An Analysis of Health and Safety Aspects of Living Environment in Dhaka City

by

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LIST OF ABBREVIATIONS

AHP	=	Analytical Hierarchy Process.
BBS	=	Bangladesh Bureau of Statistics.
BFSCD	=	Bangladesh Fire Service and Civil defense.
CESI	=	Composite Environmental Sensitivity Indices.
EAS	=	Environmental Assessment Scale.
ESM	=	Environmental Sensitivity Methodology.
FMADM	=	Fuzzy Multicriteria Decision Making.
FST	=	Fuzzy Set Theory.
GIS	=	Geographic Information System.
KBES	=	Knowledge-Based Expert System.
NEMAP	=	National Environmental Management Action Plan.
NEP	=	National Environmental Policy
SIMESEPT	=	Spatial Intelligent Multicriteria Environmental Sensitivity Evaluation Tools
ULE	=	Urban Living Environment.
WASA	=	Water and Sewerage Authority.

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ABSTRACT

Dhaka City has been experiencing a tremendous growth in population and physical expansion. The rapid growth of population has strained the environment in many ways. Manifestation of such environmental deterioration is visible in terms of incidence of fire, traffic accidents and crime, strained urban utilities etc. It is essential to investigate the distribution of living environmental quality comprehensively and systematically in order to find out the most reasonable priorities of urban redevelopment

In this exploratory type of research, a comprehensive indicator of the living environment has been established that takes into account the various components that constitute the environment. In this study the comprehensive indicator is evaluated by only two evaluation standards–health and safety. These standards are evaluated by evaluation items such as fire, traffic accident, crimes, urban utilities, health hazard, hospital, parks and open spaces, slum, noise etc which are further described by components and input indicators Analytical Hierarchy Process (AHP) has been applied to identify the priority given by residents to those items and components. Among the seven items viz. fire, traffic accident, crime, urban utilities, health hazard, health care facilities and parks and open spaces, the most important item to be came out urban utilities. Parks and open space are considered the second most important item affecting the environmental quality. Fire is the least important item that affects the safety standard of living environment quality according to the respondents

The Multicriteria Methodology has been used to derive the comprehensive indicator of the quality of urban living environment based on the indicators of health and safety standard. The weighted factor method provides a procedure where each indicator is assigned a score, which is multiplied by the weight of that factor. The results of the multiplication are added and then a comprehensive score is determined. The comprehensive indicator is categorized into three categories better, moderate and worse. Citizens of Dhaka City are more aware of the nature and extent of the problem that they are confronted with, and their input would give a solid base for an indicator for evaluating the living environment of the city. To address the particular environmental problems of an area, the opinion of residents of the area must be incorporated into the planning process. Without participation of the residents of the area no planning will be appropriate for improving the living environment.

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Urban areas of Bangladesh, as those in other developing countries, suffer from a number of environmental problems Rapid increase in urban population affect the health and safety aspects of the environment and lead to a general deterioration in the physical condition of cities. The response to rapidly growing environmental problems in Bangladesh in recent years has been quite significant. The government has formulated the National Environment Management Action Plan (NEMAP) prepared by the MoEF in consultation with people from all walks of life. The National Environmental Policy (NEP) prepared with a reasonable degree of participation of people. The actual degree of citizen participation in the planning process is questioned by many.

The quality of urban environment in Bangladesh is gradually eroding. This could be due to several reasons, including rapid urbanization Unplanned physical development of urban areas, improper urbanization process, excessive population, widespread poverty, traffic jams and unbearable black smoke from vehicles all around, lack of proper sanitation and sewerage system have all created a situation which can be termed as a serious case of degradation of urban environmental quality in Dhaka city (Hoque, 1996). The rapid growth of Dhaka is creating an environmental crisis in the city region. Dhaka has remained the main catalyst of economic development of the country Our failure to manage the negative impacts of urban growth is threatening environment quality (Quium, 1997) So it is necessary to investigate into the quality of living environment comprehensively and systematically Hence, the need for a comprehensive indicator of the living environment that takes into account the various components that constitute the environment

1.2 STATE OF THE PROBLEM

Urban living environment is a complex system composed of not only physical elements such as houses, public facilities and utilities, but also economical elements like land price and those from social and cultural aspects. Urban environment in many countries, especially in developing countries, has lagged far behind in comparison with their rapid economic achievements in the past decades The rapid growth of population and consequent increased urbanization has created a number of urban environmental problems. The living environment in some metropolises is even deteriorating in areas such as housing, transportation and urban infrastructure. Urbanization without proper planning is resulting in the rise of slums and squatter settlements, and excessive pressure on basic services such as water, sanitation and transport. Apart from this, environmental problems including the pollution of air, water, solid waste and noise are most serious that affect health and safety. The challenge of rapid urbanization will be to sustain urban growth while solving the environmental and social equity problems arising from the negative impacts of spatial concentration of a variety of urban activity systems Under the limitations of manpower and financial resources, it is essential to investigate the distribution of living environmental quality comprehensively and systematically in order to find out the most reasonable priorities of urban redevelopment.

1.3 RATIONALE OF THE RESEARCH

Due to rapid urbanization, high population growth and haphazard development of industries the urban environment of Dhaka city is gradually worsening. Thus, the city faces environmental problems, which affect the quality of living environment. It is necessary to understand these types of problem from the perspective of the affected people who are user of the environment The aim of this paper is to gain a better understanding of the characteristics related to the environment.

1.4 OBJECTIVES OF THE RESEARCH

The objectives of the study are:

I. To identify possible evaluation indicators of urban living environment with respect to health and safety.
II. To determine the priority of the indicators.
III. To develop a comprehensive indicator of urban living environment.

1.5 SCOPE OF THE RESEARCH

The worsening quality of living environment is a grave problem mainly of Dhaka City. Any concrete research of the assessment of quality of living environment is yet to be undertaken with people's participation. In this research it is expected that the citizens of Dhaka City are more aware of the nature and extent of the problem that they are confronted with, and their input would give a solid base for an indicator for evaluating the living environment of the city Urban Living Environment (ULE) should be generally defined as 'Everything surrounding us'. It means that constitutionally ULE is a complex system composed of not only physical element but also other elements. As the task of urban planner, safety means to create a safe and healthy living environment in order to prevent their citizen's natural and manmade calamities Thus, safety and health are the two fundamental standards In this research only fundamental standards has been considered and indicators, which effect this standards are customize the availability of the data.

1.6 LITERATURE REVIEW

Rubby Sen (1997) conducted research on Dhaka City to look into its environmental situation and suggest measures to mitigate environmental degradation with people's participation. To fulfil this task, data were collected through a questionnaire survey in different areas of Dhaka City. Results from the study have indicated that environmental

degradation has taken place in all the sample areas of study. The extent of environmental degradation, however, varies spatially The most encouraging finding of the study has been the high level of willingness of local people to participate in mitigating measures. Some want to contribute financially for this mitigation measure. This study has helped not only to identify the levels and extent of environmental degradation existing in Dhaka City, but also to gather the levels of people's participation in mitigating environmental problems. An action plan based on the findings of this study is recommended. This may be organized in different wards of the city, where appropriate implementing authorities could be set up composed of Ward Commissioners, local leaders and people of the locality.

Bender et al. (1997) analyzed residents' perception concerning environment quality of housing in Geneva. The aim was to gain a better understanding of the characteristics related to the environment of single-family houses in the greater Geneva area. An Analytical Hierarchy Process (AHP) methodology was applied to the data collected by means of a questionnaire which was sent to 850 owners of houses in Geneva. The pairwise comparisons were done with eight criteria. For 28 comparisons, the standard level of preferences were used, but with a multiplicative scale rather than the standard linear scale. The result shows that distance to a green area and quietness of the area are the two most important factors. Another finding is that the proximity of shopping centers and school is not as important as in other countries

Efforts of planners towards "solving" traffic problems in urban areas are generally oriented towards increasing the traffic carrying capacity of the road network to enable faster movement of motor vehicles. This has lead to a total disregard towards environment resulting in innumerable environmental problems. It is only since recently that conscious efforts are being made in the field of traffic planning giving due consideration to the environmental aspects Sulkar and Deshpande (1977) attempted to analyze the relationship between traffic and the urban environment and to evolve a

methodology to evaluate the impact of traffic on environment through an Environment Assessment Scale (EAS).

Yan and Kubo (1996) reviewed the development of environmental evaluation indicators and its integration methods. An indicator system for the evaluation of Urban Living Environment (ULE) was developed by an analytical approach and was organized in a hierarchy. A mixed evaluation method was used by mixing up various integration principles, such as minimum, maximum and multicriteria evaluation. The weights of indicators of their integration functions of intangible indicators are determined by Saaty's Analytical Hierarchy Process (AHP). The comprehensive indicator system, the mixed integration method and the application of the AHP for the determination of weights or membership functions provide a new integrated methodology for decision-making under conditions of limited information and uncertainty.

Klungboonkrong and Taylor (1998) applied a microcomputer-based decision support system, namely 'Spatial Intelligent Multicriteria Environmental Sensitivity Evaluation Planning Tool' (SIMESEPT) was to evaluate the Multicriteria Environmental Sensitivity of the Geelong road network, in Victoria, Australia. SIMESEPT is an integration of information technologies (Knowledge-Based Expert Systems (KBES), and Geographic Information Systems (GIS)), Fuzzy set theory (FST), Multicriteria Decision Making Techniques (Analytical Hierarchy Process (AHP) and Fuzzy Multicriteria Decision Making (FMADM) method), and traffic environmental impact evaluation methods (Environmental Sensitivity Methodology (ESM) and some analytical models). The outcome of the application indicate the potential utility of the system for investigation and assessing both separate and composite environmental consequences caused by road traffic in urban road network at a link-based level, indicating problem locations, and specifying the possible causes and key contributing factors to those problems. In the AHP synthesis phase, both the principle of hierarchic composition (used in typical AHP (TAHP) approach) and the fuzzy compositional evaluation methods (employed in Fuzzy Compositional AHP (FCAHP) approach) were utilized to aggregate all local priorities to

achieve global priorities (representing the Composite Environmental Sensitivity Indices (CESI)) of each link in the central Geelong road network. It was found that the TAHP appears to be more powerful in differentiating links according to their combined ES characteristics than the FCAHP.

1.7 LIMITATIONS AND CONSTRAINTS

This is an exploratory type of research The research has studied the possible environmental evaluation indicator of urban living environment. Due to limitation of time and resources, and considering the paucity of reliable data, only health and safety aspects of the environment have been considered. To explore the environmental evaluation indicator seven items and nine components that affect the living environment have been identified. Further, the input indicators of those items and components have been explored.

The study also identified the priority given by the residents to those items and components. At the end of the study a comprehensive indicator of the urban living environment has been developed. For limitations of time and resources the number of items and components had to be limited. Only important items and components were considered in this study

1.8 STRUCTURE OF THE THESIS

The remainder of the thesis has been structured into six chapters.

Chapter One (this chapter) provides an introduction to the study and relates the statement of the problem, objectives of the research, scope of the study, literature review, limitation and constraints of the study and the structure of the thesis

Chapter Two describes the evaluation of Dhaka City and its environmental situation This includes the characteristics of the study area (i.e. area, population, and social, ethnic and economic characteristics of the study area) and the physical environment.

Chapter Three presents the methodology and design techniques employed in this research. Detailed theoretical base of Expert Choice and Analytical Hierarchy Process, Multicriteria Methodology and methodology of data collection etc. have been described.

Chapter Four presents the detailed analysis with Analytical Hierarchy Process (AHP) technique and the result of AHP analysis.

Chapter Five analyses the living environment quality i.e. the comprehensive indicator.

Lastly, **Chapter Six** concludes with the summary of this study provides a package of recommendations and indicates the direction of future studies.

CHAPTER TWO

EVALUATION OF DHAKA CITY AND ITS ENVIRONMENTAL SITUATION

2.1 HISTORICAL BACKGROUND OF DHAKA CITY

In the last 200 years or so Dhaka has evolved into a big cosmopolitan city from a very humble beginning in 1610. The history of Dhaka City may be divided into five main phases. They are

Pre-Mughal period up to 1610

Mughal period from 1610 to 1760.

British period from 1764 to 1947.

Pakistan period from 1947 to 1971

Bangladesh period from 1971 to todate.

During the Pre-Mughal period, Dhaka was a small urban agglomeration comprising of 52 bazars and 53 lanes (Bradly-Brit, 1906). During the Mughal period, Dhaka expanded towards the west from Sadarghat upto Chalkbazar for a little over a mile. During the next 30 years of Mughal period, the city expanded from Narinda to Moneshhar at one end and upto Fulbaria on the other extending over an area of more than three miles It continued to expand and during the reign of Syaesta Khan it became a fairly large city, having a length of 12 miles and width of 8 miles.

During the British period, particularly at the end of the 18th century i.e. 1786 onward, Dhaka extended upto Tongi to the north from the bank of the Buriganga in the south. During this time, Dhaka also extended from Postagola in the east upto Mirpur in the west. The presence of the Buriganga in the south limited city growth beyond this river and due to presence of flood prone low land in the east and west of the city it could only grow toward the north This expanded areas however was very sparsely populated and building were also minimal. Due to the advent of Calcutta as the capital of British India, the importance of Dhaka declined, so did the physical size of the city. In 1858, however, a few unplanned residential areas started to develop such as Islampur, Tantibazar, Kamalbagh, Kamalnagar, etc. (Geddes, 1917) Later, Narinda, Ganderia, Wari, Purana Paltan areas were also developed into new residential areas.

After the partition of India in 1947, Dhaka regained some importance as the provincial capital of East Pakistan. The population of Dhaka started to increase at a rapid rate because of immigration of refugees from India (mainly from Bihar and UP). During the 1951-61 period, population increased by about 65.7%. Due to this ever increasing popnlation, residential areas snch as Dhanmondi, Mohammedpur, Lalmatia, Gulshan, Banani and Mirpur were developed.

During the Bangladesh period i.e from 1971 onward, the city started to grow at an unprecedented rate. Today, this is one of the largest urban agglomerations not only in South Asia but also in the whole world. In 1990, the Dhaka Municipality was elevated into a corporation, the Dhaka City Corporation, from a Municipality which was established in 1864. The present area of the city is estimated to be about 343.28 sq km.

2.2 ENVIRONMENTAL SITUATION OF DHAKA CITY:

Dhaka City has been witnessing a tremendous growth in population and physical expansion. Urbanization in Dhaka is essentially a process of migration from rural and smaller towns to the urban areas. Dhaka City had a total population of 0 5 million in 1961, which became about 2 million in 1974, over 3 million in 1981 and over 6 million in 1991. This indicates that Dhaka grew at an annual rate of 11.36 per cent and 10.29 per cent during the period of 1961-1974 and 1974-1981, respectively. This trend is still continuing in the snbsequent years. Dhaka's physical expansion is also fast but not as fast as to keep pace with the population growth. Hence rapid densification has become the prime concern for the policy makers and city managers. The rapid growth of population has strained the environment in many ways. Manifestation of such environmental deterioration is visible in terms of incidence of fire, traffic accidents and crime, strain urban utilities increased etc.

2.2.1 Fire

Dhaka's continuous growth in both size and population has resulted in sporadic physical development with the least concern for fire hazards. Dhaka's population density is higher than 17,442 persons per square kilometer (BBS, 1991) which causes extreme congestion substantially contributing to the fire hazard of the area Though no long term time series data on fire losses in the city is available, it has been estimated that apart from erratic incidences of human death and injury, on average, damages of property worth of more than 6 crore taka are caused by fire in the city every year (Aminul, 1995).

- The main causes of fire and the related damage to property are as follows;
- Lack of public education and awareness (Maniruzzaman and Rahman, 2000).
- Ignorance and lack of awareness of government officials and agencies.
- High density of population and houses.
- Lack of fire fighting arrangement for fire prevention and control.
- Inadequate means of escape, that is unable to find any safe area etc.

Bangladesh Fire Service and Civil Defense (BFSCD), the only major public sector organization responsible for fire fighting, has made certain attempts to develop public awareness about fire preparedness as well as fire supervision but has hardly achieved these goals.

2.2.2 Traffic Accident

Analysis of the physical characteristics of the Dhaka City, with reference to land use, reveals several planning deficiencies that may cause accidents These problems are summarized below:

- Encumbrances on roadsides, especially on reserved areas on either side of the road.
- Unrestricted/unplanned growth of shops, markets, bazars and settlements within close distances of highways and local roads
- Stoppage of buses/trucks for passengers and goods loading/unloading directly onto the road.

- Tree plantation along curved roads that limit the vision of drivers, a problem that is accentuated in darkness.
- Location of industries and institutes along the road that may cause conflicts with pedestrian and vehicular traffic.

2.2.3 Crime

The law and order situation of Dhaka City has worsened remarkably in recent years. Violence and criminal acts of various types are regular headline news in the dailies. The *mastan* (hoodlums) issue has assumed a phenomenal proportion and has already become a most critical problem for the authority and society to control.

2.2.4 Urban Utilities

The existing situation in Dhaka's water supply and sanitation is not at all satisfactory. Nearly ninety seven percent of the city population have access to drinking water from different sources but only five percent of the household are served by Dhaka Water and Sewerage Authority (WASA) supplied water. However, the quality of water in Dhaka is rather poor and even the piped water supplied by WASA is unsafe and needs treatment or to be boiled for drinking. Many poor households of the city use river or other sources of surface water for drinking purposes.
Only a small minority of Dhaka's population have access to modern sanitation system. A lot of people, particularly the poor, have no proper toilet or latrines. As in the case of water facilities in many slums in Dhaka City more than a thousand families are forced to share a single latrine on payment There is very little or highly inadequate provision for sanitation, pure drinking water and other aminities in the slum and squatter settlements.

2.2.5 Health Hazard

Dhaka City is facing innumerable problems because of haphazard growth of the city. Slum and Commercial areas are most vulnerable in respect of health, because slums have no proper sanitation and water supply system Commercial areas also generate noise because of the

concentration of people and vehicles. It is a well recognized fact that lack of proper planning creates hazards in the city, resulting degradation of the living environmental quality. Dhaka is almost crossing its 'carrying capacity' which is the "maximum population that can be supported in a given habitat without permanently impairing the productivity of an ecosystem upon which that population is dependent" (Stem et al, 1992)

Especially in Dhaka City, the highly limited access to land for housing, the high cost of housing materials, coupled with the rapid growth of population mainly through the immigration of rural poor, has caused the growth and proliferation of innumerable urban slums and squatter settlements. The situation of Dhaka City is particularly bad where a CUS (1996) study identified some 3,007 slums and squatter settlements.

2.2.6 Health Care Facilities

The health care service in Dhaka City is inadequate in both public and private health care sector. The poor particularly find access to the service difficult. Private facilities are better in Dhaka City, but these are costly and not very modernized

2.2.7 Parks and Open Spaces

In 1978 Dhaka City had a total of 1916 acres of open space (Nabi, 1978) which amounted to 0.55 acres of total open space per 1,000 people The amount of open space, however, has not increased significantly since then despite the fact that the population has more than doubled. There is also no uniformity in the provision of open space throughout the whole city. The parks and open spaces that are now available are not being maintained properly. Due to lack of proper maintenance and management the condition of existing parks and open spaces have become deplorable. Most of the parks have become places of criminal and unsocial activities.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Methodology in its simplest sense is a process of deliberate anticipation directed towards bringing an expected situation under control. Designing, therefore, refers to the process of making decision before the actual situation comes in which decisions are to be made. Research methodology precisely means drawing a systematic approach and establishing a plan of action to carry out the research In summary, research methodology is "the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure".

In this chapter the procedure followed for the research is presented along with the theoretical concepts used for the environmental quality assessment. The perception of the residents about different component of the environment was analyzed by an Analytical Hierarchy Process (AHP), a multi-attribute decision making approach which is based on pair-wise comparisons of various indicators Details of AHP and its calibration procedures are discussed in this chapter.

Multi-criteria methodology can be used to develop a comprehensive indicator of urban living environment. Multi-criteria analysis has been developed expressedly for situations where decisions must be made taking into consideration more than one objective, which cannot be reduced to a single dimension. Multi-criteria evaluation is widely applied in the evaluation of complex system where element of the system are represented by a hierarchy.

At the end, the detailed methodology for data collection, sample size, sampling strategy, survey period, and designing of questionnaire are discussed.

3.2 METHODOLOGY

The survey to study the urban living environment of Dhaka City was based upon the following methodology (Figure 3.1)

To find out the indicators of urban living environment, first we need to determine some standards. **"To Be Alive"** is the most basic desire of people. As a task of urban planners, safety means to create a safe and healthy living environment in order to prevent citizens from natural and manmade calamities

Thus, safety and health are two fundamental standards of the urban living environment (Kubo, 1996) to frame the complex system of urban living environment by decomposing its elements and identifying their relationships. In this study comprehensive indicator is evaluated by two evaluation standards. These standards are evaluated by evaluation items such as fire, traffic accident, crimes, urban utilities, health hazard, health care facilities, parks and open spaces etc which are further described by components and input indicators. They include all such environmental components, which cause hazards or damage. Some items may have only one input indicator. Input indicators, at the last level, are data sets aggregated in evaluation units. The hierarchy and relationships of the different standards, items, components and input indicators are shown in Figure 3.2. Analytical Hierarchical Process (AHP) and Multicriteria Methodology have been used to derive the comprehensive indicator of the quality of urban living environment based on the indicators of health and safety standards. The techniques are described in the following sections.

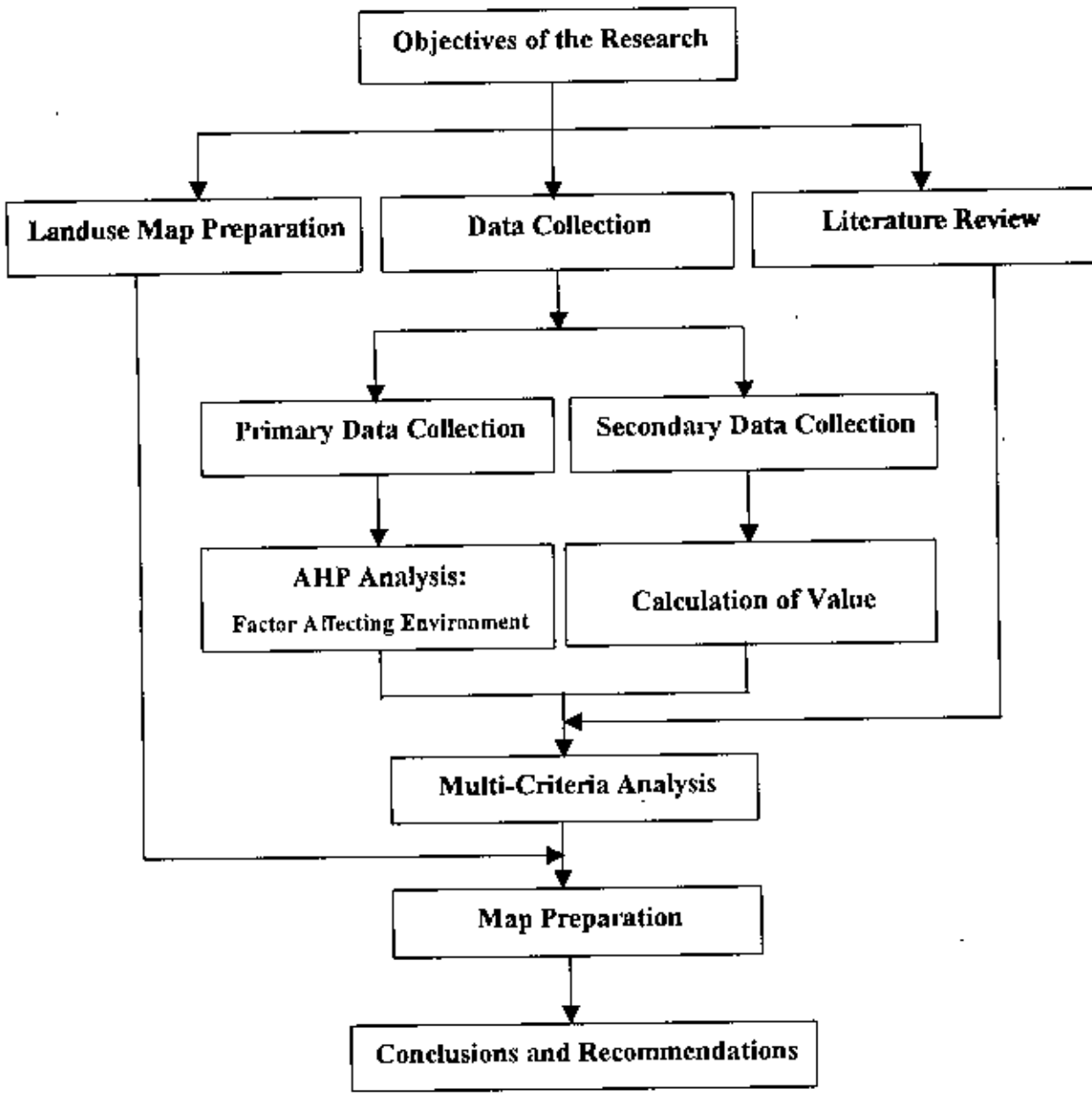


Figure – 3.1 : Methodology Followed in the Study.

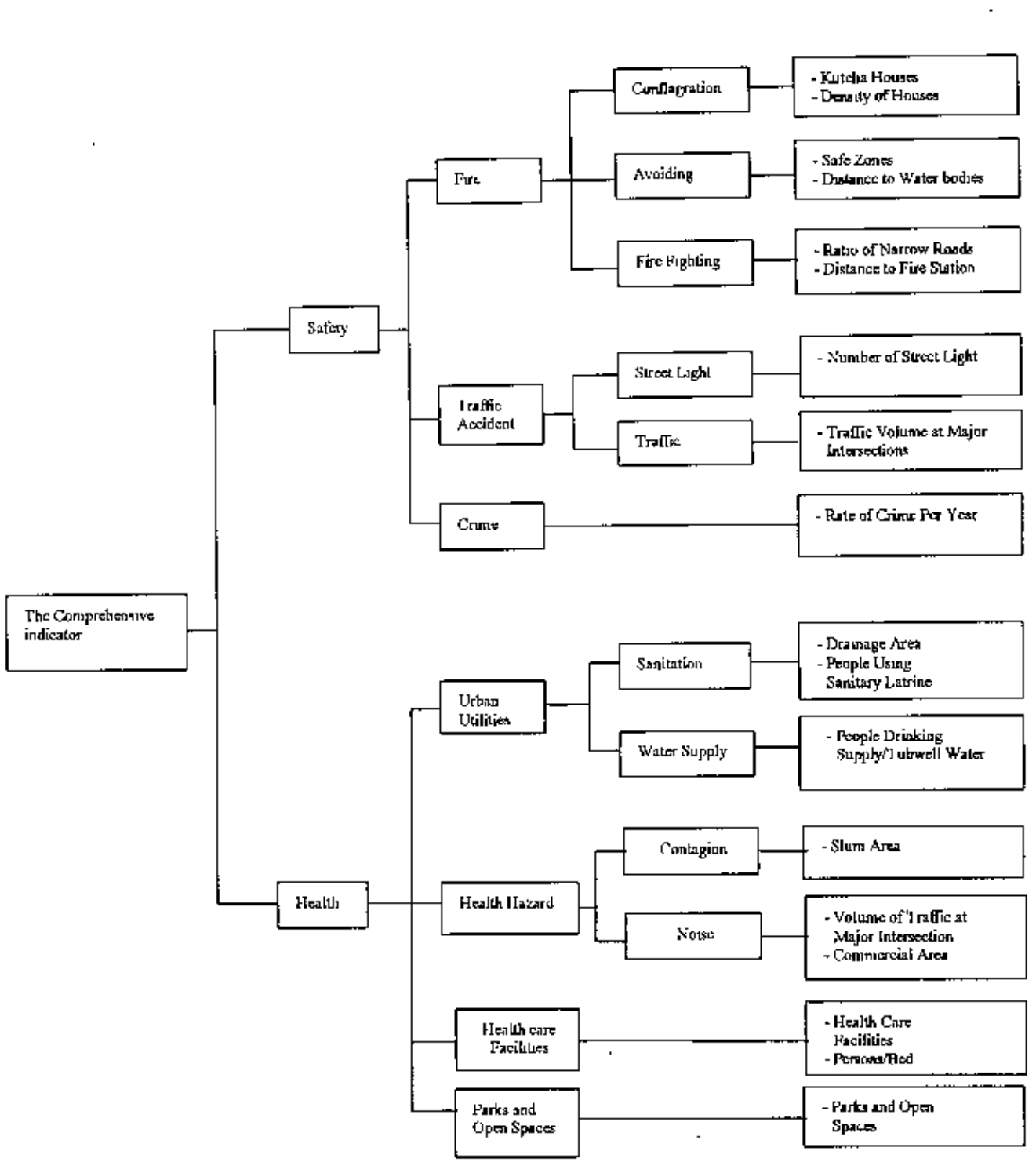


Figure – 3.2 : Different Standards, Items, Components and Input Indicators.

3.3 EXPERT CHOICE (EC) AND ANALYTICAL HIERARCHY PROCESS (AHP)

The AHP is a methodology for decision makers. It provides a user with a framework which formulates a problem into a hierarchy. The hierarchy is used to analyze all the relevant criteria in order to solve the problem in a logical, unbiased way. The user must define the problem and enter all the relevant issues into the hierarchy. The user instructs AHP as to which variables are most important, and then uses AHP to solve the problem through a series of comparisons among criteria based on what the user has defined as most important.

The problem must be broken down into separate elements, which AHP defines as criteria. The criteria may be further divided into subcriteria. AHP asks the user to compare all the criteria and subcriteria in pair and then assigns a numerical value to the criteria. These comparisons are not based on a preset ordinal scale, but rather on a scale in terms of each other – a ratio scale. AHP determines if the criteria were compared logically and ranked consistently. Finally, the criteria and subcriteria are prioritized in order to determine which criteria should carry more weight in choosing the alternative. AHP synthesizes all the information and determines which alternative is best.

3.3.1 Basics of Pairwise Comparison

Expert choice makes it possible to look at the elements of a problem in isolation: one element compared against another with respect to a single criterion. This is called pairwise comparing. Expert choice helps one to structure the problem, prompts one for one's judgment, and combines (synthesizes) all judgements into a unified whole in which one's alternatives are clearly prioritized from the best to worst.

3.3.2 Modes of Comparison

One can express the relative importance of one element over another with respect to a given criterion either verbally or numerically. Table 1 explains both scales and their relationship.

Table 3.1: Scales and Their Relationship

Numerical Scale	Verbal	Explanation
1.0	Equal importance of both elements	Two elements contribute equally.
3.0	Moderate Importance of one element over another	Experience and judgement favor one element over another.
5.0	Strong importance of one element over another	An element is strongly favored.
7.0	Very strong importance of one elements over another	An element is strongly dominant.
9.0	Extreme importance of one above the other	An element is favored by at least an order of magnitude of difference.
2.0, 4.0, 6.0, 8.0	Intermediate values between two adjacent judgements	Used for compromise between two judgements.
Increments of 0.1	Intermediate values in increments of 0.1 (example: 6.3 is a permissible entry)	

3.3.3 Causes of Inconsistency

Results may be inconsistent for a number of reasons. These are as follows;

a) **Clerical error:** mistakes in data entry may cause inconsistency.

b) **Lack of information:** Lack of information can cause the judgement to appear random resulting in a high inconsistent ratio.

c) **Lack of concentration or of interest:** Lack of concentration or of interest is often found when the respondent is fatigued or in a hurry or not in a mood to fill up the questionnaire.

d) **Lack of consistency in the decision being modeled:** The real world situations are rarely consistent by nature. The interesting example is when one has to compare three professional sports teams. The result of the game played by them are sometimes random like team 'A' defeats team 'B' and is defeated by team 'C' where as team 'B' might have defeated team 'C'.

e) **Inadequate model structure:** Ideally the complex decision process is structured in a way that the elements in a level are comparable within an order of magnitude of different factors in the level above.

3.3.4 Structure of the Model

An Expert Choice model organizes the various elements (factors) of a problem into a hierarchy similar to a family type structure (an upside-down tree structure). Each element in a tree is called a node. The top level contains the GOAL node (the tree branches downward from the GOAL). Intermediate levels represent the FACTORS, OBJECTIVES, or CRITERIA of the problem. At the bottom of the tree are the LEAVES, which represent the ALTERNATIVES of the choice.

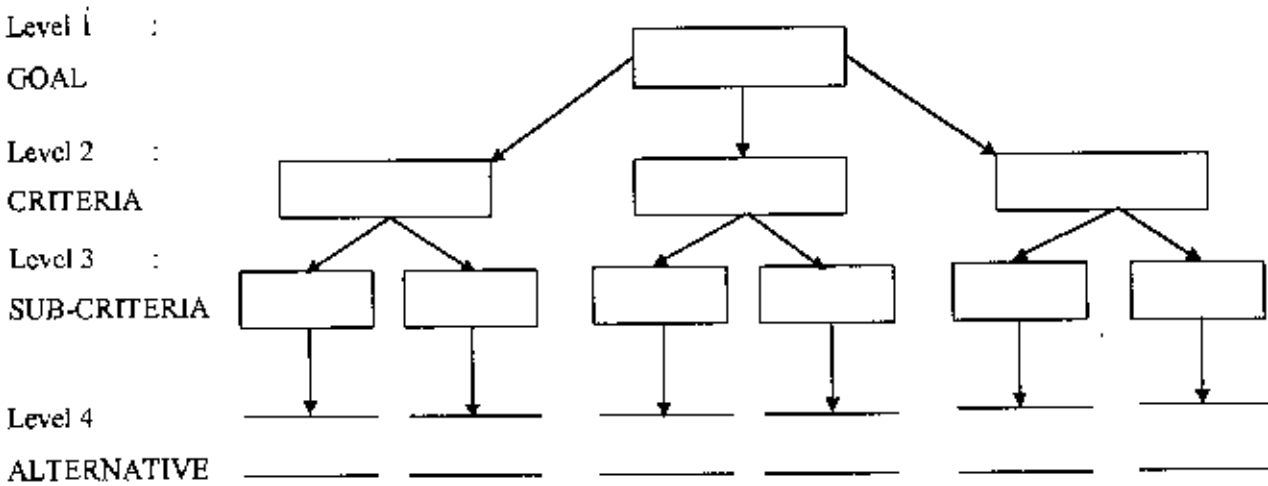


Figure – 3.3 : Structure of a Model

Simple models typically have criterion nodes below the goals, and alternative nodes below each criterion node More complex models may have additional nodes to represent further breakdowns of the main criteria into sub-criteria

3.3.5 AHP Model

A hierarchy has been viewed as a natural method of human problem solving and understanding (Saaty 1980), and it has been used logically in the development of expert systems. Here, we use a hierarchical structure to frame the complex system of ULE by decomposing its elements and identifying their relationship.

LEVEL - 1: Goal of the structure is to find out the **"Comprehensive Indicator of ULE"**.

LEVEL - 2: Standard – The comprehensive indicator of ULE evaluated by several evaluation standards. To find out the indicators of urban living environment, first we need to determine some standards. As the task of urban planners, safety means to create a safe and healthy living environment in order to prevent the citizens from natural and manmade calamities. Thus, safety and health are two fundamental standards of urban living environment (Kubo, 1996).

LEVEL - 3: **Items** - Standards are evaluated by evaluation items such as fire, traffic accident, crimes, urban utilities, health hazards, health care facilities, parks and open spaces. They include all such environmental components that cause hazard or damage.

LEVEL - 4: **Component** – Components further describe the standards Elements of safety and health are natural or social phenomena, usually with the process of occurrence, spreading, human countermeasure, and then disappearance. The item 'fire' describes the components conflagration, avoiding and fire fighting. The item traffic accident describes street light and traffic. The item urban utilities has the components of sanitation and water supply. Health hazard components include contagion and noise. Some items may have no component. The components are the last level of the hierarchy.

Some items have no component only input indicator. In hierarchy we have considered only items of the component.

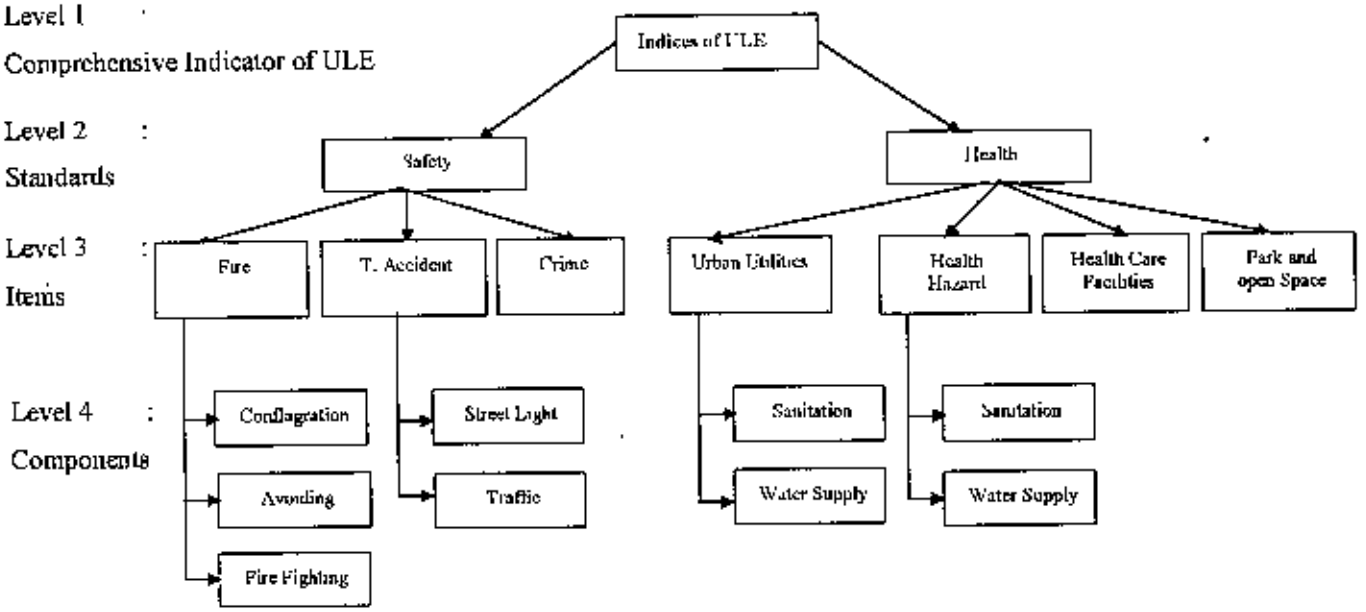


Figure – 3.4 : Structure of ULE

3.3.6 Aggregation Techniques in AHP Analysis

The individual respondent's preference weights were considered separately. The principle idea of AHP is based on pair-wise comparisons at the different hierarchical levels of the problem, which is concerned with evaluating the relative importance of a set of criteria. Pairwise comparisons of the criteria are represented in a matrix form from which the relative weights attributed to the different criteria are then calculated as the components of the normalized eigen vector for the maximum eigen value of this matrix. The basic observation is that it is easier to compare the importance of two different criteria than to make an overall comparison in one sweep.

3.4 MULTICRITERIA METHODOLOGY

In this stage, multicriteria methodology will be used to develop a comprehensive indicator of urban living environment. Multicriteria analysis has been developed expressedly for situations where decisions must be made taking into consideration more than one objective, which cannot be reduced to a single dimension. Multicriteria evaluation is widely applied in the evaluation of complex system where elements of the system are represented by a hierarchy. The AHP allows flexibility of both absolute and relative measurement in multicriteria decision analysis.

The weighted factor method provides a procedure where each indicator is assigned a score, which is multiplied by the weight of that factor The results of the multiplication are added and then a composite score is determined.

A comprehensive indicator is calculated by the following equation:

$$E = \sum_{i=1}^{n} w_i v_i \quad \text{----------(i)}$$

$$v_i = f(x_i) \quad \text{----------(ii)}$$

$$\sum_{i=1}^{n} w_i = 1 \quad \text{----------(iii)}$$

Where,

E is the composite score,

x_i is the ith indicator for E to be integrated,

n is the number of indicators,

w_i is the weight of v_i, and

v_i is the evaluated function of x_i.

Here, we will find w_i from AHP and v_i from survey and from other sources. Finally, an urban living environment map will be created, based on the calculated value of the comprehensive indicator.

3.5 METHODOLOGY FOR COLLECTION OF DATA

The information and data required for this study were collected from various sources, both primary and secondary, detailed in the following sections.

3.5.1 Selection of Study Area

Dhaka is the Primate City of Bangladesh and various environmental problems appear to be more pronounced in Dhaka. Thus Dhaka can be considered to be the most suitable place for conducting the research. Due to limitation of time and fund, it was not possible to survey the whole of Dhaka City. For this reason, the present study was conducted in five wards (Ward numbers 42, 43, 44, 45 and 46) in Mohammadpur thana. There are 21 thanas in Dhaka City. The study area includes both planned and unplanned residential areas. Map 3.1 show the study area of Mohammadpur thana.

Characteristics of the Study Area: The study area Mohammadpur has grown very fast, from 1991 to 1998 at over 5 percent annually (Islam, 1998). Some portion of the thana are still under developed as these areas are low lying. Expansion of Mohammadpur has been vigorous in the last two decades. Part of Mohammadpur is planned, the rest unplanned, developed spontaneously mainly because of slums.

Area and Population:

Mohammadpur is an urban thana of DCC with an area of about 12 sq. km. It is located in the western part of Dhaka. The thana is made up of 7 wards including one partial ward. In 1991 it had a population of 3,16,203, which included 1,73,977 males and 1,42,226 females. The density of population was 27,142 persons per sq. km. against a DCC population density of 11,000. It contains over 6 percent of DCC population and the annual compounded growth rate is 3.71 percent. The sex ratio is 122 males per 100 females. Ward basis area and population shown in the table 3.1.

Map 3.1 Study Area of Mohammadpur Thana

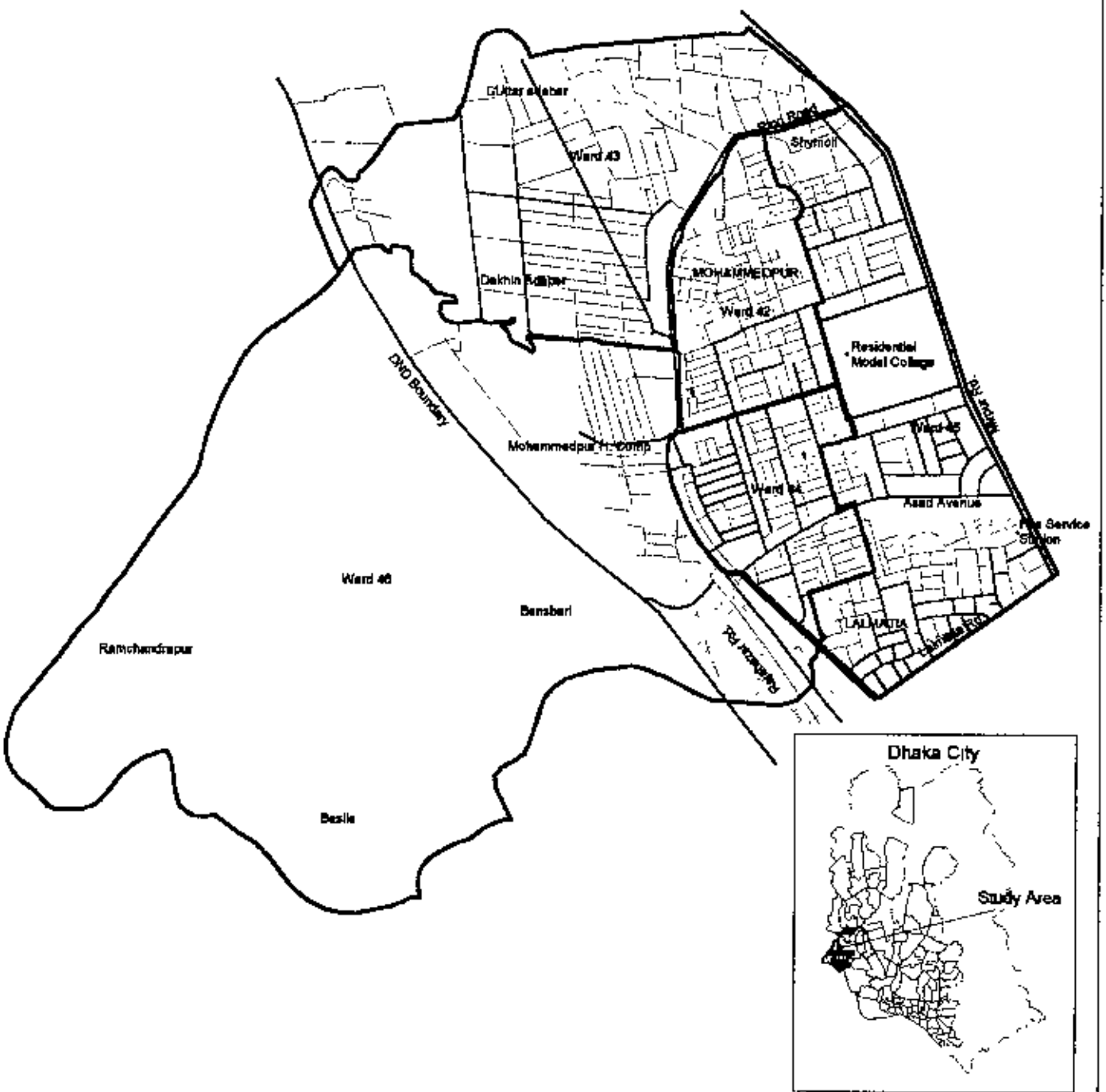


Table 3.2 : Ward Wise Area and Population

Ward No.	Area in km2.	Total Population
41	0.598	49010
42	0 621	18337
43	1.818	57769
44	0.565	56267
45	1.482	45443
46	5.360	30479
47	1.024	45201
51 (Part)	0.094	13697
Total	**11.56**	**316203**

Source. BBS Community Series Data, 1991

The literacy rate of population over 7 years of age is a little more than 56 percent for both sexes. Over 23 percent of the thana population are below 10 years of age. Nearly a quarter of the total population of Mohammadpur over the age of 10 years are not working. There are 57,551 households in the area with a household size of 5.5. It has been seen that while the population growth rate of DCC decreased from 4.5 percent to 4 percent between 1981-91 and 1991-98, population growth of Mohammadpur thana increased from 3.7 percent to 5 percent during the same period.

Social, Ethnic and Economic Characteristics of Mohammadpur Thana

Mohammadpur has within it a ghetto of "Bihari Refugees" who are originally migrants from India and keep insisting on staying "citizens' of Pakistan. They now have a special refugee status, but are economically integrated in Dhaka. Economically, Mohammadpur is a mixed area with high income, middle income, low income and poor households.

Physical Environment

Nearly a quarter of the houses are made of straw or bamboo. Over 76% of the household have access to piped water A little over 28% of the households have non-sanitary latrines with about 5% having no toilet facilities all. There are 203 slums and squatters within Mohammadpur thana (Islam, 1998).

3.5.2 Primary Data Collection

Questionnaire Survey: For primary data collection a questionnaire was designed to collect information regarding perception of environmental quality of the residential area

Sample Number

In this survey an 'individual' was chosen as a sampling unit. There is a large population in the study area of these five wards (BBS 1997). The only limitations on selecting a large sample size were time and money. Given these constraints, a sample of 350 individuals was taken for collecting living environmental quality perception data.

Sampling Size

After choosing the size of the sample, the next step was to select individuals to make up the sample. In this study subjective judgement had to be taken in the selection of individual respondents.

Survey Period

The survey was conducted during the month of August and September of 1999. An individual was selected randomly from study area during the daytime.

Designing Questionnaire

An individual perception survey about environmental quality was undertaken by means of a structured questionnaire. A sample questionnaire is shown in Appendix A.

Landuse Survey: A landuse survey was carried out to find the different uses of the land in the study area. The landuse categories were residential, commercial, park and open space, water body, mosque and road. Road survey included length and width of the roads. A landuse map was prepared with the ARC/INFO GIS software.

3.5.3 Secondary Data Collection

In order to get a better understanding of the indicator of environmental quality, relevant literatures were reviewed and data were collected from secondary sources, according to need and availability. During literature survey information were collected from books, journals, reports and documents concerning environmental quality

CHAPTER FOUR

APPLICATION OF AHP MODEL

4.1 INTRODUCTION

The analytical hierarchy process is a multi-attribute methodology. Because of its flexibility, AHP may be applied in widely different areas Expert choice is an organizer; it organizes one's decision in a hierarchical structure which allows one to see where one want to go and what one has to do to get there. The decision maker's judgement form the basis of the expert choice process.

A hierarchy has been viewed as a natural method of human problem solving and understanding (Saaty 1980), and it has been used logically in the development of expert systems Here, we use a hierarchical structure to frame the complex system of ULE by decomposing its elements and identifying their relationship. In this chapter some of the important items and component (Fire conflagration. avoiding from fire, fire fighting, street light, traffic, crime, sanitation, water supply, contagion, noise, hospital and park) have been studies to analyze to frame the complex system of urban living environment.

For the AHP model in this study, the attempt to frame the complex system of urban living environment was by discomposing its elements and identifying their relationships.

Standard – The comprehensive indicator of ULE evaluated by several evaluation standards. To find out the indicators of urban living environment, first we need to determine some standards. As the task of urban planners, safety means to create a safe and healthy living environment in order to prevent the citizens from natural and manmade calamities Thus, safety and health are two fundamental standards of urban living environment (Kubo, 1996)

Items - Standards are evaluated by evaluation items such as fire, traffic accident, crimes, urban utilities, hazards, hospital, and park. They include all such environmental components that cause hazard or damage.

Component - The item 'fire' describes the components conflagration, avoiding and fire fighting. The item traffic accident describes street light and traffic. The item urban utilities have the components of sanitation and water supply. Hazard components include contagion and noise. Some items may have no component The components are the last level of the hierarchy.

The top level is a comprehensive indicator evaluated by several evaluation standards. These standards are evaluated by evaluation items, which are further described by components and input indicators They include all such environmental components, which cause hazards or damage Some items may have only one input indicator. Input indicators, at the last level, are data sets aggregated in evaluation units.

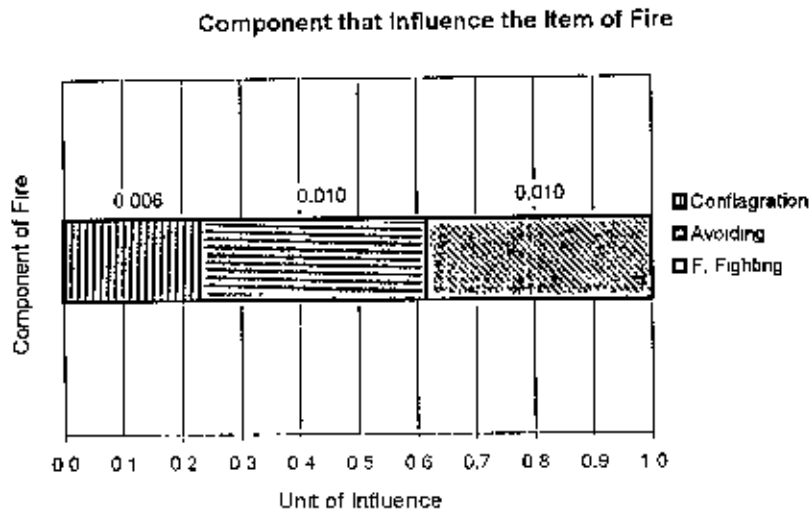
In this survey an 'individual' (person) was chosen as a sampling unit There is a large population in the study area of these five wards (BBS 1997). The only limitations on selecting a large sample size were time and money. Given these constraints, a sample of 350 individuals was taken for collecting living environmental quality perception data Subjective judgement had to be taken in the selection of individual respondents.

The individual respondent's preference weights were considered separately. The principle idea of AHP is based on pair-wise comparisons at the different hierarchical levels of the problem, which is concerned with evaluating the relative importance of a set of criteria. Pairwise comparisons of the criteria are represented in a matrix form from which the relative weights attributed to the different criteria are then calculated as the components of the normalized eigen vector for the maximum eigen value of this matrix. The basic observation is that it is easier to compare the importance of two different criteria than to make an overall comparison in one sweep

4.2 RESULT FROM AHP

4.2.1 Weights of Different Evaluation Components of Fire Influencing the Quality of the Living Environment

The spreading of fire depends on density of houses and ratio of wooden houses. Avoiding is the ratio of safe zone and distances to it. Fire fighting are distances to fire station and ratio of narrow roads. Fire fighting and avoiding play the most important role in affecting the environmental quality.

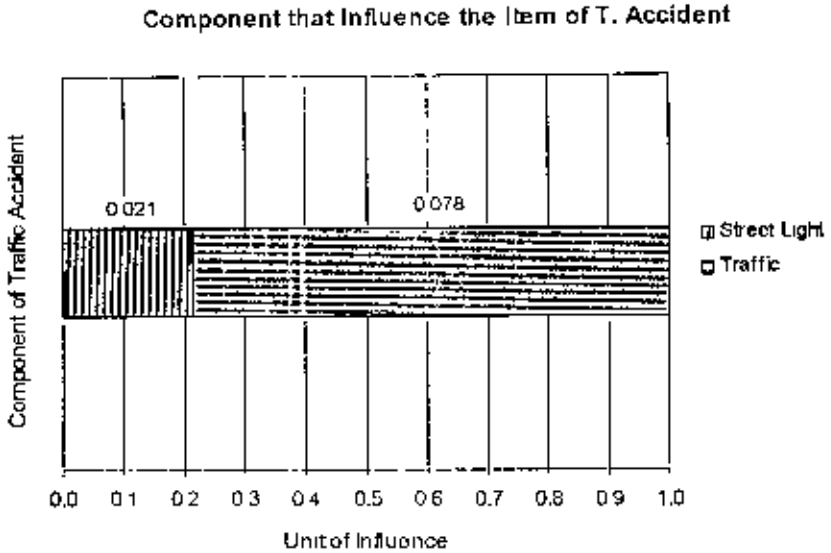


Source : Field Survey, August and September, 1999

Figure – 4.1 . Weights of Different Components Influencing Item of Fire as Obtained by AHP.

4.2.2 Weights of Different Evaluation Components of Traffic Accident Influencing the Quality of the Living Environment

Traffic accidents are an important aspect of safety in the urban living environment The increasing number of vehicles on the roads is largely responsible for traffic accidents. Also street light is the responsible for traffic accident. The weights of different components of traffic accident influencing living environmental quality' presented in Figure 4.2. Among the two components viz. Street light and traffic, traffic seems to be the most important items that more affects the quality of living environment.

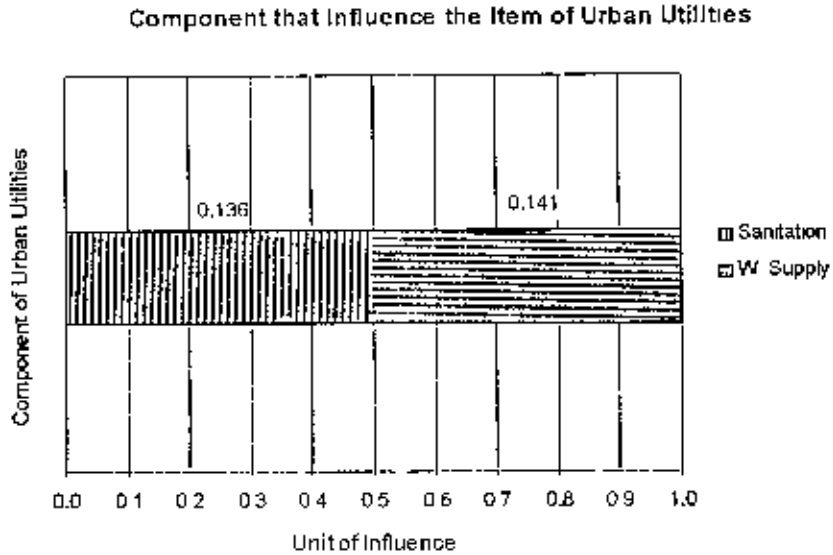


Source : Field Survey, August and September, 1999

Figure – 4.2 : Weights of Different Components Influencing Item of Traffic Accident as Obtained by AHP.

4.2.3 Weights of Different Evaluation Components of Urban Utilities Influencing the quality of the Living Environment

Sanitation and water supply play an important role in a city like Dhaka. Provision of urban utilities is insufficient in Dhaka City. Water supply and sanitation both influence the assessment of the quality of the living environment to a similar extent. The weights of different component of urban utilities influencing living environmental quality presented in Figure 4.3

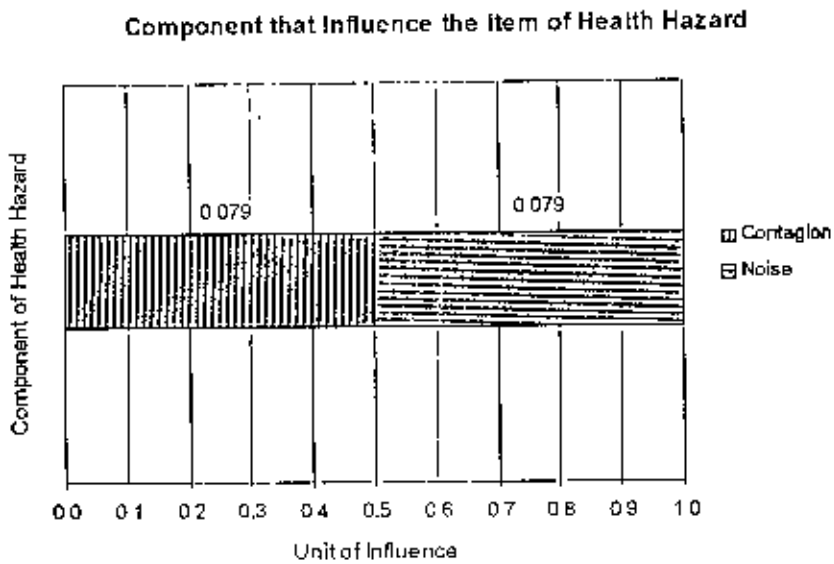


Source : Field Survey, August and September, 1999

Figure – 4.3 : Weights of Different Components Influencing Item of Urban Utilities as Obtained by AHP.

4.2.4 Weights of Different Evaluation Components of Health Hazard Influencing the Quality Living Environment

Contagion and noise both influence the living environmental quality to the same extent. In Dhaka City health hazard is a big problem because of the proliferation of slums, which degrade the living environmental quality

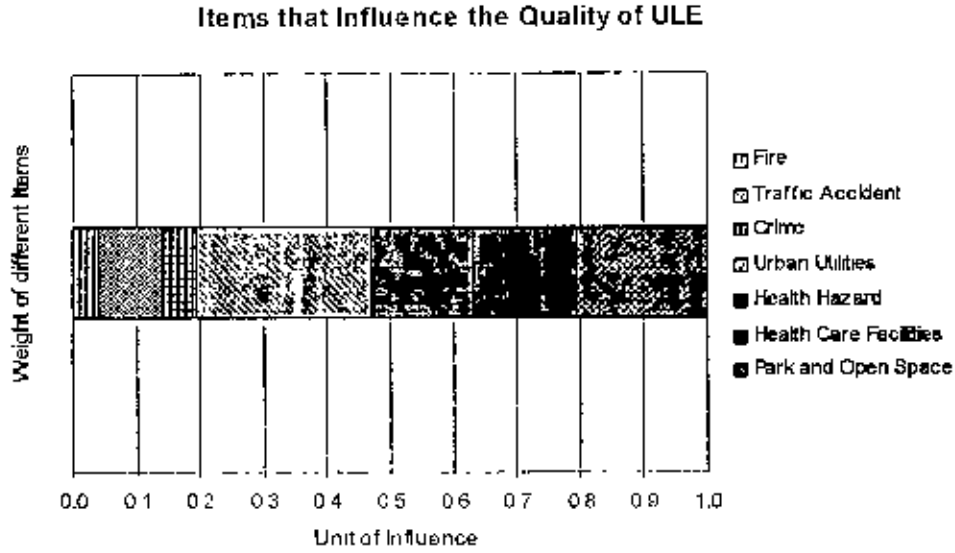


Source : Field Survey, August and September, 1999

Figure – 4.4 Weights of Different Components Influencing Item of Health Hazard as Obtained by AHP

4.2.5 Weights of Different Evaluation Items Influencing the Quality of Living Environment

The weights of different evaluation items influencing living environment quality as found through the AHP are presented in Figure 4.3. Among the seven items viz. fire, traffic accident, crime, urban utilities, health hazard, health care facilities and park and open space, urban utilities came out to be the most important item that affects the health standard of the living environmental quality. Urban utilities comprise the input indicators of water supply and sanitation, which are essential in our urbanized society. Parks and open space are considered the second most important item affecting the environmental quality. The provision of parks and open spaces in the city area is quite low compared to the actual need. Fire is the least important item that affects the safety standard of living environment quality according to the respondents. The spreading of fire depend on density of houses and ratio of wooden houses.

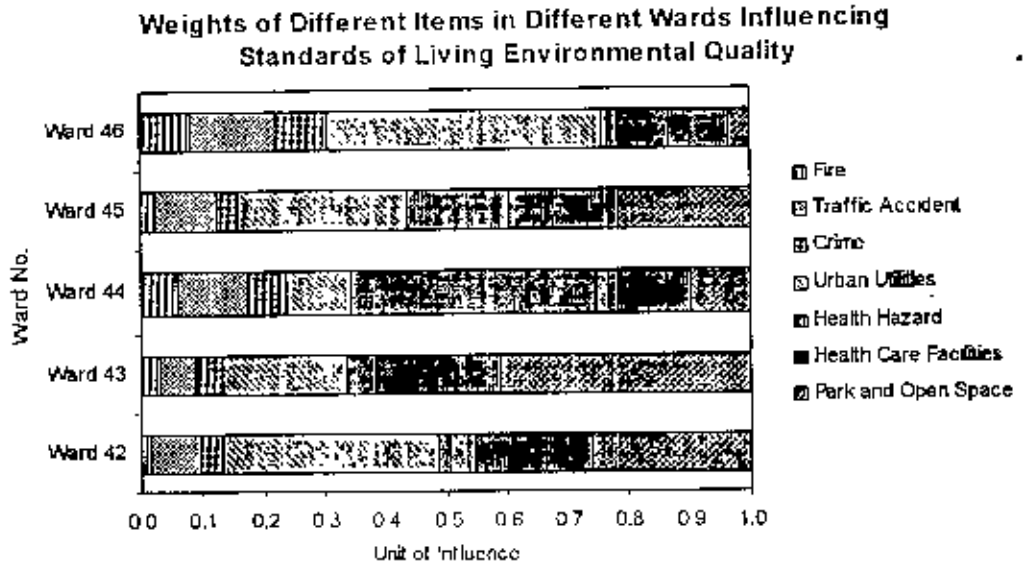


Source : Field Survey, August and September, 1999

Figure – 4.5 Weights of Different Items Influencing Standards of Living Environmental Quality as Obtained by AHP.

4.2.6 Ward Wise Weights of Different Evaluation Items Influencing the Quality of Living Environment

Ward wise weights of different items with respect to the standards are presented in the following Figures 4.6.



Source : Field Survey, August and September, 1999

Figure – 4.6 : Weights of Different Items in Different Ward Influencing Standards of Living Environmental Quality as obtained by AHP.

Urban utilities seem to be the most important items at ward 42 that affect the living environmental quality. Fire is the least important item for the deterioration of the environmental quality. Park is also the second most important items that affect the living environmental quality.

Park seems to be the most important item at ward 43 that affect the living environmental quality, fire is the least important item affecting the environmental quality. Urban utilities are in the second position.

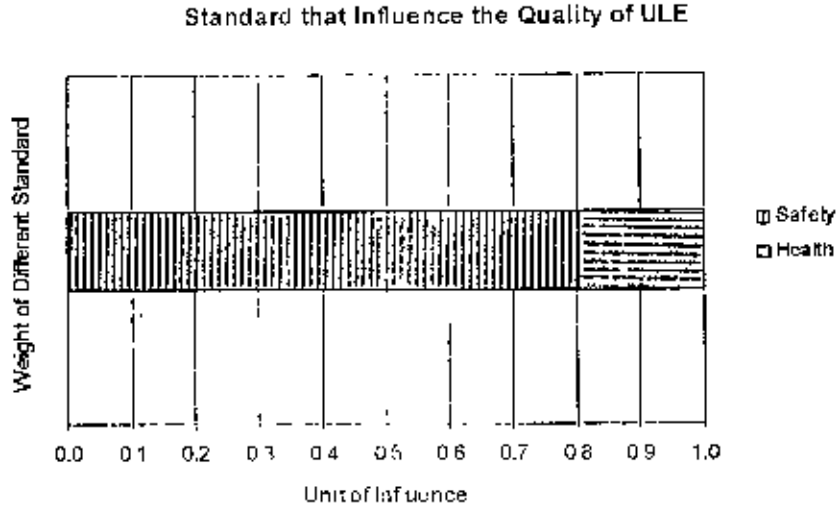
Hazard seems to be the most important item at ward 44 that affects the environmental quality. Hospital is the second most important item and fire is the least important items affect the environmental quality.

Urban utilities seem to be the most important items at ward 45 that deteriorates the environmental quality; hospital is the second important item and fire is the least important item deteriorating the environmental quality

Urban utilities seem to be the most important item at ward 46 that deteriorates the environmental quality; Park is the least important item affecting the environmental quality. Traffic accident is the second most important item that deteriorates the living environmental quality

4.2.7 Weights of Different Evaluation Standards Influencing Quality of Living Environment

The weights of different evaluation standards influencing the living environmental quality as found from the AHP are presented in Figure 4.7. Among the two standards considered, safety and health, safety seems to be the more important one. Evaluation of safety and health are usually static while the urban environment changes dynamically day by day.



Source : Field Survey, August and September, 1999

Figure – 4.7 : Weights of Different Standards Influencing Living Environmental Quality as Obtained by AHP.

CHAPTER FIVE

LIVING ENVIRONMENT QUALITY: THE COMPREHENSIVE INDICATOR

5.1 INTRODUCTION

Multi-criteria analysis has been developed expressedly for situations where decisions must be made taking into consideration more than one objective, which cannot be reduced to a single dimension. Multi-criteria evaluation is widely applied in the evaluation of complex systems where the elements of the system are represented by a hierarchy The multi criteria methodology provides a procedure where each item and component is assigned a score, which is multiplied by the weight of that factor. The results of the multiplication are added and then a composite score is determined.

In this chapter the value of items and component from the input indicators have been determined. Some indicator values were explored from secondary sources and some from the landuse (Map 5 1) and road network maps (Map 5.2). All of the indicators were turned into a single unit by using a composite score. Finally, using a multi-criteria methodology, each standard, item and component was assigned a value (by composite score), which was multiplied by the weight of that factor (determined by AHP analysis). The results of the multiplication were added and then the comprehensive indicator of urban living environment was determined.

5.2 COMPUTATION OF THE COMPOSITE SCORE

Composite score of nine components and three items have been calculated by the following method. The wards that has the highest value in terms of any of the input indicator of components and items is assigned a constant value 10 for that factor. A composite score corresponding to constant values are computed then for other remaining wards.

Here the factor represents the input indicator of a component of an item, or the items itself in the case when it is not broken down into components When a component has more than one input indicator the average composite score of the indicators is considered.

Map 5.1 Landuse Map of Mohammadpur Thana

LEGEND
- Residential
- Commercial
- Institutional
- Park/Open Space
- Slum Area
- Mosque
- Water Body
- Fire Station
- Road Area

N

0.2 0 0.2 0.4 Kilometers

Map 5.2 Road Network Map of Mohammadpur Thana

LEGEND
- 100 feet Rd.
- 75 feet Rd.
- 60 feet Rd.
- 40 feet Rd.
- 30 feet Rd.
- 20 feet Rd.
- 10 feet Rd.

N

0.3 0 0.3 0.6 Kilometers

Therefore,

$$V_j = \frac{10\, x_j}{\underset{k}{\text{Max}}\,(x_K)} \qquad \text{----------(iv)}$$

Where,

V_j = Score for the factor of ward j.

x_j = Value of the factor for ward j.

k = Subscript for ward varying from 1 to the number of wards in the study (5).

For example, the following table shows the input indicators of five wards for crime rate in the second column.

Ward	Length of Road (km)	Value
42	27	
43	43	
44	39	
45	46	
46	57	Assigned Value = 10

The maximum crime rate is observed in Ward 46 and a score of 10 is assigned to that ward. The score for some other ward, say Ward 42, is computed as follws;

$$\text{The score of the ward 42} = \frac{27 \times 10}{57} = 4.74$$

Finally, the composite score is computed for each ward using the Equation (iv).

5.3 THE COMPONENTS

Elements of safety and health are natural or social phenomena. The item fire includes the components of conflagration, fire avoiding and fire fighting. The item traffic accident includes streetlight and traffic volume. The components of urban utilities are sanitation and water supply. The components of hazards are contagion and noise. Some items have no components. The components are the last level of the hierarchy.

5.3.1 Components of Fire

The item 'fire' includes the components of conflagration, fire avoiding and fire fighting.

Conflagration: Input indicators of conflagration are the ratio of kutcha houses and the density of houses. The following table shows the ward wise Ratio of kutcha houses and density of houses.

Table 5.1: Ratio of Kutcha Houses

Ward No.	Total Pop^n	Kutcha Houses	Pucca Houses	Total	Ratio of Kutcha Houses
42	18337	3983	2144	6127	65.01
43	57769	4492	2632	7124	63.05
44	56267	3550	5255	8805	40.32
45	45443	3766	3210	6976	53.98
46	30479	2434	1420	3854	63.16

Source: BBS Community Series Data, 1991

Table 5.2: Density of Houses

Ward No.	Area in km^2.	Kutcha Houses	Pucca Houses	Total	Density of Houses
42	0 621	3983	2144	6127	9866.34
43	1.818	4492	2632	7124	3918.59
44	0 565	3550	5255	8805	15584.07
45	1.482	3766	3210	6976	4707.15
46	5 360	2434	1420	3854	0719.03

Source: BBS Community Series Data, 1991

The analysis shows that ward 46 is least vulnerable with respect to conflagration because this area has a lower density of houses According to the severity ward 42, 44, 43, 45 and 46 respectively have more risk of conflagration. Ward 42 has the highest risk of conflagrations because this ward has more slum area and also a higher ratio of kutcha houses.

Fire Avoiding: Input indicators of avoiding fire are ratio of safe zones and distance to the water bodies. Safe zones are considered to be water bodies and open areas where people can escape from fire. Here, we consider distance to nearest water body from the centroid of the ward. The following Tables 5.3 and 5 4 show the ward basis ratio of safe zones and distance from water bodies.

Table 5.3: Ratio of Safe Zones

Ward No.	Total Area (sq.km.)	Total area of Safe Zone (sq.km)	Ratio of Safe Zone
42	0.621	0 033	0.053
43	1.818	0 097	0.053
44	0.565	0.005	0 009
45	1.482	0.017	0 011
46	5.360	4.388	0.819

Source: GIS Landuse Map, 1999

Table 5.4: Distance to Water Bodies

Ward No.	Total Area (sq.km.)	Distance from Water Bodies (km)
42	0 621	0.140
43	1 818	0.670
44	0 565	0 160
45	1.482	0.940
46	5 360	0 000

Source: GIS Landuse Map, 1999

In the composite analysis ward 45 has the worst situation for avoiding fire. The reason is this ward has the least safe zones and the distance from water body is high. According to the analysis 46, 42, 44, 43, and 45 are, in the order conducive to avoiding fire..

Fire Fighting: Ratio of narrow roads and distance from fire station are the input indicators of fire fighting. Here we consider distance from the centroid of the ward to the nearest fire station. Distance computed from the fire station to the ward by in GIS network analysis. Tables 5.5 and 5.6 show the ward wise ratio of narrow roads and distance from water bodies.

Table 5.5: Ratio of Narrow Roads

Ward No.	Total Area (sq. km.)	Total length of Road (km.)	Total length of narrow road (km.)	Ratio of Narrow Roads
42	0 621	0.016	0.001	6.25
43	1.818	0.025	0.002	8.00
44	0 565	0.015	0.001	6.67
45	1.482	0.028	0.002	7.14
46	5 360	0.017	0.003	17.65

Source: GIS Landuse Map, 1999.

Table 5.6: Distance to Fire Station

Ward No.	Total Area (sq.km.)	Distance from Fire Station (km)
42	0 621	2.150
43	1.818	3.600
44	0.565	1.410
45	1 482	1.090
46	5 360	2.290

Source: GIS Road Network Map, 1999.

In the composite analysis it has been seen that Ward 45 has the most advantage for fire fighting. This area has a low ratio of narrow roads and is less distant from the fire station. Ward 46 has the least advantage for fire fighting because this area has a higher ratio of narrow roads and the distance from the fire station is high. According to the least arrangement of fire fighting 46, 43, 42, 44 and 45 highest vulnerable, respectively.

5.3.2 Components of Traffic Accident

Traffic accident has no component it has only two input indicators named streetlight and traffic. Ratio of streetlight in running distance is one of the input indicator of traffic accident. The following tables 5.7 show the ward basis ratio of streetlight in running distance.

Table 5.7: Density of Street Light

Ward No.	Length of Road (km.)	Number of Street Light		Total	Density of Street Light (# of street lump posts per km of road)
		Tube Light	Sodium Light		
42	16.419	390	178	568	0.03
43	25.129	560	-	560	0.02
44	15.221	335	68	403	0 03
45	28 191	481	103	584	0 02
46	17 064	412	49	461	0 03

Source: GIS Landuse Map, 1999

Traffic volume is another input indicator of traffic accident. Table 5 8 shows the ward wise traffic volume at major intersections.

Table 5.8: Traffic Volume at Major Intersection

Ward No.	Name of the Intersection	Ave. PCE
42	Mirpur Rd- Agargon Rd.	3952.5
	Dhanmondi 16- Shatmasjid Rd.	
43	Mirpur Rd- Agargon Rd	3952.5
	Dhanmondi 16- Shatmasjid Rd.	
44	Mirpur Rd- Asadgate Rd.	5377.0
	Dhanmondi 16- Shatmasjid Rd	
45	Mirpur Rd.- Manik Mia Avenue	5583.5
	Dhanmondi 16- Shatmasjid Rd.	
46	Dhanmondi 16- Shatmsjid Rd	3281.0
	Mirpur Rd- Asadgate Rd.	

Source: DITS study, 1990

In the composite analysis it has been seen that ward 45 has more traffic due to the existence of major roads in this ward. Ward 45 is more vulnerable to traffic accidents.

5.3.3 Component of Urban Utilities

Sanitation: Sanitation is a major of urban utility Here, the level of deficiency of sanitation is measured by the ratio of household using unsanitary latrine. Table 5.9 shows the ratio of people using unsanitary latrines.

Table 5.9: Ratio of People Using Unsanitary Latrine

Ward No.	Total number of Households	Toilet Facilities		Ratio of Household Using Unsanitary/No. Latrine
		Sanitary	Unsanitary/No	
42	6127	3993	2134	34.83
43	7124	4981	2143	30.08
44	8805	7512	1293	14.21
45	6976	6640	366	5.24
46	3854	2193	1661	43.10

Source: BBS Community Series Data, 1991

It has been seen that ward 46 is more vulnerable with respect to sanitation. A higher ratio of households in this ward use unsanitary latrines. This area has more government khas land and poor people gather in this area creating slums and squatter settlements

Water Supply: Another important urban utility is water supply. Living environment quality depends to an extent on the level of coverage of water supply. The ratio of households forced to depend on water from ponds or rivers is taken as an indicator of the deficiency of water supply. Table 5 10 shows the ratio of people drinking pond/river water.

Table 5.10: Ratio of People Drinking Pond/River Water

Ward No.	Total Household	Source of Drinking Water		Ratio of Household Drinking Pond/River Water
		Supply/Tubwell	Pond/River	
42	6127	5795	332	5.27
43	7124	7018	106	1.49
44	8805	8676	129	1.47
45	6976	6943	33	0.47
46	3854	3771	83	2.15

Source: BBS Community Series Data, 1991

Ward 42 is the highest vulnerable living environment quality with respect to water supply because more ratio of people drinking pond/river water Ward 46 is in second position regarding the deficiency of water supply Ward 45 is good position and living environment quality is better in this ward.

5.3.4 Components of Health Hazard

Hazard has two input indicators, one is contagion, which can depend on the extent of slums and squatters, and the other is noise.

Contagion: Contagion is the more important input indicator of health hazard. Health hazard is assumed to depend on the ratio of slum area. Table 5 11 shows the ratio of slum area of different ward.

Table 5.11: Ratio of Slum Area

Ward No.	Total Area (sq.km.)	Total Slum Area (sq.km.)	Ratio of Slum Area
42	0.621	0 015	2 415
43	1.818	0.080	4 400
44	0.565	0.003	0.531
45	1 482	0.033	2.227
46	5.360	0.218	4.067

Source: GIS Landuse Map, 1999

It is seen that ward 43 is more vulnerable with respect to contagion because of the higher ratio of slum area. Ward 44 is least vulnerable because of the low ratio of slum area in this ward.

Noise: Another important input indicator of hazard is noise, which may depend on the ratio of commercial area. Commercial areas attract vehicular traffic that creates noise Table 5.12 shows the ratio of commercial area in different wards

Table 5.12: Ratio of Commercial Area

Ward No.	Total Area (sq.km.)	Total Commercial Area (sq.m.)	Ratio of Commercial Area
42	0.621	0.086	13.849
43	1.818	0 074	4.070
44	0.565	0.056	9.912
45	1.482	0 123	8.300
46	5.360	0 027	0.504

Source: GIS Landuse Map, 1999.

It is seen that ward 46 is the least vulnerable because this area has a low ratio of commercial area. Ward 42 is the most vulnerable because Mohammedpur Krishi Market is situated at this area.

5.3.5 Components of Health Care Facilities

Health care facilities have no component it has only two input indicators namely Primary health care facilities and persons/bed. Primary health care facilities are measured by number of hospitals and private clinics in a particular ward Table 5.12 shows the status of health care facilities of different ward.

Table 5.13: Health Care Facilities and Bed/Person

Ward No.	Total Pop"	Number of Hospital & Private Clinic	Number of Beds	Persons per Bed
42	18337	4	40	458
43	57769	3	39	1481
44	56267	7	91	618
45	45443	15	191	237
46	30479	2	17	1792

Source: Field Survey, 1999.

It is seen that Ward 46 is the most vulnerable because this ward has fewer health care facilities. Ward 45 is the least vulnerable because high number of the clinics are situated in ward 45. According to the severity of provision of health care facilities 46, 43, 44, 42, 45 can be ranked in that order.

5.3.6 Components of Parks and Open Spaces

Parks and open spaces have no component it has only one input indicator namely ratio of parks and open spaces. Ward 45 has highest ratio of parks and open spaces and Ward 46 has the lowest. Table 5.13 shows the ratio of parks and open spaces in the different wards.

Table 5.14: Ratio of Parks and Open Spaces

Ward No.	Total Area (sq.km.)	Total Park/Open space (sq.km.)	Ratio of Park and Open Space
42	0.621	0 014	2.227
43	1.818	0 033	1.794
44	0.565	0 020	3.465
45	1.482	0 063	4.227
46	5.360	0.008	0.158

Source: GIS Landuse Map, 1999.

Ward 46 is highest vulnerable living environment quality with respect to parks and open spaces because lower ratio of parks and open spaces Ward 42 is second position in regarding vulnerability of park and open space Also ward 45 is good position and living environment quality is better in this ward.

5.4 THE ITEMS

Standards of living environment are evaluated by evaluation items such as fire, traffic accidents, crimes, urban utilities, hazards, hospitals, parks, slums, noises etc. They include all such environmental components, which cause hazards or damages. Fire, traffic accidents, crimes affect the safety aspect of living environment while urban utilities, hazards, hospitals, parks, slums and noise affect the health aspect of the living environment. The index of an item is found out by summing up the weighted scores of indicators for that item The weights were derived through AHP

The condition of urban utilities in ward 42 is highly vulnerable because some portions of this area constitute Geneva Camps, where Pakistani refugees are permanently settled and drink unsafe water Ward number 45 is least vulnerable considering in this respect. Figure 5.6 show the ward basis indices of health item urban utilities

Fire: It is seen that ward 43 has a high index value for fire. According to the severity of the index wards 43, 42, 45, 44 and 46 can be ranked in that order Figure 5.1 show the ward wise indices of fire item.

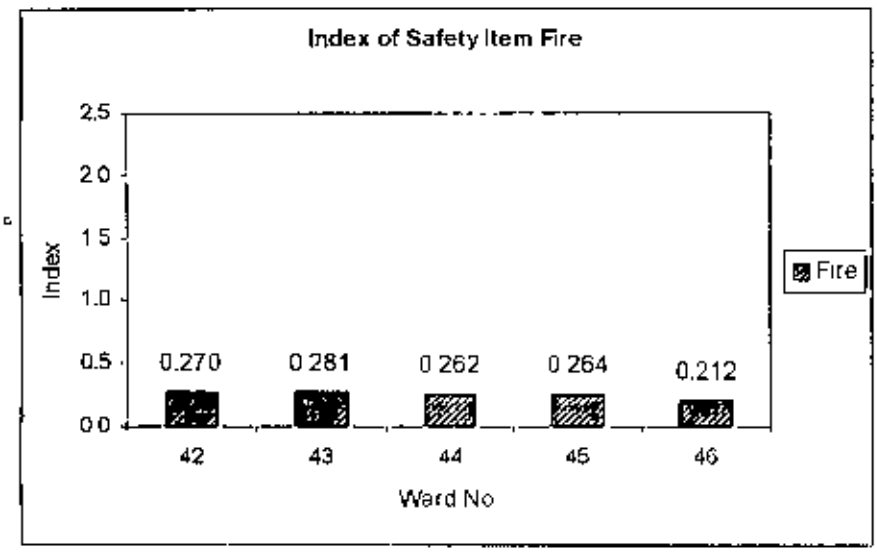


Figure 5.1: Ward Wise Indices of Safety Item Fire.

Traffic Accident: Regarding traffic accidents ward 45 is relatively more vulnerable. According to the severity of the index 45, 44, 43, 42, 46 respectively can be ranked in that order. Figure 5.2 show the ward wise indices of traffic accident item.

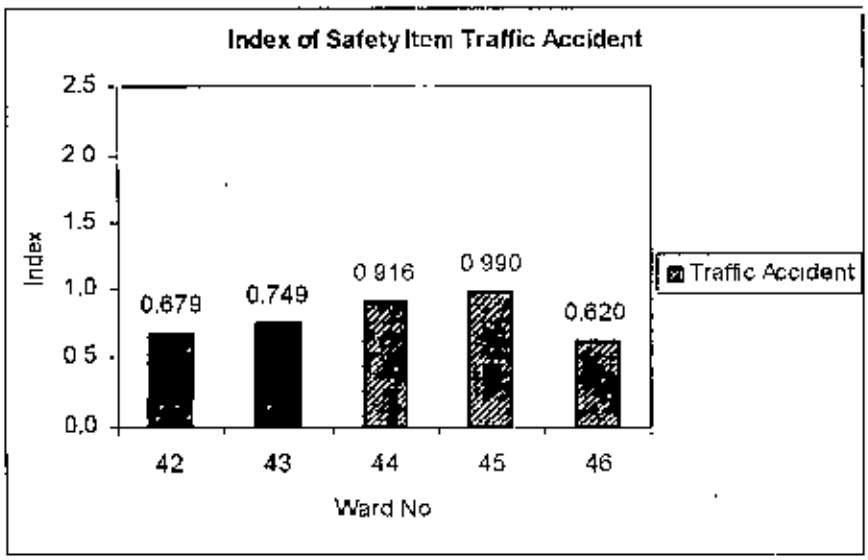


Figure 5.2: Ward Wise Indices of Safety Item Traffic Accident.

Crime: Crime has the most relative prominence in Ward 46 because most of the area of this ward is khas land and people live in this area in unauthorized slums and squatters. According to this item Wards 46, 45, 43, 44 and 42 are crime prone in that order Figure 5.3 shows the ward wise indices of crime.

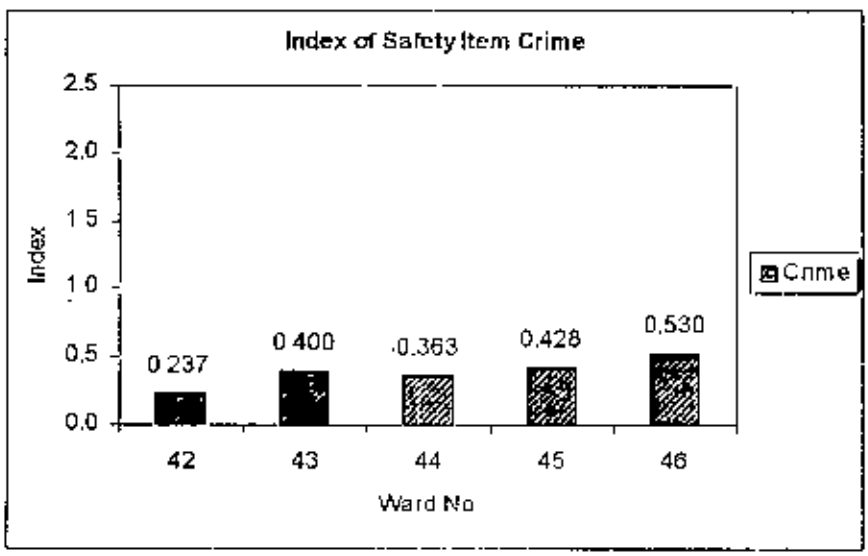


Figure 5.3 Ward Wise Indices of Safety Item Crime.

Urban Utilities: The condition of urban utilities in Ward 42 is relatively worse because of the Geneva Camp, where Pakistani refugees drink unsafe water Ward 45 is least vulnerable in this respect. Figure 5.4 shows the ward wise indices of urban utilities

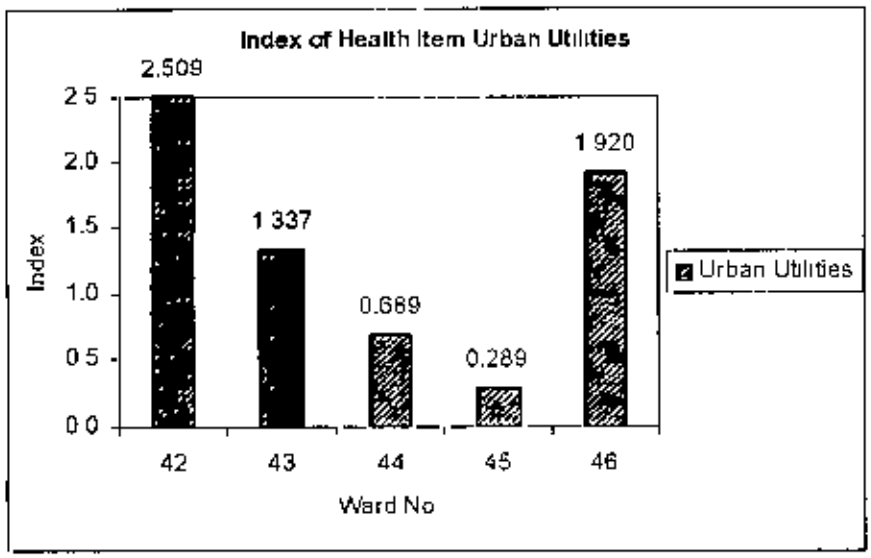


Figure 5.4: Ward Wise Indices of Health Item Urban Utilities.

Health Hazard: Regarding hazard Ward 43 is more vulnerable because this area has a higher ratio of slum area. Figure 5.5 show the ward wise indices of health item hazard.

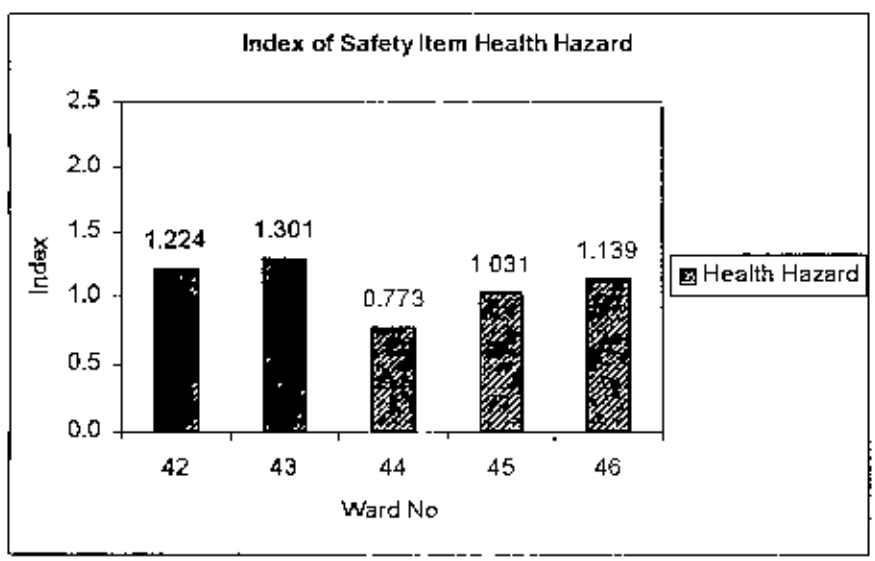


Figure 5.5 Ward Basis Indices of Health Item Health Hazard

Health Care Facilities: Considering health care facilities Ward 45 has the lowest index and ward 46 has the highest index. At ward 46, the situation of primary health facilities is most vulnerable. There are only two clinics here Otherwise, many of the clinics of Dhaka City are situated in ward 45. According to the severity of health care facilities Ward 46, 43, 44, 42, 45 are least vulnerable in that order. Figure 5 6 show the ward wise index of health item health care facilities.

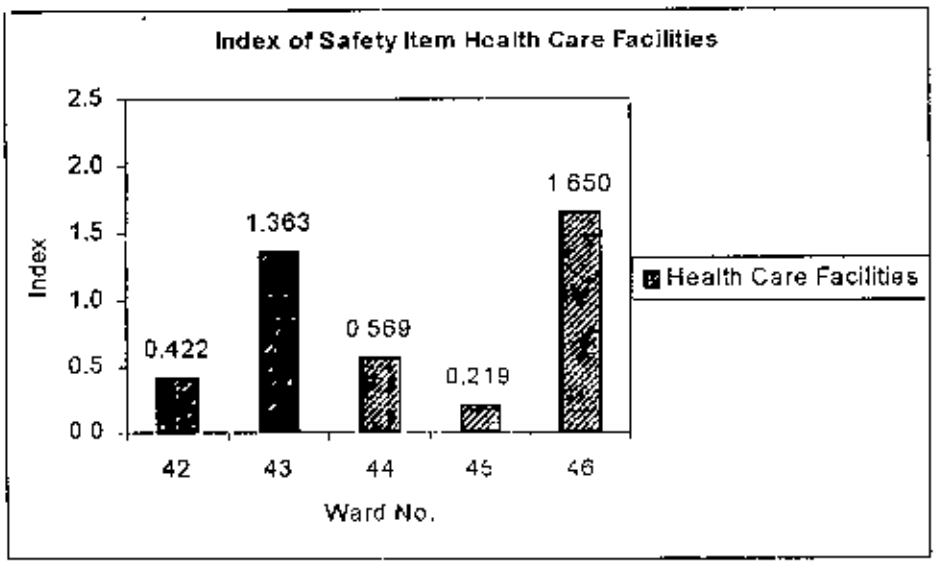


Figure 5.6: Ward Wise Indices of Health Item Health Care Facilities

Parks and Open Spaces: A high index of parks in Ward 46 was found According to the analysis all wards has almost the same area of parks and open spaces. Figure 5.7 shows the ward wise indices of parks and open spaces

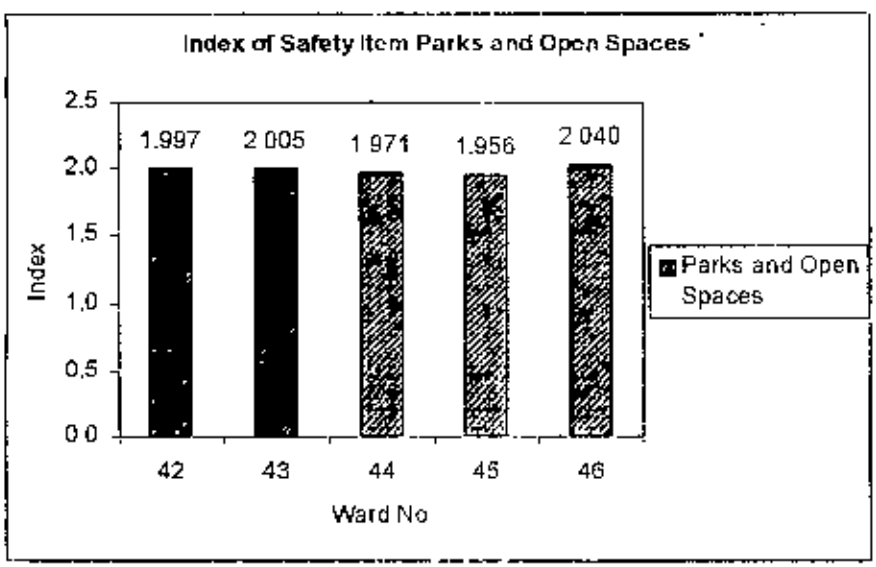


Figure 5.7: Ward Basis Indices of Health Item Parks and Open Spaces

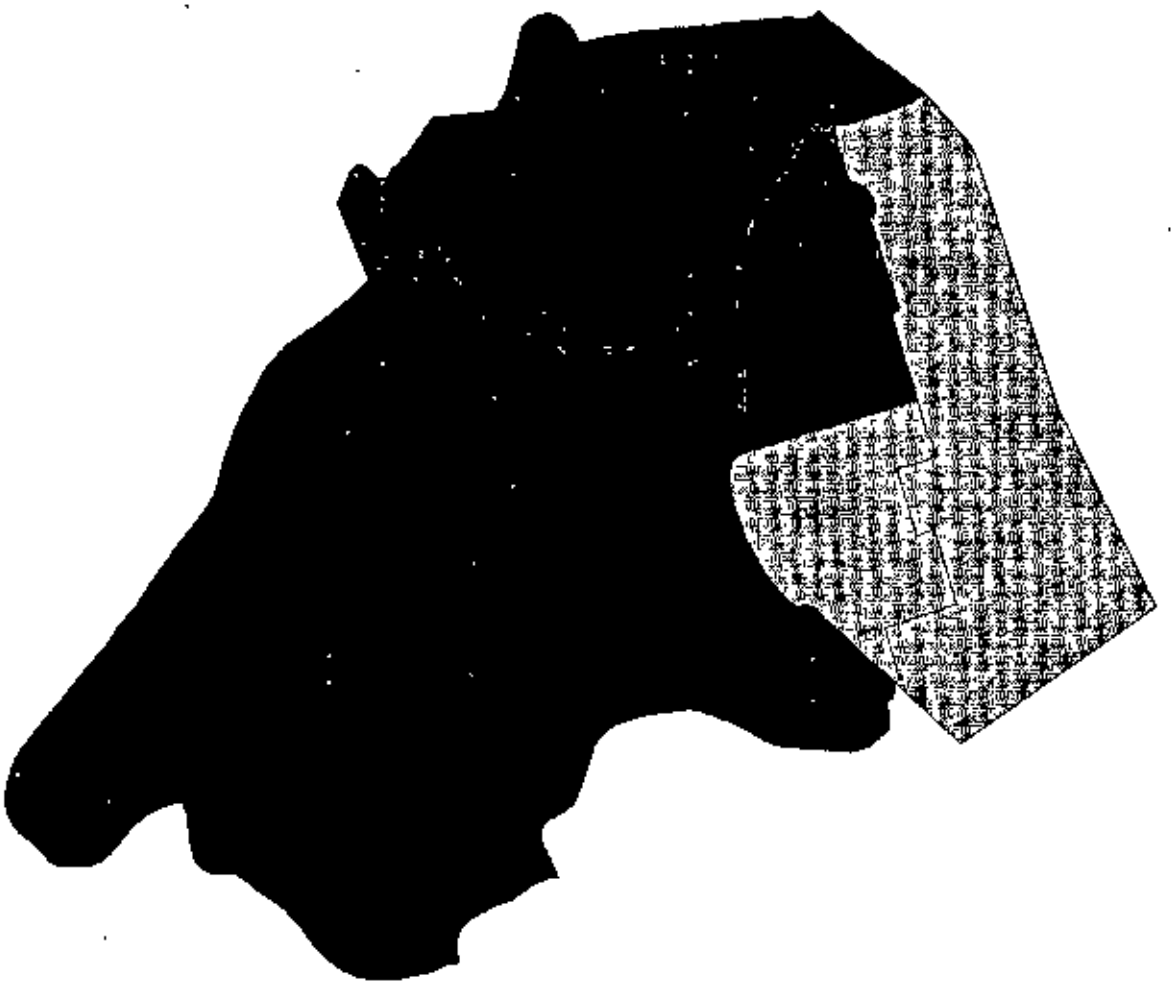
5.4 THE COMPREHENSIVE INDICATOR

The comprehensive indicator is found by summing up the weighted scores for all items. In this analysis each indicator i.e item and component of safety and health is assigned a score which is computed from the input indicator and multiplied by the weight of that item or component obtained from AHP. The results of the multiplication are the comprehensive indicator. The range of the comprehensive indicator is 0-10, which is subdivided into three categories by using equal interval scale. The living environment is considered better if the indicator is between 0 and 3.3, moderate if the indicator is above 3.3 and 6.6 and worse if the indicator lies above 6.6 and 10. The comprehensive indices for the five wards are shown in Table 5 15 It is seen ward 42, 43 and 46 has high index values. The comprehensive indicator of living environmental quality is shown in Map 5 3

Table 5.15: The Comprehensive Indicator of Five Wards

Ward No.	Comprehensive Indicator	Category
42	7 338	Worse
43	7.436	Worse
44	5.543	Moderate
45	5.178	Moderate
46	8.111	Worse

Map 5.3 Comprehensive Indicator of Urban Living Environment of Mohammadpur Thana



0.2 0 0.2 0.4 Kilometers

N

LEGEND
Worse
Moderate
Better

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY OF THE FINDINGS

The present research was exploratory in nature The aim was to investigate the perception of the residents regarding their living environment. Analytical Hierarchy Process (AHP) was applied to find out the weightage of the factors that influence the living environmental quality according to the relative degree of influence as perceived by the residents. Multicriteria methodology was used to develop a comprehensive index of living environment quality. Using a weighted factor method, each factor was assigned a score, which was multiplied by the weight of that factor. The results of the multiplication were added and a composite score was determined.

6.2 OBSERVATIONS FROM THE AHP MODEL

Evaluation of safety and health are usually static while the urban environment changes dynamically day by day The residents of the Mohammedpur area considered health to be the more important of the two standards–health and safety–that are in turn composed of different items. Findings from the AHP model also indicate that regarding safety, traffic accident is the most important factor influencing the quality of living environment Fire and crime have been given the same importance in determining the quality of living environment. Considering health, urban utilities were given the highest importance and parks the lowest. Hazard and hospitals were in second position

In the ward wise analysis, it appears that that the perception of residents regarding the relative importance of factors that affects the living environment is to some extent moulded by the pressing problems they face in their environment. It was seen that among residents of ward 42 urban utilities seemed to be the most important item that affects the quality of living environment. 5 27 percent people of this ward drink pond and river water (see Table 5.10) which is highest among the five wards. Also, 34.83

percent of households in this ward use unsanitary or defecate in the open (see Table 5.9). This rate is second highest among the five wards. It was also seen that fire was the least important item affecting the living environmental quality in the same ward. As for ward 43, it was seen that parks were given the most importance as a factor of the living environmental quality. In this ward the total area is 1.818 sq. km. and the total park/open space area is 0.033 sq. km., the second lowest ratio among the five wards (see Table 5.14) Hazard is the most important item in ward 44 affecting the living environmental quality. The ratio of slums and commercial area is high in this ward. The total area in this ward is 0.565 sq. km. and the total commercial area and slum area are 0.06 sq. km. each. Urban utilities have been given top priority possible due to a lack of drains. The total road length in Ward 45 is 28.191 km. and the length of drains is only 7 km. Fire has been given less priority in ward 45. Urban utilities have been given the highest importance in ward 46 possible due to low ratio of drains. The total length of road in this ward is 17.06 km. but there are only 3.07 km. of drained. Also, fire and crime have been given less importance in ward 46. In this ward the ratio of kutcha houses is comparatively low (see Table 5.1) Also, there is a relatively lower ratio of narrow roads in this ward.

6.3 OBSERVATIONS FROM THE MULTICRITERIA METHODOLOGY

Multicriteria methodology was applied to identify the composite indices of living environmental quality. When analyzed ward wise, the severity of input indicator of different items and component and indices that affect living environmental quality was obtained.

6.3.1 Indices

Fire

Item fire has three components namely conflagration, avoiding and fire fighting. Conflagration has two input indicators–ratio of kutcha houses and density of houses. Ratio of kutcha houses is high in ward 42 and lower in ward 44. Density of houses is high in ward 44 and lower in ward 46. Also avoiding has two input indicators–ratio of safe zones and distance to water bodies. Ward 44 has the least ratio of safe zones and ward 46 has a high ratio of safe zones. Ward 42 and 43 have the same ratio of safe

zones Finally, fire fighting has two input indicators–ratio of narrow roads and distance to fire station. Ratio of narrow roads is high in ward 46 and low in ward 45. Ward 43 is more vulnerable in respect to fire.

Traffic Accident

Item traffic accident has two components that is street light and traffic. Number of street light alone unit of road is the only input indicator of street light. Ward 43 and 45 have low density of street lights, ward 42. 44 and 46 are in a better position but not at all at a satisfactory level. Input indicator of traffic is volume of traffic at major intersections. Traffic volume is high in ward 45 because most of the major roads pass through this ward. Traffic volume is lower in ward 46, most of the roads of this ward are narrow and encroached upon by slums, peddlers and shop keepers. Regarding traffic accident, ward 45 is more vulnerable.

Crime

Crime has no component, the only input indicator of crime is rate of crime per year. Crime rate is high in ward 46 and lower in ward 42. Crime is most prominent in ward 46 because most of the area of this ward is khas land and many slums and squatters settlements have sprung up here.

Urban Utilities

Sanitation and water supply are the two components of urban utilities. The ratio of drainage area and the ratio of people using sanitary latrine are the two input indicators of sanitation. The ratio of people drinking supply/tubwell water is the only input indicator of water supply. A higher ratio of people in ward 46 uses unsanitary latrines According to the severity of sanitation, wards 46, 42, 43, 44 and 45 can be ranked in that order. A lower ratio of people use unsanitary latrines in ward 45. The condition of urban utilities in ward 42 is more vulnerable because some portion of the people of this area live in Geneva Camp, where Pakistani refugees are permanently settled and drink unsafe water Also most of the people have no sanitary toilet facilities in this area. Ward number 45 is the least vulnerable in this respect. A low index of urban utilities was found in ward 45 because of it being a planned area with better sanitation and water supply system

Health Hazard

Contagion and Noise are the two components of hazard. The ratio of slum area is the only component of contagion. Ratio of commercial area is the component of noise The highest ratio of slum area was found in ward 46. According to the severity of slum area ward 46, 43, 42, 45 and 44 can be ranked in that order. Ward 46 has a low and ward 42 has a high ratio of commercial area. According to severity of commercial area ward 42, 44, 45, 43 and 46 can be ranked in that order. Ward 42 is the most vulnerable in respect to health hazard because Mohammedpur Krishi Market is situated in this area and most of the people gather here for shopping.

Health Care Facilities'

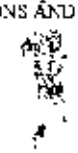
Health care facilities and persons/bed ratio are the two input indicators of primary health care facilities Considering health care facilities in ward 46, the situation is most vulnerable because there are only two clinics here According to the health care facilities, 46, 43, 44, 42, 45 have the least number of clinics and the highest ratio of persons to bed Ward 46 is the most vulnerable because this ward has few health care facilities, Ward 45 is least vulnerable because many of the clinics of Dhaka City are situated in ward 45

Parks and Open Spaces

Park and open space have no component, it has only one input indicator, namely ratio of parks and open spaces in a particular ward. Ward 45 has highest ratio of park and open space and has lower ratio of park and open space at ward 46. Ward 46 is the most vulnerable regarding park and open space because of the lower ratio of park and open space. Ward 42 is in second position Ward 45 is in good position and the living environmental quality is better in this ward.

6.3.2 Comprehensive Indicator

A comprehensive indicator of quality of living environment was determined with Multi-criteria Methodology. The range of the indicator is 0 to 10, with a lower value indicating a better quality. This range was arbitrarily subdivided into three qualitative categories' better (0 to 3 3), moderate (>3 3 to 6 6), worse (>6.6 to 10) Variation of



the index values was rather limited probably due to the selection of five contiguous wards More variation could possibly be found if wards from different parts of Dhaka City were considered According to this analysis Ward 44 and 45 were found to have a moderate quality of living environment while Wards 42, 43 and 46 had worse environment. None of the wards had a better environment

6.4 RECOMMENDATIONS

The city faces environmental problems which affect the quality of living environment. Residents of the area are more aware of the nature and extent of the problem that they are confronted with, and their input would give a solid base for an indicator for evaluating the living environment of the city. Also it is necessary to understand these types of problem from the perspective of the affected people who are the users of the environment. To address the particular environmental problems of an area, the opinion of residents of the area must be incorporated into the planning process. The people of the area can properly assess living environmental quality. Without participation of the residents of the area no planning will be appropriate for improving the living environment.

Urban living environment is a complex system composed of not only physical elements such as water quality or air quality but also other planning parameters such as road width, traffic volume etc. For the improvement of the living environmental quality, one must consider the planning parameters that affect the environment for living The priorities can be set with input from residents

Lastly, the research has studied only safety and health, two fundamental standards of living environment, but other standards such as comfort, convenience and persistence were not considered due to limitation of time and resources. Also due to limitation of time and resources, as well as paucity of data, environmental evaluation indicators beyond seven items and nine components were not considered. Further studies can be done incorporating more standards, items, components and input indicators.

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APPENDIX A

Questionnaire for Residence

Sl. No.....

Name of the interviewer:..... Signature..... .... Date ... .

General information about the Respondents **Please tick the appropriate choice (✓)**

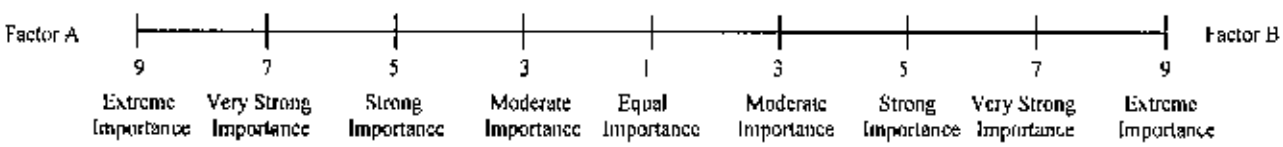
Age Group (yrs.)	Sex	Education Level	Occupation
☐ 1 = 0-14 ☐ 2 = 15-29 ☐ 3 = 30-45 ☐ 4 = 46-60 ☐ 5 = 60+	☐ M = Male ☐ F = Female	☐ 1. Primary ☐ 2. Secondary (H.S.C) ☐ 3. Higher Secondary (H.S.C) ☐ 4. Degree and Above ☐ 5. Technical Education ☐ 6. Illiterate ☐ 7. Others	☐ 1. Service ☐ 2. Business ☐ 3. Student ☐ 4. House wife ☐ 5 Worker (All type) ☐ 6. Retired ☐ 7. Others

Pairwise Comparison

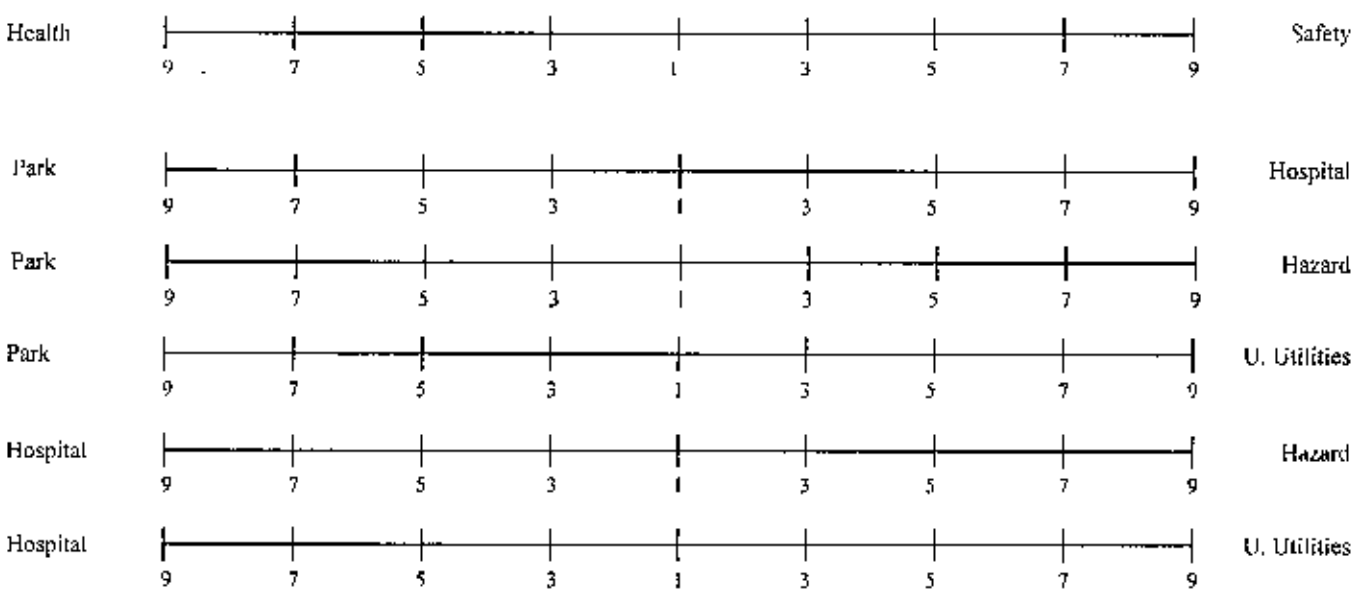
Different factors influencing your quality of living environment

You have to compare between two different factors and give a tick (✓) mark in the proper place considering which factor affects your living environment more according to your opinion.

As for example



What is the comparative effect of the following pair of standards on the quality of the living environment?



What is the comparative effect of the following pair of items on the quality of the living environment?

Hazard — U. Utilities

What is the comparative effect of the following pair of component considering hazard on the quality of the living environment?

Noise — Contagion

9 7 5 3 1 3 5 7 9

What is the comparative effect of the following pair of component considering urban utility on the quality of the living environment?

W. Supply — Sanitation

9 7 5 3 1 3 5 7 9

What is the comparative effect of the following pair of component considering safety on the quality of the living environment?

Crime — T. Accident

9 7 5 3 1 3 5 7 9

Crime — Fire

9 7 5 3 1 3 5 7 9

T. Accident — Fire

What is the comparative effect of the following pair of component considering traffic accident on the quality of the living environment?

Traffic — S. Light

What is the comparative effect of the following pair of component considering fire on the quality of the living environment?

F. Fighting — Avoiding

F. Fighting — Conflagration

Avoiding — Conflagration

If you think that there are other factors that affect your living environment, please specify.

.....

.....

What is your opinion about how to improve the quality of the living environment?

.....

.....

.....

APPENDIX B

List of Hospital and Clinic in Mohammadpur Thana

Ward No.	Name of Hospital	Bed No.	Cabin No.	Total
42	1. Janseba Clenic Road No 1, Shamoli, Dhaka	9	4	13
	2. Rog Mukti Hospital Road No. 2, Shamoli, Dhaka	3	2	5
	3. Samiya Nursing Home Madrasha Road, Aziz Mohallah 4/15, Block- F, Joint Quater, Dhaka	8	4	12
	4. Shamoli Orthopedic & General Hospital (Pvt.) Ltd. 3/A, Piciculture Housing Society, Ring Road, Shamoli, Dhaka	9	1	10
43	1. Al-Madina General Hospital 2/A, Golden Street, Ring Road Shamoli, Dhaka	9	3	12
	2. Haifia General Hospital (Pvt.) Ltd. 1/A, North Adabar,	8	4	12
	Commissioner Road, Dhaka	8	7	15
	3. Dhaka Authropedic Hospital House No. 843 Baitulaman Housing Society, Dhaka			
44.	1 Shahid Park Clinic 16/14, Azam Road,	8	0	8
	Mohammadpur	20	4	24
	2. Basundhara Hospital ¾, Block-D, Lalmatia	6	0	6
	3. Tanu Clenic 75/C, Asad Avenue	5	0	5
	4 Rahamania Clenic 38, Shersha Suri Road	20	4	24
	5. Mohammadpur Nursing Home N/24, Nurjahan Road,			
	Dhaka.	16	4	20
	6. Anirban Hospital 22/18, Shahajan Road,			
	Mohammadpur, Dhaka.	4	0	4
	7. Banu Clenic Asad Avenue, Mohammadpur, Dhaka.			
45.	1. Alberinue Hospital 23/1, Khilji Road, Mohammadpur	6	0	6
	2. City Medical Centre 2/24, Babar Road Mohammadpur	12	3	15
	3. Shava Nursing Home 19/10, Babar Road Mohammadpur	20	5	25

	4.	Tanjia Polly Clinic 22/12, Kilzi Road Block-B, Lalmatia	9	0	9
	5.	Anriban Nursing Home 14/19, Shahjan Road Mohammadpur	10	0	10
	6.	Shahjalal Polly Clenic 23/14, Khilji Road,	10	0	10
	7.	Avenue Medical Centre 2/5, Lalmatia Block-A, Road-5	10	0	10
	8.	Al Makarjun Islam Hospital House-29, Road-3	12	2	14
	9.	BDF Hospital 5/17, Humaiun Road	10	2	12
	10.	Al-Magribi Eye Hospital House No. 1/9, Lalmatia	11	2	13
	11.	Cresent Hospital and Diagnostic Centre 22, Babar Road	20	4	24
	12.	Technorient Ltd. 7/9, Sir Syed Road, Mohammedpur	10	4	14
	13.	Rahamina Clenic 38, shersha Suri Road, Mohammedpur	3	0	3
	14.	Al-Care Health Centre 4/3, Sathmosque Road Mohammedpur	10	2	12
	15.	Al-Manar Hospital Block- A, Lalmatia, Dhaka.	12	2	14
46.	1.	Mohammadi Hospital 2, Mohammadi Prodhan Sarak. Mohammadi Housing Ltd. Mohammadpur, Dhaka.	5	0	5
	2.	World Concern Health Project H-33, Rd.-2, Mohammadi Housing Society, Mohammadpur, Dhaka	12	0	12

Source: Particulars of Private Health Care and Medical Education Institutions, WHO and DGH, 1999 and field Survey, 1999.

Value of Input Indicator

A. Ratio of Kutcha Houses

Ward No.	Total Pop"	Kutcha Houses	Pucca Houses	Total	Ratio of Kutcha Houses	Composite Score
42	18337	3983	2144	6127	65.01	10.00
43	57769	4492	2632	7124	63.05	9 70
44	56267	3550	5255	8805	40.32	6.20
45	45443	3766	3210	6976	53.98	8.30
46	30479	2434	1420	3854	63.16	9.72

Source: BBS Community Series Data, 1991

B. Density of Houses

Ward No.	Area in km².	Kutcha Houses	Pucca Houses	Total	Density of Houses	Composite Score
42	0.621	3983	2144	6127	9866.34	6.33
43	1 818	4492	2632	7124	3918.59	2.51
44	0 565	3550	5255	8805	15584.07	10.00
45	1.482	3766	3210	6976	4707.15	3.02
46	5.360	2434	1420	3854	719.03	0.46

Source: BBS Community Series Data, 1991

C. Ratio of Safe Zones

Ward No.	Total Area (sq.km.)	Total area of Safe Zone (sq.km)	Ratio of Safe Zone
42	0.621	0.033	0.053
43	1.818	0.097	0 053
44	0.565	0.005	0.009
45	1.482	0.017	0.011
46	5.360	4.388	0.819

Source. GIS Landuse Map, 1999.

Ward No.	Total Area (sq.km.)	Total area of Safe Zone (sq.km)	Total Vulnerable Zone (sq.km)	Ratio of Vulnerable Zone	Composite Score
42	0.621	0.033	0.588	0.947	9.55
43	1.818	0.097	1 721	0.947	9.55
44	0 565	0 005	0.560	0.991	10.00
45	1.482	0.017	1.465	0.989	9.98
46	5.360	4.388	0 972	0 181	1.83

Source GIS Landuse Map, 1999.

D. Distance to Water Bodies

Ward No.	Total Area (sq.km.)	Distance from Water Bodies	Composite Score
42	0.621	0.140	1.49
43	1.818	0.670	7.13
44	0.565	0.160	1.70
45	1.482	0.940	10.00
46	5 360	0.000	0 00

Source: GIS Landuse Map, 1999.

E. **Distance to Fire Station**

Ward No.	Total Area (sq.km.)	Distance from Fire Station	Composite Score
42	0.621	2.150	5.97
43	1.818	3.600	10.00
44	0.565	1.410	3.92
45	1.482	1.090	3.03
46	5.360	2.290	6.36

Source: GIS Landuse Map, 1999

F. **Ratio of Narrow Roads**

Ward No.	Total Area (sq. km.)	Total length of Road (km.)	Total length of narrow road (km.)	Ratio of Narrow Roads	Composite Score
42	0.621	0.016	0.001	6.25	3.54
43	1.818	0.025	0.002	8.00	4.53
44	0.565	0.015	0.001	6.67	3.78
45	1.482	0.028	0.002	7.14	4.05
46	5.360	0.017	0.003	17.65	10.00

Source: GIS Landuse Map, 1999.

G. **Density of Street Light**

Ward No.	Length of Road (km.)	Number of Street Light		Total	Density of Street Light (# of Lump Post per km road)	Composite Score
		Tube Light	Sodium Light			
42	16.419	390	178	568	0.03	10.00
43	25.129	560	-	560	0.02	6.67
44	15.221	335	68	403	0.03	10.00
45	28.191	481	103	584	0.02	6.67
46	17.064	412	49	461	0.03	10.00

Source GIS Landuse Map, 1999.

Ward No.	Length of Road (km.)	Number of Street Light		Total	Low Density of Street Light per km.	Composite Score
		Tube Light	Sodium Light			
42	16.419	390	178	568	0.97	09.90
43	25.129	560	-	560	0.98	10.00
44	15.221	335	68	403	0.97	09.90
45	28.191	481	103	584	0.98	10.00
46	17.064	412	49	461	0.97	09.90

Source: GIS Landuse Map, 1999.

H. Traffic Volume at Major Intersection

Ward No.	Name of the Intersection	Total Ave. Hour	Ave. PCE	Composite Score
42	Mirpur Rd- Agargoan Rd. Dhanmondi 16- Shatmsjid Rd.	800	3952.5	7.08
43	Mirpur Rd- Agargoan Rd. Dhanmondi 16- Shatmsjid Rd.	800	3952.5	7.08
44	Mirpur Rd- Asedgate Rd. Dhanmondi 16- Shatmsjid Rd.	800	5377.0	9.63
45	Mirpur Rd.- Manik Mia Avenue Dhanmondi 16- Shatmsjid Rd.	800	5583 5	10.00
46	Dhanmondi 16- Shatmsjid Rd. Mirpur Rd- Asedgate Rd.	800	3281 0	5 88

Source: DITS study, 1996

I. Ratio of Crime Per Year (Reported Crime)

Ward No.	Rate of Crime Per Year	Composite Score
42	27	4.74
43	43	7.54
44	39	6.84
45	46	8.07
46	57	10.00

Source: Mohammadpur Thana, 1999.

J. Ward Basis Length of Drainage Area

Ward No.	Length of Road (km.)	Length of Drainage (km.)		Total (km.)	Ratio of Drainage Considering Length of Road	Composite Score
		Surface/Open	Pipe Line (450MM-900MM)			
42	16.419	6.96	2 88	9.84	0.59	06.48
43	25 129	1.09	2 87	3.96	0.16	01.76
44	15.221	7.29	6.60	13 89	0.91	10.00
45	28.191	5.25	1.75	7.00	0.25	02.75
46	17 064	0.48	3.07	3.55	0.21	02.31

Source: City Corporation Zonal Office, 1999.

K. Ratio of People Using Unsanitary Latrine

Ward No.	Total Household	Toilet Facilities		Ratio of Household Using Unsanitary/No. Latrine	Composite Score
		Sanitary	Unsanitary/No		
42	6127	3993	2134	34.83	8.08
43	7124	4981	2143	30.08	6.98
44	8805	7512	1293	14.21	3.30
45	6976	6640	366	5.24	1.22
46	3854	2193	1661	43 10	10.00

Source. BBS Community Series Data, 1991

L. **Ratio of People Drinking Pond/River Water**

Ward No.	Total Household	Source of Drinking Water		Ratio of Household Drinking Pond/River Water	Composite Score
		Supply/Tubwell	Pond/River		
42	6127	5795	323	5.42	10.00
43	7124	7018	106	1.49	2.75
44	8805	8676	129	1 47	2.70
45	6976	6943	33	0.47	0 87
46	3854	3771	83	2.15	3.97

Source: BBS Community Series Data, 1991

M. **Ratio of Slum Area**

Ward No.	Total Area (sq.km.)	Total Slum Area (sq.m.)	Ratio of Slum Area	Composite Score
42	0.621	0.015	2 415	05.49
43	1.818	0.080	4.400	10.00
44	0.565	0.003	0.531	01.21
45	1.482	0.033	2.227	05.06
46	5.360	0.218	4.067	09.24

Source: GIS Landuse Map, 1999.

N. **Ratio of Commercial Area**

Ward No.	Total Area (sq.km.)	Total Commercial Area (sq.m.)	Ratio of Commercial Area	Composite Score
42	0.621	0.086	13.849	10.00
43	1 818	0 074	04.070	2.94
44	0.565	0.056	09.912	7.16
45	1.482	0.123	08.300	5 99
46	5.360	0.027	00.504	0.36

Source: GIS Landuse Map, 1999.

O. **Primary Health Care Facilities**

Ward No.	Total Pop"	Number of Hospital & Private Clinic	Number of Bed and Cabin	Person per Bed	Composite Score
42	18337	4	40	458.425	2.56
43	57769	3	39	1481.256	8.26
44	56267	7	91	618.319	3.45
45	45443	15	191	237.921	1.33
46	30479	2	17	1792.882	10.00

Source: GIS Landuse Map, 1999

P. **Ratio of Park and Open Space**

Ward No.	Total Area (sq.km.)	Total Park/Open space (sq.km.)	Ratio of Park and Open Space	Composite Score
42	0.621	0.014	2.227	05.27
43	1.818	0.033	1 794	04 24
44	0.565	0.020	3.465	08.20
45	1.482	0.063	4.227	10.00
46	5.360	0.008	0.158	00.37

Source: GIS Landuse Map, 1999.

Ward No.	Total Area (sq.km.)	Total Park/Open space (sq.km.)	Ratio of other Area (Accept Park and Open Space)	Composite Score
42	0.621	0.014	97.746	9.79
43	1 818	0.033	98.185	9 83
44	0.565	0.020	96.46	9.66
45	1 482	0.063	95.749	9 59
46	5.360	0.008	99.851	10 00

Source: GIS Landuse Map, 1999.

Calculation of Value of Items and Components

APPENDIX- D

ITEMS OR COMPONENTS	Ward Number														
	WARD 42			WARD 43			WARD 44			WARD 45			WARD 46		
	Weight	Value	Index	Weight	Value	Index	Weight	Value	Index	Weight	Value	Index	Weight	Value	Index
Components of Fire															
Conflagration	0.018	8.165	0.147	0 018	6.105	0 110	0.018	8.100	0.146	0 018	5.660	0.102	0 018	5.090	0.092
Avoiding	0.012	5.520	0.066	0.012	7.040	0 084	0.012	5.850	0.070	0.012	9.990	0.120	0 012	1.830	0.022
Fire Fighting	0 012	4.750	0.057	0.012	7.260	0.087	0.012	3.850	0.046	0 012	3.540	0.042	0.012	8.180	0.098
Components of T. Accident															
Street Light	0.021	6.020	0.126	0 021	9.350	0.196	0.021	7.870	0.165	0.021	10.000	0.210	0.021	7.710	0.162
Traffic	0.078	7.079	0.552	0 078	7.079	0.552	0.078	9.630	0.751	0.078	10.000	0.780	0.078	5.876	0.458
Items of Crime															
Crime Rate	0.053	4.470	0.237	0.053	7.540	0.400	0.053	6.840	0.363	0.053	8.070	0 428	0.053	10.000	0.530
Components of Urban Utilities															
Sanitation	0 136	8.080	1.099	0.136	6.980	0.949	0.136	3 300	0.449	0 136	1.220	0.166	0.136	10.000	1.360
Water Supply	0 141	10.000	1.410	0.141	2.750	0 388	0.141	1 700	0.240	0.141	0.870	0.123	0.141	3.970	0.560
Components of Health Hazard															
Contagion	0.079	5 490	0.434	0 079	10.000	0.790	0.079	1.210	0.096	0.079	5.060	0.400	0.079	9.240	0.730
Noise	0.079	10 000	0.790	0.079	6.470	0.511	0.079	8.580	0.678	0.079	7.995	0.632	0 079	5.180	0.409
Items of Hospital															
Health Care Facilities	0.165	2 560	0.422	0.165	8.260	1.363	0.165	3.450	0 569	0.165	1.330	0.219	0.165	10.000	1.650
Items of Parks and Open Spaces															
Parks and open spaces	0.204	9.790	1.997	0.204	9.830	2.005	0.204	9.660	1.971	0.204	9.590	1.956	0.204	10.000	2.040
COMPREHENSIVE INDICATOR			**7.338**			**7.436**			**5.543**			**5.178**			**8.111**