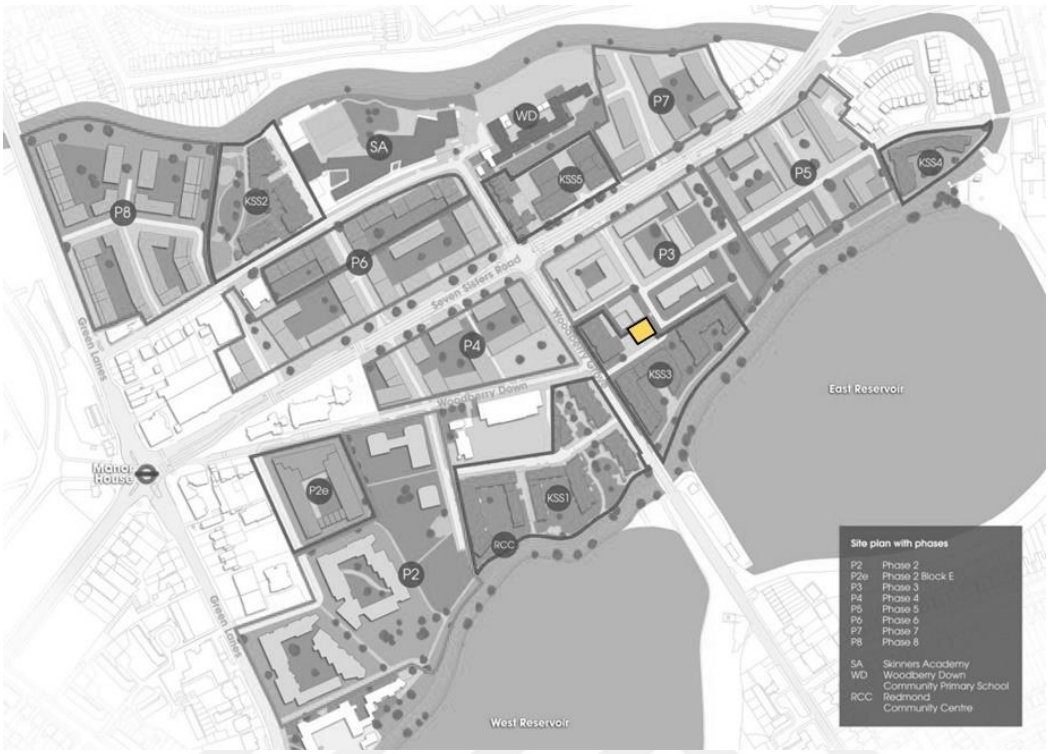

Figure 2.6 Eight phased based master plans of Woodberry Down regeneration project

Source: Architects (2022)

2.3.5 Walled City of Lahore (WCL) Conservation Project

Lahore, the second-most populous city in Pakistan is where the Walled City of Lahore region is located. This walled city had more than 22,000 structures erected inside of it and covered a total area of 2.5 square kilometers. However, as time passed on, Lahore's fame began to fade as a result of the area's extensive commercialization (Shahzad, 2011). In order to restore residential and other uses consistent with the city's historic characteristics inside the established urban fabric and to preserve the contemporary historical monuments in the area, the governmental institute launched the Walled City of Lahore Conservation project in 2006. The project area was separated into 4 stages or packages (illustrated in Figure 2.7) to reach the perceived aim, which was expected to be finished in future (WCLA, 2021).

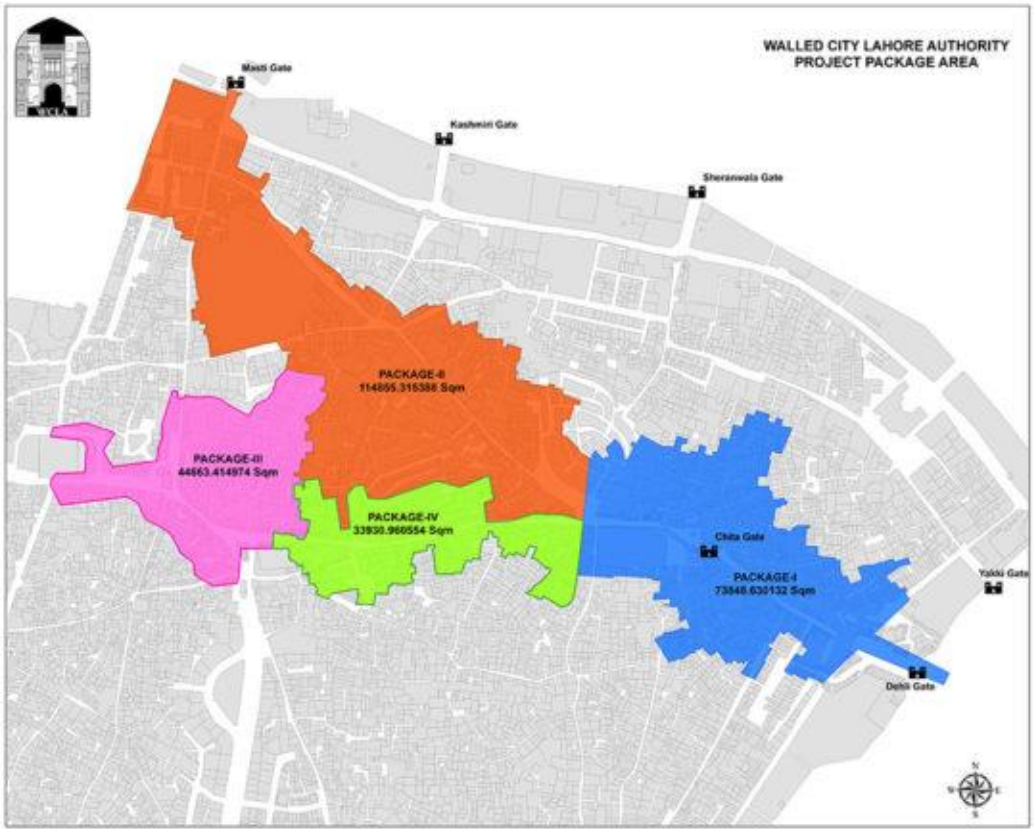

Figure 2.7 Phased based location plan of Walled City of Lahore Conservation Plan

Source: WCLA (2021)

2.4 The Gap

In the section 2.2, studies from the literature on ranking the alternative project areas are discussed briefly. It has been observed that these studies primarily focused on the raking different project sites based on quantitative analysis. However, none of these research studies has discussed phasing out the selected project site into different phases. In the section 2.3, multiple international and national case studies have been reviewed and discussed in which the projects are completed in multiple phases, however while studying the details of project implementation, none has presented the detailed account of the rationale that on what grounds the project area was divided into different phases.

Therefore, this research gap has been identified in scientific literature, which is aimed to be filled in this research study by proposing a comprehensive framework for zoning project sites into multi phases for its multiphase implementation.

Furthermore, the above discussed studies have just utilized quantitative analysis strategy, whereas in this research a mixed approach of quantitative and spatial analysis has been used to accomplish the diversified results.

3
PROPOSED FRAMEWORK

3.1 Proposed Comprehensive Framework

The primitive aim of this research was to develop a comprehensive framework that can be an effective tool to subdivide the regeneration project area into multiple phases for the multiphase project implementation. Therefore, a comprehensive framework that has been formulated in this study is briefly explained in this section.

The comprehensive framework that has been formulated in this study consists of three main stages: pre-requisites, operationalization, and finalization. During the regeneration process of any settlement, this comprehensive framework can be used during the planning phase of any project. Therefore, this framework can be implemented only when the project site for any urban regeneration project has been finalized.

The first stage of this comprehensive framework, which is pre-requisites, comprised on comprehending the factual contemporary scenarios of the selected project site for urban regeneration. In this phase, it is essential to understand and explain the contemporary portfolio of the selected regeneration project site. This can only be possible when the spatial boundary delineation of the selected project site has been finalized. Following that, the preparation of the base maps of the selected regeneration project site and understanding its contemporary portfolio can be performed simultaneously.

Contemporary portfolio of any settlement can be consisting upon the socio-economic profile of the population, utilities functioning condition, land use distribution, environmental scenarios, road infrastructure, urban fabric and morphology and numerous other variables. The socio-economic profile of the population living in the regeneration project area could be comprised of their gender, income level, education status or job position etc. It is critical to assess the socioeconomic profile of the people in order to determine how much assistance the resident population will provide in the regeneration process of any community.

One of the salient features of the formulized comprehensive framework is that this framework is based on multi-indicator analysis. Therefore, besides understanding the contemporary portfolio of the project site, the identification of the potential indicators that are causing the depletion of quality of life and place of the project area is also indispensable. These potential indicators must include the provision and efficiency of utilities services, and solid waste management etc., road infrastructure, and footpaths etc., urban furniture, social services, environmental circumstances, and building fragility and overcrowdings etc. These potential indicators can be identified through secondary data or by conducting pilot surveys of the project area, however the assistance of an expert professional can also be engaged in this regard.

After the completion of first stage of the comprehensive framework which is delineating the project site boundary, assessing the contemporary portfolio, and identifying the potential indicators; the second stage of this framework must be accomplished which is operationalization, that is consisted of two parts; data assemblage and anatomization. In the data assemblage section, the primitive process is the essential primary data collection, mining and error removing and data categorization in order to perform the socio-economic, land use and other spatial analysis. The primary data can be collected with the help of socio-economic and land use surveys for which different sampling framework and techniques can be selected. During this process, the potential indicators that were selected in the first stage can be scrutinized and finalized, furthermore, can also be amended if needed. Based on the analysis, the potential indicators which have negligible impact on the quality of place of the project area can be eliminated. The elimination of negligible indicators can be accomplished based on several yardsticks or principles that may differ in respective regeneration projects.

Another part of the operationalization stage of the formulized comprehensive framework is anatomization. For the purpose of efficient division of the project area into numerous phases based on multi-indicator analysis, the process of calculation of stress score has to be executed in this section. Stress score, in this research study, is the quantitative interpretation of the quality of place of regeneration project site. Stress score, a numerical value, indicates the intensity or severity of problems / issues in any certain location, experienced by an individual inhabitant of the locality. The stress scores of any certain location can be determined using various

methods, such as self-report questionnaires or scales including the Likert scale or a numerical scale. The higher value of stress score will represent the extreme dissatisfaction behavior of individuals toward the contemporary bad situation of the services or place; nevertheless, the lower value of stress score will elucidate the opposite. Stress score also denoted the individuals experience of deprivation, such as lacking access to essential resources, services, or opportunities. Individuals experiencing deprivation quantified as higher stress scores, indicating the negative influence of deprivation on their quality of life and well-being. However, there is no concrete scale of values of the stress score that can be applied to all case study areas, therefore these values may differ in the respective case studies or in different regeneration projects. The values of the stress scores can be calculated based on the public perceptions regarding the several indicators. The public perceptions regarding the indicators can be determined during the socio-economic surveys which are performed in the previous sections. Besides public participation, the benefits of expertise of professionals must be considered to achieve the benchmark of efficient stakeholders' inclusion in the process. To accomplish this, interviews can be conducted, or meetings can be arranged with the professionals of different institutions. During the interviews or the meetings, the regeneration project aims can be described to the professionals and asked them to assign a certain weightage index to the potential indicators based on their expertise. Following that, the cumulative stress score can be calculated based on the scores of public perception and weightage index of the professionals.

The last stage of the formulized comprehensive framework of this research study is the finalization. This stage initiates with the process of synthesizing the spatial and quantitative data. The formulized comprehensive framework provides a holistic approach of dividing the project area into distinct phases, not only centered on quantitative analysis but also based on spatial analysis. To accomplish this, the calculated accumulative stress score has to synchronize with the spatial data to perform spatial analysis. Based on these analyses, the project area can be divided into several distinct phases by using the spatial techniques; however, the number of phases may vary linked to the exigency and spatial scale of the project area. The final output achieved which the help of the formulized comprehensive framework will spatially illustrate the project area been divided into numerous distinct phases,

to accomplish the multiphase implementation of large and complex regeneration projects. The final step of this framework is the monitoring and evaluation. This step will help to ensure the proper implementation of the multi-phased project execution of regeneration project and will also allow to amend the phases if needed.

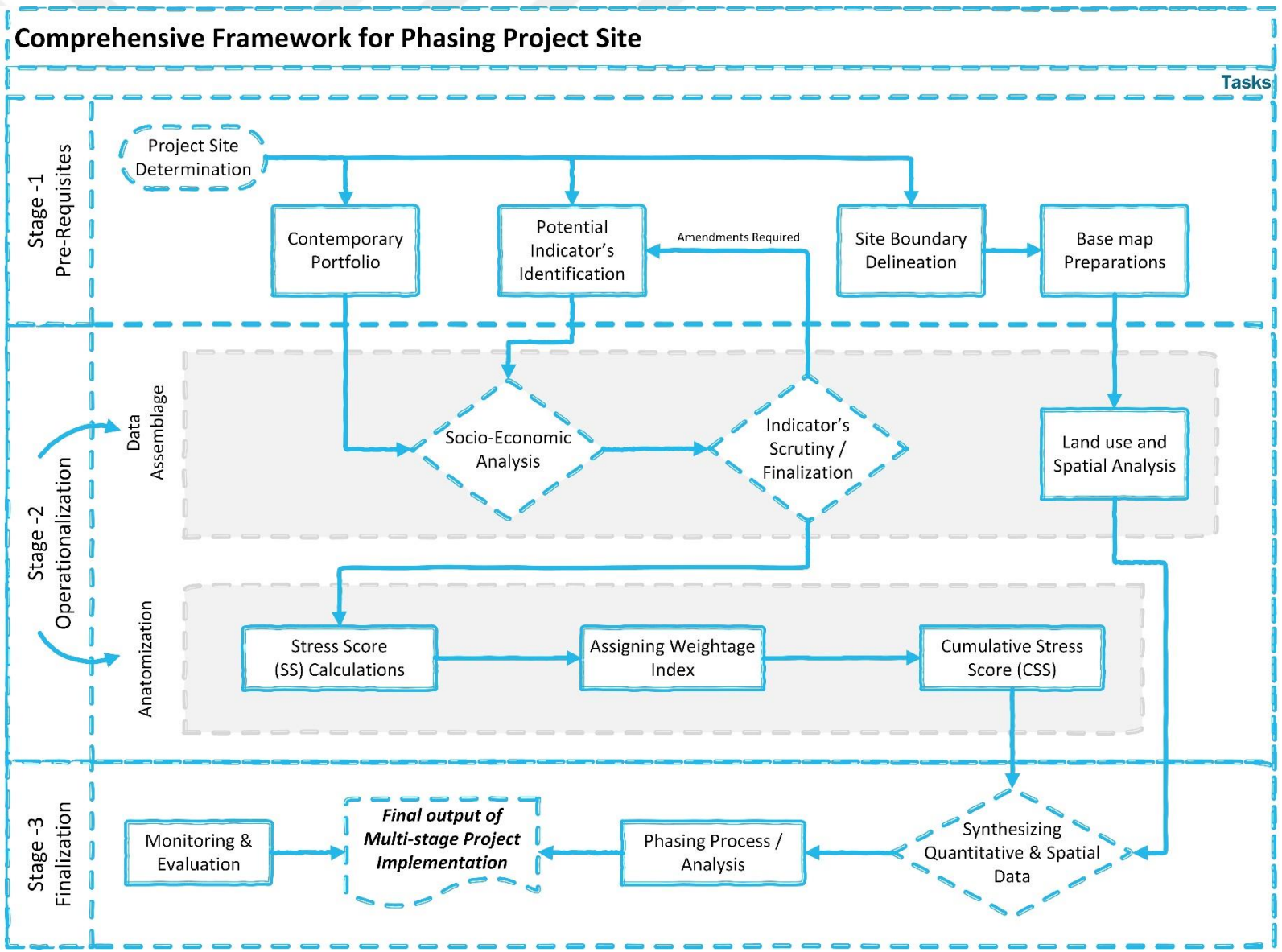

Figure 3.1 Proposed comprehensive framework for phasing project site

3.1.1 Salient Features

The formulized comprehensive framework of this study has some associated salient features with it.

- The important feature of this framework is that it ensures the extensive stakeholders' participation in the planning process of urban regeneration projects. On the factual grounds, the community participation in the planning phase of regeneration projects is either negligible or neglected (Lawson & Kearns, 2010), however this framework not only ensure the extensive community participation in the planning process but also provide efficient provision of professional's inclusion in this process.
- Moreover, this comprehensive framework helps to divide the regeneration project area into multiple phases based on multi-indicator analysis rather than the singular indicator. Traditionally the project areas are divided into several phases based on political objectives or based on personal easiness, which absolutely neglected the approach to deal which the hotspot areas on earliest. Therefore, with the help of multi-indicator analysis, this comprehensive framework tackles this alarming issue.
- Another feature is the mixed approach of qualitative and quantitative methodologies that has been suggested in the comprehensive framework. This mixed approach not only explicates the concrete quantitative based analytical techniques but also provides sufficient space for qualitative approaches.

3.2 Applicability Criteria / Limitations

The formulized framework is always coupled with a few constraints, assumptions, or application requirements. These assumptions do not necessarily restrict the perceived framework's potential, but they do give a clear path for the framework to be practical and delivered effectively. The limitations associated the formulized framework of this study are mentioned below:

- **Spatial Scalability:** The urban regeneration projects are being implemented on a variety of spatial extents: from singular buildings and neighborhoods leading toward large scale areas. In the regeneration project of singular

buildings or small streets, the division of project area is not necessarily required, but the large scale and complex regeneration projects are required to be divided into several phases. Therefore, the comprehensive framework of this research study is formulated with the intention to divide large scale and complex regeneration projects for their efficient implementation.

- **Exigency:** Despite the condition of large-scale spatial extent of project area of the regeneration projects, if there is an exigency to divide the project area into multiple phases, the formulized comprehensive framework will be an effective tool to accomplish this task.
- **Diversity:** The formulized comprehensive framework will be efficiently implemented in a project area which embraces the characteristics of diverse socio-economic and land use conditions. The diversity in any project area will assist in constructing a large set of indicators which will be a cause for efficient multi-indicator analysis.

4
CASE STUDY & DATA COLLECTION

4.1 Lahore: The Contextual Analysis

Bao Wala, an informal settlement in Lahore metropolitan city, has been selected as case study area in this research. Lahore, a second most populace city in Pakistan, housed 11.13 million population in 2017 which was increasing with the annual growth rate of 3% (Statistics, 2017), and is estimated to reach till 16.35 million by 2030. The historical population growth of Lahore metropolitan city has been illustrated in Figure 4.1. The city has experienced significant population growth in recent years, driven by a combination of natural increase and migration from other parts of the country.

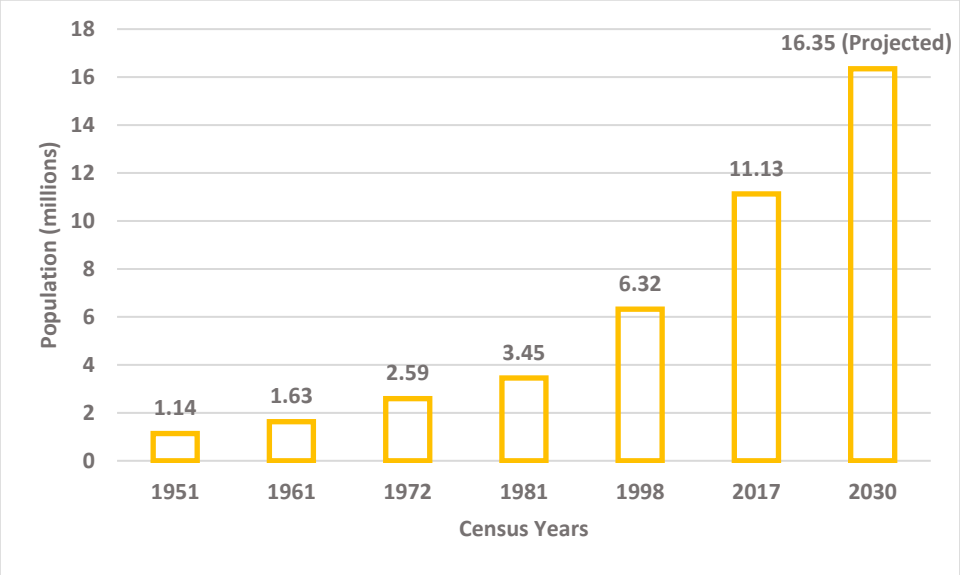

Figure 4.1 Historical population growth of Lahore

Source: Ahsan (2019)

Lahore is presently considered one of the world's megacities due to the rapid growth in its population. Lahore is nearly on par in size with other major international cities like Seoul, Delhi, etc (illustrated in Figure 4.2). If the population growth rate holds, Lahore will be on the list of the most densely inhabited cities in the world.

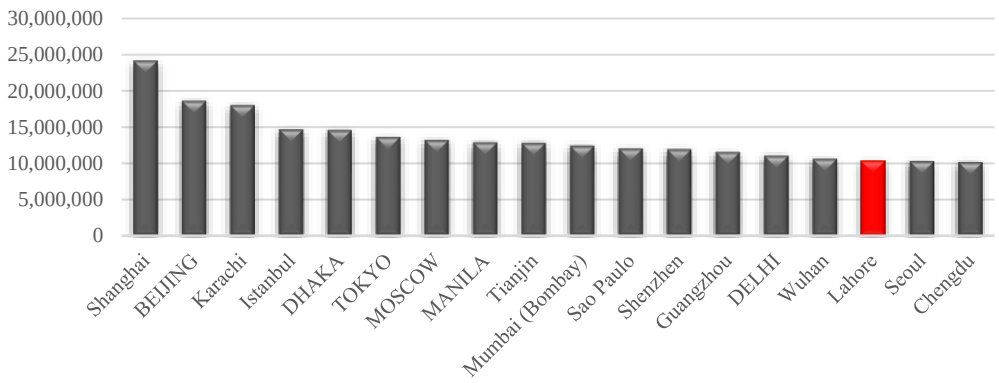

Figure 4.2 Comparative population analysis of Lahore with other mega cities

Source: Adeel et al., (2021)

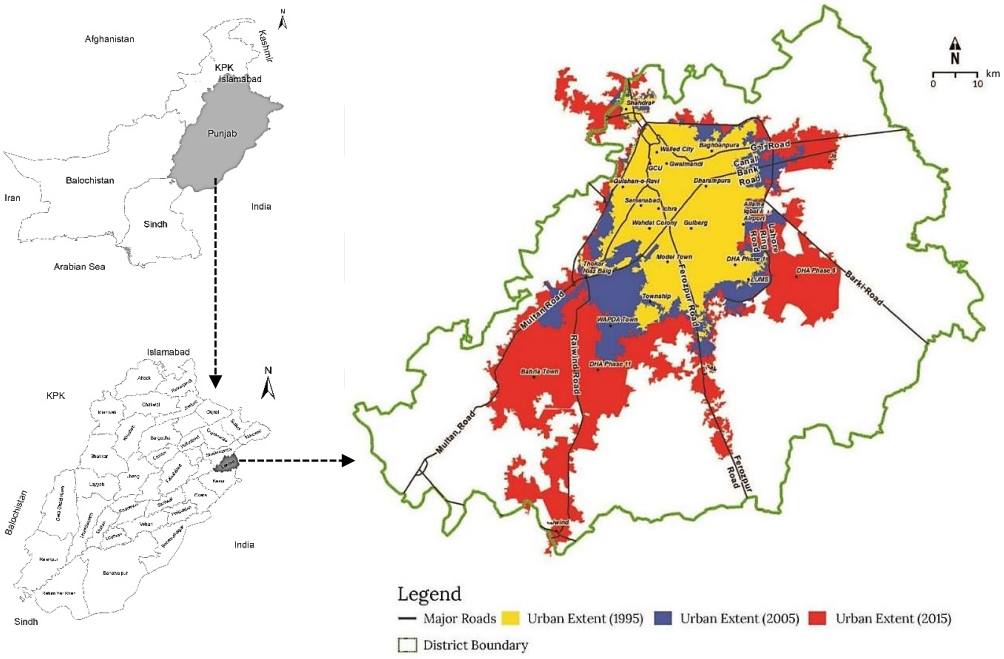

Figure 4.3 Spatial location along with historical growth of Lahore

Source: Ahsan et al., (2023); Riaz & Ibrahim (2018)

The geographical location of Lahore in Pakistani context along with its spatial growth has been illustrated in Figure 4.3. In the past, Lahore has expanded along the Grand Truck Road, which connects the subcontinent with central Asia. Lahore has expanded recently along a south and south-west axis. Lahore's spatial ballooning took place on fertile agricultural area that the city is surrounded by. As a result of a sudden increase in population, Lahore's built-up area has increased in size. Lahore's spatial augmentation has increased from 326 km^2 to 675 km^2 (nearly

twice as much) in less than two decades from 1995 to 2015 (as illustrated in Figure 4.3).

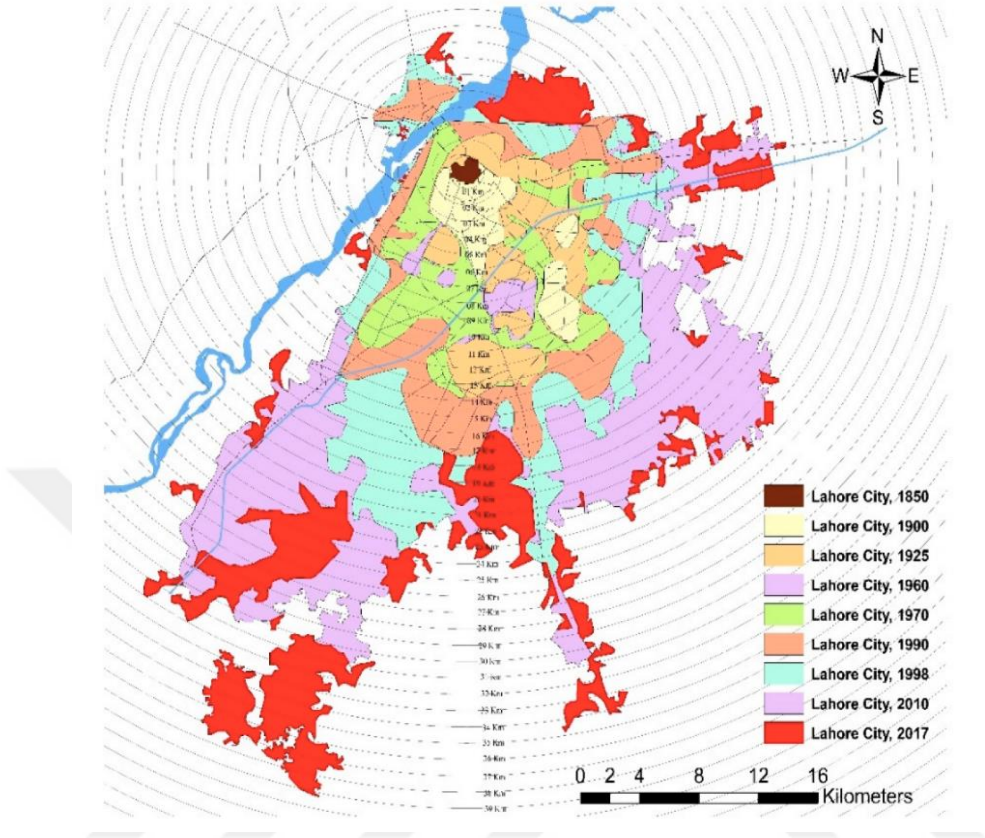

Figure 4.4 Spatio-temporal growth of Lahore from 1850 to 2017

Source: Nadeem et al., (2021)

From 1850 to 2017, the spatial expansion of Lahore city is represented in Figure 4.4. The city was initially limited to a circular layout within a 1-kilometer radius surrounding a wall, with sporadic expansion of existing population centers outside of the wall. However, due to rapid population increase in the 1960s, unplanned development took place in the south and southeast. The Indian border and the Ravi River served as barriers to expansion in the east and west, respectively. The 1970s and the late 1990s saw significant growth, which led to the city's unexpected extension to a 38-kilometer radius by 2017.

The urban development pattern of Lahore has evolved over time through a combination of historical and contemporary influences. The city has a mix of old and new neighborhoods, each with its own unique character and urban fabric. Historically, the old city of Lahore was the center of urban development. However, in the early 20th century, Lahore underwent a period of modernization and

expansion, with new neighborhoods and commercial areas being built to accommodate the growing population and changing economic needs of the city. The skyline of Lahore consists of several high-rise buildings along with mixed land use developments and commercial buildings that have contributed to the changing skyline of Lahore. Overall, the urban development pattern and the skyline of Lahore reflects the city's rich history, cultural diversity, and changing economic needs, while the city continues to evolve and grow. The historical and modern urban fabric of Lahore metropolitan along with its skyline is illustrated in Figure 4.5.

Figure 4.5 Historical (left) & modern (right) urban fabric of Lahore

Source: Holic (2017)

4.2 Bao wala: Case Study Area

The hasty increase in the population of Lahore is due to a major portion of migration of people from small and intermediate cities to this metropolitan city for seeking better opportunities (Ahsan, 2019). But unfortunately, due to exaggerative gap in demand and supply of housing in the formal market, the people started squatting the public land and formed informal settlements which are kept on increasing. Lahore, as one city in Pakistan, house 1.7 million population in more than 300 informal settlements, including both regulated and non-regulated (Malik et al., 2020). There informal settlements are known as Katchi Abadies in the context of Pakistan.

Out of the 300 informal settlements, Bao wala settlement, which is located on the eastern side of Lahore has been selected as a case study area. The spatial locational map of Bao wala, in the context of Lahore, along with other informal settlements

has shown in Figure 4.6. The locational coordinates of Bao wala settlements are 31.5294° N, 74.4372° E.

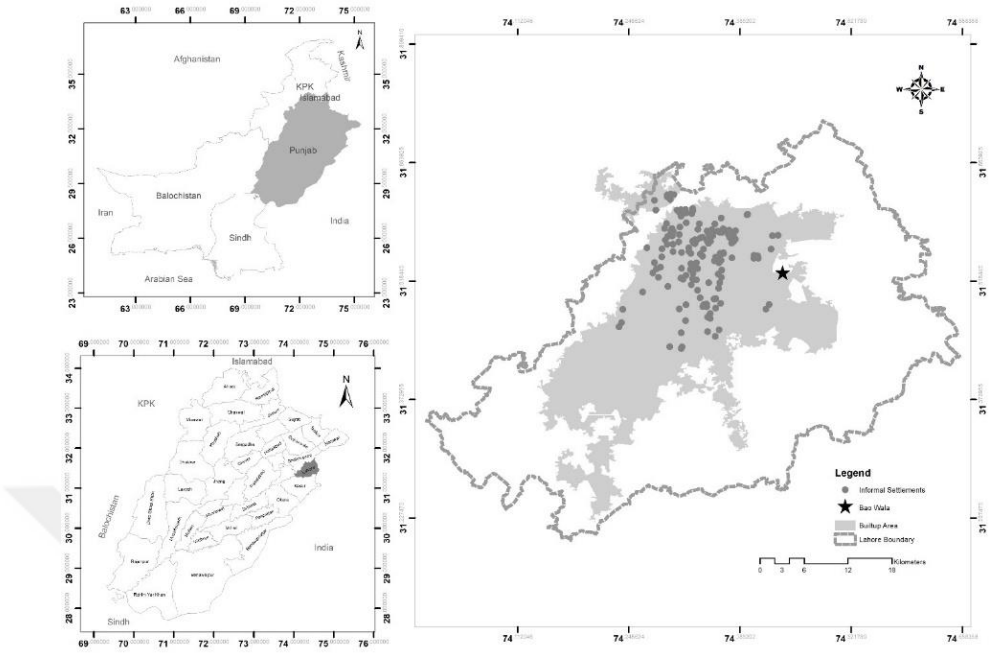

Figure 4.6 Spatial location of Bao wala in Lahore

Source: Author

Bao wala, a large-scale informal settlement, has an urban fabric distinguished by an organic street network, mid-rise construction, inadequate urban utility services, and subpar housing. Surprisingly, a green park is located next to the community, but access to the open space is limited to those living there and is instead used to service the requirements of the authorized neighborhoods next to the park's other sides.

Figure 4.7 Urban fabric of Bao wala settlement

Source: Author (survey pictures)

4.3Case Study Characteristics and Selection Rationale

Bao wala, as case study area, selected keeping in view the applicability criteria of comprehensive framework formulized in this research study. The rationales for selecting Bao wala are mentioned below:

- To formulized comprehensive framework of this study could only be implemented on large-scale informal settlement. In the metropolitan city of Lahore, majority of informal settlements comprises on less than 500 housing units, however, Bao wala is one of the informal settlements which incorporate more than 500 housing units and considered as large-scale settlements in the local context (illustrated in Figure 4.9).
- The estimated spatial area of Bao wala informal settlement is 119.6 Acres which is approximately 0.48 km2 and consists upon 2,729 land parcels. Only a few informal settlements in Lahore metropolitan city are dispersed on such a large spatial scale, and Bao wala is one of them.
- Bao wala informal settlement is located in between two main highways of Lahore; Lahore Ring Road and Barki Road (illustrated in Figure 4.8).
- Furthermore, Bao wala is located on the distance of approximately 2 kilometers from the busiest airport of Lahore (Alama Iqbal Internation Airport of Lahore). This factor has made this informal settlement a special case study area to be chosen for this study.
- As shown in the Figure 4.9, a number of small informal settlements are located in the olde part of the city, however, Bao wala a large-scale settlement is located on the potential growth way of the Lahore city.
- Moreover, Bao wala informal settlement also share its boundaries with heterogenous urban fabrics of planned communities including Aksary X housing scheme, DHA Defence Housing scheme, Eden City, Green City, and Paragon city (shown in Figure 4.8).
- Due to the greater influence of the above-mentioned planned communities, the land prices of Bao wala settlements have increased, which also increased the potential for urban regeneration to be implemented in this settlement.
- Bao wala informal settlement possesses the characteristics of diverse socio-economic and land use. Majorly this settlement consists of residential land

use, however, it also possesses critical nodes for commercial and business nodes and industrial activities

All the above-mentioned characteristics of Bao wala settlements make is best suitable case study area on which the formulized framework of this study can be implemented, and efficient results can be obtained.

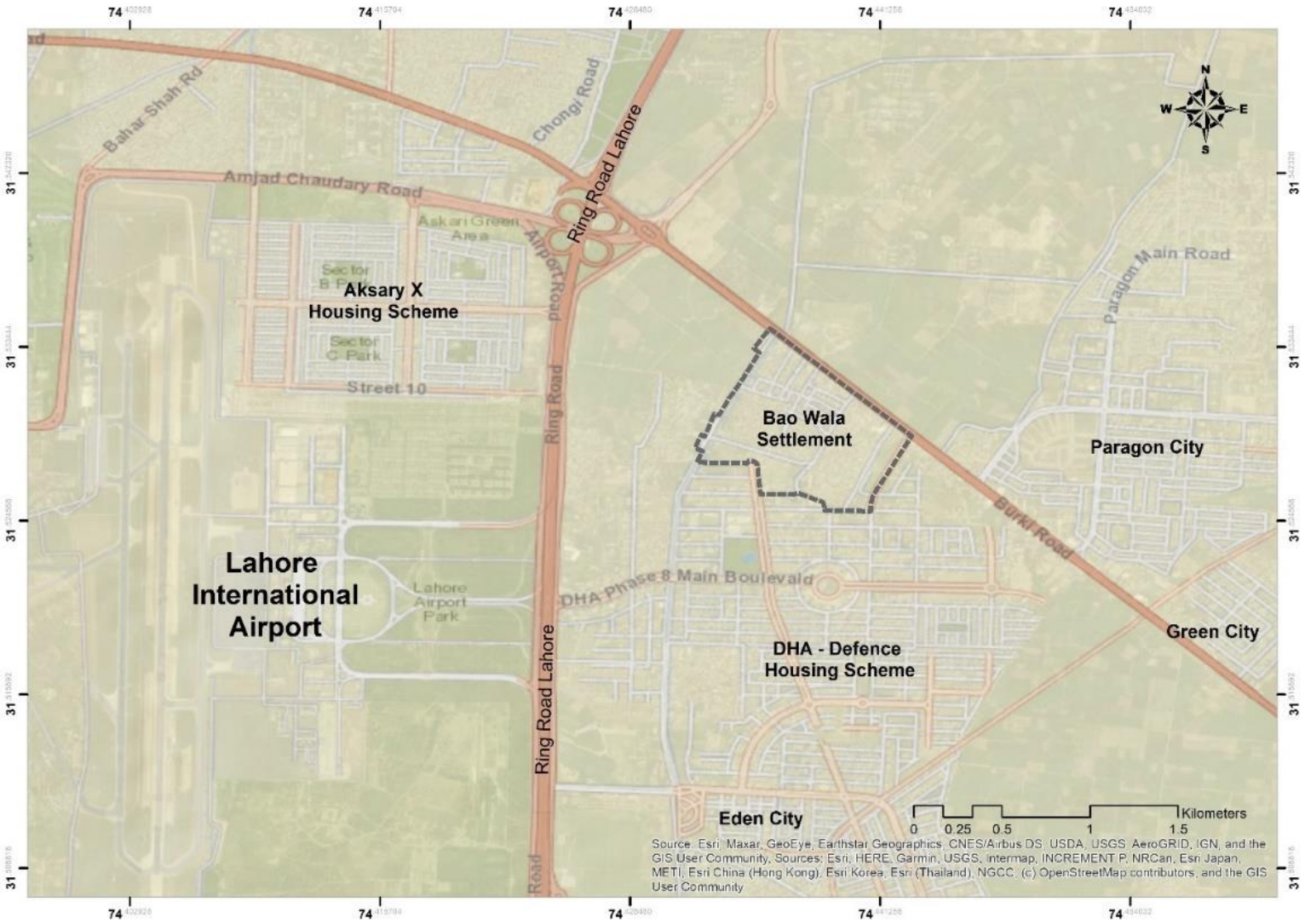

Figure 4.8 Surrounding characteristics of Bao Wala settlement

Source: Author

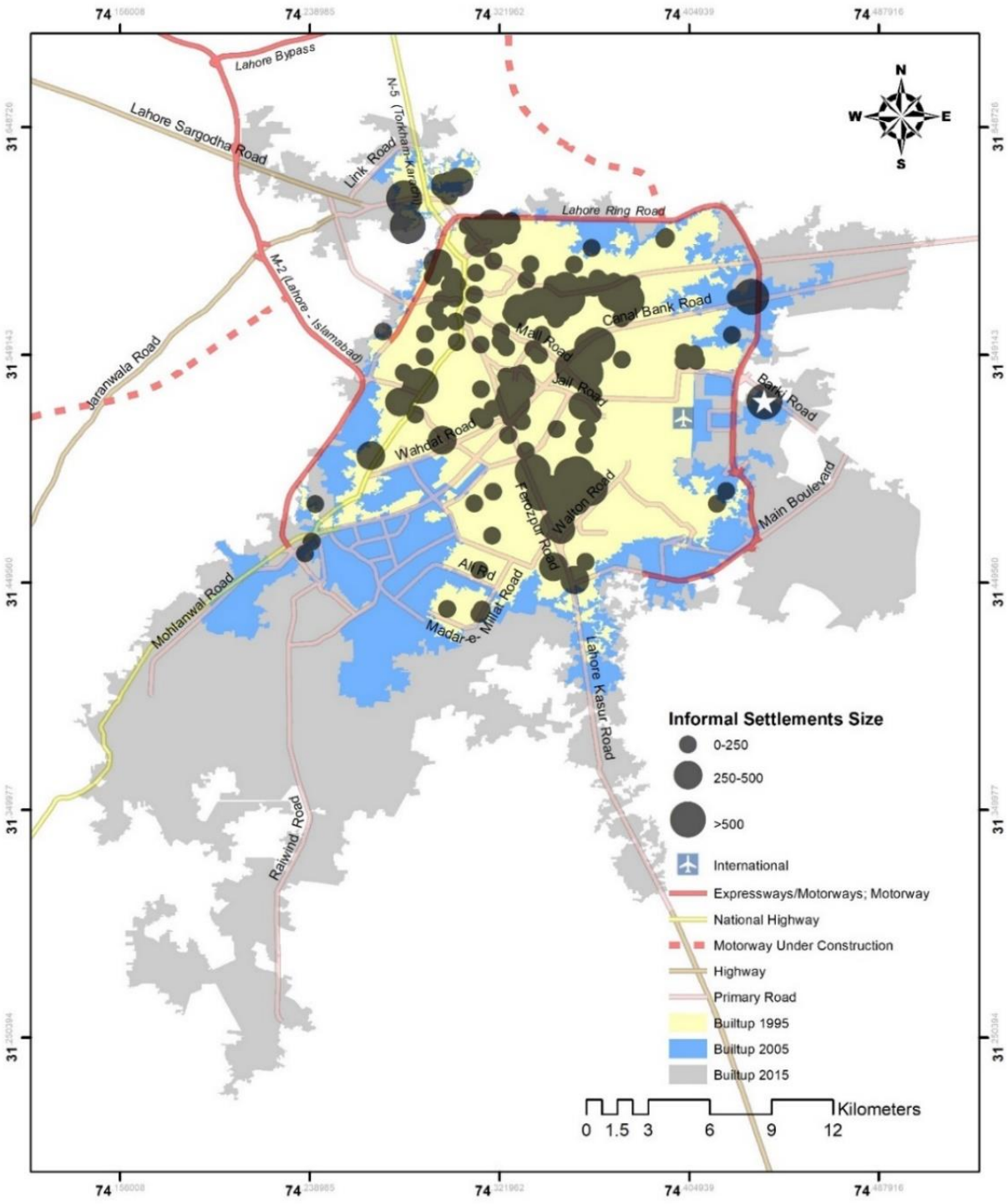

Figure 4.9 Spatial characteristic of Bao Wala in term of size and connectivity

Source: Illustrated by author – data is retrieved from LDA

4.4 Data Collection

In this research study, a comprehensive framework has been formulated which will help to divide the regeneration project area into multiple phases based on multi-indicator analysis, for which the case study of Bao wala settlement has been selected. After the finalization of the case study area, the essential task was to prepare a detailed questionnaire and base map of the settlement to conduct surveys for primary data collection. To prepare a comprehensive questionnaire, identification of potential indicators was necessary. Therefore, in this research, identification of potential indicators, and preparation of base maps and questionnaire has been performed simultaneously. Following that, the sample size and framework has been determined and the sample size was spatially distributed in the case study settlement to achieve efficient results. In the last, socio-economic and land use survey was conducted to collect the primary data, which is analyzed, and their results are discussed in the next chapter.

4.4.1 Indicator's Selection

In this study, a diverse range of potential indicators has been selected based on the detailed literature review. Five leading indicators that are finalized in this research are building densities, utilities services, road infrastructure, urban furniture, and social services. These potential indicators are chosen based on their significance and relevance to the selected settlement. The potential indicators (illustrated in the Table 4.1) play a pivotal role in determining the characteristics of the settlement's quality of place in any urban regeneration project. Moreover, these indicators hold the prime importance in measuring how developing a settlement is and also give the pathway to be focused while implementing the urban regeneration project. Furthermore, the selection of indicators is also streamlined with the guidelines of UN (United Nations Habitat, 2015) and local authorities (LDA, 2020) in defining and measuring the physical attributes of informal settlement. Local authority, in the context of Lahore, which is Lahore Development Authority (LDA), mentioned these prominent indicators in their guidelines as assessment criteria based on which the development traits of any Katchi Abadi settlement are measured (Punjab, 2012). Lack or weak implementation of these indicators is noticed within the informal

settlements, that's why these indicators have been given importance in local regeneration projects.

Five leading indicators which are building densities, utilities services, road infrastructure, urban furniture, and social services are further been divided into twenty-nine-sub indicators (shown in Table 4.1), however the description of all these indicators is explained in Table 4.2. The detailed explanation of these indicators is mentioned below:

Building density indicator has further been divided into three sub-indicators which are the fragility of building structures, floor area ratio (FAR) and living space as overcrowding. These indicators primarily represent the quality and compactness of built-up structures within the locality. Fragility of building structures indicator depicts the resilience of the building structure; therefore, bad quality of built structure is demonstrated with the higher stress score and vice versa, because in the current ages sustainable development approaches demands for good quality housing that symbolizes to the attractive built environment (Winston, 2010). Anther sub-indicator of building density is FAR, which help to compute the built-up density within the settlements. This sub-indicator has been computed with the help of GIS tool, by dividing the built space with the gross area of the respective neighborhoods. In the urban redevelopment process, higher densities in the settlements are strongly advocated because it augments the social inclusiveness besides the better access to different land uses and plentiful uses of spaces (Newton, 2010; Winston, 2010), due to which the lower density spaces in the selected case study area is denoted with higher stress score. The third sub-indicator of building density is overcrowding, which has been measured as person per room capacity in particular households. As per the WHO housing and health guidelines, the living of a greater number of people in inadequate places brings stress and affects the health of inhabitants of low, middle, and high-income countries (Organization, 2018). As per the American crowding index, crowding occurs if more than one person is living in a room (Bureau, 2011). Therefore, the higher crowding is denoted with a higher stress score in this study.

The next main indicator established in this research is the utilities service which is further apportioned into eight sub-indicators. Safe drinkable water, electricity, solid waste management and sanitation are the prominent indicators that are

declared in the UN Habitat guidelines of slums and informal settlements upgradation, which are also prescribed as basic human needs (Habitat, 2003, 2022). Besides the upgradation of these elements of utilities services, drainage flow management, gas supply, and firefighting has also been given importance in the re/development of any area (reference are illustrated in Table 4.1). Provision and efficient maintenance of the above-mentioned utilities services is essential in any society because these play a pivotal role in the social and economic development of the settlement (Hove et al., 2013) and if these infrastructure facilities collapse, it can have severe consequences towards depleting the quality of place. Subsequently, the presence of bad quality of the utility's services in the selected case study settlements is denoted with high stress score.

Road infrastructure is another main indicator which is selected in this research study, that has further been divided into three sub-indicators: road pavement, walking footpaths, and parking space. In this indicator, quality and standard of road pavement, sidewalks and parking spaces are measured based on public perception of local inhabitants. Computing the attributes of road infrastructure was necessary because it connects different societies and determined our commuting routes, moreover it also has significant impact on the economic sustainability of the societies (Ben, 2019). Road infrastructure not only plays a significant role in the commuting of goods and people (Ng et al., 2019), it also defines the outer look of our communities. Therefore, the miserable presence of road infrastructure has been indicated with higher stress score in this research.

Urban Furniture, another prominent indicator of this research is segregated into five sub-indicators which are: streetlights, street plantation, street cleanliness, sitting benches, and bus stops/ shelters. Incorporating urban furniture as an important indicator in this research was essential because it can enliven the public spaces that is considered as constructure approach for sustainable urban development. An author (Allahdadi, 2017) has listed the street benches, bus stops, lights, and plantation as important elements of urban furniture that enrich the social cohesion among the people besides bringing comfort, convenience, and aesthetics to the society. Furthermore, urban furniture is an important factor in enhancing the quality of life, therefore the occurrence of atrocious condition of the elements of urban furniture are illustrated with high stress score.

Social Services is the last main indicator that is selected in this research, which is comprised on the attributes of ten sub-indicators: health services, educational institutes, recreational places, parks and green spaces, public transport, workplace, administrative centers (town hall), sport facilities, cultural and religious places, and shopping centers. One of the pillars of sustainable development is social equity, therefore the provision and appropriate access to the above-mentioned indicators in every society is essential. However, in the actual circumstances, the provision of welfare and other public services in poor neighborhoods of societies are noticed as least served, which influences the empowerment of the societies (Ginsburg, 1999). Consequently, high stress score is illustrated for the non-existence and inappropriate access to these social services.

Wide range of indicators discussed above are selected based on their significance and relevance to the urban regeneration process of any settlements. As the formulized comprehensive framework of this study attempts to phase the project are of regeneration projects based on multi-indicator analysis, diverse set of indicators selected in this study will assist to achieve the perceived objective.

Table 4.1 Perceived indicators affecting the quality of place (continued...)

Main Indicators	Abb.	Sub-Indicators	Sources
Building Density	BD1	Fragile Building Structure	(P. Jones, 2017; Newton, 2010; Ratti et al., 2005; Samper et al., 2020; Shahraki et al., 2020; United Nation Habitat, 2018; Winston, 2010)
	BD2	Floor Area Ration (FAR)	
	BD3	Living Space (Person per Room)	
Utilities Services	US1	Safe Drinkable Water	(Arif et al., 2022; Dovey & King, 2011; Hove et al., 2013; Jones, 2017; Martínez et al., 2008; McCartney & Krishnamurthy, 2018; Samper et al., 2020; Shahraki et al., 2020; Taubenböck & Kraff, 2014; United Nation Habitat, 2018; United Nations Habitat, 2015)
	US2	Electric Supply	
	US3	Solid Waste Management	
	US4	Sanitation and Sewerage	
	US5	Drainage Flow	
	US6	Gas Supply	
	US7	Telecommunication	

Table 4.1 Perceived indicators affecting the quality of place (continued...)

Main Indicators	Abb.	Sub-Indicators	Sources
	US8	Firefighting	
Road Infrastructure	RI1	Road Pavement	(Ben, 2019; Bhatt & Rybczynski, 2003; Dovey et al., 2020; Elfouly, 2017; Kamalipour & Dovey, 2020; Ng et al., 2019)
	RI2	Walking Footpaths	
	RI3	Parking Space	
Urban Furniture	UF1	Streetlights	(Allahdadi, 2017; Arora & Kalra, 2018; Bhatt & Rybczynski, 2003; Dovey & King, 2011; El-Osta, 2007; Kamalipour, 2020)
	UF2	Street Plantation	
	UF3	Street Cleanliness	
	UF4	Sitting Benches	
	UF5	Bus Stops/ Shelters	
Social Services (Access to …)	SS1	Health Services	(Arora & Kalra, 2018; El-Osta, 2007; Faria et al., 2018; Ginsburg, 1999; Habitat, 2003, 2022; Kaklauskas et al., 2018; Kamalipour & Dovey, 2020; Sirgy et al., 2006; United Nations Habitat, 2015)
	SS2	Educational Institutes	
	SS3	Recreational Places	
	SS4	Parks and Green Spaces	
	SS5	Public Transport	
	SS6	Workplace	
	SS7	Administrative Centers (Town Hall)	
	SS8	Sport Facilities	
	SS9	Cultural and Religious Places	
	SS10	Shopping Centers	

Table 4.2 Perceived indicator's description (continued...)

Main Indicators	Abb.	Sub-indicators	Description (Respondent's perception about the…)
Building Density	BD1	Building Structure	Fragility level of their building structure
	BD2	Floor Area Ration (FAR)	Calculation of FAR to analyze the existing built-up density of the area
	BD3	Living Space (Person per Room)	Calculating the space per person in the household to determine the sufficiency of living space.
Utilities Services	US1	Safe Drinkable Water	Provision and quality of safe drinkable water
	US2	Electric Supply	Provision and maintenance of sufficient electric supply/ infrastructure
	US3	Solid Waste Management	Mechanism for collection, management, and disposal of solid waste
	US4	Sanitation and Sewerage	Sanitation system and its maintenance
	US5	Drainage Flow	Efficiency of drainage system
	US6	Gas Supply	Provision and maintenance of gas supply services
	US7	Telecommunication	Quality of telecommunication services
	US8	Firefighting	Availability and standards of firefighting infrastructure
Road Infrastructure	RI1	Road Pavement	Quality and standard of road pavement
	RI3	Walking Footpaths	Provision, existing quality, and maintenance of sidewalks / walking footpaths

Table 4.2 Perceived indicator's description (continued...)

Main Indicators	Abb.	Sub-indicators	Description (Respondent's perception about the…)
	RI4	Parking Space	Availability, sufficiency, and pricing of parking space
Urban Furniture	UF1	Streetlights	Provision, operation, and maintenance of streetlights
	UF2	Street Plantation	Availability, maintenance, and enhancement of plantation in the locality
	UF3	Street Cleanliness	Level of street cleanliness by local government
	UF4	Sitting Benches	Existence and quality of street benches
	UF5	Bus Stops/ Shelters	Provision, operation, and maintenance of public and private bus stops as waiting area
Social Services (Access to …)	SS1	Health Services	Provision, quality, and accessibility to health services
	SS2	Educational Institutes	Accessibility to educational institutes including schools, colleges, and universities
	SS3	Recreational Places	Provision, quality, maintenance, and accessibility of recreational places
	SS4	Parks and Green Spaces	Availability, characteristic, maintenance and accessibility of parks and green spaces
	SS5	Public Transport	Standard and accessibility of public transport services
	SS6	Workplace	Accessibility to workplace
	SS7	Administrative Centers (Town Hall)	Presences and operation of administrative places

Table 4.2 Perceived indicator's description (continued...)

Main Indicators	Abb.	Sub-indicators	Description (Respondent's perception about the…)
	SS8	Sport Facilities	Provision and standard of sports facilities
	SS9	Cultural and Religious Places	Preservation and maintenance of contemporary cultural and religious places
	SS10	Shopping Centers	Availability and accessibility of shopping centers

4.4.2 Base Maps

Base map of Bao wala settlement was prepared with the help of GIS tools. The first segment to prepare the base map was to entail the acquisition of spatial data which comprises the procurement of spatial imageries. Satellite imageries of the Bao wala settlements have obtained from Earth Explorer (https://earthexplorer.usgs.gov/). This database is managed by U.S. department of the interior, which provides high resolution geocoded spatial granularity of different areas, in different time zone. In the second phase, the spatial imageries than vectorized with the help of GIS and base maps of the Bao wala settlements were contrived (which is shown in Figure 4.10). With the help of this base map, the number of land parcels and the boundary area of Bao wala was measured. The below illustrated base map of Bao wala was used to conducted socio-economic and land use surveys (which are discussed in next sections).

Figure 4.10 Base map of Bao Wala settlement

4.4.3 Explanatory Variables

In this study, a comprehensive structured questionnaire was designed to collect extensive data from the Bao wala settlement (attached as Appendix A). The variables that are finalized in this questionnaire are presented in the Table 4.3 along with their respective types. Binary, open ended, categorical, and Likert scale-based data is collected in order to understand the perception of the inhabitants of Bao wala settlement.

The devised questionnaire in this study was divided into four main segments. The first section of the questionnaire focused on the personal information of the respondents, including their age, gender etc. However, the second section of the questionnaire gathered the information related to the socio-economic status of the respondents. It included the respondent's profession, income status, residence ownership status, duration of residence, respondents' education level and other household details. In the third section of the questionnaire, Likert scale-based questions were asked from the respondents in order to understand their perception regarding the presence, quality, and maintenance of the potential indicators (discussed in the section 4.4.4). Whereas the fourth segment of the questionnaire

focused on obtaining suggestions or feedback, that how the quality of life of the respective society can be improved.

Table 4.3 Explanatory variables encompassed in comprehensive questionnaire (continued...)

Variable	Variable Type	Categories
	Personal Information	
Gender	Binary	Male, Female
Age	Categorical	Less than 20 years, 20–40 years, more than 40 years
	Socio-Economic Information (Respondent`s …)	
Profession	Categorical	Student; Government / Semi-Govt. Employee; Private Employee; Private Business; None of Above; Other (_____)
Income	Categorical	None; <14,000; 14,001-30,000; 30,001 - 60,000; 60,001 - 120,000; >120,000
Education Level	Categorical	Under Matric; Matriculation; Under-Graduate; Graduate; Post-Graduation; None
Duration of Stay	Categorical	Since Birth; < 5 years; 6-10 years; 11-15 years; 16-20 years; > 20 years
House Ownership	Binary	Owned; Rented
Rooms in House	Open-ended	
Household Members	Open-ended	
	Respondent's Perception about Perceived Indicators	
Building Density	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory

Table 4.3 Explanatory variables encompassed in comprehensive questionnaire (continued...)

Variable	Variable Type	Categories
Utilities Services	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory
Road Infrastructure	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory
Urban Furniture	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory
Social Services	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory
Quality of Life	Likert scale	1-Highly Satisfactory; 2- Satisfactory; 3- Moderate; 4- Unsatisfactory; 5- Highly Unsatisfactory
Suggestions	Open Ended	

4.4.4 Likert Scale and Its Elucidation

In this research study, the Likert scale has been used as tool to assess the public perception regarding the perceived potential indicators. Likert scale ranges vary from 1 to 5, where 1 denotes to the extreme satisfaction while 5 illustrates the extreme dissatisfaction of inhabitants from the presence, quality, and maintenance of potential indicators. In this research, a reverse scoring approach of Likert's scales (5 being the worst and 1 being the good) was adopted to quantify the stress score based on the public perception and their experience toward the contemporary services. The adopted reverse scoring means that higher scores on the Likert scale would correspond to higher levels of stress at certain locations and vice versa. The quantitative illustration of Likert scale is presented in Figure 4.11, however its qualitative elucidation is explained in Table 4.4.

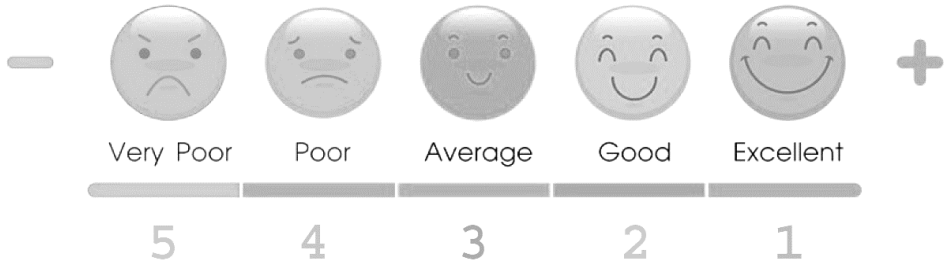

Figure 4.11 Quantitative ıllustration of likert scale

Table 4.4 Qualitative elucidation of Likert scale

Scale of perception	Numerical value	Qualitative elucidation
Highly satisfactory / Excellent	1	Respondent's utmost satisfaction with the provision, quality and maintenance of the facility/ service and no action for regeneration is needed.
Satisfactory / Good	2	Respondent's satisfaction with the provision, quality, and maintenance of the provided facility but minor improvements are required for efficient results.
Moderate / Average	3	Respondent is neither satisfied nor dissatisfied with the quality and maintenance of the facility, while enough upgrading actions are necessary to be taken to make it worthy and well-functioning.
Unsatisfactory / Poor	4	Respondent's unhappiness with the quality and maintenance with the provided facility whereas plenty of improvements are mandatory to be done to make the facility sufficient and adequate for daily life uses.
Highly Unsatisfactory / Very Poor	5	Respondent's extreme disappointment with the provision, quality, and maintenance of the provided facility, either not existed or in worst conditions that needs proper renovation/ regeneration.

4.4.5 Sample Size Calculations

Calculations of sample size of Bao wala settlement was the difficult task to perform due to lack of authentic information regarding the exact population or households

of the selected case study area. Therefore, in order to estimate the population of Bao wala settlement, the number of land parcels from base map has been quantified as units and multiplied with the average household size of Lahore. The estimated population of Bao wala settlement, determined based on above mentioned criteria, is 16,947 (illustrated in Table 4.5).

Table 4.5 Population estimation of Bao wala settlement

Number of units in Bao Wala settlement	= 2,729
Average Household Size	= 6.21 (Statistics, 2017)
Estimated Population (Bao Wala)	= No. of units * Household Size = 2,729 * 6.21 = 16,947

The sample size of Bao wala settlement has been quantified with the help of Slovin's formula (Arif et al., 2022; Aziz et al., 2018; Freund & Williams, 2003), that is mentioned below:

$$n = \frac{N}{1 + Ne^2}$$

In the above-mentioned Slovin's formula, n indicates the sample size, N portray the estimated population of Bao wala settlement, and e denotes the marginal error. The calculated sample size of Bao wala settlement is 99, corresponds to the estimated population of 16,947 and 10% of marginal error. High marginal error has been chosen in the study due to the lack of authentic information of population of Bao wala settlement.

4.4.6 Socio-Economic and Land Use Surveys

Land use surveys of the entire settlement of Bao wala are conducted based on the base maps (illustrated in Figure 4.10). During these surveys, the particular land uses of respective land parcels, building stories and structural conditions have been specifically distinguished besides other evidence. However, to conduct socio-economic surveys, the mixed approach of proportionate and random sampling techniques is adopted to gain diversified and realistic information from the different parts of the settlement. To achieve this objective, the sample size was spatially

distributed over the settlement with the help of GIS tools, which is illustrated in Figure 4.12. During the surveys, the surveyors reached at the exact marks illustrated and Figure 4.12 and filled the questionnaires while also marked the specified number to the questionnaire, to integrate the quantitative information with the spatial data on later stage to perform spatial analysis. Socio-economic and Land use surveys of Bao wala settlement are performed during the month of January and February 2022, because the entire population of the respective settlement was easy to approach during this time period due to the winter holidays.

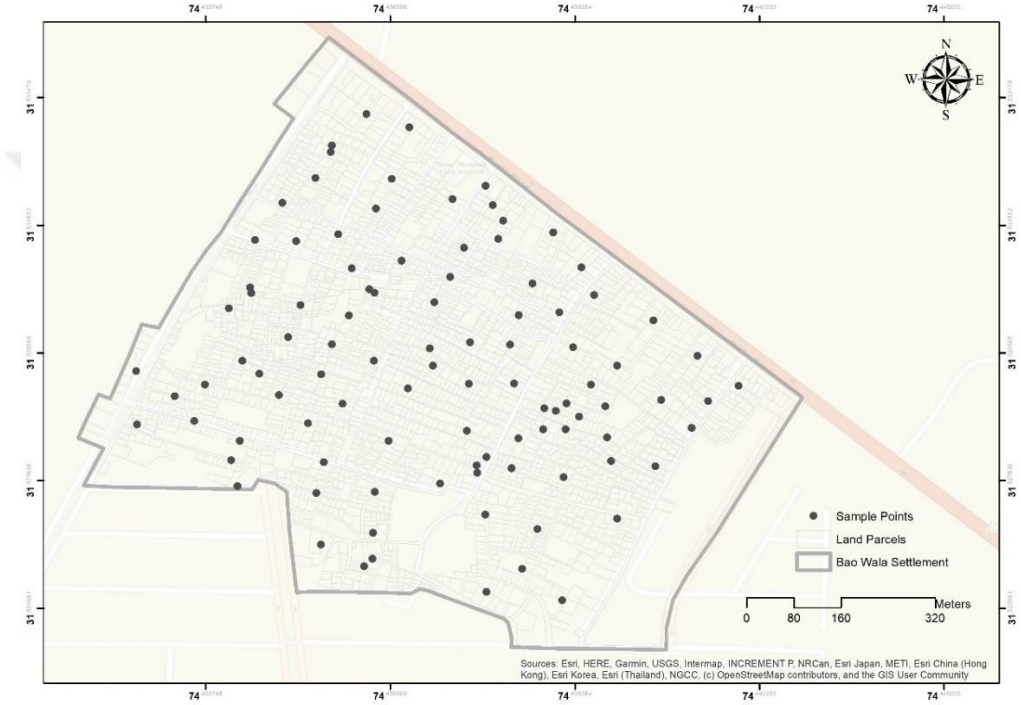

Figure 4.12 Spatial distribution of sample points in Bao wala

4.4.7 Data Analysis

The data analysis in this research study is categorized in four different sections. In the first section, the respondent's characteristics have been analyzed and descriptively illustrated in the form of frequencies and percentages. The second section of analysis demonstrates the spatial analysis of Bao wala settlements. In this section, the land use categorization, building height and structural conditions of Bao wala settlement are spatially illustrated. The third section illustrates the quantitative analysis conducted in this study. The quantitative analysis initiates with descriptive illustrations of public perception regarding the perceived potential indicators. Following that, the linear regression analysis has been performed. Regression is the

statistical analysis, which helps researchers and practitioners to understand the relationship between dependent and perceived variables and also helps to sort out the variables which don't have indeed impacts. It also assists in finding the answers to questions like: Which perceived variable has greater impact on dependent variable? How do these variables interact with each other? Which variables can be ignored to get efficient results? And how certain are the researchers about the relationship of the variables? etc. (Gallo, 2015). The regression analysis has also been used in numerous other research to understand the relationship of dependent and perceived variables such as (Abedi et al., 2012; Jankowska et al., 2011; Nolan, 2015; Parikh et al., 2015; Ullah, 2004; Zanuzdana et al., 2013). Therefore, based on this regression analysis, the perceived indictors which had least impact on dependent variable are eliminated in this study. Later the stress score of indicators obtained from public perceptions and weightage index gained from the interviews of the practitioners is multiple to achieve the cumulative stress score of the finalized indicators.

The fourth section of data analysis consists of the application of Inverse distance weighted (IDW) analysis. IDW is the technique that is used to calculate the value of unsampled location by gaining the weight from the sampled location. IDW interpolation uses the inverse distance method in which the weight is proportional of the proximity of sample locations, which means the weight influences will decrease as it goes away from the sample locations (Esri, 2022; Gimond, 2022; Watson & Philip, 1985). In this research study, the sampled locations will be the places where the survey questions were filled, weight will be the stress score that is calculated from public perception and unsampled location will be the remaining parts of the Bao wala settlement. The IDW technique has also been used in numerous other studies to calculate the values of unsampled locations (Das et al., 2021; Feizizadeh et al., 2021; Ijaz et al., 2022; Jumaah et al., 2019; Naqvi et al., 2015). With the help of IDW technique, using the cumulative stress score as weight, the Bao wala settlement is classified in 3, 4, and 5 different phases which is the ultimate output of the formulized framework of this research study. Different number of phases of any case study area can be obtained by using IDW techniques based on their spatial extent and exigency of number of phases. In the end, the

accuracy of IDW analysis has been validated with the help of RMSE statistical model.

5
RESULTS AND DISCUSSION

This chapter provides a detailed explanation of the results that have been obtained in this research study. The achieved results are categorized into four different sections. The first section elaborates the respondent's characteristics, that participated as interviewee in the socio-economic surveys. The second section demonstrates the results of spatial analysis, including land use distribution, building height and structural conditions illustration. In the third section, the results of quantitative analysis are explained, including descriptive calculations besides regression analysis. The last section of this chapter illustrates the results of IDW analysis, with the help of which the phases of regeneration project area are obtained. All the results are briefly explained in the below sections.

5.1 Respondent's Characteristics

To entail the diverse socio-economic characteristics in the results, the respondents with different age groups having diverse educational and professional background participated in the surveys (which is shown in Table 5.1). The result shows that, in the socio-economic surveys, 56.6% male population has participated, however the significant proportion of female was also the part of surveys. It is also illustrated that 39.4% of the respondents possess the young age group belonging to 20 to 40 years of age bracket, whereas the 36% respondents had the age of more than 40 year. Relatively sufficient proportionate of teen-age group (less than 20 years) was also the part of socio-economic surveys. Majorly young and old aged respondents are preferred for socio-economic surveys due to their extensive experience dealing with the factual problem of local society. This age group can comprehensively explain the contemporary issues of the neighborhoods and can also suggest their possible local solutions, that can be incorporated in the regeneration plans.

It has also shown in the results that only one third segment of the society possess the education level of above graduation, however the larger portion of the population of Bao wala settlement have their education level of below

matriculation. The main reason for not possessing higher education level in Bao wala society is the lack of sufficient access to educational institutes in informal settlements. Predominantly the young age group have urge to pursue higher education in universities, but the absence of sufficient financial resources also create hurdles in their dreams, due to which this segment of society take the responsibility to be a part in the earnings for themselves and the other family members of the household.

Results in the Table 5.1 demonstrate that the significant percentage of the population of Bao wala settlement is either working in the private section (28.3%) or performing their duties as government employees (20.2%). Only 17.2% of the population of Bao wala settlement have their own private business, which includes the availability of corner shops in the neighborhoods, few commercial and service sector related shops on the primary roads. It is also important to mention that a significant portion of this society (23.2%) is unemployed, either searching for work opportunities or being dependent on the other family members of the household.

In this study, the populace of Bao wala society is also categorized based on income levels, to assess their socio-economic class. The income brackets mentioned in this research are taken from the governmental reports (Secretariat, 2018), in which the population having income less than 30,000 PKR belongs to low-income class and the people earning less than 14,000 PKR live below the poverty line. The population fits in the income bracket of 30,000 PKR to 120,000 PKR and earning more than 120,000 PKR belongs to middle income and high-income classes, respectively. As per the guidelines of above-mentioned report, around 60.6% of the population belongs to the low-income class of the society, out of which 39.4% are living below the poverty line, having income level less than 14,000 PKR. It has also been observed that 36.4% and 3% of the population of the Bao wala settlement belongs to middle-income and high-income classes, respectively.

During the surveys, respondents were also questioned about their duration of stay at the Bao wala settlement and their house ownership status. 24.4% respondents answered that they have been living in the Bao wala settlement since birth, however 30.4% of the population have been living here for more than 16 years. It has been observed that only 6.1% of the population migrated to Bao wala settlement in recent years, in search of new economic opportunities due to the locational factor of this

settlement. The results have also illustrated that 62.6% of the population possess their own housing units in Bao wala settlement, while the rest of the population is living in rental housing units.

Table 5.1 Respondent's characteristics of Bao wala settlement (continued...)

Estimated Population of Bao Wala		947	
Sample Size		99	
Characteristics		**Freq.**	**Perc.**
Gender	Male	56	56.6%
	Female	43	43.4%
Age	Less than 20 years	24	24.2%
	20 - 40 year	39	39.4%
	More than 40 years	36	36.4%
Profession	Government / Semi-Govt. Employee	20	20.2%
	Private Employee	28	28.3%
	Private Business	17	17.2%
	Student	11	11.1%
	Unemployed	23	23.2%
Income	No Income	24	24.2%
	<14,000	15	15.2%
	14,001-30,000	21	21.2%
	30,001 - 60,000	21	21.2%
	60,001 - 120,000	15	15.2%
	>120,000	3	3.0%
Education	Under Matric	22	22.2%
	Matriculation	23	23.2%
	Under-Graduate	21	21.2%
	Graduate	16	16.2%

Table 5.1 Respondent's characteristics of Bao wala settlement (continued...)

	Post-Graduation	17	17.2%
Duration of Stay	< 5 years	6	6.1%
	6-10 years	21	21.2%
	11-15 years	18	18.2%
	16-20 years	15	15.2%
	> 20 years	15	15.2%
	Since Birth	24	24.2%
House Ownership Status	Owned	62	62.6%
	Rented	37	37.4%

5.2 Spatial Analysis

Comprehensive spatial analysis of Bao wala has been conducted to understand the land use distribution, building height and densities, and structural conditions of the building in the settlement. The spatial analysis has been conducted with the help of GIS tools.

The land use distribution map of Bao wala (shown in Figure 5.1) illustrate that the settlement is predominantly comprised on the residential land use, which is 65.8% of the whole settlement. The land use distribution analysis also illustrates that the significant proportion of commercial and residential cum commercial is also observed on the primary and secondary roads of the settlement. The commercial and residential cum commercial land uses disseminated over 3.9% and 3.5% portion of the settlement, respectively. Besides these land uses, hospitals, clinics, and a few educational institutions are also observed in the Bao wala settlement which helps to meet the basis needs of the inhabitants. However, Bao wala settlement lacks the sufficient provision of parks and open spaces in it, which act as the hubs for community gatherings and playgrounds for the children.

In the Bao wala settlement, enormous tracts of vacant land parcels are observed, which comprises on 12.1% of the whole settlement. Over the passage of time, inhabitants have squatted the previously available unoccupied land parcels and

constructed residential units on it, therefore, it is anticipated that these vacant land plots will be converted to other land uses in near future. However, at the moment, these parcels are being occupied either as playgrounds, or the sites for solid waste disposal.

Furthermore, an open drain (locally known as Nala) is also available on the western side of Bao wala settlement, which is used for sewage waste disposal, meanwhile also act as the drainage route in rainy seasons. This open drain is also a source of numerous health related problems of the inhabitants, but due to ineffective managements of solid and sewage waste disposal of the settlement by the governmental institutes, the inhabitants are forced dispose their wastes in the available open drains.

Moreover, the land use spatial analysis of Bao wala settlements has also demonstrated as big chunk of agriculture area on the eastern side of the settlements. This agriculture area is comprised of 11.3% of Bao wala settlement, where the local inhabitants provide their services. Besides the above discussed land uses, a shrine adjacent to a huge mosque and the massive land parcel of graveyard (1.6% of the total settlement) are also observed on the western side of Bao wala settlement.

Analyzing the overall portfolio of land use distribution in Bao wala, it has been discovered that the settlement consists of mixed land use practices, encompassing the residential, commercial, residential cum commercial, health and educational institutes land uses etc., which prevails in the different parts of the settlement. However, the adequate provision of parks, open spaces and other utilities services is essential to enhance the quality of the place of the settlement.

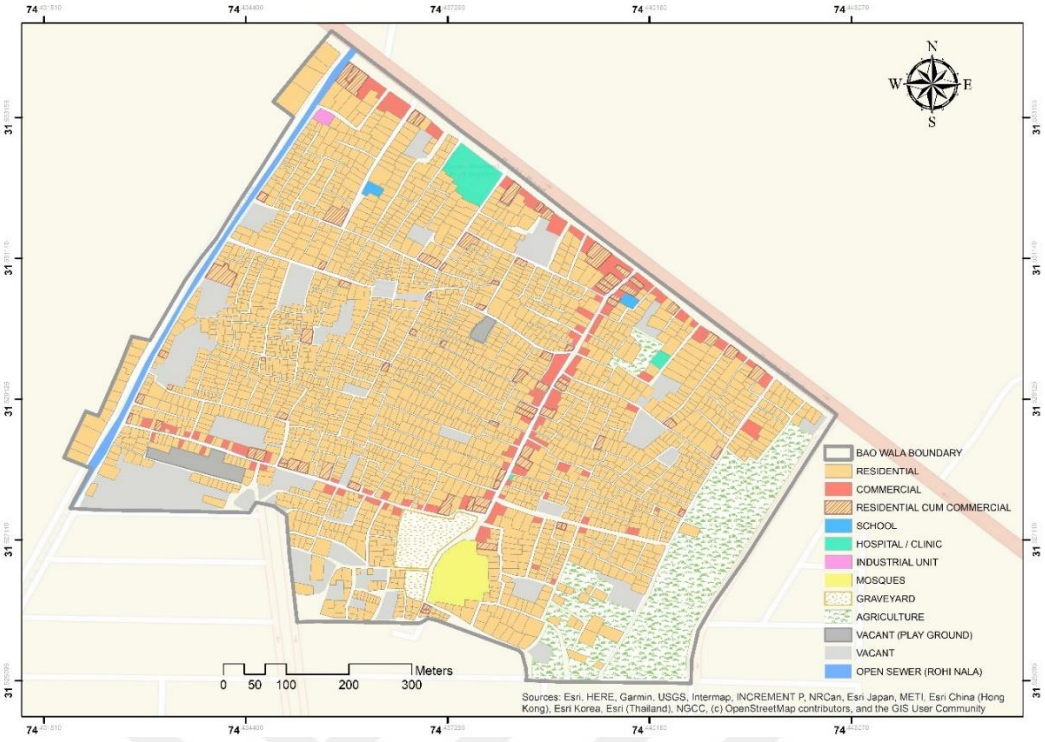

Figure 5.1 Land use distribution analysis of Bao Wala

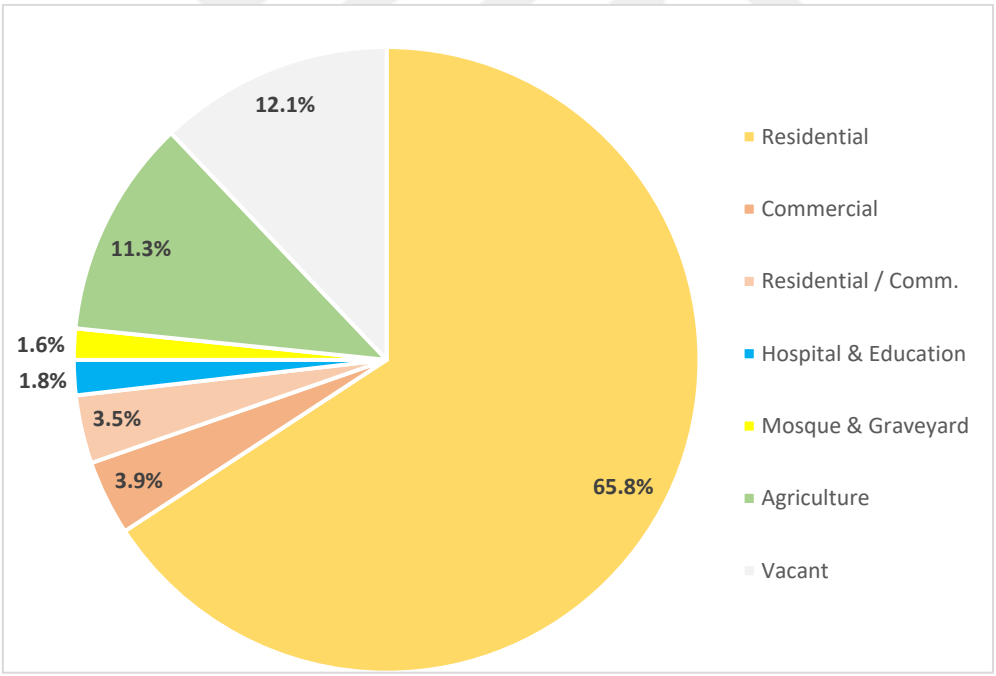

Figure 5.2 Land use percentages of Bao wala settlement

Besides land use distribution of Bao wala settlement, building's stories and their respective structural fragility has also been observed. The spatial distribution of building stories and their fragility level is illustrated in Figure 5.3 and Figure 5.5, however their quantitative divisions are shown in Table 5.2. The spatial distribution

map of building stories (Figure 5.3) of Bao wala illustrate that majority of built structure is this settlement are comprised on single stories (58.9% of total area), which are predominantly comprised on residential land uses. However, a significant portion of double stories buildings are also observed in the settlement, which is 8.5%. Furthermore, 9.3% of built structure in Bao wala settlement are observed having three or more number of stories. The buildings comprised on higher number of stories are present along the major roads of Bao wala settlement, which entails the commercial and residential cum commercial land uses distribution. The comparative illustrations of single and multi-story buildings in Bao wala are shown in Figure 5.4.

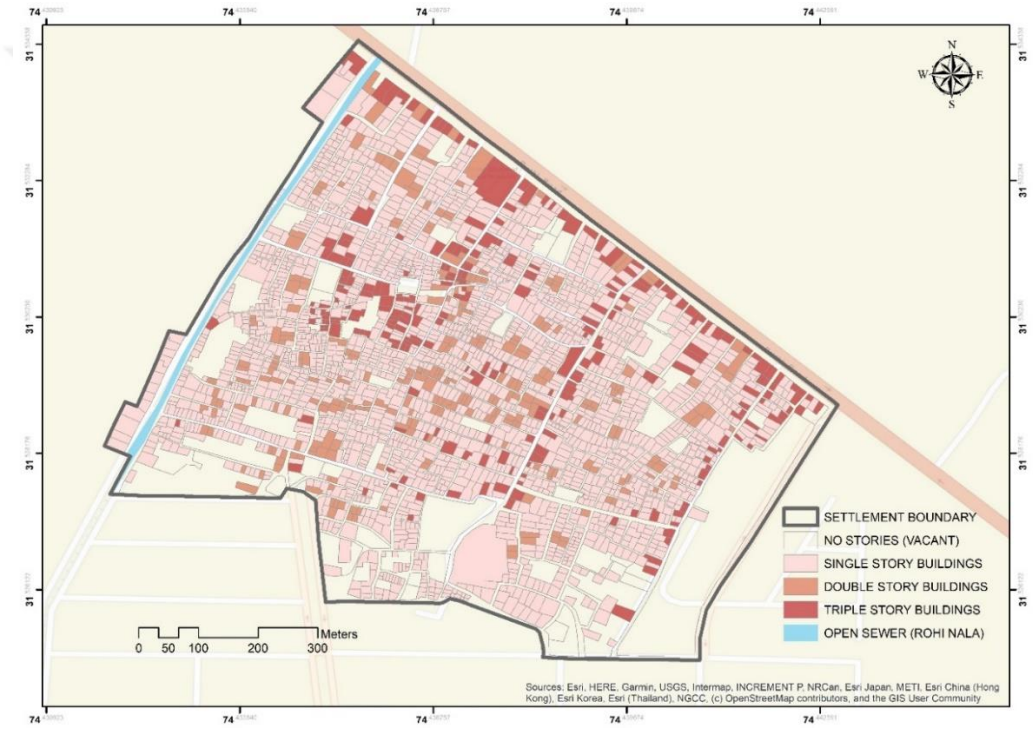

Figure 5.3 Building stories in Bao wala settlement

Figure 5.4 Illustration of single and multi-story buildings in Bao wala

Source: Author (survey pictures)

The spatial distribution map which demonstrates the fragility conditions of built structure of Bao wala settlement is illustrated in Figure 5.5. The fragility analysis demonstrates that the majority of building structures on the southern eastern side of Bao wala settlements have bad fragility quality, which is disseminated over 39.6% of the total settlement area. Buildings possessing bad fragility quality status consists of mud houses or having significant cracks in their structures, which needs substantial attention for their improvement. But mostly the inhabitants of such buildings belong to low-income class which perform the labor work; therefore, they are unable to spend a large portion of their income on housing and are forced to live in bad quality conditions. Fragility analysis also depicted that a significant proportion (24.7%) of built structures in Bao wala settlements possess normal fragility status, however only 12.3% of buildings possess good quality structures. It has been observed that such buildings are either present on the major roads of the settlements, consists of majority commercial and other land uses. The buildings possessing good quality structures are either built or renovated in recent time periods. Comparative illustrations of good and bad structure buildings in Bao wala settlement are shown in Figure 5.6.

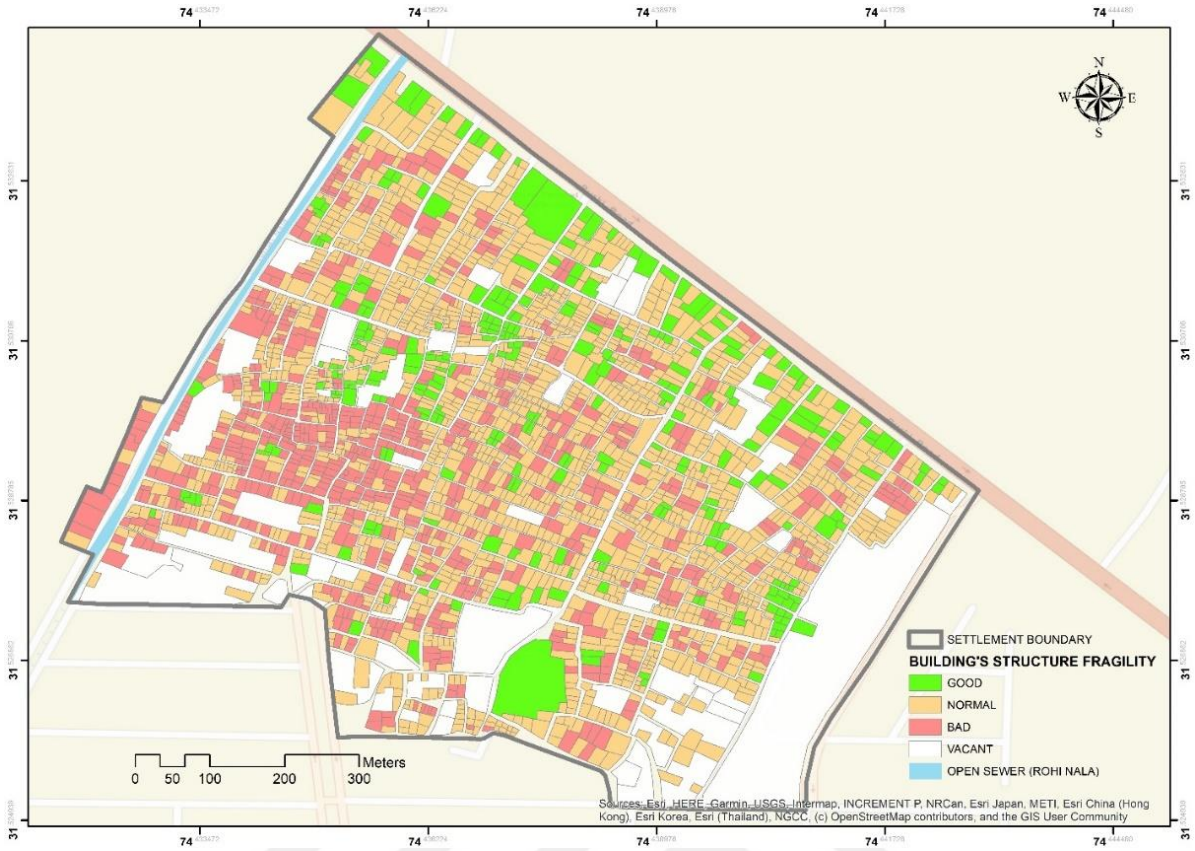

Figure 5.5 Fragility conditions of built structure in Bao wala settlement

Figure 5.6 Comparative illustrations of good and bad structure buildings in Bao wala

Source: Author (survey pictures)

Table 5.2 Percentage distribution of building`s stories and fragility conditions in Bao wala Settlement

Building`s Stories	Area (Acre)	Perc.	Fragility Conditions	Area (Acre)	Perc.
Single Story	70.5	58.9%	**Good**	14.7	12.3%
Double Story	10.1	8.5%	**Normal**	29.6	24.7%
Triple Story and More	11.1	9.3%	**Bad**	47.4	39.6%
Vacant Plots	28.0	23.4%	**Vacant Plots**	28.0	23.4%
Grand Total				119.6	100.0%

In conclusion, the spatial analysis that are discussed above illustrated that the northern side of Bao wala settlement possess the predominantly commercial and residential cum commercial land use distribution, own higher building stories and hold good fragility building structures, however, the majority of area on southern and western side of the settlements belongs to low-income population areas which have bad building structures. The southwestern side of Bao wala settlement needs necessary improvements under regeneration project on earliest basis.

5.3 Quantitative Analysis

The quantitative analysis conducted in this research study consisted of three different sections. In the first section, the public perception regarding the satisfaction level from the provision, maintenance, and performance of contemporary utilities services of the Bao wala settlement is explained. The correlation of different perceived indicators and dependent variables is described in the second section; however, the finalization of perceived indicator and calculation of stress score is illustrated in the third section.

The below mentioned Table 5.3 presents the attributes of overcrowding and FAR distribution in the Bao wala settlement. The FAR and overcrowding characteristics are measured of the certain households in the Bao wala settlement where the socio-economic surveys were conducted. The attributes of FAR in Bao wala settlement

are categorized in three different classes: low, medium, and high FAR. These three classes of FAR are derived from the study of Arif et al., (2022) in which as per the residential standards of Vancouver, British Columbia, the FAR value of less than 0.75 is denoted as low, from 0.75 to 1.3 is depicted as medium while more than 1.3 is denoted as high, respectively. Based on the mentioned standards, it has been observed that only on the 4% spatial extent of Bao wala settlement, buildings possessing the FAR value of more than 1.3 are dispersed. The infrastructure owing high FAR mainly incorporates hospitals and newly developed multi-story buildings on the primary road of Bao wala settlement besides residential cum commercial buildings where the ground floor is used for commercial while upper floors are used for residence purposes. Moreover, it has also been observed that on the 19.2% area of Bao wala settlement, buildings owing medium FAR of 0.75 to 1.3 are scattered, which mainly comprises residential and commercial buildings besides small clinics and mosques etc. Furthermore, the results also illustrate that a significant proportion of Bao wala settlements (on 76.8% area) possess buildings owing low FAR values of less than 0.75, which mainly encompass the old residential buildings on the southwestern side of the settlement.

The results of overcrowding characteristics of Bao wala settlements are also shown in Table 5.3, in which the values of overcrowding are also categorized in three classes as high, moderate, and low. In the WHO housing and health guidelines the American crowding index is elaborated which indicate overcrowding if more than one person is living in a room, therefore, households with less than one person per room, 1-2 persons per room and more than 2 persons per room are denoted as less, moderate, and highly overcrowded, respectively. The results illustrated in Table 5.3 shows that only 9.1% households of Boa wala settlement are not overcrowded, which possess greater number of room than the number of people living in it. Results also show that only 16.2% of households of Bao wala settlement are moderately crowded, however, a significant proportion of households in Bao wala settlement, which is 74.7%, are highly overcrowded. Majority area of this settlement is highly overcrowded due to numerous reasons including greater household sizes, less capacity to buy or rent new households for next generation, bad socio-economic attributes, and exaggerative land prices in the vicinity etc.

Table 5.3 FAR and overcrowding characteristics of Bao wala settlements

Floor Area Ratio (FAR)		**Overcrowding**	
Labels	**Perc.**	**Labels**	**Perc.**
High FAR (>1.3)	4.0%	**Highly Overcrowded (>2 person / room)**	74.7%
Medium FAR (0.75 - 1.3)	19.2%	**Moderate Crowded (1-2 persons / room)**	16.2%
Low FAR (<0.75)	76.8%	**No Overcrowding (<1 person / room)**	9.1%

The below illustrated results illustrate the public perceptions regarding the provision, operation, maintenance, and quality of contemporary utilities services, road infrastructure, urban furniture, and social services in Bao wala settlement. These public perceptions are measured based on a 5-point Likert scale varies from extreme dissatisfaction to extreme satisfaction. The below illustrated results shows that majority of inhabitants in Bao wala settlement are either extremely dissatisfied or shows moderate behavior towards the contemporary conditions, however only minimal segment of the society shows satisfactory behavior toward existing services.

Figure 5.7 shown below demonstrate the public perception regarding existing utilities services in Bao wala settlement. For the facility of safe drinkable water, 70% inhabitants of Bao wala settlement shows extreme dissatisfaction while other 30% shows dissatisfaction and not express the satisfactory behavior toward this service due to the presence of extremely bad quality of water supply services. Moreover, 24% and 33% of the population of Bao wala settlement express extreme dissatisfaction and dissatisfactory behavior toward the presence and maintenance of electricity infrastructure in the locality. Whereas 30% portion of the settlement show moderate while only 12% population indicate satisfactory attitude towards this utility services. This satisfactory behavior regarding electricity services was only observed on the primary roads of the settlement where the electric services are maintained regularly to maintain the façade of the settlement while the other

segment of the locality is ignored. Similarly, the public perception regarding solid waste management, sanitation and sewerage facilities is also experienced as dissatisfactory. Almost 64% of the population of Bao wala settlement express extreme dissatisfactory and dissatisfactory while only 36% segment of the society shows moderate behavior toward solid waste management in the vicinity. However, for sanitation and sewerage facilities, 79% of the inhabitants in the settlement shows dissatisfactory while only 21% of the population express a moderate attitude. The same pattern of dissatisfactory expression of the general public of Bao wala settlement is also observed for other utilities services including for gas supply, telecommunication, and firefighting services. 88%, 94% and 57% of the population of Bao wala settlement shows either extreme dissatisfactory or dissatisfactory while 12%, 6% and 39% of inhabitants shows moderator perception towards gas supply, telecommunication, and firefighting services, respectively. In general, the extreme dissatisfaction in the public perceptions regarding the utility's services in Bao wala settlement is experienced due to their bad presence and lack of proper maintenance of these respective services in the locality. Illustrations of few utilities' services in Bao wala settlement is presented in Figure 5.8.

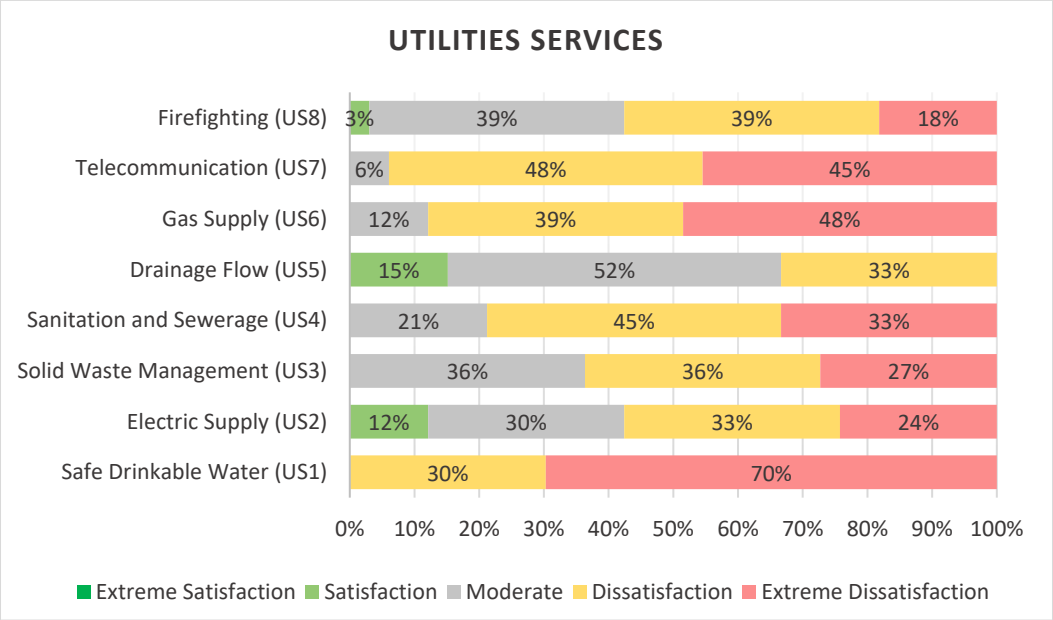

Figure 5.7 Public perception regarding utilities services in Bao wala settlement

Figure 5.8 Utilities service's conditions in Bao wala

Source: Author (survey pictures)

Figure 5.9 presented in the section illustrate the public perception of the population of Bao wala settlement regarding the road infrastructure in the locality. Similar to the public perception regarding utilities services, the public behavior towards the presence, quality, and maintenance of road infrastructure in Bao wala is experienced as extreme dissatisfactory. It has been observed in the result presented in Figure 5.9 that 58% and 29% of the population of Bao wala settlement expresses extreme dissatisfaction and dissatisfaction while only 8% and 5% inhabitants have shown the expression of moderate and satisfactory toward the presence of road pavement in their respective neighborhoods. This only 5% satisfactory public perception toward road pavement is observed on the primary road on the northern side of the settlement due to the presence of good quality of highway passing from there, otherwise in the other segments of the society, dissatisfactory behavior for this service has been observed. Similarly, for the other sub-indicators of road infrastructure, 82% and 73% of the population expresses extreme dissatisfaction and dissatisfaction while only 18% and 27% inhabitants express moderate behavior toward the presence, quality and maintenance of walking footpaths and parking space in the settlement, respectively. Street conditions from different parts of Bao wala settlements are presented in Figure 5.10.

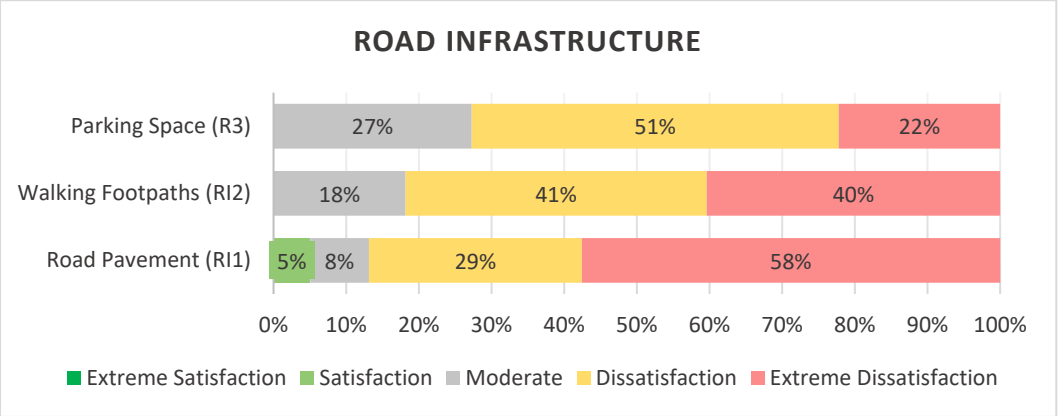

Figure 5.9 Public perception regarding road infrastructure in Bao wala

Figure 5.10 Street conditions in Bao wala

Source: Author (survey pictures)

Public perception for another important indicator of urban furniture has been observed in this study which illustrates the exceptionally terrible findings. The alarming results presented in Figure 5.11 elucidate that none of the sub-indictor of urban furniture gained the satisfactory public perception in the Bao wala settlement. Results presented in Figure 5.11 illustrate that street cleanliness is the indicators toward which 92% of the residents shows extreme dissatisfaction while only 8% expresses the moderate expressions. Similarly, 86%, 80% 74% and 80% of the population of Bao wala settlement shows extreme dissatisfaction, and dissatisfaction while only 14%, 20%, 26% and 20% inhabitants express moderate opinions towards streetlights, street plantation, sitting benches and bus stops, respectively.

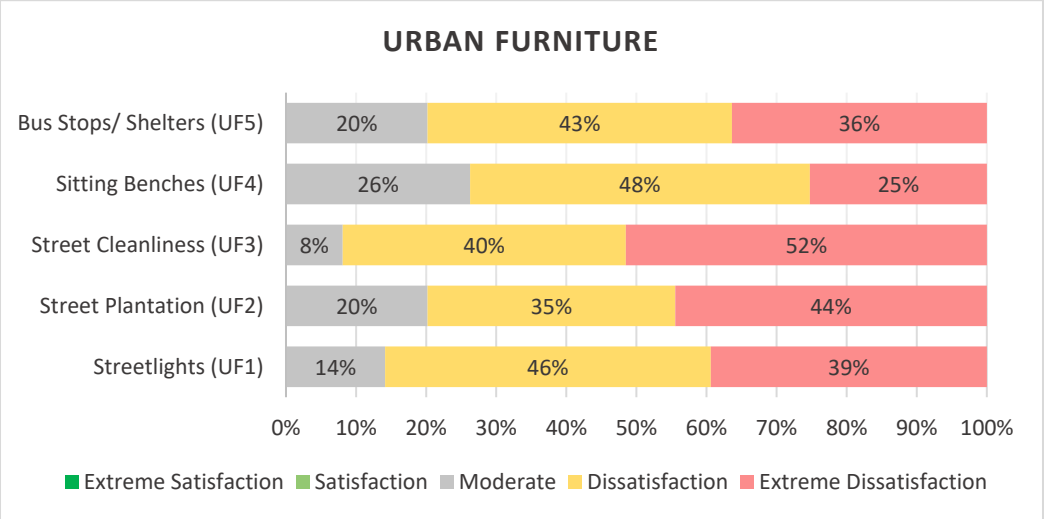

Figure 5.11 Public perception regarding urban furniture in Bao wala settlement

Furthermore, the public perception regarding the indicators of social services is exhibited in Figure 5.12. The results presented in Figure 5.12 has also illustrated that the majority of the population of Bao wala settlement has again expressed dissatisfactory behavior for these indicators as well. For health service facilities in the settlement, 76% of the population expresses dissatisfaction while only 24% of residents have shown moderate behavior. While analyzing the quality and access to educational institutes, only 15% of the population from high-income class has shown the satisfactory while other 85% of the population belonging to low and middle-income group exhibited either moderate or dissatisfactory behavior, respectively. The presented results have shown that only 3% of the population of Bao wala settlement has shown satisfactory expression for access to recreational place, parks and green spaces and public transport, however, 81%, 72%, and 82% of residents has expressed dissatisfactory attitude towards these services, respectively. Similarly, a terrible public perception as dissatisfactory from the significant proportion of the population of Bao wala settlement has been observed for other sub-indicators of social services. It has been observed that 79%, 73%, 82%, 100% and 70% of the population of Bao wala has exhibited extreme dissatisfactory and dissatisfactory while only 21%, 27%, 18%, 0%, and 30% of the population has elucidated the moderate expressions toward the presence, quality and access to workplace, administrative centers, sports facilities, cultural and religious places, and shopping centers, respectively. It is essential to mention that none of the respondents from Bao wala settlement has conveyed satisfactory

expressions for these mentioned services due to the bad quality and maintenance of these respective social services.

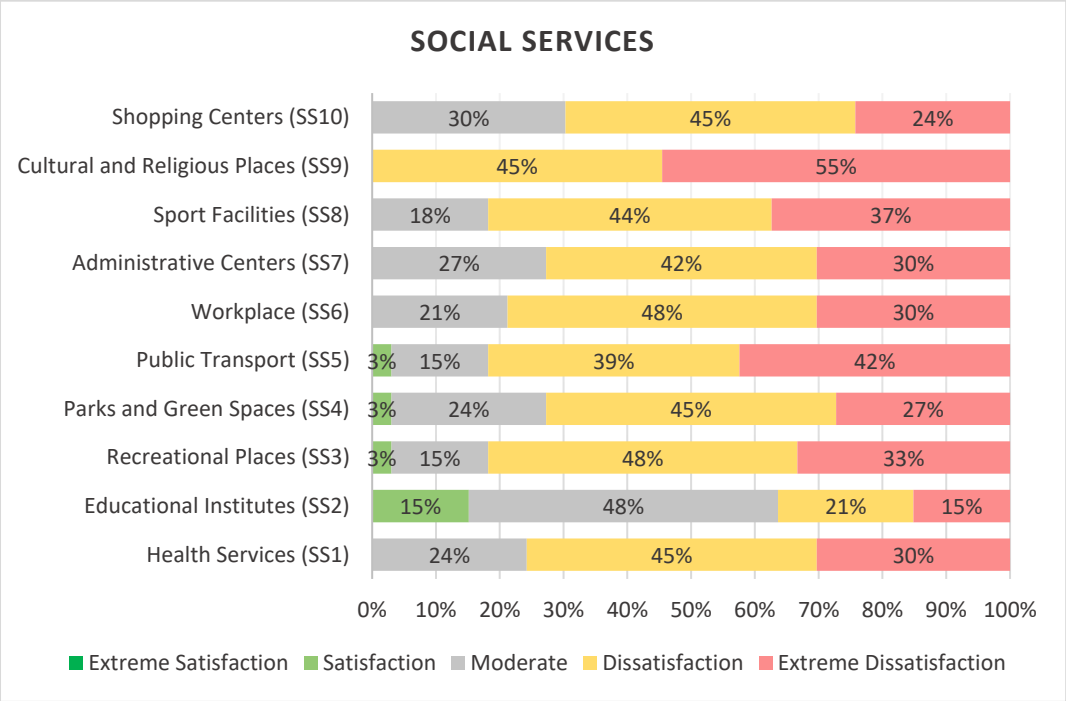

Figure 5.12 Public perception regarding social services in Bao wala settlement

Figure 5.13 Presence of public buildings in Bao wala settlements

Source: Author (survey pictures)

5.3.1 Indicator's Relation / Scrutiny

In this section of quantitative analysis, linear regression method is used to determine the relation between perceived and dependent indicators. In this research study, the perceived indicators contain all 29 sub-indicators of five leading indicators including building densities, utilities services, road infrastructure, urban furniture, and social services, whereas the quality of place is adopted as dependent indicator.

With the help of regression analysis, the relation between quality of place and 29 perceived indicators is measured. The detailed explicit results of 5 leading perceived and dependent indicator are shown in Annexes, however their brief illustration is shown in Figure 5.14. The results illustrated in Figure 5.14 shows the beta coefficient which express the level of impact of perceived indicator on dependent indicator, value to R^2 which denotes the strength of relation between perceived and dependent indicator and the significance level (P Value). The value of Beta coefficient near to zero will illustrate the least impact of perceived indicator on dependent variable and vice versa, whereas the value to R^2 below 0.5 will show least, 0.5 to 0.7 illustrate as moderate and above 0.7 denotes as strong relation between perceived and dependent variable. Moreover, based on the marginal error of 5%, the P-value less than 0.05 and 0.01 is exhibited as significant and highly significant which is denoted with single star (*) and double star (**), respectively. All these values are exhibited in the right bottom cornered legends of Figure 5.14. The results of this linear regression of five leading and 29 sub-indicators with dependent variable is explained briefly the sections below:

While analyzing the relation of building density indicators with the quality of places, it has been observed that all the sub-indicators (including BD1, BD2, and BD3) have highly significant relation with the dependent variable (C APPENDIX). The beta coefficient of these sub-indicators varies from 0.20 to 0.45 which illustrates their greater impact on the quality of place. It has been observed that the building fragility (BD1) as sub-indicator has greater impact on the quality of place of Bao wala settlement than other two sub-indicators. The R^2 value depicting the relationship strength between building density and quality of place variable is 0.780, which demonstrates the strong relation between both variables.

Following to building density, the relation of all sub-indicators of utilities services with the dependent variable of quality of place of Bao wala settlement is also analyzed (D APPENDIX). It has been observed from the results of regression analysis that R^2 value showing the strength of relation between utilities services and quality of place is 0.906, which the depict the strength of relation between these two variables as extremely strong. However, the results have also depicted that all four sub-indicators of utilities services encompassed on solid waste management (US3), sanitation and sewerage (US4), drainage flow (US5), and firefighting (US8)

have highly significant relation while safe drinkable water (US1) has significant relation with the dependent variable. All these indicators also have greater impact on the quality of place of Bao wala settlement, being analyzed from the values of beta coefficient that varies from 0.178 to 0.279. However, the sub-indicator of gas supply (US6) and telecommunication (US7) has no significant relation with dependent variables, furthermore, have low value of beta coefficient, illustrating the moderate impact on the dependent variable. In contrast, the sub-indicator of electric supply (US2) neither has significant relation nor has strong impact on the dependent variable.

The relation of sub-indicators of road infrastructure with the dependent variable has also been analyzed (E APPENDIX), which are shown in Figure 5.14. In the results, R^2 value of 0.819 shows the strong relation between the perceived indicators of road infrastructure and quality of place of Bao wala settlement. It has also been observed from the results that all the sub-indicators including RI1 - road pavement, RI2 - walking footpaths, and RI3 - parking space has highly significant relation with the quality of place of Bao wala settlement. Furthermore, the values of Beta coefficient that varies from 0.256 to 0.501 has shown the greatest impact of these sub-indicators on the dependent variables.

Furthermore, the regression analysis among the indicator of urban furniture with dependent variable (F APPENDIX) has also been analyzed and their results are also shown in Figure 5.14. As shown in the results, the value of R^2 which is 0.833 depict the extremely strong relation between the perceived variable of urban furniture and quality of place of Bao wala settlement. The results also elucidate that all the five sub-indicators of urban furniture including streetlights (UF1), street plantation (UF2), street cleanliness (UF3), sitting benches (UF4), and bus stops/ shelters (UF5) have significant relation (P value less than 0.01) with the quality of place of Bao wala settlement. The explained results also show that all these sub-indicators also have the strong impact on the quality of place of Bao wala settlement, possessing the high beta coefficient values that varies from 0.144 to 0.362. These indicators should be given high importance in consideration for urban regeneration projects in Bao wala settlement.

The regression relation between the perceived sub-indicators of social services and the dependent variables has also been analyzed (G APPENDIX), and their results

are also illustrated in Figure 5.14. The results illustrate that the value of R^2 between social services and quality of place is highest than all the previously discussed regression relations. The R^2 value of 0.946 shows the extremely strong relation between the indicators of social services and dependent variable. However, the results have also shown that the three sub-indicators of social services including access to health services (SS1), recreational places (SS3) and parks and green spaces (SS4) have highly significant relation with the quality of place. Furthermore, these sub-indicators also have the greater impact on the dependent variables (having B coefficient values between 0.112 to 0.294). These indicators must be given extreme importance during urban regeneration project of Bao wala settlement. Additionally, results also depicted that further three sub-indicators including access to educational institutes (SS2), public transport (SS5), and sport facilities (SS8) have significant relation with quality of place, while also have moderate impact on it. The remaining indicators including access to administrative centers (SS7), cultural and religious places (SS9), and shopping centers (SS10) have no significant relation with the dependent variable, also have least impact on the quality of place of Bao wala settlement. In contrast, access to workplace (SS6) neither has significant nor has good impact on the dependent variable. Such indicators can be ignored during the urban regeneration process of any informal settlement to achieve efficient planning and implementation results.

While summarizing the regression analysis of perceived and dependent variable, it has been observed that majority of sub-indicators of five leading indicators have highly significant and strong impact on the dependent variable, whereas few has significant and moderate impact on dependent variable. In the results, indicators having neither significant relation nor good impact on the dependent variable have also been observed, however the number of such perceived indicators are few. The results also depict that all the five leading indicators including building density, utilities services, road infrastructure, urban furniture and social services have strong relation with the quality of place of Bao wala settlement, possessing the R^2 values varying from 0.780 to 0.946. Among all these five leading perceived indicators, access to social services has the strongest relation with the quality of place of Bao wala settlement. This also demonstrates that the quality of social services in the

settlement is extremely poor due to inefficient provision and maintenance of these respective services.

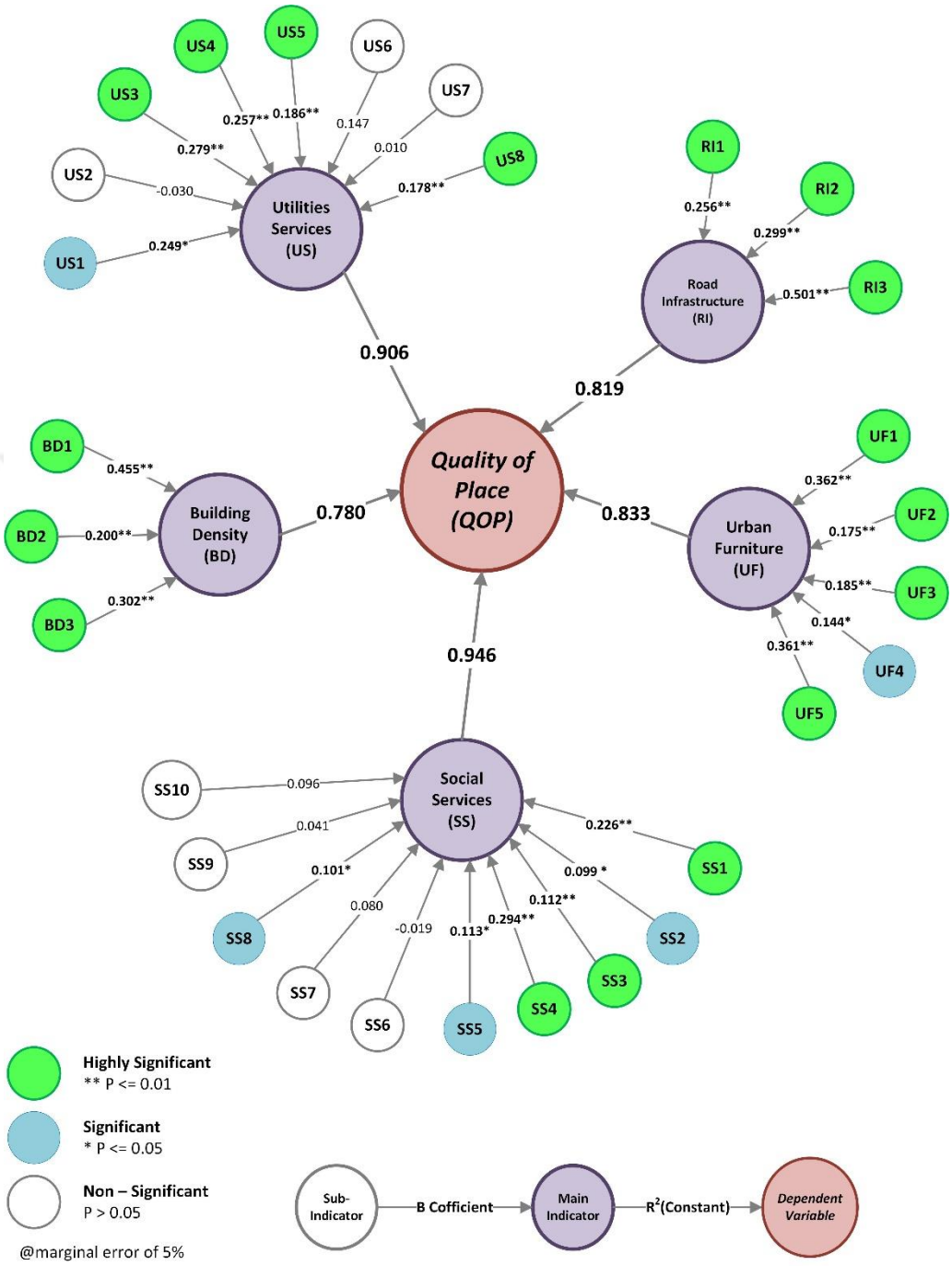

Figure 5.14 Regression relationship of dependent and perceived variables

5.3.2 Indicator's Negligence Criteria

In this research study, two distinct criteria are implemented for the negligence of inefficient perceived indicators. The adopted criteria are mentioned below:

- Perceived indicators having insignificant relationship with dependent variable.
- Perceived indicators having no or minimal impact on dependent variable (possessing the beta coefficient value of less than 0.05).

In this research study, any perceived indicator possessing both of the above-mentioned criteria are neglected while calculating the stress score of the settlement, because they will neither have significant relation nor have strong impact on the dependent variable. However, while implementing the formulated framework (discussed in section 3.1) of this research study, the indicator's negligence criteria may vary based on the adopted analysis methodology and factual contemporary grounds of the selected case study area.

5.3.3 Indicator's Finalization

Based on the perceived indicators negligence criteria discussed in the section 5.3.2, the indicators including provision of electric supply (US2), telecommunication (US7), access to workplace (SS6), and cultural and religious places (SS9) have neither significant nor sufficient impact on the dependent variable, therefore these four sub-indicators are neglected for further analysis. To divide the project area into numerous phases, the stress score has been calculated based on remaining 25 sub-indicators that are mentioned in the Table 5.4.

Table 5.4 Finalized perceived ındicators after implementing negligence criteria (continued...)

Main Indicator	Sub-Indicator
Building Density	BD1- Fragile Building Structure; BD2 - Floor Area Ration (FAR); BD3 - Living Space (Person per Room)
Utilities Services	US1 - Safe Drinkable Water; US3 - Solid Waste Management; US4 - Sanitation and Sewerage; US5 - Drainage Flow; US6 - Gas Supply; US8 - Firefighting
Road Infrastructure	RI1 - Road Pavement; RI2 - Walking Footpaths; RI3 - Parking Space

Table 5.4 Finalized perceived ındicators after implementing negligence criteria (continued...)

Main Indicator	Sub-Indicator
Urban Furniture	UF1 – Streetlights; UF2 - Street Plantation; UF3 - Street Cleanliness; UF4 - Sitting Benches; UF5 - Bus Stops/ Shelters
Social Services	SS1 - Health Services; SS2 - Educational Institutes; SS3 - Recreational Places; SS4 - Parks and Green Spaces; SS5 - Public Transport; SS7 - Administrative Centers; SS8 - Sport Facilities; SS10 - Shopping Centers

5.3.4 Stress Score Calculations

After the finalization of perceived indicators, the following step was to calculate the stress score retrieved from the public perceptions. The average stress score on all 99 sampled locations has been calculated with the help of below mentioned equation.

$$ASS_j = \frac{\sum_{i=1}^{n} SS_{oij}}{n}$$

In this equation,

ASS_j = Average Stress Score on jth sample point

SS_{oij} = Stress Score (SS_o) of ith indicator on jth sampled location, retrieve from public perception

n = Number of indicators

The calculated average stress score (ASS) on all 99 interviewed / sampled locations is illustrated in the Figure 5.15, where it has been observed that the maximum calculated ASS is 4.9 while minimum ASS is 2.9 on the scale of 5. Furthermore, it has also been analyzed that the median ASS is 4.1 out of 5, which depicts that majority of the population of the selected case study expressed extreme dissatisfaction from all services been provided and executed in this settlement. The greater values of ASS have been observed on the western and southern side of Bao wala settlement, whereas the smaller values of ASS are observed on the locations

near to the primary roads of the settlements. These variation in values of ASS portray that the services around the primary roads, majorly on the eastern sides, of the settlement have been maintained properly while the other parts of the settlements are ignored by the governmental institutes or the population living in those areas was not able to uplift these surrounding due to low socio-economic conditions.

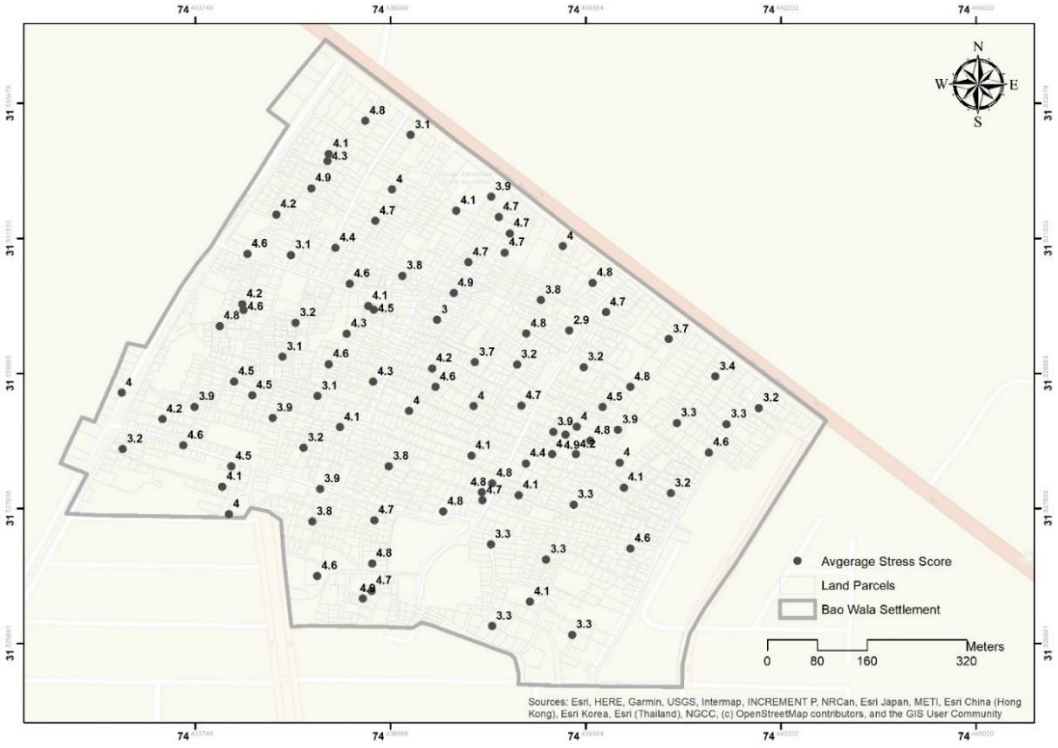

Figure 5.15 Spatial illustration of Average Stress Score (ASS)

5.3.5 Weightage Index

In the previous sections, average stress score on the sampled location based on the public perceptions retrieved from the socio-economic surveys has been calculated. However, as discussed in the salient features of the formulated framework of this research study (discussed in section 3.1.1), this framework ensures the extensive stakeholder's participation in the planning phase of any regeneration projects. The extensive stakeholder's participation includes the involvement of practitioners, academicians, and others besides the inhabitants of selected case study area. Therefore, the participation of practitioners and academicians' experts in the field of urban regeneration has also been included in this research study as well. These experts were requested to assign a certain weightage index to the finalized indicators.

Therefore, in this research study, 10 experts including practitioners and academicians from the different private and governmental institutes were selected based on snowball sampling techniques. Out of these 10 experts, 04 was the academician performing the duties as teaching staff in public and private universities, 03 was acting as assistant directors or deputy director in the governmental development management institutes, and 03 was working as researchers in the field of urban regeneration in private institutes. All these experts were performing their duties in the city of Lahore, from where the settlement of Bao wala was selected as case study area. The experts from Lahore were given preferences to assign the weightage index to the indicators that affect the quality of place, because of their extensive real time experience and expertise in the field of urban regeneration in local context. All these experts were interviewed, during which the purpose and aim of this research study was elaborated, and at the end they were requested to assign weightage index to the indicators presented in the sheet (attached as B APPENDIX). The assigned weightage index was varying on the scale of 1 to 5, where 1 indicates least while 5 denoted the utmost importance of any indicators during the urban regeneration project. The cumulative weightage index of the respective indicators gained from the knowledge, expertise, and professional experiences of the practitioners has been calculated with the equations mentioned below:

$$AWI_i = \frac{\sum_{i=1}^{n_o} WI_i}{n_o}$$

AWI_i = Average Weightage Index of ith indicator

WI_i = Weightage Index of ith indicator, retrieved from professional`s interviews

n_o = Number of professional interviews

$$CWI_i = \frac{\sum_{i=1}^{n} AWI_i}{n}$$

CWI_i = Cumulative Weightage Index of ith Leading Indicator

AWI_i = Average Weightage Index of ith indicator

n = Number of indicators

Table 5.5 has presented that out of five leading indicators, road infrastructure has gained the maximum cumulative weightage index which is 4.03. Following to the road infrastructure, urban furniture and utilities services has been assigned with the cumulative weightage index of 3.84 and 3.82, respectively. It has also been shown that social services were assigned the cumulative weightage index of 3.75 while the least weightage index is assigned to building density which is 3.73.

Table 5.5 Indicator's cumulative weightage index (continued...)

Main Indicator	Abb.	Sub-Indicator	Average Weightage Index (AWI)	Cumulative Weightage Index (CWI)
Building Density	BD1	Fragile Building Structure	3.9	3.73
	BD2	Floor Area Ration (FAR)	3.6	
	BD3	Living Space (Person per Room)	3.7	
Utilities Services	US1	Safe Drinkable Water	4.2	3.82
	US3	Solid Waste Management	4.1	
	US4	Sanitation and Sewerage	4.3	
	US5	Drainage Flow	3.9	
	US6	Gas Supply	3.3	
	US8	Firefighting	3.1	
Road Infrastructure	RI1	Road Pavement	4.1	4.03
	RI2	Walking Footpaths	4.5	
	RI3	Parking Space	3.5	
Urban Furniture	UF1	Streetlights	3.8	3.84
	UF2	Street Plantation	3.9	
	UF3	Street Cleanliness	4.4	

Table 5.5 Indicator's cumulative weightage index (continued...)

Main Indicator	Abb.	Sub-Indicator	Average Weightage Index (AWI)	Cumulative Weightage Index (CWI)
	UF4	Sitting Benches	3.6	
	UF5	Bus Stops/ Shelters	3.5	
Social Services	SS1	Health Services	4.5	3.75
	SS2	Educational Institutes	4.0	
	SS3	Recreational Places	3.8	
	SS4	Parks and Green Spaces	4.1	
	SS5	Public Transport	3.9	
	SS7	Administrative Centers	3.1	
	SS8	Sport Facilities	3.4	
	SS10	Shopping Centers	3.2	

5.3.6 Cumulative Stress Score

The final stage of quantitative analysis is the calculation of cumulative stress score (CSS), which has been quantified with the help of below mentioned equation:

$$CSS_j = \frac{\sum_{i=1}^{n}(ASS_{ij} * CWI_i)}{n}$$

In this equation,

CSS_j = Cumulative Stress Score on jth sample point

ASS_{ij} = Average Stress Score of ith indicator on jth sample point

CWI_i = Cumulative Weightage Index of ith indicator

n = Number of indicators

The final cumulative stress score that has been calculated by multiplying the CWI and ASS has spatially been illustrated in Figure 5.16. It has been shown that the maximum and minimum value of CSS is 18.8 and 11.3, while its average and

median in 15.9 and 15.8, respectively. The spatial illustration of CSS on the base map of Bao wala settlement has illustrated that the maximum and above median values of CSS are observed on the western and southern side of the settlement, however lower CSS values are detected along main roads.

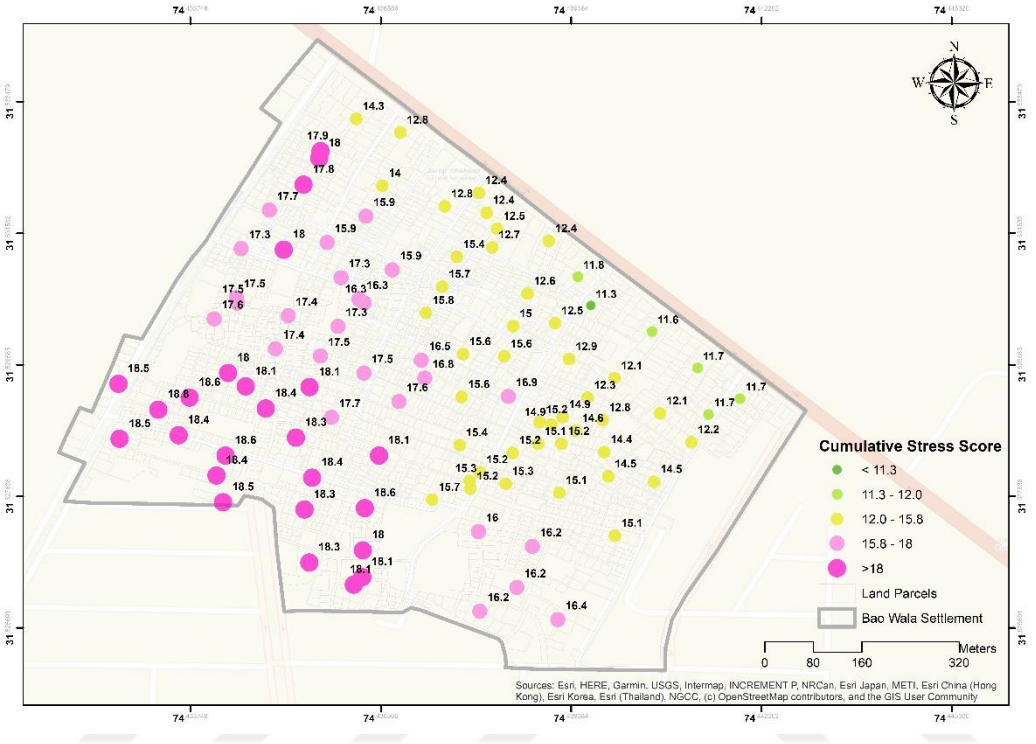

Figure 5.16 Spatial distribution of Cumulative Stress Score (CSS)

5.4 IDW Analysis

The primitive aim of research study was to divide the project area into multiple phases for which a comprehensive framework is proposed and discussed under section 3.1. The primitive step of this framework in stage 3 was to use spatial analysis technique for zoning project area into different phases. Therefore, in order to accomplish this stage, IDW analysis has been used while their results are illustrated in Figure 5.17.

By using the cumulative stress score (shown in Figure 5.16) as values of sampled location, the values on unsampled location of Bao wala settlement have been determined with the help of IDW analysis. Furthermore, for zoning the area of Bao wala settlement in multiple phases, standard deviation technique has been used to categorize the numerical values in different classes (which represent the phases). In this study, for exemplary analysis, Bao wala settlement has been zoned into three,

four and five different phases. This demonstrate that with the help of proposed framework, rather than zoning the area into fixed number of phases, the project area can be phases into numerous phases based on the project spatial scale, complexity of the project, or necessity of number of phases etc.

The spatial distribution of the phases of Bao wala settlement is illustrated in Figure 5.17 while the area distribution is demonstrated in Table 5.6. In the three-stage project implementation of Bao wala settlement, the area has been divided into three phases in which first phases possess the highest CSS value (17.15 and above), while second phase has CSS value of between 14.85 to 17.14 and the third phase has CSS value of less than 14.84. The area distribution of three stage implementation shows that phases 1, 2 and 3 possess the 34.5%, 37% and 28.6% proportion of Bao wala settlement, respectively. In the map of four stage project implementation of Bao wala settlement, the phase 1 own CSS value of greater than 17.41, phase 2 has CSS value of between 15.81 to 17.40, phase 3 possess CSS value of between 13.90 to 15.80 while phase 4 has CSS value of less than 13.89. The area distribution of this respective stage shows that phases 1, 2, 3 and 4 possess the 28.6%, 23.5%, 27.7% and 20.2% proportion of Bao wala settlement, respectively. In the last, 5 stages project implementation map illustrate that the phases 1, 2, 3, 4 and 5 possess the CSS values of greater than 17.88, 16.80 to 17.87, 15.45 to 16.79, 13.73 to 15.44 and less than 13.72, respectively, while possess the 20.2%, 17.6%, 22.7%, 21.0% and 18.5% area proportion of the Bao wala settlement.

In all the above-mentioned characteristics of three, four and five stages project implementation maps, it has been observed that phase 1 possesses the highest value of cumulative stress score. Therefore, implementing the regeneration project of phase 1 at earliest will bring exceptional results in the upgradation of project area because it will address the widespread problems of the locality. Taking into consideration of this, in the three-stage project implementation of Bao wala settlement, upgradation of phase 1 should be initiated and complement in earliest time space, while phase 2 can be upgraded in mid-term plans and phase 3 can be accomplished in long-term time space. In the four-stages project implementation, projects should be initiated and completed in phase 1, phase 2 and 3, and phase 4 in short-term, mid-term and long-term time space, respectively. In view of the above, in five-stages project implementation, regeneration project should begin in

phase 1 and 2, phase 3 and 4, and phase 5 in short-term, mid-term and long-term time space, respectively.

While summarizing the section, it can be declared that with the help of proposed framework of this study which is based on quantitative and spatial analysis, project area of any case study can be zoned into numerous phases based on their spatial scale, complexity, and necessity of number of phases, while the diversified projects in numerous numbers of phases can be initiated and completed in short-, mid- and long-term time space.

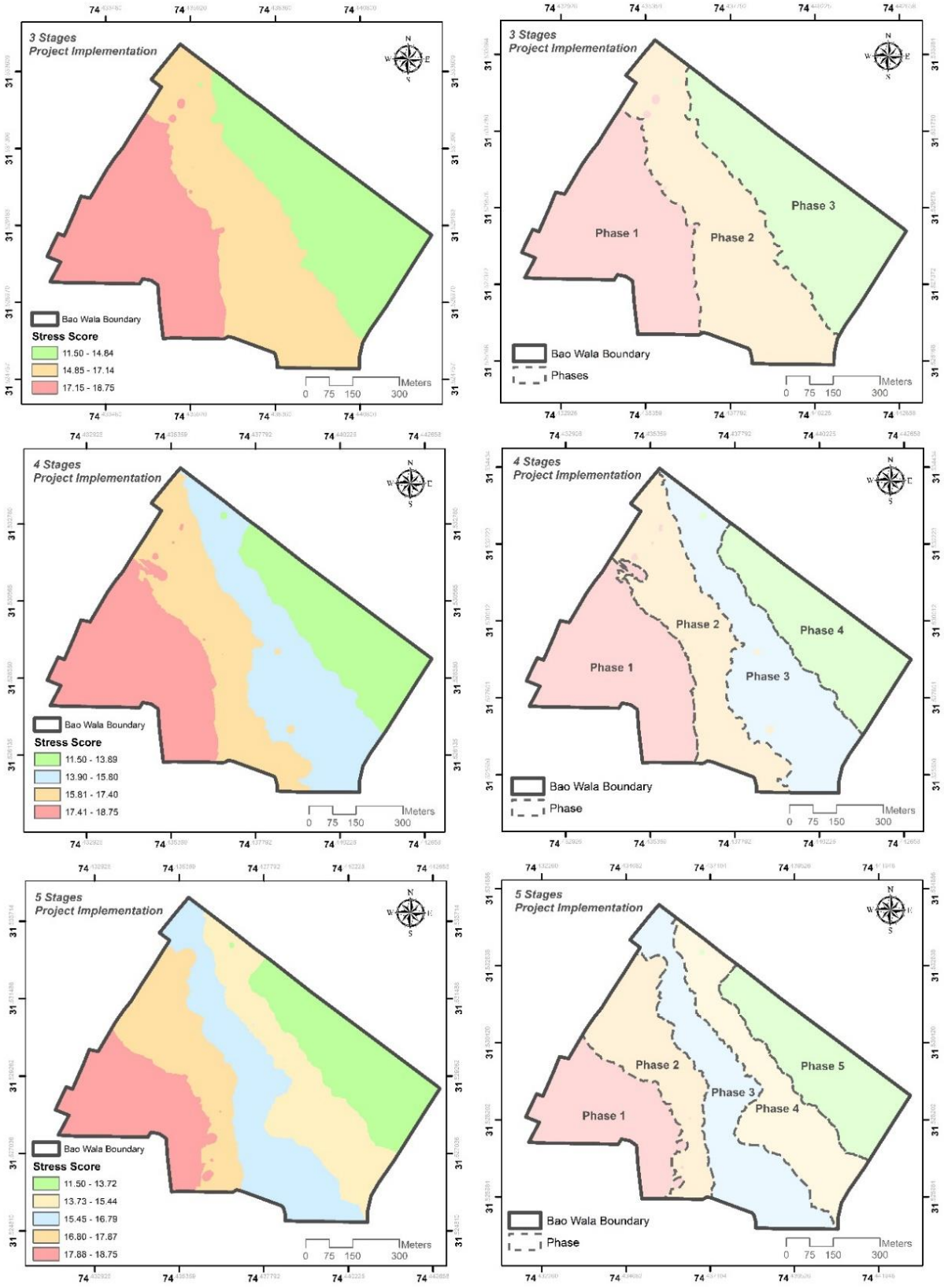

Figure 5.17 Phases for multiphase project implementation

Table 5.6 Area calculations of the phases of Bao wala settlement

3 Stage Project Implementation			
Phase	Area		Perc.
	Acre	Sq. Km	
Phase 1	41	0.17	34.5%
Phase 2	44	0.18	37.0%
Phase 3	34	0.14	28.6%
4 Stage Project Implementation			
Phase	Area		Perc.
	Acre	Sq. Km	
Phase 1	34	0.14	28.6%
Phase 2	28	0.11	23.5%
Phase 3	33	0.13	27.7%
Phase 4	24	0.10	20.2%
5 Stage Project Implementation			
Phase	Area		Perc.
	Acre	Sq. Km	
Phase 1	24	0.10	20.2%
Phase 2	21	0.09	17.6%
Phase 3	27	0.11	22.7%
Phase 4	25	0.10	21.0%
Phase 5	22	0.09	18.5%
Total	119.00	0.48	

5.4.1 Validating IDW

Validating the performance of Inverse Distance Weighting (IDW) interpolation method using Mean Squared Error (MSE) and Root Mean Squared Error (RMSE) provides a comprehensive assessment of the accuracy and precision of the

interpolative technique. In the literature, the root mean square error (RMSE) is defined as a standard statistical tool to evaluate the model accuracy and performance in scientific studies (Chai & Draxler, 2014).

As a statistical model, MSE measures the average squared difference between the predicted and actual values, while RMSE takes the square root of MSE to produce a metric in the same unit as the target variable. By comparing the calculated MSE and RMSE values with established thresholds or benchmark models, researchers can assess the effectiveness of the IDW interpolation. The numerical range of RMSE validation ranges from 0 to 1. Lower values of MSE and RMSE indicate better predictive accuracy, demonstrating that the IDW method closely matches the actual data. This validation process allows researchers to confidently utilize IDW interpolation for various applications, such as spatial analysis, environmental modeling, or geostatistical analysis, ensuring reliable and robust results. In the literature, numerous studies have utilized RMSE statistical model to validate the IDW interpolation analysis techniques and few of research studies are (Almodaresi et al., 2019; Ikechukwu et al., 2017; Meng et al., 2021; Musashi et al., 2018; Robinson & Metternicht, 2006).

Mean error (ME), mean squared error (MSE) and root mean squared error (RMSE) in this research has been calculated with the below mentioned equations.

$$ME = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)}{n}$$

$$MSE = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n}$$

$$RMSE = \frac{\sqrt{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}}{n}$$

In the above-mentioned equation, the n denotes the number of observations, y_i depict the actual or observed values and $\hat{y}_i$ denotes the predicted or interpolated values. The results achieved for validation of IDW analysis are demonstrated in Table 5.7.

Table 5.7 IDW validation, MSE and RMSE results

	ME	**MSE**	**RMSE**
Values	-0.005	0.016	0.126

The results presented in the Table 5.7 reveal that the Mean Squared Error (MSE) and Root Mean Squared Error (RMSE) values obtained from the IDW analysis in this study are 0.016 and 0.126, respectively. These error metrics are indicators of the overall performance and accuracy of the IDW interpolation method. With an MSE of 0.016, it suggests that, on average, the squared differences between the predicted and actual values are relatively low. Similarly, the RMSE value of 0.126 indicates that the average difference between the predicted and actual values is also reasonably small.

Considering these values, it can be concluded that the IDW analysis applied in this study demonstrates a good level of accuracy in estimating unknown values and interpolating data. The relatively low MSE and RMSE values indicate that the IDW method closely approximates the actual values, providing reliable and precise results. These findings support the validity and suitability of using the IDW interpolation method for the specific context of this study. The accuracy achieved by the IDW analysis enhances confidence in the reliability of the interpolated data and strengthens the overall quality of the research findings. Researchers can therefore have confidence in utilizing the IDW method for similar applications, such as spatial analysis, environmental modeling, or geostatistical analysis, within the scope of this study.

6
CONCLUSION

6.1 Conclusion

In conclusion, the aim of this research study was to formulate a comprehensive framework for the effective multiphase implementation of large-scale regeneration projects, by subdividing the project area into multiple phases based on multi-indicator analysis. The research objectives were to formulate the comprehensive framework, select and determine potential indicators that affect the quality of space and inhabitants in slums and squatters, particularly in the global south, and apply the formulated framework to understand its practical application in real-time scenarios.

The formulated framework consists of three main stages: pre-requisites, operationalization, and finalization. The first stage, pre-requisites, involves understanding the factual contemporary scenarios of the selected project site for urban regeneration. The second stage, operationalization, is divided into two parts: data assemblage and anatomization. The third stage, finalization, accomplishes the efficient division of the project area into numerous phases based on multi-indicator analysis, after synthesizing the spatial and quantitative data. The applicability criteria for this formulated framework consists of spatial scalability of the project area, exigency of number of phases, and spatial diversity in the settlement.

For practical application of formulized framework of this research study, a case study of Bao Wala, large-scale informal settlement in Lahore metropolitan city, was selected. The research findings from the case study in Bao Wala, demonstrate that the settlement consists of mixed land use practices, encompassing residential, commercial, residential cum commercial, health, and educational institutes land uses, among others. Spatial analysis demonstrates that 65.8% of the whole settlement consist of residential land use while commercial and residential cum commercial land uses disseminated over 3.9% and 3.5% portion of the settlement. The agricultural area is comprised of 11.3% of Bao wala settlement, whereas, hospitals, clinics, and a few educational institutions are also observed. The Spatial

analysis illustrated that the northern side of Bao wala settlement possess the predominantly commercial and residential cum commercial land use distribution, own higher building stories and hold good fragility building structures, however, the majority of area on southern and western side of the settlements belongs to low-income population areas which have bad building structures.

Additionally, public perceptions regarding the provision, operation, maintenance, and quality of contemporary utilities services, road infrastructure, urban furniture, and social services in Bao wala settlement were measured based on a 5-point Likert scale. For this, a comprehensive questionnaire was prepared consisting of five leading indicators which are building densities, utilities services, road infrastructure, urban furniture, and social services and twenty-nine-sub indicators. The results established that majority of inhabitants in Bao wala settlement (around 60% to 70%) are either extremely dissatisfied or shows moderate behavior towards the contemporary conditions, however only minimal segment of the society shows satisfactory behavior toward existing services.

Using regression analysis, the relationship between quality of place and 29 perceived indicators was measured, with the majority of sub-indicators of the five leading indicators having a highly significant and strong impact on the dependent variable. Four sub-indicators neither having significant relation nor having strong impact on the dependent variable was neglected and the remaining 25 sub-indicators were finalized for further analysis.

The socio-economic data collected based on 5-point Likert scale was analyzed and the average stress score (ASS) of sampled points in Bao wala settlement was calculated, while the results observed that the maximum calculated ASS is 4.9 while minimum ASS is 2.9 on the scale of 5. Following that, weightage index was calculated by interviewing the experts including practitioners and academicians from the different private and governmental institutes. Further, the final cumulative stress score (CSS) has been calculated by multiplying the weightage index and average stress score.

By using the cumulative stress score as values of sampled location, the values on unsampled location of Bao wala settlement have been determined with the help of IDW analysis. In this study, for exemplary analysis, Bao wala settlement has been zoned into three, four and five different phases, in which the projects can be

implemented in short-term, mid-term and long-term time space, respectively. In the end, IDW analysis has been validated with RMSE statistical model and the RMSE result of 0.126 has validated the accuracy of IDW analysis.

In conclusion, this research study has developed a comprehensive framework for the multiphase implementation of large-scale regeneration projects based on multi-indicator analysis. The findings from the case study in Bao Wala have demonstrated the effectiveness of the framework, and it has the potential to be applied in real-time scenarios to subdivide project areas into numerous phases, thereby ensuring efficient and effective project implementation.

6.2 Framework's Limitations

On of the prominent limitation of this study is that the formulated framework is only applicable for phasing the large-scale project areas, whereas it will not be applicable in small-scale project areas. Another limitation could be that the framework was only tested in a single case study in Bao Wala, and therefore, the generalizability of the findings to other contexts and regions may be limited. Additionally, the framework was developed based on the specific set of indicators used in the study, and the results may vary if different indicators are used in completely different case study areas. Finally, the framework does not consider the potential impact of external factors, such as changes in political policies, market conditions, and social trends, which could affect the implementation of regeneration projects.

One of the prominent limitations of this research study is that the proposed framework has only been applied and tested on the case study from the country Global South. This restricts the generalizability and external validity of the findings to other regions and contexts. Different regions, such as North America, Europe, and other countries, have their own unique socio-economic, cultural, and political characteristics that can significantly influence urban regeneration projects. Therefore, caution should be exercised when applying the proposed framework to different regions, and further research is needed to explore the applicability and effectiveness of the framework in diverse contexts.

6.3 Future Recommendations

Based on the conclusion and limitations of this study, several recommendations can be made for future research. One important recommendation is to apply the developed framework in different contexts to evaluate its effectiveness and applicability in various regeneration projects. Future research could focus on applying this framework to different case studies in different contexts to test its generalizability. This can also help to identify any possible limitations or challenges that may arise in different project scenarios and refine the framework accordingly.

Another future recommendation is related to exploring the framework's adaptability. The study's limitation suggests that the framework may not be suitable for smaller-scale projects. Therefore, future research could focus on exploring ways to adapt the framework to suit smaller projects. This may involve modifying the existing framework or developing a separate framework altogether that is specifically designed for smaller projects. This research could also examine the factors that determine the applicability of the framework to various project scales and identify the threshold for project size beyond which the framework becomes effective.

In this research, after synthesizing the quantitative data with spatial base map of the case study area, IDW analysis (one of interpolation analysis techniques) has been applied for phasing the project areas. However, in future studies other interpolation techniques such as Kriging or any other can be applied on similar or different case study areas to ensure the adaptability and generalizability of the proposed framework.

In the descriptive analysis of this research, socio-economic indicators were merged and analyzed collectively, however, in the future work, the socio-economic indicators including demographic characteristics, income, gender etc. can be analyzed distinctly and can be correlated with dependent variables.

As it has been mentioned in the limitation section that this research has not taken into account external factors such as political policies and social tendencies etc. Therefore, in future studies, further data layers such as political policies and social tendencies can be included for robust analysis. Additionally, the correlation among such variables should be examined because social tendencies and political policies

are intertwined in a complex relationship. The interplay between social tendencies and political policies highlights the importance of public engagement, advocacy, and the democratic process in shaping the direction of governance and addressing societal issues.

Considering the aforementioned limitation of application of the framework in Global South, future work should be focused on expanding the application and testing of the methodological framework in urban regeneration projects across different regions. Comparative studies can be conducted to examine the similarities and differences in the implementation and outcomes of urban regeneration initiatives in various contexts. This would provide a more comprehensive understanding of the factors influencing successful urban regeneration and help refine the framework to ensure its relevance and effectiveness across diverse geographical and cultural settings. Additionally, exploring the perspectives and experiences of stakeholders involved in urban regeneration projects from different regions would contribute to a more nuanced understanding of the challenges and opportunities specific to each context, informing tailored approaches and strategies for future urban regeneration efforts.

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A
APPENDIX

YILDIZ TECHNICAL UNIVERSITY (YTU)

CITY AND REGIONAL PLANNING DEPARTMENT

MSC. URBAN CONSERVATION AND PLANNING

34349 Beşiktaş – İstanbul, Türkiye, https://www.yildiz.edu.tr/en/

Reference No: _____

THESIS TITLE:

A METHODOLOGY PROPOSAL FOR PHASING OF URBAN REGENERATION PROJECT: LAHORE CASE

Questionnaire for

Socio-Economic Household Surveys

This questionnaire has been formulated to collect the information related to current spatial portfolio of the settlement under socio-economic household surveys. This questionnaire is intended to collect the data for master level research activity, being pursued in Yildiz Technical University (YTU). Collected data will only be used for research work, while the personal information provided by the respondent will be kept confidential. The researcher is really thankful for the respondent's participation in this survey and giving their valuable feedback.

Personal Information

1) What is the name of respondent?

   _____

2) What is the gender of respondent?

   a) Male b) Female

3) What is the age of respondent?

a) Less than 20 years
b) 20–40 years
c) More than 40 years

Socio-Economic Information

4) What is your profession of respondent?
   a) Student
   b) Government / Semi-Govt. Employee
   c) Private Employee
   d) Private Business
   e) None of Above
   f) Other (_____)

5) What is the income of respondent?
   a) None
   b) <14,000
   c) 14,001-30,000
   d) 30,001 - 60,000
   e) 60,001 - 120,000
   f) >120,000

6) What is the education level of respondent?
   a) Under Matric
   b) Matriculation
   c) Under-Graduate
   d) Graduate
   e) Post-Graduation
   f) None

7) For how long has the respondent is living in the area?
   a) Since Birth
   b) < 5 years
   c) 6-10 years
   d) 11-15 years
   e) 16-20 years
   f) > 20 years

8) What is the type of your house ownership?
   a) Owned
   b) Rented
   c) Other……

9) There are how many rooms in respondent's house? _____

10) How many people are living in respondent's house? _____

Respondent's perception

Building Density

What does the respondent think about the fragility level of their building structure (BD1)?

1. No fragility
2. Least fragility
3. Moderate fragility
4. High fragility
5. Extreme fragility

Utilities Services

What is the respondent's perception about the provision, quality and maintainance of the following utilities services?

Utilities Services	Abb.	1. Highly Satisfactory	2. Satisfactory	3. Moderate	4. Unsatisfactory	5. Highly Unsatisfactory
Safe Drinkable Water	US1					
Electric Supply	US2					
Solid Waste Management	US3					

Utilities Services	Abb.	1. Highly Satisfactory	2. Satisfactory	3. Moderate	4. Unsatisfactory	5. Highly Unsatisfactory
Sanitation and Sewerage	US4					
Drainage Flow	US5					
Gas Supply	US6					
Telecommunication	US7					
Firefighting	US8					

Road Infrastructure

What is the respondent's view about the following road infrastructure services?

Road Infrastructure Services	Abb.	1. Excellent	2. Good	3. Moderate	4. Bad	5. Terrible (Non-existence)
Road Pavement	RI1					
Walking Footpaths	RI2					
Parking Space	RI3					

Urban Furniture

What is the respondent's perception about the provision, operation, and maintenance of the following services?

Urban Furniture	Abb.	1. Highly Satisfactory	2. Satisfactory	3. Moderate	4. Unsatisfactory	5. Highly
Streetlights	UF1					
Street Plantation	UF2					
Street Cleanliness	UF3					
Sitting Benches	UF4					
Bus Stops/ Shelters	UF5					

Social Services

What is the respondent's perception about the provision, quality and accessibility to the following social services?

Social Services	Abb.	1. Highly Satisfactory	2. Satisfactory	3. Moderate	4. Unsatisfactory	5. Highly
Health Services	SS1					

Social Services	Abb.	1. Highly Satisfactory	2. Satisfactory	3. Moderate	4. Unsatisfactory	5. Highly
Educational Institutes	SS2					
Recreational Places	SS3					
Parks and Green Spaces	SS4					
Public Transport	SS5					
Workplace	SS6					
Administrative Centers (Town Hall)	SS7					
Sport Facilities	SS8					
Cultural and Religious Places	SS9					
Shopping Centers	SS10					

Quality of Life

Keeping in view to all the above asked questions, what is the respondent's perception about the quality of life of the people living in the community?

1. Highly satisfactory
2. Satisfactory
3. Moderate
4. Unsatisfactory
5. Highly Unsatisfactory

As per the respondent’s view, what is the best possible solution for the upgradation of this settlement?

_____
_____
_____
_____
_____

B
APPENDIX

YILDIZ TECHNICAL UNIVERSITY (YTU)

CITY AND REGIONAL PLANNING DEPARTMENT

MSC. URBAN CONSERVATION AND PLANNING

34349 Beşiktaş – İstanbul, Türkiye / https://www.yildiz.edu.tr/en/

THESIS TITLE:

A METHODOLOGY PROPOSAL FOR PHASING OF URBAN REGENERATION PROJECT: LAHORE CASE

Focus Group Meeting (Nominal Group Technique)

This questionnaire is designed to collect data for master level research activity, entitled mentioned above, being conducted in Yildiz Technical University (YTU), Istanbul. The purpose of this questionnaire is to get the responses from professionals and academicians who have expertise in the field of urban regeneration subject.

The primitive aim of this research is to formulate a comprehensive framework which will help in phasing a project site for multiphase implementation of regeneration projects. The list of indicators and sub-indicators mentioned in the table below are summarized from literature, which play a vital role in urban regeneration projects. Therefore, it is requested to professionals and academicians, that based on the expertise and advance knowledge, please assign a weightage index to the below mentioned indicators scaling from **1 to 5**, where 1 indicates the least while 5 demonstrate the utmost importance of respective indicator in planning and implementation of regeneration project.

It has been declared by the researcher that the collected data will only be used for research work, while the personal information provided by the respondent will be kept confidential. The researcher is thankful for the respondent's participation in this survey and giving their valuable feedbacks.

Personal Information:

Name: Profession: Institute:

Age: Designation:

Assigning Weightage Index:

"1" indicates the least while "5" demonstrate the utmost importance of respective indicator.

Main Indicators	Abbreviation	Sub-Indicators	Weightage Index
Building Density	BD1	Fragile Building Structure	
	BD2	Floor Area Ration (FAR)	
	BD3	Living Space (Person per Room)	
Utilities Services	US1	Safe Drinkable Water	
	US2	Electric Supply	
	US3	Solid Waste Management	
	US4	Sanitation and Sewerage	
	US5	Drainage Flow	
	US6	Gas Supply	
	US7	Telecommunication	
	US8	Firefighting	
Road Infrastructure	RI1	Road Pavement	
	RI2	Walking Footpaths	
	RI3	Parking Space	

Main Indicators	Abbreviation	Sub-Indicators	Weightage Index
Urban Furniture	UF1	Streetlights	
	UF2	Street Plantation	
	UF3	Street Cleanliness	
	UF4	Sitting Benches	
	UF5	Bus Stops/ Shelters	
Social Services (Access and quality of…)	SS1	Health Services	
	SS2	Educational Institutes	
	SS3	Recreational Places	
	SS4	Parks and Green Spaces	
	SS5	Public Transport	
	SS6	Workplace	
	SS7	Administrative Centers (Town Hall)	
	SS8	Sport Facilities	
	SS9	Cultural and Religious Places	
	SS10	Shopping Centers	

Feedback, Comments or Suggestion:

_____

_____

_____.

C
APPENDIX

Regression Analysis of Building Density with Dependent Variable

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	BD3, BD2, BD1 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: QOL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.883 [a]	.780	.774	.362

a. Predictors: (Constant), BD3, BD2, BD1

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	44.272	3	14.757	112.560	.000 [a]
	Residual	12.455	95	.131		
	Total	56.727	98			

a. Predictors: (Constant), BD3, BD2, BD1

b. Dependent Variable: QOL

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.317	.274		1.155	.251
	BD1	.455	.047	.589	9.689	.000
	BD2	.200	.059	.187	3.417	.001
	BD3	.302	.056	.301	5.433	.000

a. Dependent Variable: QOL

D
APPENDIX

Regression Analysis of Utilities Services with Dependent Variable

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	US8, US1, US5, US3, US7, US4, US6, US2		Enter

a. All requested variables entered.

b. Dependent Variable: QOL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	[a] .952	.906	.897	.244

a. Predictors: (Constant), US8, US1, US5, US3, US7, US4,US6, US2

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	51.377	8	6.422	108.035	[a] .000
	Residual	5.350	90	.059		
	Total	56.727	98			

a. Predictors: (Constant), US8, US1, US5, US3, US7, US4, US6, US2

b. Dependent Variable: QOL

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.965	.326		-2.963	.004
	US1	.249	.096	.151	2.586	.011
	US2	-.030	.064	-.038	-.463	.644
	US3	.279	.055	.292	5.042	.000
	US4	.257	.060	.247	4.307	.000
	US5	.186	.058	.166	3.197	.002
	US6	.147	.084	.133	1.742	.085
	US7	.010	.070	.008	.146	.885
	US8	.178	.061	.185	2.905	.005

a. Dependent Variable: QOL

E
APPENDIX

Regression Analysis of Road Infrastructure with Dependent Variable

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	RI3, RI2, RI1 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: QOL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.905 [a]	.819	.813	.329

a. Predictors: (Constant), RI3, RI2, RI1

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.471	3	15.490	143.486	.000 [a]
	Residual	10.256	95	.108		
	Total	56.727	98			

a. Predictors: (Constant), RI3, RI2, RI1

b. Dependent Variable: QOL

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.183	.216		-.849	.398
	RI1	.256	.058	.284	4.426	.000
	RI2	.299	.058	.289	5.116	.000
	RI3	.501	.070	.465	7.181	.000

a. Dependent Variable: QOL

F
APPENDIX

Regression Analysis of Urban Furniture with Dependent Variable

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	UF5, UF4, UF3, UF2, UF1[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: QOL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.913[a]	.833	.824	.319

a. Predictors: (Constant), UF5, UF4, UF3, UF2, UF1

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47.246	5	9.449	92.682	.000[a]
	Residual	9.482	93	.102		
	Total	56.727	98			

a. Predictors: (Constant), UF5, UF4, UF3, UF2, UF1

b. Dependent Variable: QOL

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.991	.264		-3.756	.000
	UF1	.362	.074	.328	4.880	.000
	UF2	.175	.054	.177	3.218	.002
	UF3	.185	.065	.156	2.827	.006
	UF4	.144	.057	.136	2.530	.013
	UF5	.361	.063	.350	5.701	.000

a. Dependent Variable: QOL

G
APPENDIX

Regression Analysis of Social Services with Dependent Variable

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	SS10, SS5, SS8, SS3, SS9, SS7, SS2, SS4, SS1, SS6 [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: QOL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.972 [a]	.946	.939	.187

a. Predictors: (Constant), SS10, SS5, SS8, SS3, SS9, SS7,SS2, SS4, SS1, SS6

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.636	10	5.364	152.690	.000 [a]
	Residual	3.091	88	.035		
	Total	56.727	98			

a. Predictors: (Constant), SS10, SS5, SS8, SS3, SS9, SS7, SS2, SS4, SS1, SS6

b. Dependent Variable: QOL

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.399	.188		-2.118	.037
	SS1	.226	.060	.219	3.729	.000
	SS2	.099	.039	.119	2.520	.014
	SS3	.112	.042	.114	2.671	.009
	SS4	.294	.052	.310	5.630	.000
	SS5	.113	.043	.120	2.597	.011
	SS6	-.019	.071	-.018	-.272	.786
	SS7	.080	.047	.080	1.699	.093
	SS8	.101	.040	.096	2.525	.013
	SS9	.041	.062	.027	.659	.512
	SS10	.096	.056	.093	1.698	.093

a. Dependent Variable: QOL

PUBLICATIONS FROM THE THESIS

Published Papers

1- Empirical Evidence on Analysing the Quality of Life of Informal Settlement for Regeneration Project Case Study of Boa Wala Settlement, Lahore

Citation:
Ahsan, M., & Özbakir, B. A., (2023). Empirical Evidence on Analysing the Quality of Life of Informal Settlement for Regeneration Project: Case Study of Boa Wala Settlement, Lahore. *International Journal of Multidisciplinary Research and Analysis*, 6(1), 236-248. DOI: https://doi.org/10.47191/ijmra/v6-i1-29.