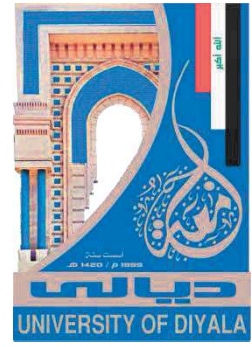


Republic of Iraq  
Ministry of Higher Education and  
Scientific Research  
University of Diyala  
College of Engineering



# **ALTERNATIVES EVALUATION AND OPTIMIZATION OF SUSTAINABLE URBAN PLANNING PROJECTS**

**A Thesis**

**Submitted to the Council of College of Engineering University  
Of Diyala in Partial Fulfillment of the Requirements for the  
Degree of Master of Science in Civil Engineering**

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**October 2016 A.D.**

**IRAQ**

**Muharram1438 A.H.**

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سورة المجادلة

الآية ( ١١ )

## Certification

I certify that the thesis entitled “**Alternatives Evaluation and Optimization of Sustainable Urban Planning Projects**” was prepared by "**Aya Ali Hasan**" under our supervision at the Department of Civil Engineering in the College of Engineering / University of Diyala in partial fulfillment of the Requirements degree of Master of Science in Civil Engineering.

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# Certification of Examining Committee

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We certify that we have read the thesis titled (**Alternatives Evaluation and Optimization of Sustainable Urban Planning Projects**) and we have examined the student (**Aya Ali Hasan**) in its content and what is related with it, and in our opinion it is adequate as a thesis for the degree of Master in Civil Engineering.

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## **Dedication**

**I dedicate this research to;**

**My Dear Father;**

**His words of inspiration and encouragement in pursuit of excellence.**

**My Affectionate Mother;**

**Whose prayers and love took me to zenith of glory and transform my dreams into reality.**

**My Brothers and Sister;**

**Who have always encouraged and supported me for further study.**

**The Researcher**

## **Acknowledgments**

I would like to express my deepest thanks and gratitude to my supervisors Prof. Dr. Walid Mustafa khamas and Asst. Prof. Dr. Hafeth Ibrahim Naji. Through their vast experiences in this field of study, they have offered a valuable time, expertise, guidance, and encouragement.

I also would like to acknowledge the Department of Civil Engineering and Engineering College – University of Diyala and Administrative Assistant to the President of Diyala University Prof. Dr. Amer Mohammed Ibrahim and Staff of Engineering Consultative Office – University of Diyala for their generous assistance. Thanks for all of the support that they have offered to me.

Thankfulness and grateful indebtedness to Directorate of Urban Planning, Diyala Governorate, Directorates of Muqdadiyah , especially Directorate of Muqdadiyah Municipality, Directorate of Diyala environment and Centre of Urban and Regional Planning -University of Baghdad for their readiness to help, support and understanding.

## ABSTRACT

### "Alternatives Evaluation and Optimization of Sustainable Urban Planning Projects"

The urban planning is guide the growth of cities, re-structure and planning in terms of identifying positions, areas, densities for construction, infrastructure and public services in a integrated way, so that leads to solve the problems of cities. In addition to the integration of sustainable development with urban planning to result the sustainable urban planning. The decisions of selecting amaster plan is characterized with a complex nature and unconfirmed environment to decision making, in opposition to reliance on the simple methods and and previous experience that leads to a delay time and the high cost of the decision making. So, required to use a smart and distinctive ways of making the right decisions such as FMCDM technique.

This research aims to develop a systematic framework includes the stages of preparation of the master plan, select the optimized master plan by fuzzy muilt criteria decision making techniques for forming a mathematical model of the integration of these techniques to give an accurate result.

To achieve the aim of the research, data is collected from the literature reviews , personal interviews, questionnaire with specialists in the field of urban planning and government departments concerned.

The results of data analysis for individuals of the sample to access a clear criteria , where the criteria are divided into five main criteria(land uses, economic, environmental, social and technical). Whereas, the results analysis FAHP shows that the land use criteria is the most important criteria (42.1%) for comparisons among the alternatives, because it mainly affects the possibility of implementing the optimized master plan.The

management system has been designed for the selection of the optimized master plan in. Whereas, it is based on integrated FAHP, FVIKOR and FTOPSIS techniques to select the optimized alternative, where the third alternative (A3) received the highest relative importance (70.3%). A computer program is designed to accelerate the accounts of a mathematical model which is a part an electronic questionnaire for the techniques, that makes it easier for experts through giving their opinions easily and with high flexibility.

In the end, it was reached to a set of conclusions, The management system and its program are easy to use and leads to raise the efficiency of decision-makers and reduce time and cost .And recommendations for the evaluation and selection of the optimized master plan, as well as a number of future studies are proposed.



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## LIST OF ABBREVIATIONS AND SYMBOLS

A	Alternative
AHP	Analytic Hierarchy Process
C	Criterion
FAHP	Fuzzy Analytic Hierarchy Process
FTOPSIS	Fuzzy Technique for Order Preference by Similarity to Ideal Solution
FVIKOR	Fuzzy ViseKriterijumska Optimizacija I Kompromisno Resenje
FMCDM	Fuzzy Multi-Criteria Decision Making
FPIS	Fuzzy positive ideal solution
FNIS	Fuzzy negative ideal solution
MCDM	Multi-Criteria Decision Making
NIS	Negative ideal solution
PIS	Positive ideal solution
TFN	Triangular Fuzzy Number
TFNs	Triangular Fuzzy Numbers
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
VIKOR	ViseKriterijumska Optimizacija I Kompromisno Resenje
$CC_i$	Closeness Coefficient of $i$ th alternatives
$d_i^+$	The distance of $i$ th alternative from fuzzy positive ideal solution
$d_i^-$	The distance of $i$ th alternatives from fuzzy negative ideal solution
$F_j^*$	The best values
$F_j^-$	The worst values
$l$	The smallest possible value
$m$	The most promising value
$\mu_A(x)$	The membership function that represents the value to which any Element $x$ in the fuzzy set A belongs to the fuzzy set A
$Q_i$	The distance of the $i$ th alternatives from to the ideal solution
$R_i$	The minimum individual regret (measure of $i$ th alternative to the the worst value)



$S_i$	A maximum group utility (measure of $i$ th alternative with the best value)
$u$	The largest possible value
$W_j$	Weight of the $j$ th criteria

# **CHAPTER ONE**

## **Introduction**

## Chapter One

### Introduction

#### 1.1 General

The increasing in population density in major cities around the world, especially after second World War, as well as the urbanization rates has dramatically increased after the mid-twentieth century, led to the emergence of many problems economic, social, environmental and political for cities. Thus, the role of urban planning which specialized in all aspects of the urban area is emerged and included multiple disciplines such as engineering, management, economics, the environment and other disciplines. Where prosperity of cities depends on the role of the services sector and the local government to be prepared for the growth rate for future long-term (25-30 years). So that, it combines economic development, good living conditions, sustainable infrastructure development in the a comprehensive framework through the activation of economic, environmental and social requirements of the cities. Also, finding engineering solutions for urban problems such as squatter areas, traffic crises and lack of infrastructure. The city planning is a method to solve or address the problems objectively in terms of implementation in the framework of a specific time plan, taking into account the possibilities and limitations existed in society.

The importance of this research appears in how to use the techniques and management methods in the construction of management system to prepare a master plan for the cities.

## 1.2 Research Problem

The most important decision facing the problems of choosing an optimized master plan for cities is how to evaluate the multiplicity of criteria and alternatives by decision makers, which currently rely in large part on intuition and guessing which could lead to conflict results or sometimes inaccurate.

## 1.3 Research Justifications

It can be summed up in the following:

1. Although there are some sustainability criteria for the development of cities, but there is no integrated framework for evaluating urban sustainability in Iraqi cities that can contribute to improve the sustainability of these cities.
2. Reduce the long time and high cost of selecting the optimized master plan for cities, in addition to the lack of research concerning the use of modern techniques that have a role in decision-making about this selection process.
3. There is an urgent need to manage urban land scientifically and accurately, rather than randomly change of land use to ensure increased the benefits and reduce the economic, environmental and social costs through choose the optimized master plan to achieve it.

## 1.4 Research Hypothesis

Based on the aforementioned justifications , the following hypothesis is formulated :

There is a need to design an integrated framework of sustainable urban planning, which includes a list of criteria that are taken as a basis for comparison between urban areas alternatives using a structured approach

which depends on scientific techniques which help decision-making in the selection of the optimized master plan for cities.

### **1.5 Research Objectives**

Depending on the hypothesis, there are several objectives need to be achieved, including:

1. Using management methods in urban planning to prepare the master plan for urban areas, and preparing the foundations in the development of this field in the country and governorate from scientific and practical aspects.
2. Construction of an integrated management system by the development more reliable way to organize the perceptions of decision makers by providing them with a supportive tool of the decision to address uncertainty cases, that often accompany the decisions of the committees concerned with this choice by using a mathematical model that includes the collection and integration of fuzzy multi-criteria decision making techniques the following: Fuzzy Analytic Hierarchy Process (FAHP), Fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (FVIKOR) and Fuzzy Technique Order Preference by Similarity to Ideal Solution (FTOPSIS).
3. Designing computer program that facilitate and speed up the work of the relevant government departments in the proposed management system application as well as it helps to make it easier to follow the process of planning, giving an accuracy of results, preparing various reports and sort the required information.

## **1.6 Research Methodology**

A scientific methodology that has been followed and includes two stages as follows:

### **1.6.1 Theoretical study**

The theoretical study includes the literature for the previous studies which deal with the following topics:

- a. The concepts of sustainable development and urban planning and its application in the cities.
- b. The stages of preparation of the master plan its own criteria.
- c. The tools and managerial techniques used to achieve the objectives of the research (FAHP, FVIKOR and FTOPSIS).

### **1.6.2 Field study**

The field study includes several stages:

#### **1- Field survey**

The field survey includes the following:

##### **a- A personal interviews and open questionnaire**

For the purpose of completing the information held by the researcher, personal interviews were conducted with a group consultants, managers and engineers with expertise in the field of urban planning through asking them a number of questions that are related to the topic of the research which includes access to the current reality of Diyala governorate and Al-Muqdadiyah city in particular (case study). As well as get to official documents supporting research and identifying the strengths and weakness points.

### **b- Closed questionnaire**

The questionnaire is distributed to a sample of specialists in the field of evaluating and selecting the master plan, then their responses are collected, analyzed and discussed.

### **1- Constructing a management system specialized in selecting the optimized master plan for cities**

Based on field study, a management system of selecting an optimized master plan for cities will design, to achieve the objectives of research within an accurate scientific method based on scientific techniques which help choosing the optimal alternative.

### **2- Designing a computer program to select master plan for cities**

Depending on the results obtained from the study, a program was designed (using Visual Basic 6.0) concerned with the stages of preparing a master plan and selecting optimized alternatives using fuzzy multi-criteria decision making techniques.

### **3- Evaluation of management system and computer program**

The proposed system will evaluate by presentation on a group of experts (engineers and planners) who are qualified in this area through the direct implementation of the program and through a closed questionnaire to determine the importance of the proposed system and the program and the extent of accuracy and easiness in the application and their appropriateness to local conditions of the governorate as well as the laws and regulations in force.

Figure (1.1) represents the methodology used in the research.

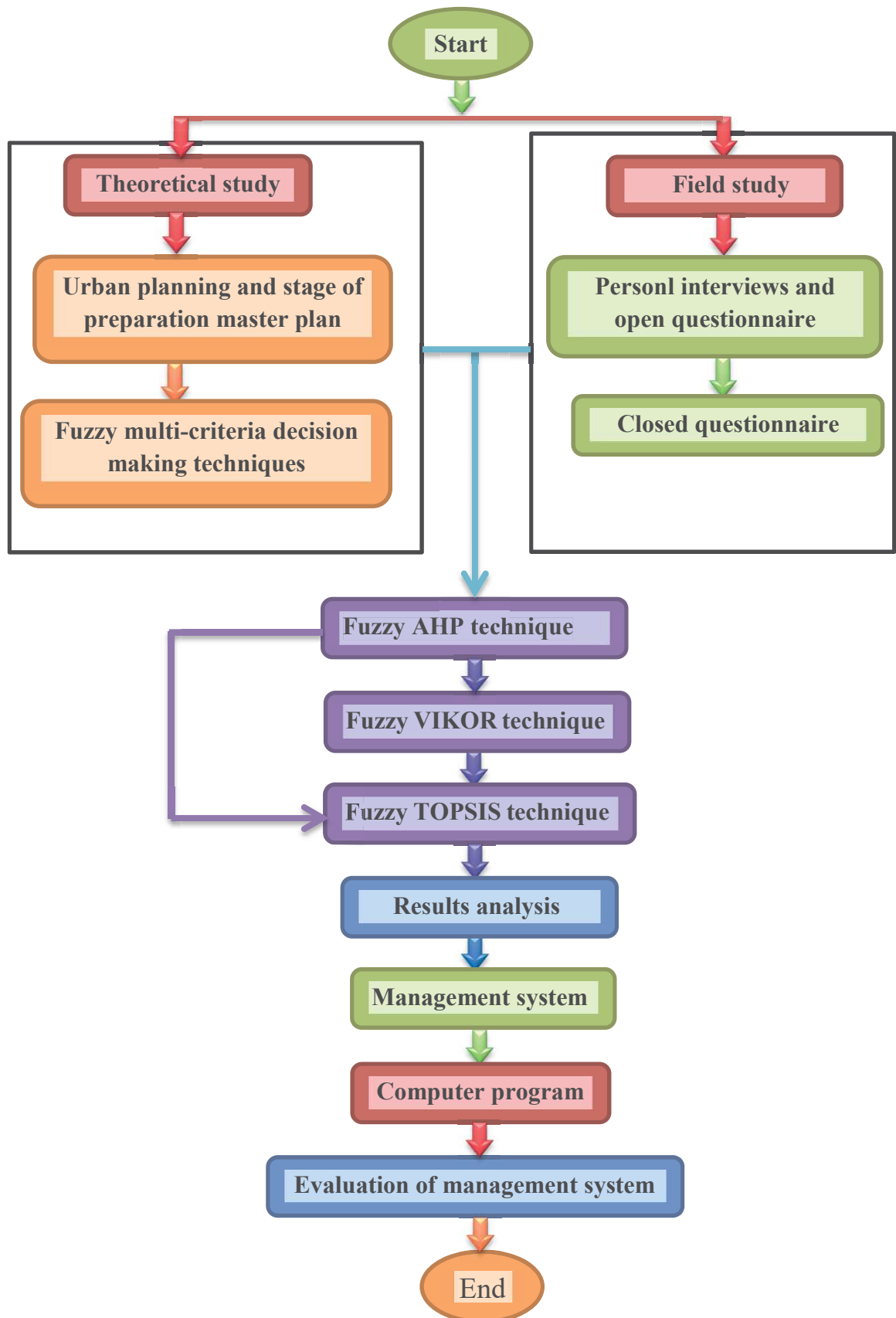


Figure (1.1): Flow chart of the methodology used in the research.

[Researcher]



## 1.7 Structure of the Thesis

Based on the aforementioned, the below structure has been adopted as follows:

1. **Chapter One:** This chapter includes a general introduction of the research, research problem, justifications, hypothesis, and also includes identifying the objectives of research, research methodology, structure of the thesis and a review of previous studies.
2. **Chapter Two:** This chapter deals with the concept of urban planning and its benefits and the stages of preparing the master plan for cities and the criteria that can be relied upon to select the optimized master plan.
3. **Chapter Three:** This chapter includes the definition of each technique in the research for decision-making and the methodology of each technique.
4. **Chapter Four:** This chapter includes field study and the various stages for conducting personal interviews and the preparation of the open and the closed of a questionnaire (electronic questionnaire) to study the selection of optimized master plan for cities and the analysis and discussion of the results obtained. Also, includes the obtain to all the data relating to case study, which is designed master plan of Al- Muqdadiyah city in Diyala governorate, also, the stages of preparing a master plan of the city as well as alternatives.
5. **Chapter Five:** This chapter deals with designing the proposed management system and the use of the program to select the master plan for the cities based on the criteria that have been identified in the previous chapters and the use of fuzzy multi-criteria decision making techniques previously mentioned that will be relied upon in the research. Also designing a computer program which helps in selecting the best alternative quickly and easily with scientific

method. The evaluation of the proposed management system and program through the direct use and questionnaire concerned with experts and users.

6. **Chapter Six:** This chapter includes a review of the conclusions obtained by the researcher with suggesting some recommendations that contribute to the application of the proposed management system as well as proposing a number of future studies.

## **1.8 Previous Studies**

### **1.8.1 Iraqi Studies**

#### **1. Kakouz (2001)**

This study deals with the concept of the master plan and the stages of preparing a master plan for the city of Baghdad, in addition to the adopted laws in the preparing and development possibilities that characterized the city. The study aims to sketch the basic trends in the preparation of the master plan for the city of Baghdad. The results of this study that the laws adopted in the preparation of the plan is an old has not kept pace with developments, which are as constraints of the master plan because affecting in terms of the shape and efficiency. The previous master plans of the city exposed to multiple problems and errors of designing, including the non-implementation of the municipality of the master plan accurately, leading to malfunction in its structure.

#### **2. AL- Daghistani (2009)**

The aim of this study is to develop a good framework for the management and development of the urban environment can be applied to the city of Baghdad. This study has been shown that a traditional way of planning is adopted in setting up master plans for the Iraqi cities, including Baghdad as well as the problems faced by the city which led to the

deterioration of the urban environment in recent decades. Where the researcher used a new method of management and planning, through the upgrading of economic, environmental and social aspects, rather than focusing on land management only.

### **3. Al-Akkam (2012)**

In this study, the researcher clarified the problem of urban regeneration of cities. The research aims to propose a way that can be done to urban regeneration for the Baghdad city by urban development through achieving environmental sustainability. Baghdad's city center is suffering from many problems such as the low level of infrastructure, traffic jams, environmental pollution and the use of non-disciplined lands. Where the results were how to get rid of the risk factors associated with the destruction of architectural heritage in the city under the pressure conversion.

## **1.8.2 International Studies**

### **1. Bolina and Zilans (2002)**

The researcher analyzed the development plans for four cities in Latvia. When comparing the development plans of the four cities according to urban sustainability, that it shows the contradiction and ambiguity because sustainability in Latvia are working out slowly. The aim of research is developing and using of sustainability criteria that can be an effective tool to promote sustainable development between the planners and the people and enhance the decision-making process. The results of this study that the municipal administration and planners lacked of knowledge criteria to measure the achievement of long-term goals for the development of cities and the principles of sustainable development. As well as the non-participation of the people in urban development plan.

## **2. Spiekermann and Wegener (2003)**

This research suggested to set up a comprehensive framework for the infrastructure especially in transport, according to the three dimensions of sustainability. Where it must provide sufficient information to assess whether using a multi-criteria analysis or cost-benefit analysis. Currently, it is being implemented the system of evaluation in seven urban areas in six European countries (Italy, Germany, Spain, Belgium, Finland, Scotland). The results of this research is to know the extent of the success of promoting sustainable urban strategies over the long term in the urban areas and the development of these areas.

## **3. Idreikh (2005)**

This study illustrated the need to preserve the environmental resources and reduce pollution. Where the aim of the study was setting up a policy and a general framework for sustainable planning in order to distribute land uses and transportation in addition to studying urban development of cities, setting up special criteria toward outdoor spaces designing, environment, movement of people, and finding out a private management of transportation with security and well system. As this study related to urban planning in terms of land use and transportation.

## **4. Adinyira et al. (2007)**

This research has been shown that how to apply sustainability in urban development where sustainability emerged in the beginnings of planning in economic and environmental terms. The aim of the research is to evaluate urban sustainability to decision making in urban development issues. So, the processing of mutual relationship among economic, environmental and social considerations in plans and projects is a major requirement for all methods of evaluation in urban sustainability. This

research concludes that there is a shortage of techniques and methodologies for assessing urban sustainability.

#### **5. Moussiopoulos et al. (2010)**

The researcher shows that sustainability in urban areas are considered the basis of local economic and social development. This study aims to propose a tool for the information administration of economic, environmental and social to assess the sustainability in urban areas. This study applied in Thessaloniki city in Greece.

#### **6. Awasthi et al. (2011)**

The researcher displayed the location planning for urban distribution centers in order to reduce the traffic jams which are resulting from the movement of materials and goods in urban areas as well as reduce the costs of this distribution. The researcher suggested to identify several potential locations for urban distribution centers proposed by the municipal departments and selecting criteria and using of Fuzzy TOPSIS technique to choose a new location so that the selected location should be sustainable and close to customer sites with less impact on the population and the environment.

#### **7. Mosadeghi et al. (2015)**

The research shown the planning of using urban land and encouraging the participation of stakeholders to avoid political and social conflicts. As the method used in the research is the comparison between the two techniques AHP and FAHP to determine land use and access to the appropriate location for each use agreed with the government interests, investors and the people. The research added a new dimension in the decision-making process and purpose which is important for the decisions of urban planning through the selection of priority area in the development

and the use of AHP technique which is enough to this case, while in the case of developing master plan will be used FAHP technique and where it will use more than one technique for ideal decision-making. The results of this study is to find differences in the ranking criteria using these two techniques as well as promoting the application of other techniques influence on the selection of the proposed area of development and this is important for urban planning decisions by local governments.