

**PRIORITIZATION OF PUBLIC INVESTMENT
PROJECT PROPOSALS USING FUZZY ANALYTIC
HIERARCHY PROCESS**

**KAMU YATIRIM PROJESİ TEKLİFLERİNİN
BULANIK ANALİTİK HİYERARŞİ SÜRECİ İLE
ÖNCELİKLENDİRİLMESİ**

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- all cited studies have been fully referenced
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27 / 06 / 2019



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ABSTRACT

PRIORITIZATION OF PUBLIC INVESTMENT PROJECT PROPOSALS USING FUZZY ANALYTIC HIERARCHY PROCESS

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Investments made by the governments in order to increase the economic, social and welfare levels of the society are called public investments. Services such as transportation, energy, communication, production, health, education, and justice, as well as various supporting activities such as construction, renovation, maintenance and repairs, and various equipment supplied to ensure the continuity of these services are examples of public investments.

All countries, especially developing countries such as Turkey have to make the right investment decisions in order to ensure effective use of their limited resources. Therefore, all projects to be realized should be analyzed through methods and models, which can quantify and prioritize those projects.

However, in the current situation, a scientific method based on quantification in the decision-making process on the selection of investment projects has not been adopted yet in Turkey.

In this context, the purpose of this thesis is to improve the quality of the selection process through a new model able to assess project proposals regardless of country, sector, and type. The model proposed in the thesis consists of two main stages. In the first stage, a set of criteria has been developed to be used in the evaluation of proposals and fuzzy AHP analysis was conducted to weight these criteria. In the second stage, a method has been developed in which the decision maker evaluates the proposal in terms of fulfilling the criteria, assigns 1 or 0 points to each criterion and thus calculates a priority score for this project proposal. Project proposals have been prioritized by using the priority scores calculated for each project proposal.

Keywords: Public Investment Projects, Project Portfolio Selection, Fuzzy AHP, Prioritization

ÖZET

KAMU YATIRIM PROJESİ TEKLİFLERİNİN BULANIK ANALİTİK HİYERARŞİ SÜRECİ İLE ÖNCELİKLENDİRİLMESİ

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Halkın ekonomik, sosyal ve refah düzeyinin artırılması amacıyla kar elde etme gayesi güdülmeyen Devlet tarafından gerçekleştirilen yatırımlara kamu yatırımları denmektedir. Ulaşım, enerji, iletişim, üretim, sağlık, eğitim ve adalet gibi hizmetlerin gerçekleştirilmesi ile bu hizmetlerin devamlılığını sağlamak üzere yapılan inşa, yenileme, bakım ve onarımlar ile temin edilen çeşitli donanımlar kamu yatırımlarına örnek olarak verilebilir.

Tüm ülkeler, özellikle Türkiye gibi gelişmekte olan ülkeler, sınırlı kaynaklarının etkin kullanımını sağlamak üzere doğru yatırım kararları vermek zorundadır. Bu nedenle gerçekleştirilecek tüm yatırım projeleri, bu projeleri ölçebilen ve öncelik sırasına koyabilen yöntemler ve modeller aracılığıyla analiz edilmelidir. Ancak, hâlihazırda Türkiye'de yatırım projelerinin seçimine ilişkin karar alma sürecinde sayısallaştırmaya dayalı bilimsel bir yöntem henüz kullanılmamaktadır.

Bu bağlamda, tezin amacı ülke, sektör ve türüne bakılmaksızın proje tekliflerini değerlendirebilen yeni bir model vasıtasıyla bu seçim sürecinin kalitesini iyileştirmektir. Tezde önerilen model iki aşamadan oluşmaktadır. İlk aşamada, tekliflerin değerlendirilmesinde kullanılmak üzere bir kriter seti geliştirilmiş ve bu kriterleri ağırlıklandırmak için bulanık AHP analizi gerçekleştirilmiştir. İkinci aşamada, karar vericinin öneriyi kriterleri yerine getirme açısından inceleyerek her bir kriter için 1 veya 0 puan atadığı ve böylece proje teklifine ilişkin bir öncelik skorunun hesaplandığı bir yöntem geliştirilmiştir. Her bir proje teklifi için hesaplanan öncelik skorları kullanılarak proje teklifleri önceliklendirilmiştir.

Anahtar Kelimeler: Kamu Yatırım Projeleri, Proje Portföyü Seçimi, Bulanık AHP, Önceliklendirme

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TABLE OF CONTENTS

ABSTRACT.....	i
ÖZET	iii
ACKNOWLEDGMENTS	v
TABLE OF CONTENTS.....	vii
LIST OF FIGURES	x
LIST OF TABLES	xi
ABBREVIATIONS	xii
INTRODUCTION	1
1. INVESTMENT AND INVESTMENT PROJECTS.....	5
1.1. The Concept of Investment.....	5
1.2. The Importance of Investments	6
1.3. Projects, Programs, and Portfolios.....	7
1.4. Project Management	10
1.5. Investment Projects.....	11
1.6. Classifying Investment Projects	12
1.7. Investment Project Planning	15
1.7.1. Pre-Selection of Investment Ideas.....	17
1.7.2. Pre-Feasibility Study.....	17
1.7.3. Feasibility Study.....	17
1.7.4. Appraisal	20
1.7.5. Investment Decision.....	24
1.7.6. Implementation	25
1.7.7. Closure	26
1.7.8. Post Completion Evaluation.....	26
1.7.9. Operation.....	26
2. PUBLIC INVESTMENT PROJECTS AND PRIORITIZATION	27
2.1. Public Expenditures and Public Investments.....	27
2.2. Characteristics of Public Investment Projects	29
2.3. Reasons for Public Investments	30
2.4. Life Cycles of Public Investments	32

2.4.1. Initiation.....	32
2.4.2. Appraisal.....	33
2.4.3. Pre-tender Planning	34
2.4.4. Tendering.....	34
2.4.5. Contracting and Implementation	35
2.4.6. Evaluation, Audit, and Closure.....	35
2.5. Difficulties in Managing Public Sector Projects	36
2.6. Drivers of Project Failures	37
2.7. Reasons for Prioritization.....	38
2.8. Challenges in Prioritization.....	39
2.9. Methods Used for Appraisal	40
3. PUBLIC SECTOR INVESTMENT PLANNING IN TURKEY	43
3.1. Planning Framework	43
3.2. Legislative Regulations	44
3.3. Policy Documents	45
3.4. Annual Investment Program Planning Process	47
3.5. Appraisal of Investment Projects Proposals.....	50
4. RESEARCH DESIGN AND METHODOLOGY	55
4.1. Literature Review	55
4.2. Research Design.....	58
4.3. Fuzzy Logic.....	61
4.4. Fuzzy Sets	63
4.4.1. Membership Functions	64
4.4.2. Fuzzy Numbers.....	66
4.5. Analytical Hierarchy Process (AHP)	66
4.5.1. Strengths and Weaknesses.....	68
4.5.2. Phases of the Method.....	70
4.6. Fuzzy Analytic Hierarchy Process (FAHP)	82
4.6.1. Comparison of Fuzzy AHP and Classical AHP	82
4.6.2. Methods Used in Fuzzy AHP	83
4.6.3. Fuzzy Scales	87
4.6.4. Consistency Analysis.....	88
5. IMPLEMENTATION	89
5.1. Proposed Methodology	89

5.2. Implementation of the the Fuzzy AHP	89
5.2.1. Criteria Set and Comparison Form	89
5.2.2. Pairwise Comparisons	95
5.3. Scoring	103
5.4. Illustration	105
5.5. Discussions on the Proposed Model	107
6. CONCLUSION	109
REFERENCES	113
ANNEXES	127
ANNEX 1 – Pairwise Comparison Form	127
ANNEX 2 – Conference Papers Extracted From the Thesis	143
ANNEX 3 - Statement of Originality	144
RESUME	145

LIST OF FIGURES

Figure 1:	Workflow of Investment Project Realization.....	18
Figure 2:	Life Cycle of Investment Projects.....	33
Figure 3:	Planning Framework.....	44
Figure 4:	Annual Investment Program Planning Process.....	51
Figure 5:	Triangular Membership Function in Fuzzy Sets.....	65
Figure 6:	Trapezoidal Membership Function in Fuzzy Sets.....	66
Figure 7:	Standard Hierarchical Structure of the AHP.....	72
Figure 8:	Pairwise Comparison Matrix.....	73
Figure 9:	The Intersection of Triangular Fuzzy Numbers M_2 and M_1	86
Figure 10:	Hierarchical Representation of Criteria Set.....	90

LIST OF TABLES

Table 1:	Classification of Investment Projects.....	13
Table 2:	Prioritization and Selection Documents by Some Countries and International Organizations.....	41
Table 3:	Some Differences Between Fuzzy Logic and Classical Logic	62
Table 4:	Saaty's Comparison Scale	76
Table 5:	Random Index (RI) Values	80
Table 6:	Triangular Fuzzy Numbers of Chang's Fuzzy AHP Method	88
Table 7:	Comparison Matrix for Main Criteria.....	97
Table 8:	Fuzzy Comparison Matrix for Main Criteria	97
Table 9:	Fuzzy Comparison Matrix of Sub-criteria of (A) Main Criteria Set	97
Table 10:	Fuzzy Comparison Matrix of Sub-criteria of (B) Supportive Criteria Set...	97
Table 11:	Fuzzy Comparison Matrix of Sub-criteria of (B1) Economic and Social Effects	97
Table 12:	Fuzzy Comparison Matrix of Sub-criteria of (B2) Cost of Investment Project	98
Table 13:	Fuzzy Comparison Matrix of Sub-criteria of (B2.1) Cost of Financing.....	98
Table 14:	Fuzzy Comparison Matrix of Sub-criteria of (B3) Project Management and Implementation	98
Table 15:	Fuzzy Comparison Matrix of Sub-criteria of (B4) Risks in Project	98
Table 16:	Fuzzy Comparison Matrix of Sub-criteria of (B5) Features of Final Product/ Service.....	99
Table 17:	Fuzzy Comparison Matrix of Sub-criteria of (B5.5) Beneficiaries	99
Table 18:	Fuzzy Comparison Matrix Sub-Criteria of (A) Main Criteria Set.....	100
Table 19:	Local Weights of Sub-criteria of (A) Main Criteria Set	101
Table 20:	Local and Global Weights of Criteria and Sub-criteria	102
Table 21:	Calculation of Priority Scores.....	104
Table 22:	Priority Scores of Investment Project Proposal Scenarios	105
Table 23:	1/0 Scoring of Investment Project Proposals (P) in Scenarios	106

ABBREVIATIONS

AHP	Analytic Hierarchy Process
CBA	Cost-Benefit Analysis
CBR	Cost Benefit Ratio
CEA	Cost-Effectiveness Analysis
CER	Cost Effectiveness Ratio
CI	Consistency Index
CR	Consistency Ratio
EPB	Economic Policy Board
FAHP	Fuzzy Analytic Hierarchy Process
IBRD	International Bank for Reconstruction and Development
IDCAS	Industrial Development Center of the Arab States
IMF	International Money Fund
IRR	Internal Rate of Return
MCDM	Multi Criteria Decision Making
MTF	Ministry of Treasury and Finance
MTFP	The Medium-Term Fiscal Plan
MTP	Medium Term Program
NPV	Net Present Value
NPC	Net Present Cost
NVA	Expected Net Value Added
ODI	Overseas Development Institution
OECD	The Organization for Economic Co-operation and Development
PI	Profitability Index
PPP	Public – Private Partnership
RI	Random Index
SBD	Strategy and Budget Directorate
UNIDO	United Nations Industrial Development Organization

INTRODUCTION

The expenditures made by the government to provide services that are common to society such as production, transportation, communication, energy, and infrastructure are called public expenditures. Investments made by these expenditures, which increase the economic, social and welfare levels of the people, which require high costs, address the masses of the public and which are not for profit are called public investments.

Public investments are generally based on durable goods, which benefit more than one year. Services such as transportation, energy, communication, production, health, education, and justice, as well as various supporting activities such as construction, renovation, maintenance and repairs, and various equipment supplied to ensure the continuity of these services are examples of public investments.

The process of public investment program management in Turkey is carried out by the Strategy and Budget Directorate (SBD) within the Presidency.

Public institutions are obliged to prepare a feasibility report and submit them to SBD for investment proposals over 10 million TL. Investment proposals are assessed in the framework of the interviews between the relevant sector experts of the SBD and the public institutions that offer proposals. In this way, The Investment Program is created by merging the parts. After publication in the Official Gazette, the Investment Program comes into force.

The budget allocated for public investments in our country grows every year, and the total budget allocated for 2018 is 88.1 billion TL. The investment budget of the following year consists of expenses for ongoing projects and newly started projects.

The prioritization and selection process of investment project proposals is currently carried out based on sectors. The proposals within the same sector are assessed in compliance with the competence and experience of the expert assigned.

Considering that Turkey's income sources are limited, it is very important to prioritize and select public investment projects, which are allocated high budgets.

In the current situation, however, an objective method based on quantification is not used in the selection process. The priorities of the proposals are determined only for projects within the same sector and for non-sector projects just by taking into account the features and benefits of the project. This approach does not allow a comparison of investment proposals in different sectors.

On the other hand, the lack of a set of objective criteria may cause overlook of the possibility that a priority project in a sector may be less priority and urgent when it is compared to a non-priority project in another sector.

In this context, the purpose of the thesis is threefold. Firstly it aims to create a criteria set that will enable to assess public project proposals regardless of sector, type, etc. by public institutions. The second aim is to weight the mentioned criteria. The Final aim is to contribute to the decision making in the selection of proposals by providing a priority score for each proposal.

In the first chapter of the study, the concepts of investment, investment projects, and the stages of an investment project from the idea to the final product or service have been examined in detail.

In the second chapter, public expenditures and public investments are explained, and the characteristics and importance of these investments have been mentioned. Also, life cycles of public investment projects and challenges in investment project management in the public sector have been examined.

Right after the challenges, , issues related to the prioritization and selections of public investment projects are included. The benefits of prioritization and problems encountered have been analyzed in detail. What is more, brief information about the worldwide methods used in public institutions in the selection process has taken place in this chapter.

In the third chapter, the investment planning process that is currently implemented in our country is detailed comprehensively. The investment planning process, the actors involved in this process, the legislative and policy documents considered have been mentioned. As well, how investment project proposals are prioritized and selected has been mentioned.

The fourth chapter provides information on the design of the research, and methodology. At this stage, the literature on the prioritization of investment projects in the public sector has been reviewed, and brief examinations were given about those studies. The Fuzzy logic, analytic hierarchy process, and fuzzy analytic hierarchy process have been discussed and explained comprehensively.

In the sixth chapter where information on the prioritization model is given, the steps of the model are explained, and an exemplification has been implemented by using the model.

In the final chapter, the outcome of the study has been concluded.

1. INVESTMENT AND INVESTMENT PROJECTS

1.1. The Concept of Investment

Investment, with the most general definition, is to the commitment of the assets held today to another form of movable or immovable assets in order to provide a monetary benefit in the future.

Feibel [1] defines investment as a current loss of a valuable thing in trade in order to have more than the current loss where the difference between them is called return.

Reilly et al. [2] emphasize that investment is the attachment of the capital to investment instruments for a while on the purpose of gaining future profits in return for the period at which capital tied up, expected inflation rate and the uncertainty of the future earnings.

Investment is the use of savings to generate income or to make a profit for individual investors [3]. In addition to individuals, the definition comprises of investments made by governments, pension funds, and corporations regardless of the type of investment as well [2].

No matter in which sector those investments are made, new installations, tools, and machinery of corporations, and dwellings, transportation services and infrastructure constructions of public institutions are examples of real investments [4, 2].

On the other hand, although different definitions have been developed for investments depending on the sector in which they are defined, these definitions are essentially the same. Some of them are exemplified below.

First of all investment, in daily life, is generally used for the use of capital in a business or for the allocation of valuables to a business with the purpose of profit [5]. Purchase of foreign exchange, gold, stocks, and bonds, the establishment of factories and facilities, equipment, building, and land acquisition are examples of investments [3].

In terms of business science, investment is the expenditures made to increase in production capacity of enterprise or ensure sustainability. This definition is valid not only for fixed assets but also for investments in current assets [6].

In economics, the term of investment means an attitude of bringing about an urgent expense in the desire for future prizes [7]. Other views for the same discipline characterize investment as a portion of the goods produced and imported in a given period, which are not consumed and not exported at that time [8]. In another definition, it is the net additions to the stock of capital goods and the expenses made to raise the production capacity in a given period [9, 10] .

Similar to definitions in economics, in macro planning studies, investments are considered as part of the national income spent on increasing the production capacity of the economy. The definition of investment in micro-planning is identical to the definition of investment in business science [5].

Finally, from a public management perspective, investments are the governments' actions that increase the economic, social and welfare levels of lives of the people, require high costs, address the broader public masses, and do not aim for the profit. Public investments play a role as an indicator of the countries' development.

Some typical features shape all investments. All of them are more or less risky. These risks may be because of operational, financial, political, social or legal issues. Investors favor investments where the risk can be minimized. One other common feature is that investments are realized to gain a profit. Investors assume their capital to be rewarded with continuous and high profits [11].

1.2. The Importance of Investments

Why are investments so fundamental for both of public and private sectors? The answer to this question is the expectations for future benefits. The main objective of private sector investments in the narrow sense is to make a profit, while the purpose of public investments is to serve the society rather than making a profit [9].

They can be characterized as public or private sector expenditures on the purpose of meeting the needs of others or increasing the production capacity of existing enterprises.

The principal purpose of investments in the private sector is the growth of the enterprise. Because of the investments, the increase in the production amount, sales volume, equity, number of employment and profit is defined as growth. As this growth is realized, an increase in investment amounts is observed [12].

On the other hand, investments are impulses for continuous development and improvement of countries. In a continuous and sustainable economic growth, investments are the most powerful and dynamic elements affecting the political, social and cultural structure [13]. It can be said that robust investment helps and quickens development [14]. Having an imperative effect in the long run and short run growth, investments are assumed as bridges between the present and what is to come [15].

1.3. Projects, Programs, and Portfolios

Many stages are followed in the process of making investments from idea stage to an outcome. Investment ideas are structured as projects in order to ensure that the transformation process of capital into investment is carried out healthily by controlling the time, quality and cost.

A project is a set of actions followed in order to implement ideas following a systematical way. Even though many authors, professionals, and institutions have defined project, their definitions resemble each other substantially [16]. Therefore, instead of citing them here, it is better to pay attention to globally accepted organizations' documents and standards in project management as exemplified below.

The Project Management Institute (PMI), a worldwide known non-profit professional organization for project management, characterizes projects as “the temporary endeavor undertaken to create a unique product, service, or result.” [17].

According to BS 6079-1: 2000 by British Standards Institution (BSI), Project is “a unique set of coordinated activities, with definite starting and finishing points, undertaken by an individual or organization to meet specific objectives within a defined schedule, cost and performance parameters.” [18].

The Australian Institute of Project Management (AIPM) [19], the peak body for project management in Australia, defines the project as “the temporary endeavor undertaken to create a unique product, service or result in order to achieve an outcome.”

Projects in a Controlled Environment (PRINCE2)) [20], a project management method which is not only known and preferred in the United Kingdom by private sector companies but also recognized and employed by many other companies around the world describes the project as “a temporary organization that is created for the purpose of delivering one or more business products according to an agreed business case.”

Association for Project Management’s (APM) characterizes the project as “a unique, transient endeavor, undertaken to achieve planned objectives which could be defined in terms of outputs, outcomes or benefits” [21]

It can be seen that all of the definitions mentioned above share a few common characteristics. First of them is its uniqueness of projects. No matter what kind of projects they are, and whether they have tangible or intangible outcomes, projects serve to fulfill objectives. As long as the objectives vary, the deliverables of the projects diversify [17].

In BS 6079-1:2000 standards [18], it is highlighted that projects are “the drivers of change.” In this context, projects offer favorable novelties to institutions and individuals to attain goals in a much efficient way by means of change [22].

The need for the change might be caused by inadequate funds, advances in technology, changing patterns of rivalry, demands, suppliers, public needs and burdens [23], desire for increasing revenues, decreasing expenditures, raising productivity [18], strategic opportunities, legal mandates, and problems [17].

Projects create value and novelty. It is aimed in a project to get a better condition different from the current, which means this novelty has to provide benefits in return. Those benefits may be in different forms, such as tangible, intangible, money, time, goods, services that are called business values [17].

Projects differ from daily routine works [18], and in order to get planned results, some actions are taken. Some of the resources such as labor, machinery, and stuff [24] are allocated for only that work [19].

Sometimes location differences, the nature of the work and the necessity of labor and technical knowledge from many different disciplines, the use of many of methods and tools in project management, having numerous stakeholders and customers, the length of completion time, the high cost and the need for different financing paths make projects quite big and complex. Because of this kind of situations, it is difficult to perform management and control functions.

Divisions of these kinds of massive projects into sub-systems and parts as different projects under a program enable more efficient planning and management. In this context, PMI defines programs as “a group of related projects, subprograms, and program activities that are managed in a coordinated way to obtain benefits not available from managing them individually” [25].

Each program consists of at least one project or subprogram. Subprograms consist of subprograms and/or projects as well. Projects involved in the program should be related to each other through a common strategic objective.

Reaching the strategic objectives and desired results by just program and project management tools may not be adequate in this competitive environment. Therefore, organizations have to select and prioritize programs and projects from a holistic perspective. Project portfolio management is designed to meet this need [16].

Portfolios are composed of projects, programs, subprograms and subportfolios, and operations in the purpose of accomplishing strategic objectives [17, 25]. Cooper [26]

defines portfolio management as a live decision process in which new projects are assessed, selected and prioritized, the fate of existing projects are decided, and allocation and/or reallocation of resources to active projects are decided.

Organizations endeavor to achieve strategic objectives employing portfolios, programs, and projects. Corporate goals and objectives can be attained by properly managed portfolios, programs, and projects [17].

1.4. Project Management

The projects are managed in order to be effectively and efficiently completed in the planned scope, time, cost, quality, and standard. The project management is a process which manages all stages from the beginning to end of the projects in the frame of cost, quality, and time parameters.

When the definitions developed by professional project management organizations such as the Project Management Institute [17], The International Project Management Association [17], The Projects in a Controlled Environment [27], The Australian Institute of Project Management [28], and the Association for Project Management [21] are examined, it will be seen that there are common points in all definitions. These points are summarized below.

- Project management is the use of information, competences, and resources to fulfill the objectives.
- It follows basic steps from start to closure in order to attain project goals by using limited resources.
- It is a whole that consists of stages where different activities are carried out at each stage.
- Project management is the management of change with a dynamic approach.
- It aims to overcome ambiguity and complicatedness.

1.5. Investment Projects

Investment projects are proper ways of creating, expanding and developing some opportunities to augment the production amounts of both goods and services within a specified period. Investment projects are innovative, holistic and legal structures shaped by time, resources and institutional support [29].

In an inclusive sense, investment project may be outlined as the expenditure of resources within the present, to come up with advantages within the future [30], and as a proposal for the long-run allocation of capital with the expectation of gaining profit in the future [31].

An investment project incorporates elements of purpose, time, source, scope, and method. The phases followed in any project can be applied in investment projects [32]. However, investment projects have some features which make them different from other projects. They require that some of the available resources to be used in the purpose of obtaining further profits in the future when compared to today [27].

It may take several years for some investment projects to be completed and benefits to be acquired, seen and felt. This period may extend up to 50 years mainly for public infrastructure investment projects [33]. What is more, if continuous maintenance is carried out, some projects may serve continuously [27].

It should be emphasized that they have significant external impacts. These effects appear in the form of environmental and operational impacts. The environmental impacts include changes in human health, water and air pollution and decline in production in agriculture, livestock, and fisheries because of pollution [33], damages on infrastructure, losses on visual enjoyment and opportunities in landscaping [34]. They may cause losses in the efficiency and productivity of other existing systems.

In investment projects, some of the limited resources are irreversibly allocated to the project so that the resources cannot be used in any other activity or project. Various legislative amendments can be made especially for investment projects which are carried out by the public sector and in need of large amounts of resources [27].

Financing of investment projects originates in various ways such as the use of shareholders' equity, providing credit from international institutions and organizations, and leasing. Moreover, financing by extra-budgetary funds, use of resources created by state-owned enterprises in the financing of their own investments, project consortiums, and public-private partnership models are other funding methods in the public sector.

1.6. Classifying Investment Projects

As mentioned in the previous sections, each investment project has its own characteristics [13], different objectives at different levels [35] and outcomes [16]. This differentiation makes management style and actions to be taken separately.

Determining the type of the project is a serious element in decision-making, project planning, monitoring and control [5], effective use of capital [12], and defining necessary processes and procedures [36]. Investors have to evaluate alternative financing tools and facilities according to the type of investment due to the different financing needs of different investments [5].

For the needs and reasons mentioned above, investment projects have been classified in many different ways within the framework of various criteria in literature. These classifications are exemplified in Table 1. In the scope of the thesis, we will be interested in brief explanations of a few classifications are given below.

According to the characteristics of the assets which sources tied up, projects are classified as fixed assets investments and current assets investments [9].

The investments which are included in the operating period of the entity and the benefits provided to them within the period are current investments. Current assets are those that can be converted to money within one year or less. Investments on assets which are not purchased for re-sale can be used for more than one-year period during the activity period, and its benefits are spread over more than one-year period. These are called fixed investments [37].

Table 1: Classification of Investment Projects

1. According to the characteristics of the assets in which sources tied up [5, 9]
1.1. Fixed asset investments
1.2. Current assets investments in

2. According to the subjects of investments [9, 13] and physical condition [3]
2.1. Fixed capital (real) investments
2.2. Financial investments

3. According to the period in which capital tied up [9]
3.1. Short-term investments
3.2. Long-term investments

4. According to the investor's expectations, [9]
4.1. Income-generating investments,
4.2. Efficiency increasing investments,
4.3. Both Income-generating and Efficiency increasing investments

5. According to the profitability Purpose [27]
5.1. Non-Profit investments
5.2. Investments where the benefits cannot be measured
5.3. Profit-Based investments

6. According to the reasons for realization [3, 9, 12]
6.1. New investment
6.2. Renewal (Substitution) investments
6.3. Extension investments (Expansion Investments)
6.4. Modernization investments
6.5. Completion investments
6.6. Bottleneck investments
6.7. R&D investments

7. According to dependencies [3, 5, 9, 13, 38]
7.1. Independent (Autonomous) Investments
7.2. Dependent Investments

8. According to the executives [9]
8.1. Public sector investments
8.2. Private Sector investments

9. According to risk and uncertainty levels

10. According to the situation of obligation [13]
10.1. Compulsory investments
10.2. Non-compulsory investments

According to the subjects, the investments are classified as fixed capital (real) investments and financial investments [3, 9, 13].

Financial investments are financial assets such as deposit accounts, currency, stocks, and bonds in order to make a profit. The investor tries to profit from the value of the financial assets employing fluctuations. Fixed capital (real) investments are investments such as the establishment of new facilities to increase the production capacity, building additional buildings, additions to the inventory of machinery and raw materials, construction of new roads, bridges, railways, and airports. Such investments create new production and employment capacities [3].

According to the period in which capital tied up are grouped as short and long-term investments [9].

Short-term investments which are also referred to transitory or current investments are investments in financial instruments such as stocks, bonds, real estate and cash which are predicted to be transformed into money in less than one year. Long-term investments are assets that are held for more than a year, not used for the operations of companies during the current cycle [39]. These investments may be real investments such as machinery, buildings, land, land, vehicles, which the enterprise intends to use for more than one year or non-real investments, such as patents or trademarks. Long-term investment decisions have a high return. However, this maturity is variable in the sector [9].

According to the investor's expectations, they are categorized as income-generating investments, efficiency increasing investments and both income-generating and efficiency increasing investments [9]. Some investments can generate direct earnings in turn. On the other hand, some investments are carried out to increase the efficiency of the existing system. Additionally, some investments provide both income generating and efficiency concurrently.

According to profitability, investments can be classified as non-profit investments, profit-based investments, investments where the benefits cannot be measured.

As it is known, the primary purpose of investment projects is to make profits or increase profits. Contrary to the general opinion, some investments are carried out in order not to profit but to meet a need or a requirement. For example, investments, in order to ensure occupational health and safety or reduce pollution in the environment, are carried out due to legal responsibility [3]. On the other hand, there are some investments such as educational investments where it is not possible to measure the benefits in terms of money.

According to the executives, investments can be grouped as public sector and private sector investments.

Investments which require a large amount of capital or which are not regarded as profitable by private enterprises shall be realized by the state. In this respect, the investments made by the public production units [27] without profit expectation [10] are called public investments. The most important item in public investments is fixed capital investments [40]. The investments realized by the production units of the private sector are called private sector investments. The difference from public investments is that the main objective is maximizing profits [9].

According to obligation situation [13] they can be categorized as compulsory and non-compulsory investments. Compulsory investments are outside the initiative and decision of the enterprise and are mostly made due to legal requirements. Investments such as waste management, ventilation system, and security measures are compulsory investments [12].

1.7. Investment Project Planning

If a new investor wants to invest, profit will be the primary goal no matter how long it will take. Consequently, a well-prepared feasibility report and plan is required to use the appropriate ways to accomplish this goal, particularly in order to reduce the risks on the ultimate outcome of investments [41].

For countries as well as companies and investors, investment planning is crucial. Principally developing countries have barely limited financial capital to invest. These finite resources must be very well planned and must be properly used. This is a more realistic

approach, rather than risking resources for such an investment that is unlikely to attain the aimed consequences [41].

Planning and feasibility studies guide investors in discovering the right ways to use resources. A well-designed project plan is a road map to a profitable investment. The unique features of each investment project determine the aspects of concern. Objective and extensive research into the short and long run functioning of the project within its ecosystem helps recognize the issues to be examined and suitable project development activities and events related to each phase of the project [42].

An investment project matures through various processes and stages. All the processes and activities taking place in the period from the investment idea to operation including preparation, screening, selection, implementation, and completion phases are called the project stages or processes [3].

Whereas the activities to be carried out during the project process are shown under different phases and/or called differently in various sources, a typical investment project is composed of basic stages given below.

1. The emergence and pre-selection of investment ideas
2. Preliminary (pre-feasibility) study
3. Feasibility study (economic, technical, financial and marketing studies)
4. Appraisal, (overall evaluation)
5. Investment decision
6. Implementation of the project (investment phase)
7. Closing project
8. Post-completion evaluation
9. Operation

Figure 1 picturizes the flowchart diagram of the steps taken by the investment projects from the idea stage to the final product.

1.7.1. Pre-Selection of Investment Ideas

The elementary purpose of the enterprises is to increase profits and thus to maintain their assets. In this context, enterprises have to assess all possible investment ideas and opportunities. In terms of business growth, selections of investing ideas and opportunities have to be in unison with the mission and objectives of the enterprise are of great importance.

There may be difficulties in conducting an in-depth review of all investment areas and preparing economic, technical, financial and marketing studies. For this reason, it is necessary to determine the investment areas that may yield profit before the project initiation [43].

1.7.2. Pre-Feasibility Study

It is not possible to investigate all investment issues in detail in the planning of business investments. Therefore, a preliminary selection is made among appropriate investment proposals before analyzing each investment issue in detail in economic, technical and financial terms. In the appropriate investment area determined as a result of the preliminary selection, a detailed feasibility study is conducted. In this way, the losses caused by doing detailed work on unsuitable investment issues are prevented.

1.7.3. Feasibility Study

The feasibility analysis has to be performed for projects or programs that have passed pre-feasibility checks [44].

The feasibility study is a process that produces detailed information on both investment and its results within the framework of certain assumptions and estimates in a new project development process [32]. By reviewing all the concerned data, the feasibility study clarifies the expected project results and describes selected projects to achieve project goals [44].

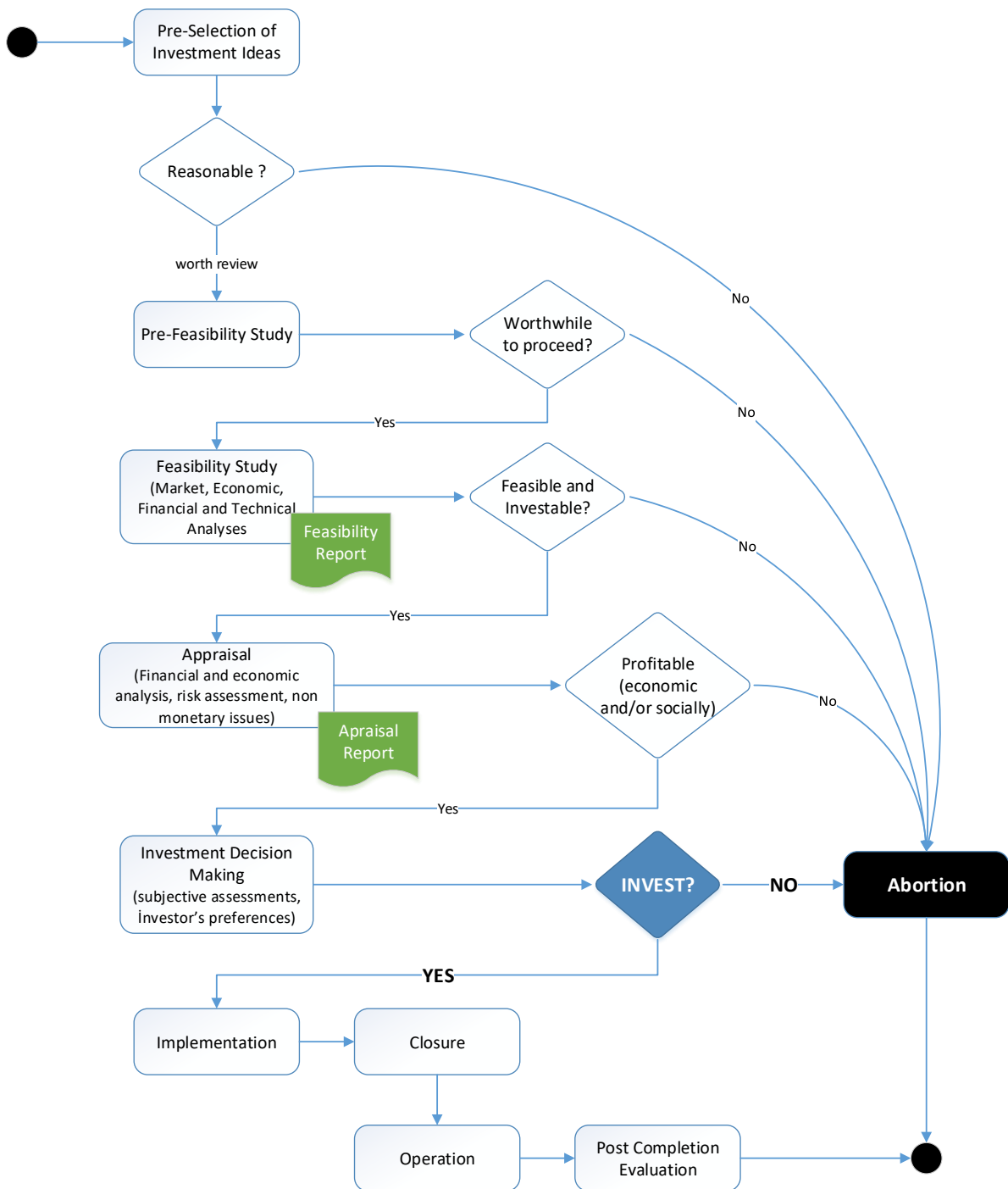


Figure 1: Workflow of Investment Project Realization

A project can be considered viable if it satisfies the technical, legal, fiscal and other restrictions related to the geographical location where it is initiated. The feasibility analysis is a prerequisite for all projects regardless of type [45].

Feasibility studies are economic, technical and financial studies conducted prior to decision stage [6], and are one of the most prominent tools to help make the right decisions about the projects. It is prepared in order to anticipate the possible difficulties that may be encountered during the implementation of the project and to take measures [46]. A wrong decision to be made at the initial stages will fail the project [32].

When the feasibility studies come to an end, a report is produced which can answer questions such as what the investor would produce, how to produce, where to sell the produced goods, how much to invest, and how much to earn. This report plays an important role in making an investment decision. On the other hand, feasibility reports are mandatory for the approval of projects by authorized approval authorities and for providing financial support from financial institutions to the project [46].

All the issues to be included in the feasibility study are classified under few analyses on market, technical and financial issues. These analyses are as follows.

Market Analysis

The market analysis intends to comprehend the dynamics of the market, reactions to the product and the possible effects of the market and the environment in which the project product will be included. Prior to implementation, it is necessary to foresee the possible markets where the product will be distributed and identify possible clients [47].

After that analysis, if there is a suitable market for the project product and the product is a marketable, the other stages of the feasibility study start. However, if the market analysis shows an inappropriate situation, either then the market analysis should be re-examined, or the project should be abandoned because it is clear that projects that do not have market and marketing capability will not be successful.

Technical Analysis

The technical analysis determines and coordinates the elements such as machinery, equipment, and technology involved in these processes within the system approach [12].

The technical study mainly covers the selection of the production method, determination of the labor need, the types of products and residues, physical and chemical properties of the products to be produced, residual evaluation facilities, the qualities and preference of the machinery and equipment to be used [48].

Economic Analysis

The common costs for investment projects include expenses for personnel, IT, capital assets, machinery, overheads, running, maintenance, and environmental issues [49].

The economic study covers the analysis of the amount of fund required, the examination of internal and external channels for financing and profitability of the enterprise [5]. It aims to estimate the total amount of fund required in the establishment period, the working capital requirement in the operation stage, the incomes to be obtained and the evaluations of the investment project using these estimates.

Financial Analysis

As it is the money that assembles the labor, machinery and raw materials for the entrepreneur to produce goods or services, finance is one of the most high-priority preconditions in an investment process [46].

Financial feasibility is the study that examines the expenditure of the planned investment as a whole and predicts how profitable the project will be. These studies are of critical importance for both the investors themselves and the financial institutions that will evaluate the project. The financial analysis focuses on cost, revenues, finance sources, estimations related to operating capital, cash flow and balance sheet [46], monetary sustainability issues [45], financial ratios to be used, and financial risks [27].

1.7.4. Appraisal

The appraisal deals with benefits and costs along with the information produced in the feasibility study and details them. It is used to select one or more among alternative investments. Appraisals are also called evaluation, assessment, study, analysis, benefit-cost

analysis, and cost-effectiveness analysis. It examines both present and future benefits and the costs of all investment related matters [50]. This effort is to decide whether the project stages proceed.

The appraisal process is a requirement for all projects, regardless of whether they generate revenue [51]. Project assessment can apply notwithstanding the type to any investment project. Though the methods of assessment vary according to investment types, various criteria can be applied to all investment projects for the final decision.

Projects should be appraised in terms of the competence of meeting the targets and expectations. The financial return rate for private sector investments is fundamental, while the economic rate of return for public investment projects is critical [51]. As well as financial considerations, non-material and non-monetary issues such as environmental, social and technical issues are taken into consideration in the appraisals [50].

The investment project creates economic prosperity for the whole society in the geography where the project is implemented. In this location, market prices to be used in the appraisal may not reflect the value of social opportunity costs. In these cases, contrary to these distorted market prices, shadow prices which are calculated using suitable and available transformations of market prices are used [45].

Project costs and benefits of which market prices cannot be determined such as environmental, social or health impacts, may exist in an investment project. However, in terms of its importance and impact, such costs and benefits have to take place in appraisals. In the case that market values cannot be accessed, such benefits and costs can be converted into monetary values employing appropriate techniques [45].

The analysis at this stage provides a compilation of various information about the project's effects on the project owner organization, community, financial situation, stakeholders, project risks and sustainability of the investment project [34]. These are country, sector and demand analysis, as well analysis of cost-benefit, sustainability, sensitivity and risk, and distribution analysis [49].

Country, Sector and Demand Analysis

An investor needs to know the dynamics of the country in which he or she will invest. In order to make the right decision regarding the investment, it is necessary to follow the political and economic conjuncture in the country. For this purpose, gross national product, money supply, interest rates, deficits in the balance of foreign trade payments, inflation, unemployment, fixed investment expenditures, developments in the construction sector, various indicators such as monetary and fiscal policies can be used [52].

Another issue that needs to be examined is the analysis of the sectors to be invested in. Sector analysis is required for determining inter-sectoral and sectoral priorities and the relations between sectors and projects [46]. A sector diagnostic examination can contribute to define and prioritize challenges as well as being momentous to recognize the context, to justify the aim of a possible investment [53].

The demand analysis determines the main rationale and magnitude of the project. Therefore, it is an influential factor affecting the future success of the project [54]. A project with insufficient demand for the products and services to be produced is a project where there is an ineffective use of limited resources [49].

Cost-Benefit and Cost-Effectiveness Analysis

The cost-benefit analysis is the pre-calculation of all the costs and benefits, which show up during investment and after completion, and making comparison of these by reducing to a benchmark year. This analysis, which can reveal the investments having more benefits than the others do is a process that enables to get the project's net economic value by calculating the cost and benefit in monetary terms.

Alternative investment project proposals can be compared by using Cost-benefit analysis [55]. Both private enterprises and various public institutions often face limited resources such as labor power, capital, machinery and raw materials to be used in alternative investment areas. Since the use of resources in a particular area means the abandonment of investments in other areas. Therefore selecting ones among many investment projects is a necessity to use scarce resources most efficiently. Cost-benefit analysis can support the

effective distribution of resources in such investment projects, which do not have any markets to provide social values by itself and are abundant in the public sector [49].

In the analysis, if the benefit's present value (B) is greater than the cost's present value (C), it is considered appropriate to proceed with the investment. So if $B > C$, the investment project is profitable. If it is the opposite which means $B < C$, there is no possibility to implement the investment project [56].

In many projects in areas such as energy, transportation, urban planning, and rustic watering, monetary benefits are quantified, and economic viability can be tested with a full cost-benefit analysis [53].

However, for many social sector projects on such as poverty and environmental issues, traditional economic benefit metrics may be insufficient to calculate the social values of these projects. For these projects, the economic viability of a project can be assessed by a cost-effectiveness analysis or, if possible, multi-criteria analysis [49]. Cost-effectiveness analysis is used where it is not possible to apply benefit-cost analysis [27].

In cost-effectiveness analysis, the alternatives are contrasted through cost per unit activity by using a predetermined and non-monetary activity criterion [49]. Cost-effectiveness analysis is used to find the project that has the lowest total cost among alternative projects. In this technique, shadow prices are used when calculating project costs and expenses [27]. However, this method, which is based on the selection of the cheapest among the different alternatives that give the same result, may not always provide the right solution.

Sustainability Analysis

For a project to be economically feasible, it must be designed to provide net economic benefits over its lifetime. In this respect, it is essential to consider the project's financial and corporate sustainability [49] and sustainability in the market share [32].

Financial sustainability analysis examines whether the financial resources are adequate to meet all outflows throughout the life of the project. Qualified personnel, technological

infrastructure, and innovation capacity, which are required for the continuation of the technical implementation after the project, are evaluated within the framework of sustainability [30].

Sensitivity and Risk Analysis

Sensitivity analysis is a method to examine the investment costs and profits in case of the fluctuations in variables related to the investment project [57]. It can be seen as a method of risk analysis to gauge to what extent the NPV has shifted as a result of changes in the main variables which make up the project's net present value. In this context, it is used to determine and estimate potential risk in project efficiency. Instead of calculating the risk value, the analysis estimates the effects of the variables on the NPV. If the NPV is responsive to these changes, the project is considered as risky [58].

Distribution Analysis

In the analysis of income distribution effect, the distribution of the net social benefit created by the project among the income groups is investigated. In the economic assessment of an investment project, the examination of groups and people benefiting from this project apart from the main beneficiary, to what extent they benefit from, and to what extent compensate for their costs can be considered as a must [46]. The beneficiaries who gain or lose maybe project, other private business, government, workers, consumers, external sectors [59].

The net social benefit generated by the project, such as the economic net present value, reflects the increase in the welfare level of the total investment, as well as the increase in the income of certain social groups.

1.7.5. Investment Decision

Following the feasibility and appraisal studies carried out, the project which is examined in many respects becomes “investable”. At this stage, whether the investment will be realized is clarified. If there is more than one project investable, prioritization and selection can be made among these projects by looking at the resource status. Into the bargain, financial

evaluations and various criteria, investor preferences, subjective evaluation, socioeconomic and ecological effects [60], particularly commercial and national profitability, laws, regulations [3] are paid attention in decision-making.

In the decision phase, considering analysis results obtained in the previous stages, if there is only one project proposal, the investor decides whether to invest. If there is more than one project proposal, the investor decides which proposals to be invested among a few proposals [54].

Undoubtedly, in every organization, some projects are of top priority. However, the general mistake during the formation of the portfolio is not to include such projects in the portfolio, but rather to include projects more than the available resources can handle. When more projects are included in the portfolio, all projects will be slow down. This situation prevents the completion of projects on time and increases project costs [54].

1.7.6. Implementation

The investment is realized physically in the implementation phase in which orders are given, and physical works are initiated. Installation of the ordered machines is carried out at this stage as well [5]. Infrastructure investments are completed while the construction of buildings and other facilities is underway.

At this stage, project and engineering designs, meetings, license, and patent contracts, construction and installation work, training, testing and commissioning of the plant are carried out [3].

The success of this phase, which involves many actions, depends on the proper preparation of the projects at the earlier stages, the analysis, and selection of the project proposals well-fitting objectives. Nevertheless, unpredictable and unexpected situations may arise in the realization phase of the investment [61].

1.7.7. Closure

The project closure phase is carried out in order to achieve a certainly delineated endpoint, transfer the liability of the outputs to the customer, unbind the resources attached to the project and ensure customer's official acceptance of the results [62]. Processes and tender files are closed, and products and services are transferred to related parties.

Project closure aims for creating an anchored stone where the acknowledgment of the goods or services produced is achieved and to meeting the objectives defined at the beginning of the project [27]. It includes checking the completeness of all outputs and generally involves a final presentation and report [63]. What is important during the closing phase is the transfer and use of the knowledge and skills learned to the next projects.

1.7.8. Post Completion Evaluation

The evaluations following the closure are carried out to ensure that the results of the implementation are compared with the ones in the plan and evaluate whether the activities done are reasonable and useful [54].

1.7.9. Operation

After the completion of the investment, the operation phase starts by following the standard production period [3]. In case of any unforeseen developments during the operation period, it may be essential to update the decisions on the investment project and revise it considering the current situation [56].

2. PUBLIC INVESTMENT PROJECTS AND PRIORITIZATION

2.1. Public Expenditures and Public Investments

Governments have to make various public expenditures on the purpose of continuing public services and achieving economic and social objectives [64].

Public expenditures can be defined as the expenses for the services offered to the public as well as the use of resources to ensure the growth of the country [65]. In a country's growth progress, public outlays have crucial importance on promotion of economic development. The achievement of balanced regional development, the fair distribution of public resources, reinforcements in agricultural and industrial growth, the increase in the competence for the use of underground sources and ensuring rural development can accelerate economic development [66].

IMF [67] describes public investment as a mix of physical infrastructure spending on transportation and communication networks, providing energy and water distribution and sewage systems etc., and social infrastructure spending on education, health and justice services, etc. All kinds of expenditures made for generating goods and services in the public sector can be regarded as public expenditures. The expenditures of the government on the redistribution of income are also called public expenditures. The purpose of public expenditures is to ensure continuity in public services regularly [68].

Generally, public investments often refer to investments in physical assets called fixed capital investments. Public investment management relates to the government's efforts to manage and shape this process [69].

Investment expenditures increase production, affect productivity positively, enable benefits from the resources, increase the efficiency of production factors and are for the durable goods used for more than one year. Benefits of investment expenditures can be seen in the long term. Roads, structures, dams, facilities, salient repairs, expropriation expenses are within this scope.

The areas invested by the public sector can be detailed under five main headings as shown below.

- Construction and Infrastructure projects are composed of all kinds of constructions, furnishings and maintenance and repair projects.
- IT projects are applications and projects for information and communication technologies.
- R&D projects, scientific and technological research, and application projects.
- Procurement of goods and service includes applications and projects related to purchasing, maintenance, and repair of vehicles/construction machinery and
- Production projects include manufacturing of goods.

Drinking water, wastewater treatment plants, sewage works, dams and ponds, irrigation and drainage facilities, electricity generation facilities (hydroelectric, geothermal, nuclear, wind power plants, bioenergy plants), electricity transmission and distribution lines, underground cabling works, railway, rail system, highway etc. all kinds of transportation, communication etc. investments in the areas are called as public infrastructure investments [70].

The most prominent features of infrastructure investments [70] are as follows.

- They are high-cost investments. Infrastructure investments are investments that require a huge amount of resources for sustainable infrastructure, in parallel with the advancing technology.
- They are mostly realized by the public sector (local administrations, central government) in all countries.
- They serve a wide community.

Additionally, public investments are some kind of triggers in terms of achieving sustainable development. They should be carried out in order to continue services provided in the basic investments such as transportation services, infrastructure constructions, and health, education, and safety services.

Furthermore, they are used as policy instruments in growth. Investments in human resource, innovation, and especially infrastructure provide economic performance and efficiency [4]. Employment is increased via investments and services offered to the community are improved. In this way, it is aimed to strengthen the economic structure and to ensure sustainability in development [71]. Thus the demand level is increased, and the economy is revived.

2.2. Characteristics of Public Investment Projects

These investments can be characterized as an indicator that illustrates the level of development as it increases production, reduces production costs, improves economic indicators, and increases the standard of living and welfare of individuals [72].

These investments are generally made by the government. It requires a huge amount of financial resources. No citizens can be restricted in the use of these investments, but they may be provided in return of reasonable prices [72].

Public investment projects differ from private sector projects in some aspects. While private sector investments are carried out with the motivation of increasing the profit of the enterprise, profit-making is not an objective in public investments. The government invests in order to increase the social welfare of the citizen by using public resources effectively [73].

Public projects are exposed to political risks as well as risks arising from the project itself due to uncertainty. Along with the political risks, economic, managerial and social events that may negatively affect project financing are the main menaces to the realization of the project. Moreover, it is known that political decisions on public investments influence other parameters such as income distribution, unemployment, foreign trade balance, and budgetary constraints [74].

Public investment projects are carried out by following a set of rules tightly shaped by the laws throughout the project. The complexity of the budget process, making the budget for

only for the relevant year and allowing of using the appropriation only within that year make investment projects just difficult [73].

They are generally attention drawing projects that have an influential impact on society, the environment, and the budget. The Channel Istanbul Project can be considered as a good example of those kinds of projects. The length of such a mega project is usually more than five years. The project is multi-stakeholder and technological innovations are included by the time in the project [73]. Therefore, it may take many years to see the beneficial effects of some projects [27].

The fact that the final product or service produced as result of the investment enables long-term use is another important feature of public projects. Especially transportation, energy and communication network, infrastructure and superstructure investments produce products and services with a long life.

Another common feature of public investments is that large number of stakeholders involved in the process. These stakeholders can influence the progress of the project politically, socially and financially.

Generally, these investments are behind private sector investments in performance measurement. Especially in large-scale public investments, there are difficulties in measuring the social benefit of the investment [73].

One of the most important constraints in public investments is budgetary limitations. Within the budget constraints, projects that will provide the highest efficiency from investments should be selected [74].

2.3. Reasons for Public Investments

The fully competitive market mechanism sometimes loses efficiency in resource allocation and decreases competitiveness in the market. In these cases, some of the goods are produced inadequately or not at all. This deterioration in both the production and price is called market failure.

In case of the market failures, the government must intervene in the function of resource allocation of markets, correct market failures or take measures to mitigate the effects of market failure. Market failure is a reason for governments to play a significant role in the economy [9].

Another reason is that in the way of providing economic and social infrastructure, most developing countries experience colossal shortfalls, and the governments have to play a notable role in the closure of such shortfalls using policies [75].

Public investments significantly affect employment. Increasing public investments in economies which are operating under full employment levels help reducing unemployment rate at least in the short term by increasing the total demand [30]. The impact of public investments on employment has two ways. First, employment is created during the investment process. Secondly, once the investments are completed, employment is created once again in the business period [9].

In addition, public investments are dominant factors in expanding the growth rate by revitalizing economic activities [76]. It is known that the investments made by the public sector during the periods of stagnation in the economy contribute notably to the economic revival. In these periods, public investments are increased, and the economy converges to full employment [9]. They increase labor capacity and additions to physical capital, contribute to the increase of production capacity and thus provide economic growth [30].

Due to inequalities in income distribution, parallel to economic policies of governments to ensure fair income distribution, some investments are carried out publicly. These policies can be applied to specific regions or specific sectors or groups of individuals. The investments made in the Southeastern Anatolia Region can be shown as an example of these investments.

The other areas requiring governments to invest are where the private sector cannot make profit, and therefore not invest. Investments in the environmental and forestry sector are examples of these investments. Public investments are important from the stand points of

improving the welfare and quality of life of the society, increasing the efficiency of access to public services and the services rendered and improving human resources [9].

In economies without well-functioning capital and insurance markets, the private sector will refrain from undertaking risky investment projects and long-term investments. Therefore, in these economies, it is imperative for the public sector to undertake risky and long-term investments or to share this risk with the private sector [9].

In terms of the private sector, the most substantial aspect of public investments is the preparation of the infrastructure and business environment which the private sector needs. The establishment of organized industrial zones and the development of a transport network to increase commercial mobility can be cited as examples. In this respect, public investments contribute to the increase in competitiveness and export [9].

Finally, besides these economic reasons, governments sometimes make investment decisions for political reasons. As a result of the political economy, governments use public investments as tools to bring their promises to their electorate or to reassure their political dominance in the electoral districts [30].

2.4. Life Cycles of Public Investments

Public investment projects are carried out by following a set of rules brought by various laws and regulations starting from the project idea to the closing of the project. In many countries, public projects follow similar main steps and complete life cycles except some details in the implementation phase. This cycle consists of six basic steps as shown in Figure 2.

2.4.1. Initiation

The cycle begins by defining the needs and alternative ways to handle these requirements. The needs analysis must ensure the proposed investment to be economically and socially acceptable [4].

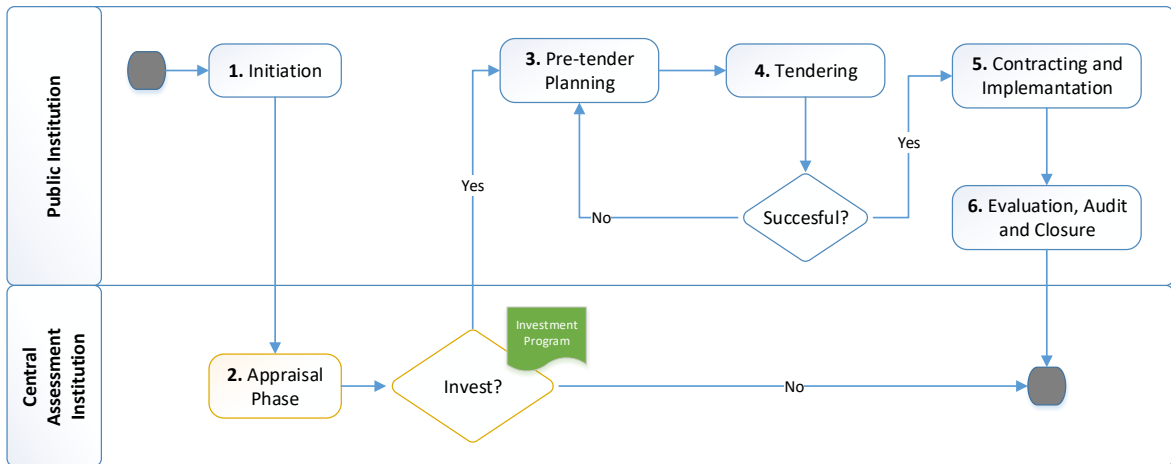


Figure 2: Life Cycle of Investment Projects

At this stage, it is decided whether to be continued the proposed project using the feasibility reports prepared. Feasibility studies are evaluation studies in which the legal issues and risks are discussed in detail together with the economic, technical and financial analyses related to the project. The feasibility report produced at the end of this study clarifies whether the project moves to the next stage.

If the institution believes that the project is feasible within the framework of its own investigations and analyzes, the investment is considered as a formal project proposal. It is forwarded to the senior management, the competent authority or the board, who make the final decision on the realization of this investment.

2.4.2. Appraisal

The project proposals prepared in different sectors and sub-sectors by public institutions are gathered in a central institution or board at the national level. This institution or board examines each project proposal within the framework of parameters such as macroeconomic developments, budget and government policies at the national level. This is the stage where the opinions of the different stakeholders and consultants regarding the proposal are taken.

If a project has been proposed individually, it is decided whether to invest. If a program consisting of many projects has been proposed, it is decided which one of the projects in the program will be invested [77].

At the end of this phase each program and project that is decided to be invested, the institutions to invest in these projects, the sectors and sub-sectors of these projects, the methods and amounts of financing, and the start and end dates of the projects are officially published as national investment programs.

The appraisal stage is vital considering the selection and successful completion of the projects [71].

2.4.3. Pre-tender Planning

Public institutions begin to study details and prepare documents to implement projects approved by the central decision-making body.

From this point on, a tender document is prepared in which the works to be tendered, and their qualifications within the scope of the project, and the positions, tasks, authorities, and liabilities of the project owner and the contractor are clarified.

Tender documents are intensely significant for the fairness and transparency of the bidding process, and it is necessary to announce these documents publicly. Thus, it is ensured that all candidates have equal conditions in the competitive environment [4]. These documents include general, administrative specifications, technical and special specifications, purchase lists and other documents according to the nature of the work.

2.4.4. Tendering

The tender commission shall be established at the institution following the tender announcement. In the meantime, the tender offers prepared by the tenderers must be submitted to the institution until the tender time.

The tender commission announces the approximate cost in the presence of the tenderers, opens the tender offers, reads the bid prices and evaluates the bids of the tenderers professionally and technically. Following the evaluation, the winner of the tender selection is announced. Within the framework of the relevant legal arrangement, a contract is signed between the institution and the winner of the tender.

Public investment tenders are where large amounts of money are transferred to the selected contractor in the tender. In this context, it should be ensured that the electoral decision is impartial and that there is no interest relation between the relevant public authorities and the bidders [4].

2.4.5. Contracting and Implementation

The implementation phase is expressed as the stage in which expenditures are made, and the investment begins to show itself physically. At this stage, project and engineering designs, interviews, construction and installation works, training, testing and commissioning of the plant, etc. are carried out after contracting [78].

2.4.6. Evaluation, Audit, and Closure

After the project completion and the completion of all actions and processes, the project owner carries out various inspections to ensure that the output of the project meets the general, administrative, technical and special conditions in the contract. This audit can be carried out by the institution itself or by an external audit service.

The contractor is requested to eliminate the deficiencies detected. The project is not closed until the output of the project meets the terms of the contract. On the other hand, although it is not encountered frequently, the institution may decide that the output of the project does not meet the terms of the contract and may not receive the output.

At the last stage, the processes and tender files are closed, and the products and services are taken by public institutions. The closure is the final stage of a project where the official closure is approved.

2.5. Difficulties in Managing Public Sector Projects

The realization of some projects in public institutions can be more complex and unpredictable than the private sector. Technology investments, in particular, can be given as an example. These types of investments are highly sensitive to external factors and are characterized as managerially challenging projects [79].

Public projects involve too many stakeholders and thus the project may be changed in the following stages. This makes it difficult to compare the actual results with planned results [79].

Another issue is that large-scale investment projects can cause inefficiency and therefore waste. There may be cases where the equivalent of the money spent on investment cannot be obtained from the realized investment. Especially in developing countries, which are in need for infrastructure investments, the lack of competence of public institutions in the areas of investment planning and realization leads to inefficiency. It should not be overlooked that expenditures on large-scale public projects create a burden on the budget and this situation causes excessive borrowing risk [69].

Another note is that large-scale investment projects may face the resistance of society. In our country, the projects of digging gold using cyanide in Izmir Bergama, the establishment of nuclear power plant Mersin Akkuyu district, the flood of ancient cities due to the dam construction in Gaziantep and Şanlıurfa are some examples of social reactions to projects. These kinds of social reactions may hinder the progress of the investment project in the course of planning and scope.

Since public investments are large-scale in monetary terms and have multi-stakeholders, the whole process may be subject to various degenerations and malicious actions such as rent, bribery, and corruption [69].

Furthermore, public investments are sometimes intended to be carried out for mainly political purposes, regardless of their costs and benefits. Various power and pressure groups carry out lobbying activities with the expectation of rent. Thus the parameters such as project plan and content, size, duration, geographic location may change. The results

and benefits obtained at the end of the project may be very different from those planned at the beginning of the project. It is called the white elephant projects where the benefit obtained is too small when compared to the cost.

Another point is that due to various reasons, the contractors cannot be paid on time and the project is slowed down or even stopped due to the contractor's financial difficulties.

Finally, it can be said that in long duration investment projects, though there is a continuous cash outflow, the expected benefits can be seen only after the investment is completed [69].

2.6. Drivers of Project Failures

This section will focus on the factors causing investment projects to fail just because they are carried out in the public sector. These are briefly mentioned below [79].

There may be different political views between the managers of public institutions which distributes the resource and the politicians, administrative managers or project owners who use these resources. Change in political composition due to the elections may result in the change of new government's investment preferences [79]. Also due to the political interventions in the projects, the confidence in pre-investment assessments may deteriorate [75].

In large-scale infrastructure projects, because of the location of the project, measures should be taken regarding settlement problems and protection of the environment. This causes delays and cost increases [75].

Because of the limitations of legislation, the qualified staff in the institution cannot be assigned to the projects in a timely and necessary manner. It is also true for the assignment of the external professional consultants due to budget constraints. Since the project advances following the legal regulations, the progress of the project is slow [79]. Delays may occur due to the prolonged design and implementation phases [75].

There may be difficulties in determining the objectives and performance indicators because of the involvement of a large number of stakeholders [79]. There may be a lack of coordination and communication between the organization that offers or finances the project and the institution that evaluates the project proposal. This leads to the late start and late completion of the project [75].

The allocation of resources to multi-year investment projects puts a strain on the budget. This, in particular, is a difficulty for weak budgetary systems in the phases of project preparation and implementation [75]. The project exceeds the planned cost due to various reasons [44].

2.7. Reasons for Prioritization

The main motivation for prioritizing investment projects is to ensure that scarce resources are used in projects which provide the highest economic and social benefits.

However, considering the reasons and the impacts of public investments, prioritization may be made due to many different reasons. Even one of these reasons can ensure that the investment is realized or prioritized if there is no other reason.

The first of these reasons may be the level of urgency that makes the realization of the investment project as soon as possible. It may be necessary to realize investment projects due to possible loss of life and property, the strategic importance of the final goods or services of investments in the economy and social life.

The investment project may be compulsorily realized in order to meet the national and international laws, agreements and decisions. Another reason may be the existence of other projects where the project has relationships of primacy/succession/complementarity with it.

Within the framework of government policies, some investment projects may be given priority as they are within the scope of priority investment areas. Also, some of them may be carried out in order to meet a need that has been demonstrated by concrete reasons and evidence.

The investment project may be carried out within the framework of the expectations of politicians to gain prestige and to leave a mark on their own.

Inadequate resources available for investment are important reasons for prioritization and selection. Each investment project which is funded can create an opportunity cost and may pave the way for another project that could provide much more economical and social benefits than itself [49].

2.8. Challenges in Prioritization

The first of these challenges is both the lack of data on the investment project and the unreliability of existing ones. This situation causes the decision-makers suspect of the cost, duration, adequacy of resources, and benefits to be gained. Thus it makes it challenging to prioritize and make choices [80].

Another point is that the prioritization and selection process may be manipulated by various lobbying activities [81]. The pressure and political interventions of various interest groups can be effective in this process.

Some of the investment projects that need to be carried out in areas such as health, education, and defense cannot be quantified in terms of their qualifications, and therefore benefit-cost analysis cannot be realized [82].

The costs of the projects and their benefits will vary according to the date they are realized. In this respect, although a project can be invested according to the results of today's evaluation, it may be a better choice to give up this investment or postpone it to a later date. The main reason for this preference may be that the economy of scale has not been achieved yet. If it is realized today, there may be a surplus of supply [82].

There is no generally accepted practice in the prioritization and selection process. Prioritization and selection processes are shaped in parallel with the perspective of the decision-maker because each method has its own benefits and drawbacks [83].

2.9. Methods Used for Appraisal

Institutions in the public sector prioritize alternative investment proposals because of limited resources and select the appropriate one among them. In order to allocate resources to the investments that will provide the best results for the purpose, project proposals are assessed and decided.

Several methods are used in the prioritization and selection of investment projects. Some of them try to decide on the realization of a single project proposal, while others provide prioritization by comparing the projects with each other.

In a single project appraisal, the investor analyzes whether the project is worth investing. In the case of many investment projects, the investor tries to identify projects more preferable than others [50].

In order to prioritize investment projects, basic methods such as ratios and indicators, methods used under uncertainty such as risk, sensitivity and simulation analysis and multi-criteria decision-making methods such as AHP, ELECTRE and PROMETHEE are employed.

While private sector organizations use the mentioned methods in a wide range, public institutions are more conservative in terms of method diversity. Investment projects realized by the private sector to make a profit can be quantified, and thus a wide range of methods can be used in this way. However, because the economic and social benefit is the main objective in public projects, many other aspects of investment are not available for measurement other than financial data.

Many countries analyze investment project proposals in line with the guides they prepared or adopted for prioritization and selection those proposals. Various international organizations have developed models that enable prioritization and selection of public investment projects.

Some examples of these guides and the methods and criteria used proposed in these documents are given in Table 2.

Table 2: Prioritization and Selection Documents by Some Countries and International Organizations

The Guides	Prepared by	The Methods	Recommended Indicators in Decision Making
Handbook on Benefit-Cost Analysis [55]	Australian Government	Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA)	Net Present Value (NPV)
Canadian Cost-Benefit Analysis Guide [84]	Treasury Board of Canada Secretariat	CBA and CEA	NPV
Guidance on the Methodology for Carrying Out Cost-Benefit Analysis [45]	European Commission (EC)	CBA and Sensitivity and risk Analysis	Financial NPV, Financial Internal Rate of Return (Financial IRR), Economic NPV, Economic Internal Rate of Return (Economic IRR) and Benefit Cost Ratio (B/C)
Cost Benefit Analysis Primer [85]	Government of New Zealand	CBA, Scenario Analysis, Sensitivity, and Risk Analysis	NPV, IRR and B/C
Guide to Social Cost Benefit Analysis [86]	Government of New Zealand	CBA	NPV, IRR and B/C
The Green Book: Appraisal and Evaluation in Central Government [87]	HM Treasury, United Kingdom	CBA, CEA, Sensitivity and Risk Analysis, Monte Carlo Analysis, Discounted Cash Flow Analysis	NPV and Net Present Cost (NPC)
Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs [88]	U.S. Office of Management and Budget (OMB)	CBA and CEA	NPV
Guidelines for the Appraisal and Management of Capital and Expenditure Proposals in the Public Sector [89]	Government of Ireland	CBA	NPV, IRR and B/C

Table 2 (continued)

Guidelines for the Economic Analysis of Projects [90]	Asian Development Bank (ADB)	CBA	Economic NPV, Economic IRR, B/C and Cost-Effectiveness Ratio (CER)
A public financial management introductory guide [69]	Overseas Development Institute (ODI)	CBA and CEA	NPV, B/C and CER
Investment Program Preparation Guide, Feasibility Report for Public Investment Project Proposals [91]	SBD, Turkey	CBA, CEA and Sensitivity and Risk Analysis	NPV, IRR, Economic NPV, Economic IRR, and CER
Manual of Industrial Project Analysis in Developing Countries: Social Cost Benefit Analysis [92]	Ian M. D. Little and James A. Mirrlees for OECD 1968	CBA through shadow prices and social discount rate based on world (border) prices	NPV
Project Appraisal and Planning for Developing Countries [82]	Ian M. D. Little and James A. Mirrlees for UNIDO 1974	CBA through shadow prices and social discount rate based on domestic market prices	NPV
Economic Analysis of Projects [93]	Lyn Squire and Herman G. Van Der Tak for World Bank 1978	CBA through shadow prices and social discount rate based on world (border) prices	NPV
Manual for Evaluation of Industrial Projects [94]	UNIDO and IDCAS 1986	The national value-added method through adjusted market prices	Expected Net Value Added by the project (NVA)

3. PUBLIC SECTOR INVESTMENT PLANNING IN TURKEY

3.1. Planning Framework

The planning process in Turkey is composed of three stages which are macro planning, sectoral planning, and project planning.

In the first stage, the macro planning studies and mathematical modeling studies are carried out, the target growth rate is determined by the macroeconomic sizes such as consumption, investment, savings, imports, and exports. Population, employment, and similar socio-economic parameters are estimated. Consistency tests are applied by comparing the results obtained from these estimations both within themselves and with the results of other stages. The macroeconomic framework of the policies to be followed in order to realize the targets are determined [8]. Sectoral planning studies, the second phase, serve as a bridge between macroeconomic planning and project planning. At this stage; agriculture, manufacturing, mining, energy, services and etc., supply-demand balances of goods and services to be produced in basic sectors, import, export, capacity, the status of production technologies, investments in the sector, competitiveness, etc. are examined in detail. Sector analyzes are realized in order to determine intersectoral and sectoral priorities and relations between sectors and projects. Otherwise, the project planning process that follows will be disrupted and wrong investment decisions will be made, wasting scarce resources and deviating from plan targets [27].

In the third phase of planning, projects are discussed. While equilibrium and intersectoral consistency among macro-magnitudes are considered in the first two stages, the most important point at this stage is maximizing the effectiveness. In other words, the integrity, consistency, and success of the plans in the implementation phase depend on the selection of the most suitable and effective projects. In this stage, where the basic preferences of public investments to be transferred to sub-sectors, the areas where public resources will be used in terms of fixed capital investments are determined too [8].

Coordination during the implementation of these plans and programs is provided by the Strategy and Budget Directorate (SBD) of the Presidency. The main framework [27] is illustrated in Figure 3.

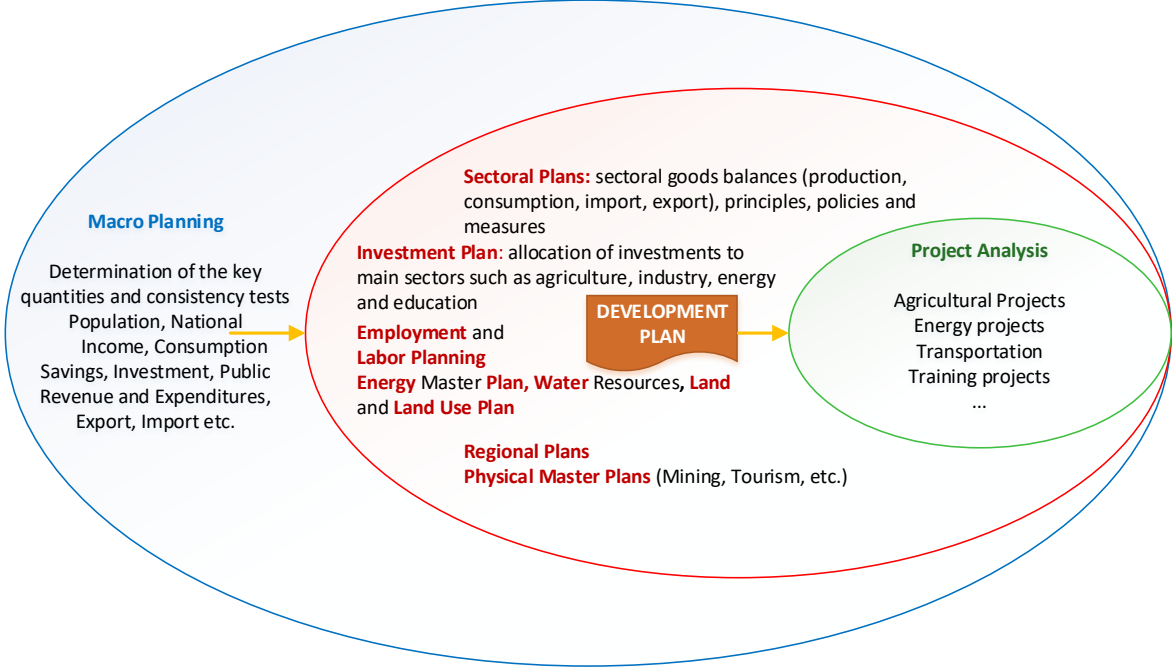


Figure 3: Planning Framework¹

3.2. Legislative Regulations

Details on the preparation and implementation of the budget, the actors and their duties involved in this process, and the timetable for the budget process are regulated in various articles of the Public Financial Management and Control Law No. 5018. The Public Investment Program is being prepared simultaneously with the budget preparation process as part of the same law.

In the article titled “Public Investment Projects”, it has been stated that “public investment projects will be prepared, implemented and monitored within the framework of the Decree Law No. 540 dated 19.6.1994, Investment Program Preparation Guide and other relevant legislation provisions”. Under the title of “Public Investment Projects” Law No. 5018, it is stated that “public investment projects will be prepared, implemented and monitored

¹ This figure has been adapted from Ayanoğlu et al. [27].

within the framework of the Decree Law No. 540 dated 19.6.1994, The Guidance on Preparing the Investment Program and other relevant legislation”.

The Law states that the public institutions taking place in the scope the central government will cooperate with the Ministry of Treasury and Finance (MTF) to ensure the integrity of the budget.

In order for the new project proposals to be included in the Investment Program, it is also stated that there should be a feasibility study that covers analyses of cost-benefit or and environment, and these feasibility studies should be reviewed and approved by SBD (former Ministry of Development).

Furthermore, it is stipulated in the Law that “the realization and implementation results of public investment projects will shared by public institutions with the Court of Auditors, MTF, and SBD in the form of a report by the end of March of the following year”.

Other regulations regarding the programming process are regulated in the Program Decisions, Investment Program Preparation Guidelines, and Investment Circles.

3.3. Policy Documents

Policy documents are where the government draws the direction of the country considering the economic, social and cyclical situation of the country in order to ensure a planned and sustainable development and growth. These documents are some kind of road maps of for countries. They are generally in a hierarchical structure where the level of detail increases in various subdocuments from top to bottom.

The document at the top is composed of *long-term strategies* which determine the general objectives and policies related to public investments. In Turkey, the Long Term Development of 2001 - 2023 periods is currently valid.

SBD's five-year development plans are mandatory to be followed by the public sector in order to achieve the economic and social development goals set for the whole country or a

particular region. These plans are important in terms of directing all the organs of the state within the framework of predetermined targets and policies.

In sectoral policy documents, the steps to be taken by the state take place for each sector. In this context, priority actions and strategies for each sector and sub-sector are defined. The public institutions responsible for the realization of these actions and strategies are identified. The National Rural Development Strategy (2014-2020), Turkey Export Strategy and Action Plan (2023), and Turkey Transportation and Communication Strategy can be given as examples of sectoral strategy documents.

In the Investment Program Preparation Guide for the 2019-2021 period, it was stated that budget allocation priority would be given to education, health, drinking water and sewage, science-technology, transportation, energy and irrigation sectors, and others carried out via Public-Private Partnership model (PPP) [91].

Another document that directs public investments is the regional plans that give a spatial dimension to development. Regional development plans are prepared and implemented in order to reduce development and welfare gaps among the regions.

Some regional plans implemented in Turkey as of 2019 are the Southeast Anatolia Project Master Plan (GAP), the Eastern Anatolia Project Master Plan (EAP), and the Konya Plain Project (KOP).

The medium-term investment plans of the institutions are defined in their strategic plans as objectives and targets. Strategic plans are the documents that are prepared as a road map of institutions for the future in parallel to development plans, regional and sectoral plans. Institutions explain their mission and vision, objectives and how to achieve them in institutional strategic plans.

Another macro policy document which is prepared in congruence with the development plan and guides public investments is the Medium Term Program (MTP) prepared by SBD. The MTP defined in Law No. 5018 is prepared for three years to cover macro policies, main economic dimensions of objectives and indicators, development axis of development

plans and development policies and sectoral policies. The MTPs are documented before the end of May and approved by the Council of Ministers within the same period and published in the Official Gazette. The MTP is not a static document and is renewed every year.

The Medium-Term Fiscal Plan (MTFP) defined in Law No. 5018 is composed of estimations of both total revenue and expenditure for the next three years and the appropriation ceiling of public administrations. MTFP is prepared by MTF and, published by the Economic Policy Board (EPB) of the Presidency by the 15th of June in the Official Gazette.

Annual programs are annual macro policy documents providing information on the activities to be carried out in the budget year in unison with the priorities set forth in the MTP. Also, they include economic, financial, social and cultural policies to be implemented to succeed in the objectives. So programs are the means of implementation of development plans [30].

The public investment program presents the distribution of the investment budgets allocated to public institutions in the budget year. The preparation of the public investment program is regulated in Law No. 5018 as part of the budget process. It is prepared by SBD and published in the Official Gazette as annexed to the Decision of the Council of Ministers on the Implementation, Coordination, and Monitoring of the Annual Program within 15 days after the Central Government Budget Law comes in to force.

The Investment program which is listed based on sector and organization shows the annual appropriations allocated to projects and the sum of previous years' expenditure of those. Besides the program demonstrates, and projects' costs, locations, characteristics and start years [30].

3.4. Annual Investment Program Planning Process

The preparation process of the public investment program is carried out simultaneously with the preparation process of the central government budget, which is described in the Law No. 5018.

The preparation of MTP by SBD is the start point of the budget and public investment program. The MTP is a document in which macro-policy, principles, objective and indicative basic economic magnitudes of the development plans, development axes, and sectoral policies are defined for three years. The MTP is approved by the Council of Ministers until the end of the first week of September and is published in the Official Gazette.

In compliance with the MTP, MTFP which includes estimations for total revenue and expenditure for the next three years, target deficit and borrowing status, and ceilings of budget proposal of public administrations to be valid for a 3 years period is prepared by the MTF. The MTFP is finalized by the EPB and published in the Official Gazette by the fifteenth of September.

In keeping with the priorities set in the MTP and MTFP, the Budget Call and its Annex are prepared by MTF and published in the Official Gazette until the fifteenth of September. In order to make the investment proposals in conformity with the Budget Call and its Annex to the Guide for the Budget Preparation, the Investment Circular and Investment Program Preparation Guide are prepared by the SBD and published in the Official Gazette within the same period.

The Investment Circular includes investment policies, sectoral and project-based priorities, while the Investment Program Preparation Guide mainly covers the principles to be followed and information to be used when preparing investment proposals. These are tables to be used in proposals, deflator set, and exchange rates to be used in calculations, feasibility study format, and etc. Investment offer ceilings of public institutions are also attached to the Guide.

Public institutions, adhere to Investment Circular and its annex the Investment Program Preparation Guide and start to prepare expenditure and investment proposals for the relevant year.

At this stage, each public institution carries out preliminary work on the ideas of the investment project it wishes to implement in the relevant year, and the ones that can be

realized with the pre-selection are determined. Public institutions are obliged to prepare detailed feasibility reports through cost-benefit or cost-effectiveness analysis for the new project proposals requiring capital 10 million TL and above. These reports demonstrate the technical, financial, economic and social feasibility, priority, impacts on the environment and contribution to employment [91].

The institutions carry out detailed feasibility studies for project ideas that they think are feasible. Until the end of September, each institution submits both investment project proposals and feasibility reports to SBD. Expense proposals are submitted to the MTF within the same period to be evaluated.

SOEs, institutions having revolving funds, and institutions in the scope of privatization, social security institutions and Iller Bank that are outside the scope of the central government budget, submit their investment proposals to SBD within the same period.

Investment proposals that reach SBD are submitted to sector experts for evaluation. At this stage, investment meetings are held to discuss investment proposals between sector experts and investor organizations. Coordination meetings are held between the Ministry and the SBD authorities in relation to the general investment sizes.

Following these interviews and assessments, the Draft of the Investment Program prepared within the framework of sectoral objectives in the light of macroeconomic insights is submitted to the EPB. Program draft, macroeconomic indicators, and budget sizes are discussed in the Board and final decisions on macro sizes are made. These decisions are published in the Official Gazette as EBP Decisions.

After clarifying of the final amounts, the budget tables are prepared by the MTF. Following the issuance of a visa for the investment appropriations by the Ministry, it issues a visa for investment expenditures in the SBD.

The budget and its annexes are all submitted to the Turkish Grand National Assembly at the latest in October along with the central government budget draft. The Central Government Budget has to be published in the Official Gazette before the fiscal year.

The public investment program is published in the Official Gazette as an attachment of the Council of Ministers Decision within fifteen days from the date of entry into force of the Central Government Budget Law [27]. To demonstrate the annual investment planning process, a flowchart is given in Figure 4.

3.5. Appraisal of Investment Projects Proposals

Investment projects are generally subject to several stages of elimination and selection in the public sector, as briefly described below.

In the first stage, each investor institution makes various assessments on the investment project ideas that it wants to realize. After preliminary elimination of these proposals, the projects that are decided to be submitted as project proposals are clarified.

The investor prepares a feasibility report for each project proposal that requires more than 10 million TL. In the report, reasons for the project, economic and social benefits, technical analysis, and amount of capital, completion time and environmental impacts are discussed in detail. Some political preferences can be effective at this stage.

In the second stage, the investment proposals and feasibility reports prepared by the institutions in congruence with the Investment Program Preparation Guide are submitted to the SBD. These proposals are analyzed for compliance with macro targets, sectoral and intersectoral balance, and compliance with specific socioeconomic criteria and preferences.

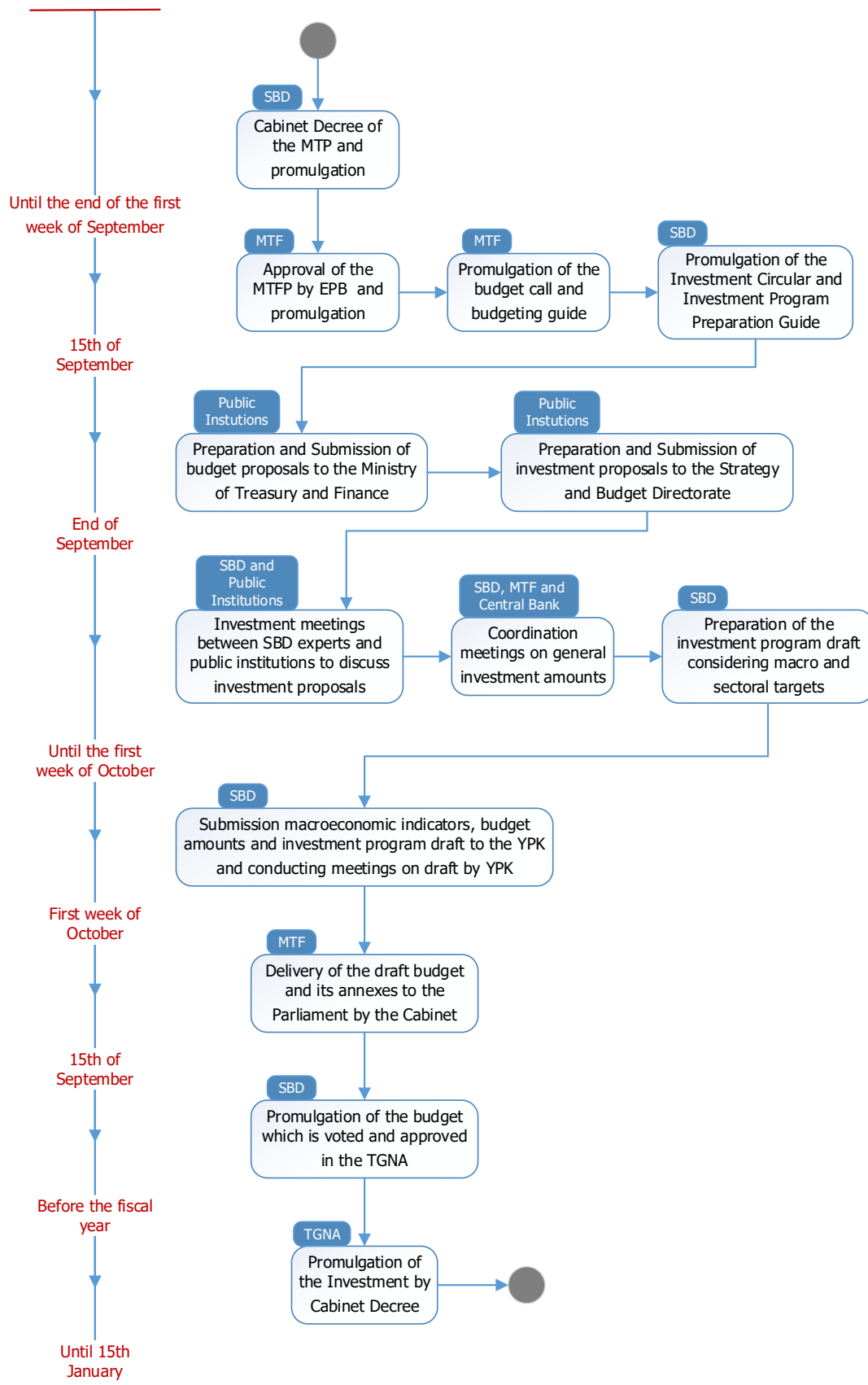


Figure 4: Annual Investment Program Planning Process

The appropriation of allocations to projects which passes eliminations are done, and remnants form the draft of the Investment Program. Then, the program draft is submitted to the EPB for approval [27].

In the process of selection among the projects of many institutions, the methods to be used in the analysis are mentioned in the legislation. In the 2019's investment program preparation guide [95], it was stated that "Public investment proposals and decisions will be based on sectoral and regional plans and strategies, action plans and qualified feasibility studies that analyze needs, problems and solutions for them."

This provision states that policy documents and feasibility studies will be taken as a basis in the process of determining projects which will take place in the investment program among the proposals gathered in the SBD. Financial, economic, social and regional analyses and cost-benefit or cost-effectiveness analyses included in feasibility reports play an important role in decision making.

Also, in the Article 13 of Public Financial Control Law No. 5018 [96], it is stated that "The budgets shall be prepared, implemented and controlled in conformity with the policies, targets and priorities envisaged in the development plans and programs, and according to the strategic plans, performance criteria and cost-benefit analysis of the administrations."

According to this provision, the projects to be included in the programs should be evaluated within the framework of the benefit-cost analysis (BCA) principle. In this context, the SBD uses the Financial BCA and the Economic BCA methods in the selection of public investment projects from many sectors in project planning [97].

The feasibility studies and the technical, economic, social, financial and environmental analyses of the investment proposals of the institutions are of great importance in terms of effective utilization of scarce public resources and the social welfare. In this context, the cost-benefit analysis was applied in the late 1960s and 1970s.

As the main criterion in Turkey until 1975, the social benefit-cost ratio was used in the calculation of costs, benefits, shadow prices, and interest rates. After 1975, because of the

lack of data, it was adopted that market prices reflect the equilibrium prices to a large extent and their use is sufficient. These prices were adjusted, and single criteria methods such as value added effect, employment effect, the balance of payments effect came to the fore.

One of the most comprehensive studies examining the analysis that can be used in the selection process is Ayanoğlu's [27] study. In the book titled Planning and Analysis of Public Investment Projects, where all of the authors are planning experts, program and project relation, project planning, project preparation, and project analysis techniques are analyzed in the light of the knowledge and experience gained from the theory and application.

However, in the book mentioned above includes techniques that allow decision-makers to assess project proposals individually and compare multiple projects using a single criterion. Moreover, because the book was published in 1997, it does not provide information on the currently used assessment methods.

At this point, no information has been provided by the SBD in any document published regarding the existence of a method aside from those specified in the legislation.

In April 2019, within the scope of The Right to Information Act Law No 4982, the author of this thesis requested some information on whether there is/are any MCDM methods used in the assessment of sectoral and intersectoral project proposals.

In the response given by the SBD, It was mentioned that any MCDM method has not been currently used to compare the proposals, and the assessments have been carried out by experts within the framework of the feasibility study, the relevant legislation and Investment Program Preparation Guide program.

From this point of view, it can be said that the selection process is conducted within the framework of analysis obliged by the legislation and the knowledge and experience of the sectoral experts. Based on this situation, due to expertise in the sectoral fields, it can be

concluded that there is a possibility to make mistakes in comparing sectoral and intersectoral projects.

4. RESEARCH DESIGN AND METHODOLOGY

4.1. Literature Review

When reviewed the academic studies on multi-criteria decision-making methods, it is seen that these methods are used in many areas including decision making, preference, prioritization, and portfolio creation.

However, the studies on the examination of functions of and qualifications of public administration and public institutions where MCDM methods are employed are just a few. Although few studies have been conducted on the project portfolio formation which is the subject of our thesis, there is no comprehensive study on the creation of the project portfolio using fuzzy AHP method in the public sector. In a very few numbers of studies, the fuzzy AHP method was preferred for only some specific types of project such as R&D and transportation. In this context, fuzzy AHP on prioritization and selection of public and private sector projects will be mentioned.

Huang et al. [98] have worked on the technical qualifications of the Industrial Technology Development Program Technical Committee in the selection of R&D investment projects that will provide state support in Taiwan in 2008. The criteria set developed for this purpose was weighted by fuzzy AHP method within the framework of the responses of the experts in the committee. In the light of the results obtained from the analysis, it was concluded that the contribution criteria to be provided by the experts in scientific and technological terms is the most important criterion.

In 2009, Arslan [99] presented a hybrid model of fuzzy logic and AHP as a decision support model, which includes public participation and oversight to help policy-makers choose appropriate transport projects. The proposed model was applied as a questionnaire in order to show the public preferences about public bus transportation in Eskişehir. According to the results, there is a tendency for the public bus to be operated by the private company.

Amiri [100] proposed a hybrid model in which AHP and Fuzzy TOPSIS methods were used respectively in a study conducted in 2010 in order to prioritize and select the investment project alternatives to be realized by the National Iranian Oil Company. Fuzzy TOPSIS method was then used to obtain the ranking of alternative projects. Within the framework of these 6 criteria, the model was applied on 5 project alternatives and their priority queues were obtained.

Nassif et al. [101] developed a proposal by using fuzzy logic approach in the selection of project alternatives in the field of information technologies in 2013. The application of the model was carried out with a case study. Following the put forward of the projects needed by the IT crew, the projects were classified and linked to the actions in the strategic plan of the organization. Then the verbal variables, fuzzy function and inference rules were described by the stakeholders. Finally, a fuzzy logic simulation was performed to obtain the probability of success of each project. In addition, it was concluded that a decrease in external dependence and cost reduction of the project had a positive effect on the success of the project.

In 2013, to prioritize municipal projects, Baysal et al. [102] conducted a study which is composed of 2 methods used respectively. In the first stage, the main project group was selected through fuzzy TOPSIS method and in the second stage the best project was selected for this project group using and fuzzy AHP method. Methodology was applied in Konya Metropolitan Municipality. According to the results, the investment project in the field of urban development was obtained as the first priority investment.

In 2015, to assist in the selection of the most suitable improvement project in short and medium term for a company which manufactures pipes, Kargı [103] made a study by using fuzzy AHP method. In the model, five main criteria are defined as productivity, cost, quality, customer satisfaction, and occupational safety. Increasing the welding automation rate, reducing welding errors, increasing the safety of material handling and decreasing the amount of spool paint consumables are described as projects.

As a result of the analysis, the highest weighted criterion was the occupational safety criterion (25%). Occupational safety criterion is followed by quality (23%), customer

satisfaction criterion (17%) and cost and efficiency (12%) criterion criteria. In this respect, it was concluded that the company should prioritize the improvement project in the field of occupational safety. Increasing the welding automation rate has been found as a priority project.

In a study in 2016, Khamas et al. [104] proposed a two-stage hybrid model employing fuzzy logic approach to evaluate urban planning projects and determine an ideal master city plan for cities. In the first stage, fuzzy AHP was employed to find the weights of the project evaluation criteria, and in the second stage, fuzzy VIKOR method was used to select the optimum project by ordering alternative projects. The implementation was carried out for the Iraqi city of Mukdadiyah and it was concluded that the 3rd project was considered as the master plan among the 3 alternative projects planned for the city.

In the study conducted by Kusumawardani et al. [105] in 2016, a hierarchical structure was established by determining the various criteria used in the selection of research proposals to be provided with budget support under the control of the LPPM within the UNS. The criteria were weighted by the fuzzy AHP method in the selection of the recommendations from the two sample research programs, and the proposed research was successful in both programs.

In a study by Anisseh et al. [106] a hybrid model including fuzzy Delphi, fuzzy AHP and fuzzy TOPSIS methods respectively was established to select the best project portfolio in 2018. The criteria and sub-criteria to be used in the selection of the project with the fuzzy Delphi method were determined. These criteria and sub-criteria were weighted by fuzzy AHP method. A fuzzy TOPSIS method was used to determine the relative distances of the solutions to the ideal solution. The sub criteria of “the impact of the resources required for the new project on the resources of ongoing projects” has been more influential than the other criteria. The proposed methodology results in that the Rajaie Bridge and Nokhbegan Pedestrian Bridge projects are priority among the five projects underway.

In the study conducted by Chatterjee et al. [107] in 2018, fuzzy AHP method was used in order to prioritize the project proposals in the investment portfolio of a project-based private sector organization. The experts of the company handled the project proposals at

different project risk levels within the framework of criteria and sub-criteria. The results of the analysis says that the sub-criteria on financial issues obtained the highest weight total. Using these weights, the company scored different project proposals on a scale of very poor, poor, satisfactory, good and excellent.

In another study in 2018, Kiraz et al. [108] focused on determining the Priority Sectors of Investment in Sakarya Province. Fuzzy AHP and fuzzy TOPSIS method were used in order to determine the factors that are effective in determining priority areas in the research carried out in two steps using Fuzzy AHP and fuzzy TOPSIS Methods. As a result of the fuzzy AHP, the three most important criteria for determining the investment-priority sectors were determined as the market, incentives and support and the proximity to raw materials. As a result of fuzzy TOPSIS, priority sectors for Sakarya province are determined as automotive and sub-industry, iron and steel metal processing, and agriculture-agriculture and livestock sectors.

In 2019, Shaygan et al. [109] conducted a study using fuzzy AHP to determine the reasons for weak performance of the appointment system in a hospital. The causes of weak performance are identified using a cause-and-effect diagram and structured into a hierarchy. These criteria were compared in pairs by 14 employees in the administrative staff of the hospital and prioritized by fuzzy AHP method. The results revealed that the reasons for poor performance were largely related to the appointment scheduling and telecommunication sub-criteria.

4.2. Research Design

The Problem

In Turkey, various public investments are needed in terms of effective provision of public services, improvement of the standard of living, county's competitiveness and development of social and physical infrastructure for sustainable growth, protection of the environment and elimination of inter-regional development differences.

As the resources of the government are scarce, the budgeting process is complicated to allocate sufficient resources to the investments. In addition to limited public resources, the

selection of projects without feasibility studies leads to the inability to allocate sufficient resources to the priority projects, to prolong the duration of the projects, to increase their costs and to delay their benefits.

In our country, the investment proposals which public institutions desire and/or need to realize are submitted to the strategy and budget directorate in the form of project proposals and feasibility reports. These proposals are handled by project experts and related sectoral experts within the directorate. Experts discuss the details of the proposal and investments cost with a one-to-one meeting with the bidder public institutions.

Experts subjectively assess the sectoral or intersectoral proposals using the information extracted from feasibility reports and interviews within the framework of the competence and experience they had. The accepted projects are included in the annual investment program and resources are allocated for each.

On the flip side, there is no prioritization method in which there are quantifiable objective criteria that can prioritize intersectoral or sectoral proposals. **The problem** is that an objective assessment is not performed and wrong projects may take place in the investment program due to the lack of a method to compare project proposals with others, regardless of sectoral and intersectoral distinction. This lack may be causing wasting of national wealth in terms of cost, time and labor elements. Even worse, in terms of benefits, they provide it may cause other projects which deserve to be in the investment program to be ignored in the program preparation process.

The Purpose

The purpose of this study is to create criteria for assessing project proposals to be used in the prioritization and selection of investment projects proposed by public institutions, to weight the mentioned criteria and to create a new selection system based on quantified data by obtaining a priority score for each project proposal within the framework of these criteria.

The Scope

The scope of the study is the prioritization and selection of only public sector investment proposals. Private sector projects have been ignored as the investing reasons of public sector differs from private sector is different.

The Data

The criteria set has been shaped by various academic and official sources and the authors' own thoughts. The criteria and comparisons which will be scored by experts have been designed as an online form that allows pairwise comparisons. This comparison form aims to evaluate the public comparisons by a few public employees who have knowledge and experience in the field of public investments, selection and realization of investments, to ensure realistic and healthy comparisons. A hardcopy of the form mentioned is given in Annex 1.

Responses of 14 experts who are mid-level managers and senior management positions at the Presidency, Strategy and Budget Directorate, The Turkish Grand National Assembly, The Treasury and The Ministry of Finance, The Ministry of Transport and Infrastructure and General Directorate of State Hydraulic Works have been received. The majority of the responses has been collected with online form while the rest of them has been collected as hard copies.

The Constraints

In order to be used in the thesis, various information regarding the project proposals rejected in the years 2017 and 2018 has been requested from the SBD in accordance with the Right to Information Act Law No 4982. However, in SBD's response, it has been stated that the information about the rejected proposals is not shared with the public. Therefore, the illustration of the model will be carried out by using various project proposal scenarios.

In this study, fuzzy AHP method will be employed. The fuzzy logic, fuzzy sets and numbers will be briefly explained before going to the details of fuzzy AHP method. Then, why fuzzy AHP method is preferred instead of classical AHP method will be given.

Finally, fuzzy AHP method that combines classical AHP method and fuzzy logic application, will be detailed.

4.3. Fuzzy Logic

The fuzzy logic system, a multi-logic system which is developed against Aristotle's binary logic, tries to determine what events happen by assigning membership degrees to the events [110].

In mathematical reasoning, a scientific conclusion or decision-making process is made with propositions such as absolute false or absolute true expressed by 0-1 binary number system. However, the dual logic in this way is insufficient to explain the uncertainty of the real world. In real life, solutions are generally considered to be partially true, in some cases, true or false.

Even though the inadequacy of classical logic understanding was previously recognized, the most basic study on this subject was made by Lotfi A. Zadeh in 1965. Zadeh was the first to propose the concept of fuzzy clusters, arguing that the elements in a cluster should belong to a certain degree of the cluster [111].

In the 1970s, many studies were conducted. The theory began to gain importance with the modeling of the control of a steam engine developed by Mamdani and Assilian in 1975 with a fuzzy system [112]. Although its development was first seen in Europe, Japan, and Far-Asian countries were the centers of use and spread [113].

Fuzzy logic is the generalized version of classical binary logic (0,1), and in the broader sense, it refers to all the theories and technologies that use fuzzy sets [114]. According to Zadeh, the basis of fuzzy logic is as follows [115];

- Fuzzy logic uses non-clear close values.
- For the fuzzy logic, the expression of information can be very good, good, very small, and very large.
- Membership degree values in the fuzzy logic are between (0-1).

- Logic expressions can be found that can be converted to a fuzzy expression.
- Systems containing difficult and complicated models are suitable for fuzzy logic method.

The subjects, objects, and situations which fuzzy logic theory deals with are fuzzy, while the theory itself is not fuzzy. In other words, the theory is not without rules [116]. The values of the fuzzy set elements can vary between (0,1) as an infinite number. The main features of fuzzy logic can be listed as follows [117].

- It has inference rules, although the validity is uncertain,
- Fuzzy logic has verbal degrees of accuracy expressed as extremely important, important, and less important,
- It can make fuzzification of any logical system,

The first of the cases where fuzzy logic is most valid is that the event is very complicated and if there is not enough information, the opinions and judgments of the people should be included, and the second is the cases that require human understanding and judgment [118]. In other words, fuzzy logic softens rigid transitions such as 1 and 0 in classical logic, allowing the logic rules to be implemented flexibly. Table 3 shows some essential differences of fuzzy logic which differs from classical logic [117].

Table 3: Some Differences Between Fuzzy Logic and Classical Logic

Fuzzy Logic	Classical Logic
Partial	Exact
Specific Degrees	All or None
Continuity Between 0 and 1	0 or 1
Fuzzy Units	Binary Units

The advantages of fuzzy logic can be listed as follows [119].

- The fuzzy logic is very close to the human thought system and style.
- It does not necessarily require a mathematical model in the application process.
- The fuzzy logic provides ease in comprehending.

- Due to the use of membership values, it is more flexible than other control techniques.
- The use of non-certainty (uncertain) information is involved.
- The fuzzy logic allows modeling of nonlinear functions.
- A model or system based on fuzzy logic can be designed effortlessly based on the experience of experts

Besides its advantages, there are some inabilities and inadequacies of fuzzy logic which are listed as follows [117].

- The rules to be used depend on experience.
- Since there is no rule in determining the membership function, the membership function must be found through trial and error, which causes the trial and error process to take a long time.
- Stability analysis cannot be performed, and the outcome cannot be predicted. So the only thing that can be done is the analogy.

4.4. Fuzzy Sets

Clusters whose boundary conditions can be expressed as variables are called fuzzy sets. This concept allows conditional membership. It generalizes the concept of the classic set, and any value in the range $[0,1]$ is accepted. In the classical cluster, belonging to the cluster is more rigid. Classical and fuzzy clusters are separated from each other in this aspect [120].

The central concept of the fuzzy theory is known as fuzzy sets. Clusters are classically defined as a collection of well-defined objects. In the classical cluster definition, any object is either the element of a set or not. . In other words, an element is evaluated as 1 if it belongs to the set and 0 if it is not. Fuzzy clusters have no such certainty.

In general, although the understanding of classical clusters is sufficient for the numbers that mathematics deals with, it is insufficient for the classical cluster concept to express the real objects and abstract concepts in nature.

Fuzzy set theory expands the classical set theory by allowing partial membership and accepts any value in the $[0, 1]$ range for cluster membership. Fuzzy sets do not draw strict boundaries. It is more flexible than classical logic and includes verbal expressions. Since people can think verbally and can convey verbal expressions to others, these statements cannot be expected to be definite.

The fuzzy set has managed to define the events close to reality and to create systems that represent the real world better by assigning membership degrees as little bad-less bad, less beautiful-less ugly, warm-cool, slightly short-a little long [121].

4.4.1. Membership Functions

The basis of fuzzy set theory is membership functions [122]. The main feature that distinguishes fuzzy clusters from classical clusters is that they consist of elements with different membership degrees ranging from 0 to 1. While membership degree is defined as “the value of the change between 0 and 1 for each element”, membership function is defined as “the change of membership degree within a subset” [112]. Membership of a fuzzy number is represented as below:

$$\mu_A(x) = E \rightarrow [0,1]$$

Fuzzy numbers are defined by their membership functions. Therefore, there are as many fuzzy numbers as the membership function type. Both triangular fuzzy numbers and trapezoidal fuzzy numbers are widely used due to their ease of use which take their names from the forms of membership functions [123].

Triangular Membership Function

A triangular membership function, a specific condition of the trapezoidal membership function, is defined by three parameters l , m and u [114].

$$\mu_{\bar{A}}(x) = \begin{cases} 0, & x < l \text{ or } x > u \\ \frac{x-l}{m-l}, & l \leq x \leq m \\ \frac{u-x}{u-m}, & m \leq x \leq u \end{cases} \quad (4.1)$$

As seen in (4.1) there is an order of $l < m < u$ among the parameters. l is the lowest value; u is the maximum value, and m is the most likely value. The graph of the triangular membership function in fuzzy sets is shown in Figure 5.

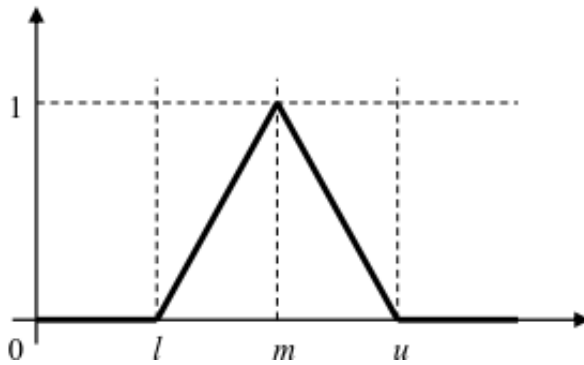


Figure 5: Triangular Membership Function in Fuzzy Sets

Trapezoidal Membership Function

Trapezoidal membership functions are defined by four parameters, which are l , m , n , and u [114].

$$\mu_{\bar{A}}(x) = \begin{cases} \frac{x-l}{m-l}, & l \leq x \leq m \\ 1, & m \leq x \leq n \\ \frac{u-x}{u-n}, & n \leq x \leq u \\ 0, & x < l \text{ or } x > u \end{cases} \quad (4.2)$$

As seen in (4.2), the parameters are in the order of $l < m < n < u$. The graph of trapezoidal membership function in fuzzy clusters is shown in Figure 6.

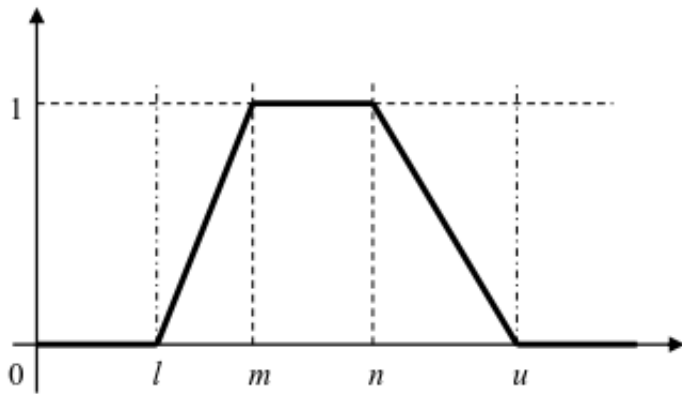


Figure 6: Trapezoidal Membership Function in Fuzzy Sets

4.4.2. Fuzzy Numbers

Fuzzy numbers are a subset of fuzzy sets. Fuzzy numbers are expressed based on the relationship between the α -truncation method and the interval analysis. The value of a fuzzy number cannot be expressed in absolute terms. The membership degrees, however, can be expressed in absolute terms [124].

4.5. Analytical Hierarchy Process (AHP)

Myers and Alpert first introduced the Analytic Hierarchy Process (AHP) in 1968. Then Thomas Lorie Saaty improved it in 1977 as a model [117, 125]. AHP has been a decision-making approach that is frequently used by decision-makers and researchers in the solution of MCDM problems [126].

AHP is an easy intuitive approach used to express and analyze decisions [127]. In its most general definition, it is a structural approach used to determine multiple criteria and criteria weights. AHP approach is a decision-making process based on “assigning relative importance values to decision alternatives and criteria in complex decision-making problems” [128].

It is developed based on the knowledge that the human brain evaluates options and criteria during Pairwise comparisons in decision-making problems consisting of multiple criteria [129]. Therefore, it is an approach that reveals how humankind perceives and shapes a complex decision problem [130]. AHP is an intuitive and logical evaluation process for choosing the best one among multiple criteria alternatives. In this process, the decision

maker determines the importance levels between alternatives with simple pairwise comparisons [131]. AHP, an organized hierarchical structure consisting of objectives, main criteria, sub-criteria, and alternatives that enables the determination of priorities by making pairwise comparisons [132].

All the parts that make up the hierarchical structure are associated with each other. Therefore, one can see how a modification to be done in any element will influence other elements [133]. It enables the decision maker to integrate experience, knowledge, and intuition into the decision process by quantifying [134]. The most crucial feature of AHP is that it allows decision-maker to incorporate objective and subjective considerations into the same decision making process [135].

Basic principles of the method

In the AHP approach, the three fundamental principles are defined by Saaty (1986) for the solution of problems [136].

- **Decomposition:** It refers to the decomposition of the elements of the problem into low level and minor parts in a hierarchical structure so as to provide a better understanding and evaluation of a decision problem [137]. Miller [138] stated that the upper limit of the number of items that the human brain can process in the short-term memory is 7 and may vary ± 2 according to the person.
- **Comparative Judgments:** To have the relative significance of the elements compared to other elements in the hierarchical structure, it is necessary to compare them in pairs using a basic score of 1-9. If the number of items in the hierarchical structure level is n , $n(n-1)/2$ pairwise comparisons has to be performed, and these comparisons should be arranged in the form of matrixes [137].
- **Synthesis of Priorities:** it is the principle of achieving global priority by combining the clustered local priorities obtained by pairwise comparisons [139]. Using the priorities obtained from the lowest level of the hierarchy, a priority is determined for the whole problem [140]. The synthesis step consists of calculating and

normalizing the eigenvalue and the eigenvector corresponding to this eigenvalue [141].

4.5.1. Strengths and Weaknesses

The AHP approach offers several advantages to the decision-maker. These advantages and conveniences are briefly mentioned below.

Many decision problems involve subjective and objective elements. Analytic Hierarchy Process is a structure that allows decision-maker to integrate both objective and subjective elements into the solution process is a more practical solution method than many decision-making methods [128].

The strength of AHP stems from its ability to incorporate intuitive assessments that are difficult or impossible to handle despite affecting decisions [142]. In the case of decision-making, AHP allows the inclusion of knowledge and experience as valuable as data [140]. AHP offers a technique that can be easily applied to complex decision problems where subjective decision elements exist [128].

AHP, although easy to understand, does not include unnecessary mathematical applications is an easy method to apply [143]. AHP is an approach that has a wide range of applications from individual decisions to complex business decisions [140]. It is a method that helps to improve the decision-making process [144]. By organizing complex brain processes, it helps to resolve the confusion in the decision problem for the decision maker [145].

AHP allows the practitioner to structure complex decision problems in a hierarchical order or clustering into integrated levels. AHP reduces a complex decision-making process to a multi-level hierarchical structure [146]. Another point is that AHP can be used together with many operations research techniques [137].

As well as the advantages of the method, it is subject to various criticisms due to some disadvantages. AHP ignores the uncertainties regarding the decision, criteria, and options in the evaluations made, and this has a significant effect on the decision to be made. AHP

should be used in well-defined and analyzed decision-making problems, as it gives good results in such problems [147].

AHP's modeling of the decision problem with a unidirectional hierarchy and ignoring the relationships between criteria and criteria groups also cause controversy that this method is not sufficient to model the problem [144].

As the number of levels and the number of elements to be compared increases in the hierarchy of the decision problem, the problem becomes more complicated, and this causes loss of time [137]. AHP approach allows decision-making group decision, but the increase in the number of members of the group may create application difficulties [148].

It uses a poorly balanced scale (1/9, 1/8,..., 1, 2,... .., 9) for evaluation in AHP. One side of the pairwise comparisons matrix consists of numbers 2 to 9, while the conjugate side of the matrix is composed of the corresponding numbers of 1/2 to 1/9. The weight ratio of the conjugate side of the matrix $1 / 2-1 / 9 = 0.40$ is compared with the weight ratio of the other side of the matrix $9-2 = 7$ [147].

If a worse option is added to a decision problem solved by AHP method, there is a possibility of rank reversal of options. In addition, the subjectivity characteristic of the process is seen as a limitation of AHP. That implies that AHP cannot warrant “absolutely right” decisions [137].

Because of the mentioned disadvantages, AHP is used in conjunction with fuzzy logic to find solutions to decision problems, and various methods are proposed.

Application Areas of AHP

Today, AHP Method has a wide range of applications from complex management modeling problems to quality management issues, accounting and finance, production, customer selection, personnel evaluation, software evaluation, project selection, strategic mapping and investment decisions [137].

Golden et al. (1989) stated that AHP approach is appropriate to use in decision problems such as database selection, design and architecture, accounting and finance, capital investment, decision support, planning, production, macroeconomic planning, marketing, consumer selection, product design, marketing strategy, portfolio selection, risk analysis, application evaluations, group decision making, site selection, resource allocation, policy/strategy and transportation.

4.5.2. Phases of the Method

To solve a decision-making problem using AHP, there are stages that must be followed and completed in order. These are described roughly below.

1. Defining the Decision Problem

As with all decision problems, the decision problem in which the AHP approach will be applied should first be defined in detail, and the structure of the problem should be determined in accordance with the AHP approach.

In the AHP approach, the definition of the decision problem is realized in two phases [117].

- The first phases is about determining decision points. In short, it is the answer to the question of how many results will be evaluated is sought.
- The second phases is about determining the factors influential on these decision points.

2. Establishing a hierarchy of decision problems

A decision problem is a process that is split up into sub-problems in a hierarchical order for easier understanding [137].

By dealing with a complex decision problem in a simple hierarchical structure, quantitative and qualitative variables are evaluated together, and thus, the problem is combined after being solved in pieces. In addition, since all of the criteria that affect the decision are not addressed at the same time, the method becomes simple and feasible, and the accuracy of the results reached increases [149].

Furthermore, AHP provides the decision-maker with the opportunity to compare the components of the problem, to judge the components of the related components and to evaluate alternatives in terms of decision factors by addressing the problem in a hierarchical structure [128].

After the objectives are determined in AHP, the criteria that may affect the selection are put forward for this purpose, and then the potential alternatives are determined by taking into consideration the determined criteria. Thus, the hierarchical structure of the decision problem is established [144].

At the top of the decision hierarchy; the main objective (objective), the criteria affecting the decision at a lower level, the hierarchy at the bottom level, there are decision options. If the criteria that affect the decision have characteristics that may affect the main purpose, sub-criteria can be added to the hierarchy [146]. The number of levels to be formed in the hierarchy is counts on the complicatedness of the decision problem and the degree of detail [150].

Hierarchy design consists of three processes that are not consecutive but related to each other. These processes include identifying elements and their levels in the hierarchy, defining concepts, and formulating questions about structuring. First, the levels and elements that will form the hierarchy are determined, and the concepts are defined, and the definitions are used in the formulation of the questions. If the decision-maker encounters problems in answering questions, the definition of levels and elements is reviewed.

Hierarchical design process repeats itself until the questions are answerable and consistent with the available information [140].

Hierarchical structure to be considered while creating the following issues can be listed as follows [151].

- The decision problem should be represented in the hierarchy as much as possible so as not to lose its sensitivity to the changes in the elements.
- The environment of the decision problem should be considered.
- Qualifications and contributions that contribute to the solution should be identified.
- Participations related to the problem should be identified.

Standard hierarchical structure used in AHP approach is shown in Figure 7 [150].

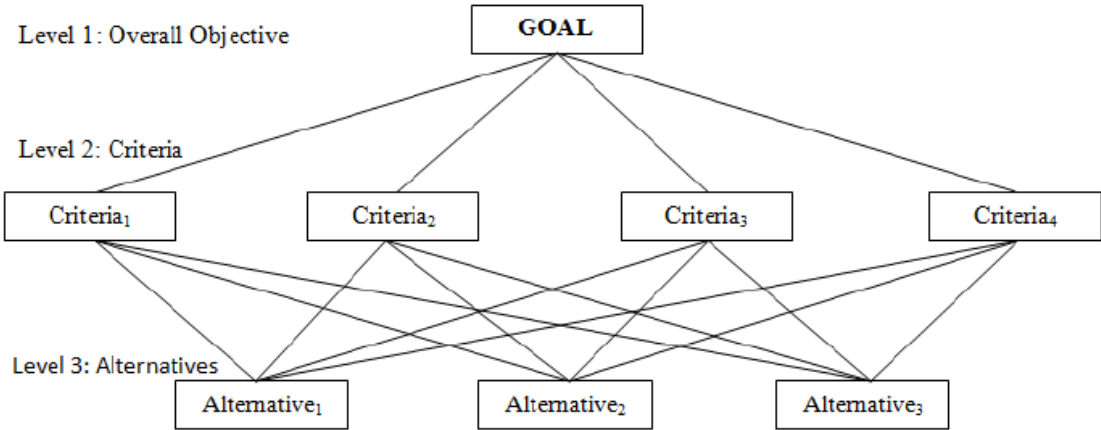


Figure 7: Standard Hierarchical Structure of the AHP

3. Creating Binary Comparison Matrixes

The step of forming pairwise comparison matrixes can be expressed as evaluating the hierarchical structure created in the previous step by making comparisons that provide a numerical representation of the relations between the elements in the hierarchical structure [140].

AHP is based on the comparison of options and criteria in binary format. Therefore, pairwise comparisons are the essential phase of AHP [146]. The term pairwise comparison

refers to the comparison of the two criteria based on the judgment of the decision-maker [137].

In AHP, the criteria are compared with each other as well as the alternatives according to the criteria are also compared with each other [132]. According to information obtained from pairwise comparisons, the judgments are transformed into matrixes [112].

The pairwise comparison matrix as seen below is a square matrix. The resulting square matrix is the ratio of each element, the column element at which the intersection points and the row elements are paired. When the criteria are compared in AHP, the matrix of pairwise comparisons is shown in Figure 8.

	1 st Criterion	2 nd Criterion	⋮	n th Criterion
1 st Criterion	a_{11}	a_{12}	⋯	a_{1n}
2 nd Criterion	a_{21}	a_{22}	⋯	a_{2n}
⋮	⋮	⋮	⋮	⋮
n th Criterion	a_{n1}	a_{n2}	⋯	a_{nn}

Figure 8: Pairwise Comparison Matrix

Since the $i = j$ equation is provided on the diagonal of the square matrix, each element is compared with itself, and therefore the matrix components take the value of "1" [140]. As a result of this situation, if there are n elements at the specified level of the hierarchy, it is sufficient to make $n.(n-1)/2$ pair comparison [137]. In light of this information, the square matrix is created as follows.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \dots & \dots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}_{n \times n} = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \vdots & \dots & 1 & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix}_{n \times n}$$

In making pairwise comparison judgments, the weight (w) ratios assigned by the decision maker to the criteria according to significance scale 1-9 are used and are expressed by the following equation.

$$\frac{w_i}{w_j} = a_{ij} (i, j = 1, 2, \dots, n) \tag{4.3}$$

In this case, all the a_{ij} values of matrix A consist of the positive values obtained from the ratio in (4.3). This ratio shows how many times criterion i is important than criterion j. For example, if the second criterion by the decision maker is found to be weakly significant when compared to the fourth criterion, then the second row, fourth column component ($i=2, j=4$) of the comparison matrix will have a value of 3 determined from the scale. When the opposite is done, that is, when the fourth criterion is compared with the second criterion, AHP will have a value of 1/3 according to the Axiom of Inverse Condition, and this value will be the fourth row, second column component of the comparison matrix. The same result can be achieved using (4.3). The matrix obtained from the dual comparison judgments of the second and fourth criteria can be shown as follows:

$$\begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \frac{w_1}{w_3} & \frac{w_1}{w_4} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \frac{w_2}{w_3} & \frac{w_2}{w_4} \\ \frac{w_3}{w_1} & \frac{w_3}{w_2} & \frac{w_3}{w_3} & \frac{w_3}{w_4} \\ \frac{w_4}{w_1} & \frac{w_4}{w_2} & \frac{w_4}{w_3} & \frac{w_4}{w_4} \end{bmatrix}_{4 \times 4} = \begin{bmatrix} 1 & \dots & \dots & \dots \\ \dots & 1 & \dots & 3 \\ \dots & \dots & 1 & \dots \\ \dots & 1/3 & \dots & 1 \end{bmatrix}_{4 \times 4}$$

The ordinal 1-9 significance scale proposed by Saaty (1980) is used to construct pairwise comparison matrixes. Saaty argues that this scale not only overlaps with the ability of people to distinguish between two elements but also provides ease of use. In order to obtain the best results in paired comparisons, the 1-9 scale recommended by Saaty should be used.

Since the scale 1-9 is used as the basic scale in the AHP approach, the pairwise comparisons matrix to be formed will be a square matrix and the matrix elements will always be positive (Saaty, 1980).

$$a_{ij} > 0, i, j = 1, 2, \dots, n \quad (4.4)$$

The following equations are provided in a matrix of fully consistent pairwise comparisons made by the decision maker giving consistent answers [130].

$$a_{ij} \cdot a_{jk} = a_{ik} \quad i, j, k = 1, 2, \dots, n \quad (4.5)$$

$$a_{ij} \cdot a_j = \left(\frac{w_i}{w_j} \right) \cdot \left(\frac{w_j}{w_k} \right) = \frac{w_i}{w_k} = a_{ik} \quad i, j, k = 1, 2, \dots, n \quad (4.6)$$

The upper limit of the ratings based on the scale used to compare the judgments proposed by Saaty is 9. He listed the various reasons for this [151].

- Differences in quality are meaningful in practice, and the fact that the numbers being compared is of the same magnitude or that they are close to each other in relation to the features used to make the comparison gives a high accuracy to the study.
- In order to distinguish in terms of quality, five symbols can be defined as equal, weak, strong, very strong, and absolute. When higher accuracy is required, in addition to these five symbols, intermediate values adjacent to the values of these symbols are added, and a total of 9 values is needed.
- A practical method often used to evaluate numbers is to classify feelings into three categories. These are high, medium, and low levels. For a more detailed classification, each of these categories is again classified as high, medium, and low. As can be understood from here, 9 different species always express the differences of meaning. Therefore, the number 9 should not be exceeded.

- One person can evaluate 7 ± 2 cases at the same time. This method developed by Saaty gives the best results for $n < 10$ criteria, especially 7 criteria. In other words, if the number of criteria is greater than 9, large inconsistencies may occur when solving CCPV problems with AHP method. Furthermore, if the elements of a matrix consist of very large numbers, this may result in greater inconsistencies.

The basic scales and definitions used in AHP are shown in Table 4.

Table 4: Saaty's Comparison Scale²

Intensity of Importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very Strong importance
9	Extreme importance
2, 4, 6 and 8	Intermediate values

As can be seen in Table 4, the values 2, 4, 6, and 8 are intermediate values and are the values that decision makers use when they are undecided between the two main values.

Scale 1-9 has been developed to determine how important each alternative is for the criteria that cannot be expressed numerically. In other words, it allows the verbal expressions to be added to the solution by quantifying.

In cases where evaluation is made according to numerical criteria, the value taken by the alternative for that criterion is used since there is no need to use the 1-9 scale.

AHP approach allows decision making when many decision makers formed a grouped [148]. If the decision to be taken in AHP can affect many people, that is, a person cannot make decisions alone;

² This table is adopted from [136]

- Considering that the group members come together for a common purpose, they are expected to reach consensus in making the appropriate decision and to reach consensus for the joint decision by means of brainstorming and voting [128].
- Pairwise comparison matrixes can be obtained by combining the subjective judgments of different individuals. As a result of the merging process, the geometric mean method is preferred to obtain consistent comparison matrixes [144].

4. Determining the Relative Importance of Criteria and Alternatives

After the comparisons matrix is established in the AHP approach, the calculation is continued by determining the relative importance of criteria and alternatives. Pairwise comparison matrix depicts the significance levels of the criteria in relation to each other but does not show the weights of the criteria within the whole [117].

In this step, also known as synthesis, the eigenvalue and the eigenvector corresponding to this eigenvalue is calculated by calculating normalization operations [137]. In the AHP approach, the W priority vector exists with the solution of the (4.7) equation

$$(A - \lambda_{max}I)W = 0 \quad (4.7)$$

λ_{max} is the largest eigenvalue of A which is the matrix of pairwise comparisons; W represents the eigenvector or the priority vector corresponding to the eigenvalue λ_{max} .

Formula (4.7) is reached as follows. If the pairwise comparisons matrix is fully consistent, a_{ij} is obtained from the ratio w_i / w_j . So $a_{ij} = w_i / w_j$. However, all measurements, including those made with real-life measuring instruments, result in inconsistent results as a result of experimental error or measuring instrument error. Due to the presence of these inconsistent results that deviate from the ideal situation, it would be more logical to express the w_i value as an average.

$$w_i = \frac{1}{n} \cdot \sum_{j=1}^n a_{ij} \cdot w_j \quad (i, j = 1, 2, \dots, n) \quad (4.8)$$

In case of consistency, $\lambda_{\max} = n$ is provided. However, if there is a deviation from the ideal situation, the $\lambda_{\max} = n$ cannot be achieved, it will take a value close to λ_{\max} . Also, in order to be able to change w_i and w_j values in accordance with the non-ideal situation, n should be changed.

$$w_i = \frac{1}{\lambda_{\max}} \cdot \sum_{j=1}^n a_{ij} \cdot w_j \quad (i, j = 1, 2, \dots, n) \quad (4.9)$$

If the equation above is generalized, equation (4.10) is obtained.

$$A \cdot W = \lambda_{\max} \cdot W \quad (4.10)$$

Therefore, what needs to be done is to find the vector W , which reflects the relative importance using matrix A , to realize the equation of (4.10).

In order to have the relative significance of the criteria and alternatives, column vectors forming the pairwise comparison matrix are constructed using n and B column vectors with n elements.

$$B_i = \begin{bmatrix} b_{11} \\ b_{21} \\ b_{31} \\ \vdots \\ b_{n1} \end{bmatrix}_{n \times 1} \quad i = 1, 2, \dots, n \quad (4.11)$$

Column B is found using (4.12).

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}} \quad (4.12)$$

By combining n column B vectors in a matrix, the matrix C is formed.

$$C = \begin{bmatrix} b_{11} & b_{12} & b_{13} & \dots & b_{1n} \\ b_{21} & b_{22} & b_{23} & \dots & b_{2n} \\ b_{31} & b_{32} & b_{33} & \dots & b_{3n} \\ \dots & \dots & \dots & \dots & \dots \\ b_{n1} & b_{n2} & b_{n3} & \dots & b_{nn} \end{bmatrix}_{n \times n} \quad i, j = 1, 2, \dots, n \quad (4.13)$$

The arithmetic mean of the row components that make up the matrix C is calculated, and thus the W column vector, the priority vector, is obtained [117].

$$w_{ij} = \frac{\sum_{j=1}^n c_{ij}}{n} \quad (4.14)$$

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix} \quad (4.15)$$

5. Calculation and Control of Consistency Ratio

After having the relative significance of the elements in the comparison matrix in AHP approach, next step is to calculate the consistency ratio of the judgments of each pairwise comparison matrix to determine whether the decision maker behaves consistently in pairwise comparisons.

This stage of the AHP enables decision-makers to detect misinterpretations in pairwise comparisons while reducing careless errors but also allows decision-makers to see errors in their comparisons or exaggerated assessments [140].

Calculation of the consistency ratio is a necessary process to increase the quality of the final decision [137]. This measure called Consistency Ratio (CR) expresses the probability of the items as a percentage of the total random comparison [140].

In the consistency analysis, the aim is to provide a proportional consistency such as " If A is two times more important than B, and B is three times more important than C, then A is six times more important than C." [142].

By human nature, the decision-maker is unlikely to compare elements with perfect consistency. The AHP method permits a certain degree of inconsistency in comparisons.

The maximum eigenvalue of the matrix generated as a result of a consistent comparison must be equal to the number of elements, and in the case of consistency, $\lambda_{max} = n$ must be ensured. If there is a deviation from this equation, this deviation is called the Consistency Index (CI). CR is calculated by the ratio of CI to Random Index RI. RI is the average indicator value of the same magnitude but completely randomly selected and derived from a large number of Matrixes. Random Index RI values are given in Table 5. These calculations are done using the following equations.

$$CI = \frac{\lambda_{max} - 1}{n - 1} \quad (4.16)$$

$$CR = \frac{CI}{RI} \quad (4.17)$$

Table 5: Random Index (RI) Values³

n	1	2	3	4	5	6	7	8	9	10
RI	-	-	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

It is desired that the consistency ratio of pairwise comparison matrixes should not be over 0.10 [152]. When the ratio is less than 0.10, the result is considered to be within the compliance limits. For a consistency above 0.10, the quality of the judgments must be refined, as the judgments will be considered inconsistent [131]. In such a case, the judgments should be reviewed, or the problem should be re-established correctly, and the process should be handled from the beginning. As the CR gets closer to zero, the much consistency will be achieved.

6. Determination of the Ranking of Alternatives

In the case of consistency of each pairwise comparison matrix in the AHP approach, at this stage, in order to realize the primary purpose of the problem, a composite vector of priorities is created to show the order of decision alternatives [137]. To create this vector,

³ This table is adopted from [151].

weighted average of the priority vectors for each variable is used [150]. The matrix created shows the level of alternatives to meet the ultimate goal [135].

The priority value of each alternative is calculated by multiplying the importance weights of the criteria and the importance weights of the alternatives. The highest valued alternative is determined as the best alternative for the decision problem [144].

The obtained priority values are also called decision alternative scores, and they show the intensity of the judicial perceptions of the decision maker's choices [142].

7. Sensitivity Analysis

After determining the order of alternatives, it is necessary to review the results of the established model. The review is carried out with sensitivity analysis and will show the parts in the judgments or hierarchy where correction is needed. In addition, the effect of subjectivity on the decision can be examined by sensitivity analysis [128].

The purpose of the sensitivity analysis in the AHP approach is to determine how susceptible the changes in the judgments are to the order of alternatives and the final stage of the decision. Sensitivity analysis is based on the assumption that judgments may differ from one person to another in the creation of pairwise comparisons, or that a person who has previously made a particular judgment may have different opinions over time. In this process, the w_i/w_j matrix (w^*) is created first.

Using the w_i/w_j ratios, the decisions are corrected in the lines where the differences are greatest in the absolute differences matrix (4.18).

$$\left[\left| a_{ij} - \frac{w_i}{w_j} \right| \right] \quad (4.18)$$

If the correction is continued using this method, it is seen that a_{ij} converges to w_i/w_j . The method consists of replacing all a_{ij} values with the corresponding w_i/w_j values in the lines and calculating the priority vector repeatedly [137].

4.6. Fuzzy Analytic Hierarchy Process (FAHP)

Decisions taken in daily life are generally formed by the effects of abstract concepts as well as concrete concepts, so uncertainty emerges. For this reason, fuzzy logic is used by integrating decision problem solution methods due to the proximity of the human to the logic of thought and enables more effective decision making in case of uncertainty.

Although the AHP approach is used effectively in solving many real life decision-making, it has been criticized for using integers in pairwise comparisons [144]. Besides, the AHP approach is criticized for being inadequate to address uncertainty and uncertainty [153].

Due to these shortcomings in effective decision making in case of uncertainties, the AHP approach has been used as FAHP approach with fuzzy logic integration.

FAHP is a method that criticizes the use of real numbers in the process of pairwise comparisons in the analytic hierarchy process method and recommends the use of fuzzy numbers. Instead of evaluating with integer values, decision-makers often find it more reliable to use the values that refer to a given range.

AHP uses exact values when making decision-making evaluations in the approach, but it is easier to evaluate by using fuzzy numbers or linguistic variables in the FAHP approach [154]. FAHP approach is a problem-solving technique that combines the AHP process with the use of fuzzy logic and linguistic variables [155].

In 1983, the pioneer study employing fuzzy numbers in pairwise comparisons was published by Van Laarhoven and Pedrycz [156]. In the following years, several studies using fuzzy numbers in pairwise comparisons were made.

4.6.1. Comparison of Fuzzy AHP and Classical AHP

FAHP technique is an advanced analytical method developed from classical AHP. Although they appear as two intertwined techniques, in theory; there are differences in application. Bali and Gencer [155] compare AHP and FAHP methods as follows.

- Implementation of the AHP may create some drawbacks when criteria and alternatives are numerous. The main reason for this is that there are many pairwise comparisons to be made by the decision-maker, which creates discomfort in the decision-maker and consumes excessive time.
- In Fuzzy AHP, it is easier and more accurate to make pairwise comparison with linguistic expressions than AHP method.
- Although it may be easier to compare with fuzzy AHP, the limits of fuzzy values corresponding to linguistic expressions need to be determined correctly. Incorrect detection of fuzzy boundaries will lead to the wrong result.
- The AHP method seems to be more difficult for the decision maker to influence the outcome directly. The reason for this is that the final result is closer to the induction method.
- Although it is possible to measure consistency in the AHP method, a control mechanism that can measure consistency in fuzzy AHP does not exist in the structure of model [157].

4.6.2. Methods Used in Fuzzy AHP

Various authors proposed many FAHP methods as seen in the literature.

In their study, Van Laarhoven and Pedrycz [156] directly extended the classical AHP method using triangular fuzzy numbers and used Lootsma's (1981) least squares method to obtain fuzzy weights and scores. In the approach, classical AHP approach procedures are followed. Fuzzy benefits are calculated using triangular fuzzy numbers. Lootsma's least-squares method allows modeling the evaluations of multiple decision-makers.

Buckley (1985), [158] in his study, expanded the classical AHP approach using fuzzy comparison rates. Buckley used the geometric mean method to calculate fuzzy weight and performance values. The geometric mean method is preferred because it allows for a single solution in comparison matrixes, which can be easily expanded in fuzzy situations. In Buckley approach, trapezoidal fuzzy numbers are used instead of triangular fuzzy numbers to show the comparison rates of decision makers.

The method proposed by Boender (1989) [159] is a slightly improved version of the method of Van Laarhoven and Pedrycz. Boender's method provides a more robust approach to normalizing local priorities. It should be noted that the calculation is not easy.

Different sorting methods give different results in fuzzy values. In the Total Integral Value Method of Liou and Wang [160], which is one of these methods, the total integral value is calculated for the triangular fuzzy number given as $A = (l, m, u)$ with $\alpha \in [0,1]$ optimism index. Here, the $\alpha \in [0,1]$ optimism index expresses the decision-maker's perspective. While the growth of α value indicates that the decision maker is optimistic, the decrease in α value indicates a pessimistic decision maker [161].

Cheng (1996) developed a method based on entropy weight by utilizing Shannon entropy. Entropy, in the simplest sense, refers to the uncertainty that exists in a system. Shannon entropy is a measure of uncertainty [147].

Fuzzy standards are created in the method, and performance scores are obtained by using membership functions. Since it does not require much calculation, it provides an advantage over other methods [147]. The relative importance of the criteria relative to each other is indicated by the fuzzy ratios expressed as 1, 3, 5, 7, and 9.

Another method is Chang's (1996) Extended Analysis method [162]. The method requires fewer calculations than others require. It also follows the steps of classic AHP and does not require additional processing. However, only triangular fuzzy numbers can be used in the method. In this study, the mentioned method will be used. The following is detailed information about the method.

In most of the studies conducted through the fuzzy analytic hierarchical process, the extended Fuzzy AHP method proposed by Chang is preferred [163]. This method is easy to use in practice as it is applied by following classical AHP steps. In this study, Chang's Extended Fuzzy AHP Method will be used.

Chang's Extended Fuzzy AHP Method proposed

Let $\{X_1, X_2, \dots, X_n\}$ be a set of criteria, and $U = \{U_1, U_2, \dots, U_n\}$ be a set of objectives. According to Chang's extended analysis method, the analysis is performed for each target by using each criterion. Thus, m synthetic extent values which are shown with M is obtained for each criterion.

$$M_{g_i}^j, M_{g_i}^j, \dots, M_{g_i}^j, i = 1, 2, \dots, n \quad (4.19)$$

The following steps are then followed to perform an extended analysis of Chang.

Step 1

The fuzzy synthetic extent value according to i^{th} criterion is calculated using the equation (4.20), where S_i is the synthetic extent value of i^{th} criterion, $M_{g_i}^j$ is the extended value, and (l_i, m_i, u_i) is a triangular fuzzy number.

$$M_i = (l_i, m_i, u_i)$$

$$S_i = \sum_{j=1}^m M_{g_i}^j \otimes \left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} \quad (4.20)$$

To obtain the sum of $M_{g_i}^j$ for $i = 1, 2, \dots, n$ and $j = 1, 2, \dots, m$, fuzzy addition is applied to the synthetic extent values. Using equation (4.20), the equations (4.21), (4.22), and (4.23) are obtained.

$$\sum_{j=1}^m M_{g_i}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right) \quad (4.21)$$

$$\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right) \quad (4.22)$$

$$\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (4.23)$$

Step 2

Let M_1 be represented by parameters (l_1, m_1, u_1) and M_2 be (l_2, m_2, u_2) . The degree of probability of $M_1 = (l_1, m_1, u_1) \leq M_2 = (l_2, m_2, u_2)$ is defined as (4.24) and this degree of probability (V) for a convex fuzzy number is calculated using the equation (4.25).

$$V(M_2 \geq M_1) = \sup_{y \geq x} \left[\min \left(\mu_{M_1}(x), \mu_{M_2}(y) \right) \right] \quad (4.24)$$

$$V(M_2 \geq M_1) = \begin{cases} 1, m_2 \geq m_1 \\ 0, l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, \text{ otherwise} \end{cases} \quad (4.25)$$

$V(M_2 \geq M_1)$ is the value of the membership function. To compare M_1 and M_2 , Both of $V(M_2 \geq M_1)$ and $V(M_1 \geq M_2)$ must be calculated in order to make comparison. The figure 9 is the depiction of equation (4.25).

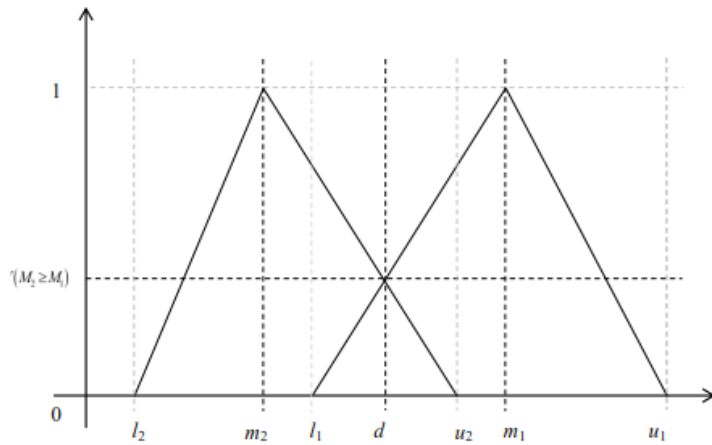


Figure 9: The Intersection of Triangular Fuzzy Numbers M_2 and M_1

Step 3

The degree of possibility of a convex fuzzy number to be greater than k convex fuzzy numbers is obtained through (4.26)

$$\begin{aligned}
&= V(M \geq M_1, M_1, \dots, M_k) \\
&= V[(M \geq M_1), (M \geq M_2), \dots, (M \geq M_k)] \\
&= \min V(M \geq M_i), i = 1, 2, \dots, k
\end{aligned} \tag{4.26}$$

For $k = 1, 2, \dots, n$ and $k \neq j$, W' which represents the relative weight of one criterion over others is computed as through equation (4.27).

$$W' = [\min V(S_1 \geq S_k), \min V(S_2 \geq S_k), \dots, \min V(S_i \geq S_k)]^T \tag{4.27}$$

Step 4

Finally, W' is normalized in order to find the priority vector (W) consisting of non-fuzzy numbers. These numbers are weights of criteria.

$$W = (w(S_1), w(S_2), \dots, w(S_n))^T \tag{4.28}$$

4.6.3. Fuzzy Scales

The scale used in the BAHP Approach varies according to the method applied. Commonly used scales are generally composed of triangular fuzzy numbers [164].

In this study, fuzzy scale used in Chang's Extended Analysis Method was used. The scale is shown in Table 6.

Table 6: Triangular Fuzzy Numbers of Chang's Fuzzy AHP Method

Saaty's Scale of Importance	Definition	Triangular Fuzzy Numbers	Inverses
1	Equal importance	(1, 1, 2)	(1/2, 1, 1)
2	Intermediate value	(1, 2, 3)	(1/3, 1/2, 1)
3	Moderate importance	(2, 3, 4)	(1/4, 1/3, 1/2)
4	Intermediate value	(3, 4, 5)	(1/5, 1/4, 1/3)
5	Strong importance	(4, 5, 6)	(1/6, 1/5, 1/4)
6	Intermediate value	(5, 6, 7)	(1/7, 1/6, 1/5)
7	Very Strong importance	(6, 7, 8)	(1/8, 1/7, 1/6)
8	Intermediate value	(7, 8, 9)	(1/9, 1/8, 1/7)
9	Extreme importance	(8, 9, 9)	(1/9, 1/9, 1/8)

* This table is adopted from [162].

4.6.4. Consistency Analysis

In light of the literature review, it can be said that there is not much information about the consistency ratio in the FAHP.

Özdağoğlu et al. [165] stated that the uncertainty phenomenon also includes the inconsistencies of the decision-maker, and therefore, there is no consistency calculation in many studies using Chang's method.

Also, it is not possible to calculate the consistency in the extended analysis method because the weight of some criteria in the weight vector is zero, and the division into zero indicates mathematical indeterminacy.

5. IMPLEMENTATION

5.1. Proposed Methodology

Project proposals can be prioritized by way of a new model consisting of two phases, fuzzy AHP, and 1/0 scoring.

Fuzzy AHP method will be used in the first stage. At this stage, various evaluation criteria will be established in order to prioritize project proposals, and a hierarchy of criteria will be built. Comparisons will be made into a form and will be shared with experts to make evaluations. In accordance with the responses received, we will find the weights of all criteria employing fuzzy AHP method.

In the second stage, the priority score of a project proposal will be calculated. For any project, each criterion's weight will be multiplied by 1 or 0 points given by the decision maker, and then these multiplication results will be summed. The final value calculated by summation will be the priority score of that project.

In the final step, for each project proposal in the public investment project portfolio, priority scores calculated will be sorted from the highest to lowest.

5.2. Implementation of the Fuzzy AHP

5.2.1. Criteria Set and Comparison Form

In the study, a set of criteria and sub-criteria has been formed in which each criterion question the importance and priority of any investment project proposal from different perspectives. The criteria in the set combine literature, the knowledge, and experience of experts and the author of the thesis.

After the criteria were clarified, the hierarchical structure has been formed as shown in Figure 10, and it has been explained what each criterion meant in the following pages.

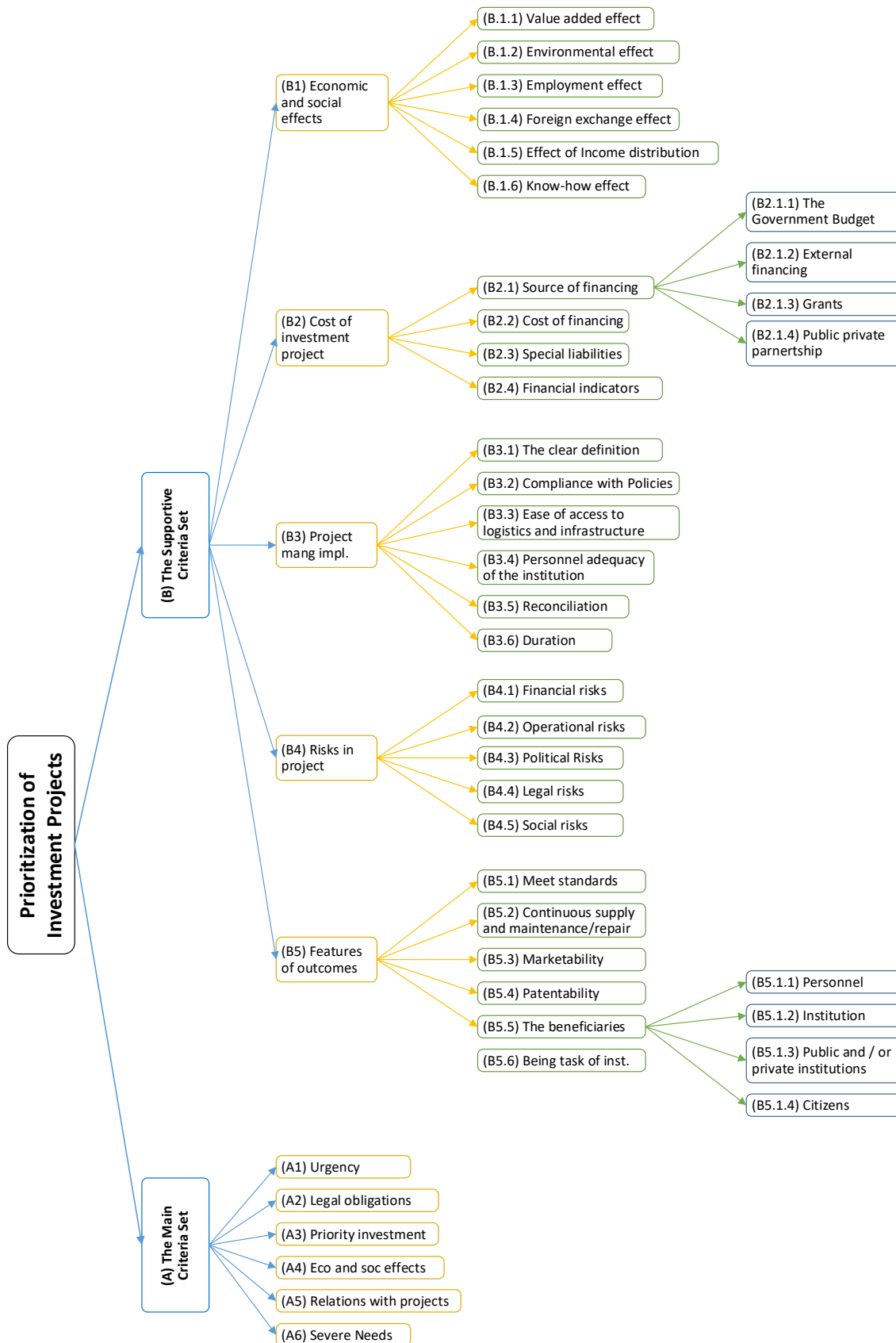


Figure 10: Hierarchical Representation of Criteria Set

Then, an online form including pairwise comparisons of these criteria has been designed and sent to a few experts who have experience and knowledge in public investment planning. Fourteen of the experts made comparisons and forwarded the completed form.

Saaty's AHP [166] scale given in Table 6 has been used in the form above for pairwise comparisons of criteria. The hierarchical representation and explanations of the criteria and sub-criteria used in the Fuzzy AHP are given below.

Prioritization of Investment Projects

- 1. (A) The main criteria set (Reasons for Realization of Investment Project):** The main criteria set consists of criteria covering the reasons for the realization of investment projects. This cluster includes the criteria of the urgency of the investment project, the realization of the project due to the obligation, the relationships of the project with others, the project's being within the scope of the priority investment areas and the realization of the project based on a concrete need.
- 2. (B) The supportive criteria set (Project Details):** The supportive criteria set defines the main characteristics of a public investment project. This cluster includes the social and economic impacts, cost, management and implementation of the project, the risks and the evaluations on the final product and service criteria.

Sub-criteria of (A) Main Criteria Set

- 1. (A1) Urgency:** This criterion includes situations such as likely loss of life and/or property, problems in the economy, public administration and the social life and having strategic the importance.
- 2. (A2) Legal obligations:** This means that the project is implemented consistent with national and international laws, agreements and obligations.
- 3. (A3) Priority investment:** This means that the project is realized as it is within the scope of the priority investment areas stated in the policy documents.
- 4. (A4) Economic and social effects:** this criterion considers the direct effects of the projects on development, population, employment, income distribution and benefits in social and cultural improvement.
- 5. (A5) Relationship with other projects:** It means that the project is carried out because it has a succession or complementarity relationship with another project.

6. **(A6) Severe Needs:** This means that the project is realized because there is a need based on real reasons and evidence.

Sub-criteria of the (B) Supportive Criteria Set

1. **(B1) Economic and social effects:** This criterion covers the value added to be provided by the investment project and impacts of the project on the environment, employment, the distribution of income and foreign exchange gain sub-criteria.
2. **(B2) Cost of investment project:** This criterion covers financing source, the cost of financing, specific requirements for financing and financial ratios sub-criteria.
3. **(B3) Project management and implementation:** This criterion includes issues such as the aim of the project, ease of access to logistics and infrastructure services, whether human resource/knowledge/experience need can be met with the personnel of the institution, the agreement with the project partners and the duration of the project.
4. **(B4) Risks in projects:** These are financial, operational, political, legal and social risks that may be encountered in the project process or at the end of the project.
5. **(B5) Features of the final product and/or service:** This cluster includes criteria about whether the product or service obtained can be marketed, need continuous supply and maintenance and meet various international standards, and the target group of final product or service who/which will benefit from.

Sub-criteria of (B1) Economic and Social Effects Criteria

1. **(B.1.1) Value-added effect:** Refers to the impact of the investment project on national income and growth.
2. **(B.1.2) Environmental effect:** Refers to the pollution and / or impact caused by the project on the environment.
3. **(B.1.3) Employment effect:** This means that the project may increase or decrease employment.
4. **(B.1.4) Foreign exchange effect:** It means the foreign currency gain.
5. **(B.1.5) Effect of Income distribution:** This means the improvement of income distribution and the reduction of the development differences between geographic locations.

6. **(B.1.6) Know-how effect:** It refers to the ability of the project to provide new information/technology to the institution/sector/ country.

Sub-criteria of (B2) Cost of Investment Project Criteria

1. **(B2.1) Source of financing:** It addresses whether the project is financed by budget, foreign credit, and grant or public-private partnership.
2. **(B2.2) Cost of financing:** This refers to the interest burdens of the financing in case of external credit from foreign institutions.
3. **(B2.3) Special liabilities related to financing:** In case the external credit is to be used from foreign institutions there may be various preconditions of these institutions to give credit.
4. **(B2.4) Financial indicators:** Indicates the values of various indicators such as cost, income, working capital estimates, cash flow and balance sheet to be taken into consideration

Sub-criteria of (B2.1) Source of Financing Criteria

1. **(B2.1.1) The Government Budget:** It means that the financing needed in the project is covered by the state budget.
2. **(B2.1.2) External financing (credit):** It means the financing of the project by way of external credit.
3. **(B2.1.3) Grants:** This means that the financing is provided as a grant from foreign institutions and organizations.
4. **(B2.1.4) Public-private-partnership:** It is the case that the private sector undertakes to finance in return for the provision of various supports such as operation and leasing privilege,

Sub-criteria of (B3) Project Management and Implementation Criteria

1. **(B3.1) The clear definition of the project:** This means that the aim, the objective, and the activities to be carried out and details are clearly defined.
2. **(B3.2) Compliance with the Government policies:** The fact that the project complies with the policy documents.
3. **(B3.3) Ease of access to logistics and infrastructure services of the project:** It means the accessibility of raw material resources, transportation and communication

systems, water-electricity-natural gas networks, land use, sub-industry, distribution and marketing opportunities in terms of location of the investment project,

4. **(B3.4) Personnel knowledge/experience adequacy of the institution:** It means whether the human resources, knowledge, and experience required can be met by using the resources of the institution.
5. **(B3.5) Reconciliation with the project partner:** That means briefly an agreement with other public institutions in the project, in terms of task distribution, authority and responsibility.
6. **(B3.6) Duration of the project:** It means the time needed to begin and/ or complete the project

Sub-criteria of (B4) Risks in Project

1. **(B4.1) Financial risks:** This criterion covers the risks caused by the foreign exchange rate, inflation, interest rates, the unexpected changes in input prices and the inadequacy of the budget.
2. **(B4.2) Operational risks:** These are the risks caused by occupational health and safety, strikes and natural disasters, etc.
3. **(B4.3) Political Risks:** This indicates the situations such as lack of political stability, limitations in commercial activities, restrictions on exports/imports, restrictions on money and transfers, etc.
4. **(B4.4) Legal risks:** It refers to the situations such as change of relevant legislation, additional labor, expenditure, and time requirement, violation of licenses and patent rights, and civil law cases within and outside the organization.
5. **(B4.5) Social risks:** Refers to situations such as public perception, social reaction, and protest.

Sub-criteria of (B5) Features of the Final Product and/or Service Criteria

1. **(B5.1) The ability to meet various standards:** That means whether the final product or service can meet national and/or international general or sectoral standards.
2. **(B5.2) The need for continuous supply and maintenance/repair:** It means the obligation of continuous production of the final product or service and the need for regular maintenance and repair in case of deterioration/failure.

3. **(B5.3) Marketability:** It means that the final product/service can be marketed domestically and/ or outside.
4. **(B5.4) Patentability:** It means producing an innovation as a result of an investment project and obtaining a patent.
5. **(B5.5) Beneficiaries:** This criterion is about who will benefit directly from the outcomes. Beneficiaries may be the organization's staff, the institution, other public and/ or private sector institutions or the citizen.
6. **(B5.6) Being the main task of the institution:** That means whether the investment desired to be realized is in the scope of the institution's duties, responsibilities, and authorities.

Sub-criteria of (B5.5) the Beneficiaries Criteria

Expresses who will benefit from the final product and/or service directly.

1. **(B5.1.1) Personnel of the institution:** That means the investment project is realized for the benefit of only the personnel of the institution
2. **(B5.1.2) Project owner institution:** That means the final product and/or service will be used in the functioning of the institution.
3. **(B5.1.3) Public and/or private sector institutions:** That means the final product and/or service will be used in the functioning of public and/or private sector institutions including the owner of the project.
4. **(B5.1.4) Citizens:** That means the final product and/or service will be for the benefit of the citizens in order to improve their daily lives, standards of living, and well-being.

5.2.2. Pairwise Comparisons

During the implementation phase, a survey including criteria and sub-criteria's pairwise comparisons has been conducted, and expert opinions have been collected. In order to ensure the consistency of the paired comparisons of the criteria, the geometric averages have been calculated, rounded and the comparison matrix shown in the following tables have been formed.

In order to make pairwise comparisons in line with the hierarchy created, experts preparing public investment project proposals on behalf of the institution they work for or evaluating the investment project proposals coming from public institutions during the creation of the investment program were preferred.

Responses of 14 experts who are mid-level managers and senior management positions at the Presidency, Strategy and Budget Directorate, The Turkish Grand National Assembly, The Treasury and The Ministry of Finance, The Ministry of Transport and Infrastructure and General Directorate of State Hydraulic Works have been received. The majority of the responses has been collected with online form while the rest of them has been collected as hard copies.

The comparison values included in the forwarded forms have been separated based on criteria. The geometric mean of the comparison above values that are scored through Saaty's scale has been calculated and rounded to the nearest value of Chang's triangular fuzzy scale. Each rounded value has been transformed into fuzzy triangular numbers in the scale given in Table 6.

In the next step, pairwise fuzzy comparison matrixes have been formed as Tables 7-17. For the first two main criteria, the geometric mean of the comparison values in the responses received from the respondents within the framework of the Saaty scale was calculated as 2.

This score means that the main criteria set are superiority on the detailed set is an intermediate value between 1: Equal importance and 3: Moderate importance. It can be said that the first criterion is a little bit important than the second criterion.

Based on this value, the AHP comparison matrix has been formed as shown in Table 7. After this value has been converted to fuzzy triangular numbers using Table 6, the fuzzy AHP comparison matrixes has been formed as shown in Table 8. The other fuzzy comparison matrixes for the pairwise comparisons are given Table 9 – 17.

Table 7: Comparison Matrix for Main Criteria

	A	B
A	1	2
B	1/2	1

Table 8: Fuzzy Comparison Matrix for Main Criteria

	A	B
A	(1, 1, 1)	(1, 2, 3)
B	(1/3, 1/2, 1)	(1, 1, 1)

Table 9: Fuzzy Comparison Matrix of Sub-criteria of (A) Main Criteria Set

	A1	A2	A3	A4	A5	A6
A1	(1, 1, 1)	(2, 3, 4)	(2, 3, 4)	(1, 2, 3)	(2, 3, 4)	(2, 3, 4)
A2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)
A3	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)	(1, 1, 1)	(1/3, 1/2, 1)	(1, 2, 3)	(1, 1, 2)
A4	(1/3, 1/2, 1)	(1, 1, 2)	(1, 2, 3)	(1, 1, 1)	(3, 4, 5)	(1, 2, 3)
A5	(1/4, 1/3, 1/2)	(1, 1, 2)	(1/3, 1/2, 1)	(1/5, 1/4, 1/3)	(1, 1, 1)	(1/3, 1/2, 1)
A6	(1/4, 1/3, 1/2)	(1, 1, 2)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 2, 3)	(1, 1, 1)

Table 10: Fuzzy Comparison Matrix of Sub-criteria of (B) Supportive Criteria Set

	B1	B2	B3	B4	B5
B1	(1, 1, 1)	(2, 3, 4)	(2, 3, 4)	(1, 2, 3)	(2, 3, 4)
B2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)	(1, 1, 2)
B3	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)	(1, 1, 1)	(1, 1, 2)	(1, 1, 2)
B4	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 2)	(1, 1, 1)	(1, 1, 2)
B5	(1/4, 1/3, 1/2)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)	(1, 1, 1)

Table 11: Fuzzy Comparison Matrix of Sub-criteria of (B1) Economic and Social Effects

	B1.1	B1.2	B1.3	B1.4	B1.5	B1.6
B1.1	(1, 1, 1)	(1, 2, 2)	(1, 2, 3)	(1, 1, 2)	(3, 4, 5)	(1, 2, 3)
B1.2	(1/3, 1/2, 1)	(1, 1, 1)	(1/3, 1/2, 1)	(2, 3, 4)	(2, 3, 4)	(1, 2, 3)
B1.3	(1/3, 1/2, 1)	(1, 2, 3)	(1, 1, 1)	(3, 4, 5)	(1, 2, 3)	(1, 1, 2)
B1.4	(1, 1, 2)	(1/4, 1/3, 1/2)	(1/5, 1/4, 1/3)	(1, 1, 1)	(1, 1, 2)	(1, 1, 2)
B1.5	(1/5, 1/4, 1/3)	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 1)	(1, 2, 3)
B1.6	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 1, 1)

Table 12: Fuzzy Comparison Matrix of Sub-criteria of (B2) Cost of Investment Project

	B2.1	B2.2	B2.3	B2.4
B2.1	(1, 1, 1)	(1/3, 1/2, 2)	(1/3, 1/2, 1)	(1, 1, 2)
B2.2	(1, 2, 3)	(1, 1, 1)	(1, 2, 3)	(2, 3, 4)
B2.3	(1, 2, 3)	(1/3, 1/2, 1)	(1, 1, 1)	(2, 3, 4)
B2.4	(1, 1, 2)	(1/4, 1/3, 1/2)	(1/4, 1/3, 1/2)	(1, 1, 1)

Table 13: Fuzzy Comparison Matrix of Sub-criteria of (B2.1) Cost of Financing

	B2.1.1	B2.1.2	B2.1.3	B2.1.4
B2.1.1	(1, 1, 1)	(2, 3, 3)	(1/4, 1/3, 1/2)	(1, 2, 3)
B2.1.2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)
B2.1.3	(8, 9, 9)	(8, 9, 9)	(1, 1, 1)	(1, 2, 3)
B2.1.4	(1/3, 1/2, 1)	(1, 2, 3)	(1/3, 1/2, 1)	(1, 1, 1)

Table 14: Fuzzy Comparison Matrix of Sub-criteria of (B3) Project Management and Implementation

	B3.1	B3.2	B3.3	B3.4	B3.5	B3.6
B3.1	(1, 1, 1)	(2, 3, 3)	(1, 2, 3)	(1, 2, 3)	(1, 2, 3)	(1, 2, 3)
B3.2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)	(1, 2, 3)	(1, 2, 3)
B3.3	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)	(1, 1, 2)	(1, 2, 3)	(1, 2, 3)
B3.4	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 2)	(1, 1, 1)	(2, 3, 4)	(2, 3, 4)
B3.5	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)
B3.6	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)	(1, 1, 1)

Table 15: Fuzzy Comparison Matrix of Sub-criteria of (B4) Risks in Project

	B4.1	B4.2	B4.3	B4.4	B4.5
B4.1	(1, 1, 1)	(1, 1, 1)	(1, 1, 2)	(1, 2, 3)	(1, 1, 2)
B4.2	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)
B4.3	(1, 1, 2)	(1, 1, 2)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)
B4.4	(1/3, 1/2, 1)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 1, 2)	(1, 1, 2)
B4.5	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)

Table 16: Fuzzy Comparison Matrix of Sub-criteria of (B5) Features of Final Product/ Service

	B5.1	B5.2	B5.3	B5.4	B5.5	B5.6
B5.1	(1, 1, 1)	(2, 3, 2)	(1, 2, 3)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 1, 2)
B5.2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1, 2, 3)	(1/3, 1/2, 1)	(1, 1, 2)
B5.3	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)	(1, 2, 3)
B5.4	(1, 1, 2)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)	(1, 1, 2)	(1, 1, 2)
B5.5	(1, 2, 3)	(1, 2, 3)	(1, 1, 2)	(1, 1, 2)	(1, 1, 1)	(2, 3, 4)
B5.6	(1, 1, 2)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 1, 2)	(1/4, 1/3, 1/2)	(1, 1, 1)

Table 17: Fuzzy Comparison Matrix of Sub-criteria of (B5.5) Beneficiaries

	B5.5.1	B5.5.2	B5.5.3	B5.5.4
B5.5.1	(1, 1, 1)	(1, 1, 2)	(1/3, 1/2, 1)	(1/7, 1/6, 1/5)
B5.5.2	(1, 1, 2)	(1, 1, 1)	(1/3, 1/2, 1)	(1/6, 1/5, 1/4)
B5.5.3	(1, 2, 3)	(1, 2, 3)	(1, 1, 1)	(1/5, 1/4, 1/3)
B5.5.4	(5, 6, 7)	(4, 5, 6)	(3, 4, 5)	(1, 1, 1)

The fuzzy comparison matrix for the sub-criteria of the (A) *Main Criteria Set*, as seen in Table 18, will be used to comprehensively illustrate the fuzzy AHP procedure in the following section. Computations for other criteria and sub-criteria will not be presented here. Instead, the weights computed for each criterion will be shown in a table at the end of this section.

Firstly, using fuzzy comparison matrix of sub-criteria, the fuzzy synthetic extent value (S_i) of each criterion is calculated by equation (4.18).

Table 18: Fuzzy Comparison Matrix Sub-Criteria of (A) Main Criteria Set

	A1	A2	A3	A4	A5	A6
A1	(1, 1, 1)	(2, 3, 4)	(2, 3, 4)	(1, 2, 3)	(2, 3, 4)	(2, 3, 4)
A2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1, 1, 2)	(1, 1, 2)	(1, 1, 2)
A3	(1/4, 1/3, 1/2)	(1/3, 1/2, 1)	(1, 1, 1)	(1/3, 1/2, 1)	(1, 2, 3)	(1, 1, 2)
A4	(1/3, 1/2, 1)	(1, 1, 2)	(1, 2, 3)	(1, 1, 1)	(3, 4, 5)	(1, 2, 3)
A5	(1/4, 1/3, 1/2)	(1, 1, 2)	(1/3, 1/2, 1)	(1/5, 1/4, 1/3)	(1, 1, 1)	(1/3, 1/2, 1)
A6	(1/4, 1/3, 1/2)	(1, 1, 2)	(1, 1, 2)	(1/3, 1/2, 1)	(1, 2, 3)	(1, 1, 1)

Computation of fuzzy synthetic extent values (S_i) values

$S_{urgency}$	(10, 15, 20)	⊗	(0,01, 0,02, 0,03)	=	(0,14, 0,32, 0,58)
$S_{legal\ obligations}$	(5,25, 6,33, 10,5)	⊗	(0,01, 0,02, 0,03)	=	(0,08, 0,14, 0,31)
$S_{priority\ inv.}$	(3,92, 5,33, 8,5)	⊗	(0,01, 0,02, 0,03)	=	(0,06, 0,11, 0,25)
$S_{eco\ social\ ben.}$	(7,33, 10,5, 15)	⊗	(0,01, 0,02, 0,03)	=	(0,11, 0,23, 0,44)
$S_{relationships}$	(3,12, 3,58, 5,83)	⊗	(0,01, 0,02, 0,03)	=	(0,04, 0,08, 0,17)
$S_{severe\ needs}$	(4,58, 5,83, 9,5)	⊗	(0,01, 0,02, 0,03)	=	(0,07, 0,13, 0,28)

In order to obtain degrees of the possibilities of criteria (V), each fuzzy synthesis number S is compared with others respectively. Each V is calculated by using equation (6.5).

$$\begin{matrix}
 & \mathbf{l} & \mathbf{m} & \mathbf{u} \\
 (S_u) & \begin{matrix} 0,144 & 0,322 & 0,585 \end{matrix} \\
 (S_l) & \begin{matrix} 0,076 & 0,136 & 0,307 \end{matrix}
 \end{matrix}
 \quad V(S_u \geq S_l) = 1$$

$V(S_u \geq S_l) = 1$	$V(S_u \geq S_p) = 1$	$V(S_u \geq S_e) = 1$	$V(S_u \geq S_r) = 1$	$V(S_u \geq S_s) = 1$
$V(S_l \geq S_u) = 0,47$	$V(S_l \geq S_p) = 1$	$V(S_l \geq S_e) = 0,69$	$V(S_l \geq S_r) = 1$	$V(S_l \geq S_s) = 1$
$V(S_p \geq S_u) = 0,33$	$V(S_p \geq S_l) = 0,9$	$V(S_p \geq S_e) = 0,56$	$V(S_p \geq S_r) = 1$	$V(S_p \geq S_s) = 0,94$
$V(S_e \geq S_u) = 0,75$	$V(S_e \geq S_l) = 1$	$V(S_e \geq S_p) = 1$	$V(S_e \geq S_r) = 1$	$V(S_e \geq S_s) = 1$
$V(S_r \geq S_u) = 0,10$	$V(S_r \geq S_l) = 0,62$	$V(S_r \geq S_p) = 0,75$	$V(S_r \geq S_e) = 0,30$	$V(S_r \geq S_s) = 0,68$
$V(S_s \geq S_u) = 0,40$	$V(S_s \geq S_l) = 0,95$	$V(S_s \geq S_p) = 1$	$V(S_s \geq S_e) = 0,63$	$V(S_s \geq S_r) = 1$

The minimum values in each row d_i are taken to form the W' , the relative weights of each criterion.

$$d_1 = 1,00 \quad d_2 = 0,47 \quad d_3 = 0,33 \quad d_4 = 0,75 \quad d_5 = 0,10 \quad d_6 = 0,40$$

After normalization of W' , weights of criteria has been calculated as shown in Table 19.

Table 19: Local Weights of Sub-criteria of (A) Main Criteria Set

	W'	Weights	Criteria
	1,00	1,00/3,06	0,33 Urgency
	0,47	0,47/3,06	0,15 Legal obligations
	0,33	0,33/3,06	0,11 Priority investment
	0,75	0,75/3,06	0,25 Economic and social benefits
	0,10	0,10/3,06	0,03 Relationship with other projects
	0,40	0,40/3,06	0,13 Severe Needs
Sum	3,06	3,06 / 3,06 =	1,00

It should be noted that the weights calculated are local weights. In order to obtain global weights, these weights have to be multiplied by the weight of criterion, located one step above, including these sub-criteria.

Local and global weights of all the criteria sub-criteria are shown in Table 20.

Table 20: Local and Global Weights of Criteria and Sub-criteria

Criteria	Local Weights 1	Local Weights 2	Local Weights 3	Local Weights 4	Global weights
A. Basic criteria set	0,692				
A1. Urgency		0,327			0,227
A2. Legal obligations		0,153			0,106
A3. Priority investment		0,109			0,076
A4. Economic and social benefits		0,246			0,171
A5. Relationship with other projects		0,032			0,022
A6. Severe needs		0,132			0,092
B. Detail criteria set	0,308				
B1. Economic and Social Impacts		0,412			
B1.1 Value adding effect			0,233		0,030
B1.2 Impacts on environment			0,205		0,026
B1.3 Contribution to employment			0,213		0,027
B1.4 Contribution to foreign exchange gain			0,115		0,015
B1.5 Contribution to income distribution			0,119		0,015
B1.6 Contribution to know-how			0,116		0,015
B2. Cost of Investment Project		0,182			
B2.1 Financing source			0,182		
B2.1.1 The government budget				-	-
B2.1.2 External financing				-	-
B2.1.3 Grants				0,511	0,005
B2.1.4 Public-private partnership				0,489	0,005
B2.2 Cost of financing			0,360		0,020
B2.3 Special liabilities related to financing			0,310		0,017
B2.4 Financial indicators			0,148		0,008
B3. Project Mgmt and Implementation Process		0,106			
B3.1 Clear definition of the project			0,231		0,008
B3.2 Compliance with Government policies			0,185		0,006
B3.3 Access to logistics/infrastructure			0,165		0,005
B3.4 Personnel competence			0,204		0,007
B3.5 Reconciliation with partners			0,126		0,004
B3.6 Duration			0,090		0,003
B4. Risks in Project Process		0,158			
B4.1 Financial risks			0,224		0,011
B4.2 Operational risks			0,185		0,009
B4.3 Political risks			0,224		0,011
B4.4 Legal risks			0,168		0,008
B4.5 Social risks			0,200		0,010
B5. Final Product and Service		0,142			
B5.1 Meeting various standards			0,187		0,008
B5.2 Need for supply/maintenance			0,161		0,007
B5.3 Marketability of the product			0,166		0,007
B5.4 Patentability of the product			0,128		0,006
B5.5 Beneficiaries of the product			0,215		
B5.5.1 Personnel of the institution				-	-
B5.5.2 Project owner institution				-	-
B5.5.3 Public / private sector institutions				-	-
B5.5.4 Citizens				1,000	0,009
B5.6 The main task of the institution			0,142		0,006

5.3. Scoring

At this stage, the decision-maker will calculate the priority score by giving a score of 1 or 0 to each criterion of the investment project proposal. A score of 1 means that it can meet the relevant criterion, and if it is 0, it cannot meet the criterion.

- First (A1): The decision maker assesses whether the project is urgent. If the project urgent then he gives 1 as score, and if not 0.
- Second (A2): The decision maker assesses if there are legal obligations for this project to be implemented. If the answer yes, then he gives 1 as the score, and if not 0.
- Third (A3): The decision maker assesses whether this investment project is or related to one of the priority investment areas determined by the government and published in the annual investment program. If the answer yes, then he gives 1 as the score, and if not 0.

The scoring process continues in this way. The calculation of the priority score of any investment project proposal given has been exemplified as shown in Table 21.

Multiplying the global weight of any criterion by 1 or 0, the project proposal will be calculated in terms of meeting the criterion. This procedure will be applied for all criteria and. These weights will be summed, and thus a priority score on the project proposal will be obtained.

Table 21: Calculation of Priority Scores

Criteria	Global weights	X	Scoring (1 or 0)	=	Score
A. Basic criteria set					
A1. Urgency	0,227	x	1	=	0,227
A2. Legal obligations	0,106	x	1	=	0,106
A3. Priority investment	0,076	x	0	=	-
A4. Economic and social benefits	0,171	x	1	=	0,171
A5. Relationship with other projects	0,022	x	0	=	-
A6. Severe needs	0,092	x	0	=	-
B. Detail criteria set					
B1. Economic and Social Impacts					
B1.1 Value adding effect	0,030	x	1	=	0,030
B1.2 Impacts on environment	0,026	x	0	=	-
B1.3 Contribution to employment	0,027	x	0	=	-
B1.4 Contribution to foreign exchange gain	0,015	x	0	=	-
B1.5 Contribution to income distribution	0,015	x	1	=	0,015
B1.6 Contribution to know-how	0,015	x	0	=	-
B2. Cost of Investment Project					
B2.1 Financing source					
B2.1.1 The government budget	-	x	1	=	-
B2.1.2 External financing	-	x	0	=	-
B2.1.3 Grants	0,005	x	1	=	0,005
B2.1.4 Public-private partnership	0,005	x	0	=	-
B2.2 Cost of financing	0,020	x	1	=	0,020
B2.3 Special liabilities related to financing	0,017	x	0	=	-
B2.4 Financial indicators	0,008	x	0	=	-
B3. Project Mgmt and Implementation Process					
B3.1 Clear definition of the project	0,008	x	0	=	-
B3.2 Compliance with Government policies	0,006	x	0	=	-
B3.3 Access to logistics/infrastructure	0,005	x	1	=	0,005
B3.4 Personnel competence	0,007	x	0	=	-
B3.5 Reconciliation with partners	0,004	x	1	=	0,004
B3.6 Duration	0,003	x	0	=	-
B4. Risks in Project Process					
B4.1 Financial risks	0,011	x	1	=	0,011
B4.2 Operational risks	0,009	x	1	=	0,009
B4.3 Political risks	0,011	x	0	=	-
B4.4 Legal risks	0,008	x	1	=	0,008
B4.5 Social risks	0,010	x	1	=	0,010
B5. Final Product and Service					
B5.1 Meeting various standards	0,008	x	1	=	0,008
B5.2 Need for supply/maintenance	0,007	x	1	=	0,007
B5.3 Marketability of the product	0,007	x	0	=	-
B5.4 Patentability of the product	0,006	x	1	=	0,006
B5.5 Beneficiaries of the product					
B5.5.1 Personnel of the institution	-	x	0	=	0
B5.5.2 Project owner institution	-	x	0	=	0
B5.5.3 Public / private sector institutions	-	x	0	=	0
B5.5.4 Citizens	0,009	x	0	=	0
B5.6 The main task of the institution	0,006	x	1	=	0,006
Priority Scores					0,647

5.4. Illustration

The illustration of the model and obtaining the priority scores will be carried out by using various project proposal scenarios which will be scored. These are given in Table 23.

In the final step of stage 2, priority scores of each project proposal which is a candidate to be in the public investment project portfolio, has been sorted from the highest to lowest as shown in Table 22.

Table 22: Priority Scores of Investment Project Proposal Scenarios

Rank	Proposals	Priority Scores
1	P 8	0,81
5	P 7	0,66
3	P 1	0,64
7	P 4	0,59
2	P 5	0,55
6	P 6	0,53
4	P 10	0,50
8	P 3	0,50
9	P 2	0,43
10	P 9	0,34

As seen in Table 22, the highest score is 0.81 belonging to number 8 in the scenario. While all other parameters are kept constant, the decision maker will decide on which projects should take place in the project portfolio taking this order into account.

Table 23: 1/0 Scoring of Investment Project Proposals (P) in Scenarios

Criteria	Global weights	P 1 P 2 P 3 P 4 P 5 P 6 P 7 P 8 P 9 P 10									
		P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10
A. Basic criteria set											
A1. Urgency	0,227	1	0	0	1	0	0	1	1	0	1
A2. Legal obligations	0,106	1	1	1	0	0	0	1	0	0	0
A3. Priority investment	0,076	1	0	0	1	1	1	1	1	0	0
A4. Economic and social benefits	0,171	0	1	1	1	1	1	0	1	1	0
A5. Relationship with other projects	0,022	1	1	0	0	1	0	0	1	0	1
A6. Severe needs	0,092	0	0	1	0	1	1	1	1	0	1
B. Detail criteria set											
B1. Economic and Social Impacts											
B1.1 Value adding effect	0,030	1	0	0	0	0	0	1	1	0	0
B1.2 Impacts on environment	0,026	1	0	1	1	0	1	0	1	1	0
B1.3 Contribution to employment	0,027	1	0	1	0	1	1	1	1	0	1
B1.4 Contribution to foreign exchange gain	0,015	1	1	0	1	1	1	0	1	0	1
B1.5 Contribution to income distribution	0,015	1	1	1	0	0	0	1	1	0	1
B1.6 Contribution to know-how	0,015	1	0	1	0	1	1	0	1	1	1
B2. Cost of Investment Project											
B2.1 Financing source											
B2.1.1 The government budget	-	1	1	0	1	1	0	0	0	1	1
B2.1.2 External financing	-	1	0	0	1	1	0	1	0	1	1
B2.1.3 Grants	0,005	1	1	0	1	0	0	0	1	0	0
B2.1.4 Public-private partnership	0,005	1	1	1	1	0	0	0	0	1	1
B2.2 Cost of financing	0,020	0	1	0	1	1	1	1	1	1	0
B2.3 Special liabilities related to financing	0,017	0	1	0	0	1	0	0	0	0	1
B2.4 Financial indicators	0,008	1	1	0	0	1	1	1	0	1	1
B3. Project Mgmt and Implementation Process											
B3.1 Clear definition of the project	0,008	1	0	0	0	1	1	0	0	1	0
B3.2 Compliance with Government policies	0,006	0	0	0	1	0	1	0	1	1	0
B3.3 Access to logistics/infrastructure	0,005	0	1	0	1	0	1	1	0	1	1
B3.4 Personnel competence	0,007	1	1	0	0	1	1	1	0	0	1
B3.5 Reconciliation with partners	0,004	1	1	1	0	1	0	1	0	1	0
B3.6 Duration	0,003	1	1	0	1	0	1	1	1	1	0
B4. Risks in Project Process											
B4.1 Financial risks	0,011	1	0	1	1	1	1	1	1	0	1
B4.2 Operational risks	0,009	0	0	0	0	1	0	0	0	1	0
B4.3 Political risks	0,011	1	1	0	0	1	0	1	1	1	0
B4.4 Legal risks	0,008	0	1	1	0	0	0	0	1	1	1
B4.5 Social risks	0,010	0	0	1	1	1	0	0	1	1	1
B5. Final Product and Service											
B5.1 Meeting various standards	0,008	1	0	1	0	0	1	0	0	1	1
B5.2 Need for supply/maintenance	0,007	1	1	0	0	1	1	0	0	1	1
B5.3 Marketability of the product	0,007	0	0	0	0	1	1	0	1	1	0
B5.4 Patentability of the product	0,006	0	1	1	0	1	1	1	1	0	1
B5.5 Beneficiaries of the product											
B5.5.1 Personnel of the institution	-	1	0	1	0	1	1	1	1	1	1
B5.5.2 Project owner institution	-	0	1	0	1	1	0	1	0	1	0
B5.5.3 Public / private sector institutions	-	1	0	0	0	0	1	1	1	0	1
B5.5.4 Citizens	0,009	0	0	0	1	1	1	1	0	1	0
B5.6 The main task of the institution	0,006	1	0	0	1	0	0	1	1	0	0
PRIORITY SCORES		0,64	0,43	0,50	0,59	0,55	0,53	0,66	0,81	0,34	0,50

5.5. Discussions on the Proposed Model

In the fuzzy AHP section of the proposed model, collaboration has been formed with experts who are well-informed and experienced about public investments in determining the evaluation criteria, establishing the hierarchy of criteria and obtaining pairwise comparisons. Therefore, the weights of the criteria in the first stage were obtained within the framework of healthy and reliable information.

In the second stage, because information on actual investments is not published publicly, the 1/0 assignment could not have been done.

After the results obtained from the fuzzy AHP analysis are examined, it was observed that the criteria covering the reasons for the realization of investment projects have very high weights. The criteria of urgency, economic and social benefits and legal obligations were the first three high weighted criteria. Also, it is seen that the total weights of these three criteria constitute 72.6 % of the total weight of the whole criteria set.

This shows that the reasons for investing really matter and are much more important than the details related to the investment.

The highest five criteria in the details of the project criteria are B1.1 Value adding effect (0.030), B1.3 Contribution to employment (0.027), B1.2 Impacts on the environment (0,26) B2.2 Cost of financing (0.020) and B2.3 Special liabilities related to financing (0,017) respectively. The total weights of these criteria correspond to 12.0% of the weight totals of the total weight of the whole criteria set.

Moreover, the results of the analysis have been shared with the experts who contributed to the study and the results have been evaluated by them. In this context, a common opinion has been that the weights of the criteria were meaningful and consistent.

6. CONCLUSION

With the gathering of people in a certain geographical area in order to sustain their lives, various everyday needs have emerged, and these needs have increased and diversified from the beginning of collective life to the present. Large amounts of capital which a person or group cannot meet are needed to meet these services which are common to the society such as production, transportation, communication, energy, and infrastructure. Besides, the execution of these services may not be economical. Regarding both of these reasons, all services aforementioned above are executed by governments [72].

By using the limited resources available, the Governments make various investments in order to increase the economic, social and welfare levels of society.

Public investments are generally based on durable goods of which benefit more than one year. Services such as transportation, energy, communication, production, health, education, and justice, as well as various equipment provided by construction, renovation, maintenance, and repairs to ensure the continuity of these services are examples of public investments.

Lack of resources is an important problem in achieving the desired level of growth and economic development in developing countries. Therefore, it is necessary to direct scarce resources to the most appropriate investment areas and to act rationally when making an investment decision.

For effective use of limited resources, the Governments align the projects in their development programs, annual programs, and budgets within the framework of the priorities and urgency of these investments.

Since public investment projects are generally large-scale, have a long period of impact and are often impossible to return the investment, it is of the utmost importance to select the right investment projects. In particular, the limited capital allocated for investments

requires that the capital has to be allocated to projects that will provide the highest efficiency.

For this reason, the benefits and costs that will arise as a result of the investment expenditures should be considered in terms of the national economy. The projects constitute the building blocks of development, so selecting the right projects is really vital for the growth and development of the country's economy.

The process of public investment program management in Turkey is carried out by the Strategy and Budget Directorate (SBD) within the Presidency.

The prioritization and selection process of investment project proposals is currently carried out based on sectors. The project proposals within the same sector are evaluated agreement the competence and experience of the expert assigned.

Considering that our country's income sources are limited, it is very important to prioritize and select public investment projects, which are allocated high budgets, from an objective point of view and quantifying methods.

However, in the current practice, an objective method based on quantification is not used in the project selection process carried out by the SBD. This situation does not allow comparison of investment proposals in different sectors.

This situation is the starting point of the thesis study. In this thesis, it is aimed to prioritize investment project proposals with a quantitative standard model in order to overcome these problems and to contribute to the project selection process.

The model proposed follows two stages correspondingly: fuzzy AHP and 0/1 scoring. At the fuzzy AHP stage of the model, the criteria to be used in the assessment of project proposals have been determined and designed as a hierarchical structure. The Fuzzy AHP analysis has been conducted within the framework of the responses obtained from the experts who are well-informed and experienced about public investments..

In the second stage, decision-maker examines the proposal in terms of meeting the criteria. If the proposal meets the criterion, 1 point otherwise 0 point is assigned to the criterion. Then, he multiplies the weight of criterion with the score of criterion. The priority score of the project proposal is calculated by summing the products. Various project proposal scenarios have been created in order to illustrate the model and priority score of each proposal has been calculated.

When the literature on this subject is examined, it is seen that there are various studies in forming project portfolios. However, it has been observed that a comprehensive model for public projects on this issue has not been published. In a few numbers of studies on prioritization and selection of public project proposals, it can be said that only specific types of projects were prioritized and selected by a model.

The model developed in the thesis is able to assess any kind of project proposal offered by public institutions from a wide variety of aspects, regardless of sector. In determining the weights of the criteria in the first stage, the decision-maker just assigns 1/0 values to relevant criteria. The model can be easily used in real life public projects prioritization and selection processes.

Beyond, the broad set of criteria developed that can questions proposal from different aspects is at least as important as the model itself. Those criteria can be used to prioritize and select investment project proposals regardless of country, sector, and type. It should be noted that values of paired comparisons in the method have to be modified in line with country, region, political preferences and conjuncture in which the project will be carried out.

For the future research, some other the points related to this kind of a project proposal prioritization in public sector may be considered. These are given as follows.

The proposed method is to compare public investment project proposals regardless of the sector. However, in order to achieve more precise rankings, in-sector prioritizations can also be made by using this set of criteria and prioritization model.

Another point to consider is that (A) the main set of criteria and (B) should be weighted in two different FAHP studies instead of in the same hierarchy. According to the results obtained from the application, the sum of criteria weights in the main set of criteria (A) corresponds to 69% of the total weights of all criteria in the hierarchy. The 6 criteria in the main criteria set share a total weight of 0.69, while the 34 criteria in the supporting criteria set share 0.31 weight. Therefore, it can be considered that the main set of criteria and the supporting set of criteria are not in the same hierarchy. One suggestion is that the first priority should be realized with the main criteria set considering the adequacy of the investment budget, and if the budget is sufficient, the remaining project proposals should be prioritized with the supporting criteria set.

In the thesis, a score of 1/0 was applied according to the competence of the project proposals to meet the relevant sub-criteria. Instead of the integer values 0 and 1, more flexible scoring values can be considered for the criterion such as {0.2, 0.4, 0.6, 0.8, 1.0}. In addition, any value in the range (0-1) can also be used.

Following this study, the sensitivity of the selection can be tested using different hybrid selection methods. The model must be validated according to the actual data. On the flip side, it is extremely important to develop new models that strengthen the set of criteria and making realistic comparisons.

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ANNEXES

Annex 1 – Pairwise Comparison Form

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

1. Bilgilendirme

Bilindiği üzere ülkemizde sürekli ve istikrarlı kalkınma ve büyümenin sağlanması için sınırlı gelir kaynakları çerçevesinde çeşitli kamu yatırımları gerçekleştirilmektedir.

Yıllık yatırım programının oluşturulması sürecinde kurumlar tarafından önerilen yatırım teklifleri, Strateji ve Bütçe Başkanlığında değerlendirilmekte ve yatırım programına alınıp alınmamasına karar verilmektedir.

Ülkemizde 2017 ve 2018 yılları için kamu yatırımlarına sırasıyla 80,3 Milyar TL ve 88,1 Milyar TL tahsis edilmiştir. Gelir kaynaklarımızın sınırlı olduğu göz önünde bulundurulduğunda, kamu yatırım projelerinin henüz teklif aşamalarında iken sayısal önceliklendirilmesi ve seçilmesi oldukça önem arz etmektedir.

Bahsedilen hususta gerçekleştirilecek akademik bir çalışma kapsamında, sizin konuya ilişkin uzmanlığınız ve tecrübenizden istifade etmek üzere bu değerlendirme formu tarafınıza iletilmiştir.

Formda, proje tekliflerinin önceliklendirilmesine yönelik kriterler tanımlanmış olup, bu kriterlerin ikili olarak birbirleriyle karşılaştırılması ve hangi kriterin diğerine göre ne ölçüde önem arz ettiği sorulmaktadır. Formdaki sayfalarda kriterlere ilişkin kısa açıklamalara yer verilmektedir.

Sorularda her bir karşılaştırma için **ilk kriter kırmızı renkle**, **ikinci kriter mavi renkle** yazılmıştır.

- **İlk kriterin diğerine göre daha önemli** olduğunu düşünüyorsanız, ölçeğin solunda **kırmızı ile yazılan kısma** önem derecesini işaretlemeniz gerekmektedir.
- Eğer **ikinci kriter daha önemli** ise ölçeğin sağında **mavi ile yazılan kısma** önem derecesini işaretlemeniz gerekmektedir.

Sağlayacağınız katkıyla, proje tekliflerinin seçiminde karar vericiye destek olabilecek nesnel bir model kurulması sağlanacaktır.

Proje seçim sürecinde, modelimizin tek bir teklifin dahi yatırım programına alınması/alınmaması kararına destek olması, milyon TL ile ifade edilen bir tutarın boşuna harcanmamasını sağlayarak kaynak kıtlığı nedeniyle programa alınamayan başka bir proje teklifinin önünü açacaktır.

Desteğiniz için teşekkür ediyorum.

Form, yaklaşık 15 dakika içinde tamamlanabilmektedir.

Ekran boyutu nedeniyle, form akıllı telefonlarda bozuk görünmektedir. Bu nedenle formun, bilgisayar üzerinde tamamlanması çok daha kolay ve hızlı olabilmektedir.

1. Çalıştığınız kurum (isteğe bağlı)

* 2. Mevcut durumunuza uygun pozisyon ve kıdeminiz

Kıdem

Üst Düzey Yönetici

Orta Düzey Yönetici (Genel Müdür Yrd., Daire Başkanı ve dengi pozisyonlar)

Kariyer Meslek Memuru (Uzman, Kontrolör, Denetmen, Müfettiş vb veya Yrd ve dengi pozisyonlar)

İdari Memur

Diğer

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

2. Yatırım Projesinin Önceliklendirilmesi

Kriterler ve Açıklamaları

Yatırım projesinin seçiminde;

Temel Kriter Havuzu: Projenin temel gereklileri (acı olması, zorunluluk/yükümlülük nedeniyle gerçekleştirilmesi, başka projelerle ilişkisi, öncelikli yatırım alanları kapsamında olması ve somut bir ihtiyaç olması gibi nedenler)

Detay Kriter Havuzu: Projenin özellikleri ve faydaları (maliyeti, projenin yönetimi ve uygulaması, riskleri ve nihai ürün/hizmete ilişkin değerlendirmeler vb.)

Yukarıdaki kriterler ve açıklamaları çerçevesinde lütfen aşağıdaki kıyaslamaları yapınız.

* 3. Yatırım projesinin gerçekleştirilmek istenmesinde; sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Temel kriter havuzu (gerçekleştirilme nedenleri)
2. kriter: Detay kriter havuzu (projenin özellikleri)

İlk Kriter	İkinci Kriter
Son Derece Önemli	Son Derece Önemli
Çok Önemli	Çok Önemli
Orta Önemli	Orta Önemli
Daha Az Önemli	Daha Az Önemli
En Az Önemli	En Az Önemli

Temel kriter havuzu (gerçekleştirilme nedenleri)
Detay kriter havuzu (projenin özellikleri)

Son Derece Önemli	Çok Önemli	Orta Önemli	Daha Az Önemli	En Az Önemli
9	7	5	3	1

Son Derece Önemli	Çok Önemli	Orta Önemli	Daha Az Önemli	En Az Önemli
9	7	5	3	1

2

3

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

3. Yatırım Projesinin Gerçekleştirilme Nedeni

Kriterler ve Açıklamaları

Aciliyet: Gerçekleşmiş ya da olaası can ve mal kayıplarının olması, projenin stratejik seviyede önem taşıması, ekonomi, kamu yönetimi ve sosyal hayatta yaşanan / olası sıkıntılar vb. nedeniyle acil olması.

Yasal Zorunluluk / Yükümlülük olması: Projenin ulusal ve uluslararası yasalara, anlaşmalar ve kararlar doğrultusunda bir zorunluluk ya da yükümlülük nedeniyle gerçekleştirilmesi.

Öncelikli Yatırım: Projenin, üst politika belgelerinde belirtilen öncelikli yatırım alanları kapsamında olması nedeniyle gerçekleştirilmesi.

Ekonomik ve Sosyal Fayda: Projenin dolaysız, doğrudan etkileri dikkate alınarak kalkınma, nüfus, istihdam, gelir dağılımı, sosyal hizmetler, kültürel vb. alanlarda sağlayacağı fayda nedeniyle gerçekleştirilmesi.

Başka Projeye İlişkili: Projenin, başka bir projeye öncüllük / ardıllık / tamamlayıcılık ilişkisi taşıması nedeniyle gerçekleştirilmesi.

İhtiyaç: Projenin somut gerekeç ve delillerle ortaya konulan bir ihtiyaç olması nedeniyle gerçekleştirilmesi.

Yukarıdaki kriterler ve açıklamaları çerçevesinde lütfen aşağıdaki kıyaslamaları yapınız.

* 4. Yatırım projelerini, gerçekleştirilme nedeni açısından değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Aciliyete sahip olması
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter				
Aciliyete sahip olması	9	7	5	3	1	→	←	9
Yasal zorunluluk olması	9	7	5	3	1	→	←	9
Aciliyete sahip olması	9	7	5	3	1	→	←	9
Öncelikli yatırım olması	9	7	5	3	1	→	←	9
Aciliyete sahip olması	9	7	5	3	1	→	←	9
Ekonomik ve sosyal fayda sağlanması	9	7	5	3	1	→	←	9
Aciliyete sahip olması	9	7	5	3	1	→	←	9
Başka projeye ilişkili olması	9	7	5	3	1	→	←	9
Aciliyete sahip olması	9	7	5	3	1	→	←	9
İhtiyaç olması	9	7	5	3	1	→	←	9

* 5. Yatırım projelerini, gerçekleştirilme nedeni açısından değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Yasal zorunluluk olması
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter				
Yasal zorunluluk olması	9	7	5	3	1	→	←	9
Öncelikli yatırım olması	9	7	5	3	1	→	←	9
Yasal zorunluluk olması	9	7	5	3	1	→	←	9
Ekonomik ve sosyal fayda sağlanması	9	7	5	3	1	→	←	9
Yasal zorunluluk olması	9	7	5	3	1	→	←	9
Başka projeye ilişkili olması	9	7	5	3	1	→	←	9
Yasal zorunluluk olması	9	7	5	3	1	→	←	9
İhtiyaç olması	9	7	5	3	1	→	←	9

* 6. Yatırım projelerini, gerçekleştirilme nedeni açısından değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Öncelikli yatırım olması
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter				
Öncelikli yatırım olması	9	7	5	3	1	→	←	9
Ekonomik ve sosyal fayda sağlanması	9	7	5	3	1	→	←	9
Öncelikli yatırım olması	9	7	5	3	1	→	←	9
Başka projeye ilişkili olması	9	7	5	3	1	→	←	9
Öncelikli yatırım olması	9	7	5	3	1	→	←	9
İhtiyaç olması	9	7	5	3	1	→	←	9

* 10. Yatırım projesine ilişkin detayları incelediğinizde, sizce hangi husus daha önemli ve ne derecede?

1. kriter: Maliyeti

2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece	←	→	Son Derece
Çok Önemli	←	→	Çok Önemli
7	←	→	7
5	←	→	5
3	←	→	3
Biraz Önemli	←	→	Biraz Önemli
1	←	→	1
Eşit Önemde	←	→	Eşit Önemde
3	←	→	3
Daha Önemli	←	→	Daha Önemli
5	←	→	5
7	←	→	7
9	←	→	9

Maliyeti
Projenin yönetimi ve uygulaması

Maliyeti
Proje riskleri

Maliyeti
Nihai ürün/hizmetin özellikleri

* 11. Yatırım projesine ilişkin detayları incelediğinizde, sizce hangi husus daha önemli ve ne derecede?

1. kriter: Projenin yönetimi ve uygulaması

2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece	←	→	Son Derece
Çok Önemli	←	→	Çok Önemli
7	←	→	7
5	←	→	5
3	←	→	3
Biraz Önemli	←	→	Biraz Önemli
1	←	→	1
Eşit Önemde	←	→	Eşit Önemde
3	←	→	3
Daha Önemli	←	→	Daha Önemli
5	←	→	5
7	←	→	7
9	←	→	9

Projenin yönetimi ve uygulaması
Proje riskleri

Projenin yönetimi ve uygulaması
Nihai ürün/hizmetin özellikleri

* 12. Yatırım projesine ilişkin detayları incelediğinizde, sizce hangi husus daha önemli ve ne derecede?

1. kriter: Proje riskleri

2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece	←	→	Son Derece
Çok Önemli	←	→	Çok Önemli
7	←	→	7
5	←	→	5
3	←	→	3
Biraz Önemli	←	→	Biraz Önemli
1	←	→	1
Eşit Önemde	←	→	Eşit Önemde
3	←	→	3
Daha Önemli	←	→	Daha Önemli
5	←	→	5
7	←	→	7
9	←	→	9

Proje riskleri
Nihai ürün/hizmetin özellikleri

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

5. Ekonomik ve Sosyal Etki Kriterleri ve Açıklamaları

Yatırım projesinin;

Katma değer etkisi: Yatırım projesinin ulusal gelir ve büyüme etkisi.

Çevresel etkisi: Projenin çevrede kirlilik yaratması ve/veya canlı hayatını etkilemesi

İstihdam etkisi: Projenin istihdamı artırması ya da azaltması

Döviz kazancı etkisi: Projenin döviz kazandırması.

Gelir dağılımı etkisi: Projenin gelir dağılımını iyileştirilmesi, gelişmişlik farkını azaltması ya da tersine neden olması

Know-how etkisi: Projenin kuruma/ sektöre/ülkemize yeni bilgi/teknoloji sağlaması.

Yukarıdaki kriterler ve açıklamaları çerçevesinde lütfen aşağıdaki kıyaslamaları yapınız.

* 13. Yatırım projesinin sağlayacağı ekonomik ve sosyal etkileri değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Katma değer etkisi
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter		İkinci Kriter	
	←	→	←	→
Katma değer etkisi	○	○	○	○
Çevreye etkisi	○	○	○	○
Katma değer etkisi	○	○	○	○
İstihdam etkisi	○	○	○	○
Katma değer etkisi	○	○	○	○
Döviz kazancı etkisi	○	○	○	○
Katma değer etkisi	○	○	○	○
Gelir dağılımı etkisi	○	○	○	○
Katma değer etkisi	○	○	○	○
Know-how etkisi	○	○	○	○

10

* 14. Yatırım projesinin sağlayacağı ekonomik ve sosyal etkileri değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Çevreye etkisi
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter		İkinci Kriter	
	←	→	←	→
Çevreye etkisi	○	○	○	○
İstihdam etkisi	○	○	○	○
Çevreye etkisi	○	○	○	○
Döviz Kazancı etkisi	○	○	○	○
Çevreye etkisi	○	○	○	○
Gelir Dağılımı etkisi	○	○	○	○
Çevreye etkisi	○	○	○	○
Know-how etkisi	○	○	○	○

* 15. Yatırım projesinin sağlayacağı ekonomik ve sosyal etkileri değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: İstihdam etkisi
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter		İkinci Kriter	
	←	→	←	→
İstihdam etkisi	○	○	○	○
Döviz Kazancı etkisi	○	○	○	○
İstihdam etkisi	○	○	○	○
Gelir Dağılımı etkisi	○	○	○	○
İstihdam etkisi	○	○	○	○
Know-how etkisi	○	○	○	○

11

* 16. Yatırım projesinin sağlayacağı ekonomik ve sosyal etkileri değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Döviz Kazancı etkisi
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece Önemli	9	7	3
Çok Önemli	5	3	1
Biraz Önemli	3	1	0
Daha Önemli	1	0	0
Oldukça Önemli	0	0	0
Biraz Önemli	0	0	0
Daha Önemli	0	0	0
Oldukça Önemli	0	0	0
Çok Önemli	0	0	0
Son Derece Önemli	0	0	0

Döviz Kazancı etkisi
Gelir Dağılımı etkisi

Döviz Kazancı etkisi
Know-how etkisi

* 17. Yatırım projesinin sağlayacağı ekonomik ve sosyal etkileri değerlendirdiğinizde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Gelir Dağılımı etkisi
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece Önemli	9	7	3
Çok Önemli	5	3	1
Biraz Önemli	3	1	0
Daha Önemli	1	0	0
Oldukça Önemli	0	0	0
Biraz Önemli	0	0	0
Daha Önemli	0	0	0
Oldukça Önemli	0	0	0
Çok Önemli	0	0	0
Son Derece Önemli	0	0	0

Gelir Dağılımı etkisi
Know-how etkisi

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

6. Yatırım Projesinin Maliyeti

Kriterler ve Açıklamaları

Yatırım projesinin;

Finansman kaynağı: Projenin bütçe, yabancı kredi, hibe ya da kamu-özel işbirliği gibi finansman kaynaklarından hangisinin kullanılarak finanse edileceği hususu.

Finansmanın maliyeti: Proje için yabancı kurum ve kuruluşlardan dış kredi kullanılması durumunda, bu finansmanın getireceği faiz yükü.

Finansmana ilişkin özel yükümlülükler: Projede yabancı kurum ve kuruluşlardan dış kredi kullanılmak istenilmesi durumunda, bu kurum ve kuruluşların kredi verilmesi için öne sürdüğü çeşitli ön şartların bulunması.

Finansal göstergeler: Projede maliyet, gelir, işletme sermayesi ile ilgili tahminler, nakit akışı ve bilanço gibi kalemlere ilişkin çeşitli göstergelerin değerleri.

Yukarıdaki kriterler ve açıklamaları lütfen aşağıdaki kıyaslamaları yapınız.

* 18. Yatırım projesine ilişkin mali hususların değerlendirilmesinde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Finansmanın Kaynağı
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece Önemli	9	7	3
Çok Önemli	5	3	1
Biraz Önemli	3	1	0
Daha Önemli	1	0	0
Oldukça Önemli	0	0	0
Biraz Önemli	0	0	0
Daha Önemli	0	0	0
Oldukça Önemli	0	0	0
Çok Önemli	0	0	0
Son Derece Önemli	0	0	0

Finansmanın kaynağı
Finansmanın maliyeti

Finansmanın kaynağı
Finansmana ilişkin özel yükümlülükler

Finansmanın kaynağı
Finansal göstergeler

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

8. Proje Yönetimi ve Uygulama Süreci

Kriterler ve Açıklamalar

Projenin net tanımlanması: Projenin amacı, hedefi ve gerçekleştirilecek faaliyetlerin açık ve net tanımlanmış olması

Üst politikalara uyum: Projenin üst politika belgeleriyle uyumlu olması üst politika belgelerine/uzatıda uyumlu olması

Projenin lojistik ve altyapı hizmetlerine erişim kolaylığı; hammadde kaynaklarına erişilebilirlik, ulaşım ve haberleşme sistemi, su-elektrik-doğal gaz şebekeleri, arazi kullanımı, yan sanayi, dağıtım ve pazarlama olanakları vb.

Kurumun personele/bilgi/tecrübe yeterliliği: Projenin gerçekleştirilmesi için ihtiyaç duyulan insan kaynağı ile bilgi ve tecrübenin kurumun öz kaynakları kullanılarak karşılanabilmesi

Proje ortağıyla mutabakat: diğer kamu kuruluşları ile proje süreci, görev dağılımı, yetki ve sorumluluk vb. konularda mutabık kalınması

Projenin süresi: Projeye başlanması veyaveya tamamlanması için ihtiyaç duyulan süre

Yukarıdaki kriterler ve açıklamaları çerçevesinde lütfen aşağıdaki kıyaslamaları yapınız.

* 22. Yatırım projelerinin finansman kaynağını düşündüğünüzde; hangi kaynak daha tercih edilebilir ve ne ölçüde önemli?

1. kriter: Dış finansman yoluyla karşılanması
2. kriter: ... (Sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter	
Son Derece Önemli	9	7	Son Derece Önemli	9
Biraz Önemli	8	6	Biraz Önemli	8
Orta Önemli	7	5	Orta Önemli	7
Biraz Daha Önemli	6	4	Biraz Daha Önemli	6
Çok Önemli	5	3	Çok Önemli	5
Eşit Önemli	4	2	Eşit Önemli	4
Biraz Daha Az Önemli	3	1	Biraz Daha Az Önemli	3
Biraz Az Önemli	2	0	Biraz Az Önemli	2
Az Önemli	1	0	Az Önemli	1
Hiç Önemli Değil	0	0	Hiç Önemli Değil	0

Dış finansman (kredi)
Hibe yoluyla karşılanması
Dış finansman (kredi)
Kamu - özel işbirliği

* 23. Yatırım projelerinin finansman kaynağını düşündüğünüzde; hangi kaynak daha tercih edilebilir ve ne ölçüde önemli?

1. kriter: Hibe yoluyla karşılanması
2. kriter: ... (Sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter	
Son Derece Önemli	9	7	Son Derece Önemli	9
Biraz Önemli	8	6	Biraz Önemli	8
Orta Önemli	7	5	Orta Önemli	7
Biraz Daha Önemli	6	4	Biraz Daha Önemli	6
Çok Önemli	5	3	Çok Önemli	5
Eşit Önemli	4	2	Eşit Önemli	4
Biraz Daha Az Önemli	3	1	Biraz Daha Az Önemli	3
Biraz Az Önemli	2	0	Biraz Az Önemli	2
Az Önemli	1	0	Az Önemli	1
Hiç Önemli Değil	0	0	Hiç Önemli Değil	0

Hibe
Kamu - özel işbirliği

* 26. Proje yönetimi ve uygulama sürecini düşündüğünüzde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Lojistik ve altyapı hizmetlerine erişim
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	Biraz Daha Önemli	Esit Önemde	Biraz Daha Az Önemli	→	→	İkinci Kriter
	Son Derece Önemli	9	7	5	3	1	3	5	Son Derece Önemli
Lojistik ve altyapı hizmetlerine erişim	○								○
Kurumun personel/bilgi/tecrübe yeterliliği	○								○
Lojistik ve altyapı hizmetlerine erişim	○								○
Proje ortağıyla mutabakat sağlanması	○								○
Lojistik ve altyapı hizmetlerine erişim	○								○
Projenin süresi	○								○

* 27. Proje yönetimi ve uygulama sürecini düşündüğünüzde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Kurumun personel/bilgi/tecrübe yeterliliği
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	Biraz Daha Önemli	Esit Önemde	Biraz Daha Az Önemli	→	→	İkinci Kriter
	Son Derece Önemli	9	7	5	3	1	3	5	Son Derece Önemli
Kurumun personel/bilgi/tecrübe yeterliliği	○								○
Proje ortağıyla mutabakat sağlanması	○								○
Kurumun personel/bilgi/tecrübe yeterliliği	○								○
Projenin süresi	○								○

19

* 24. Proje yönetimi ve uygulama sürecini düşündüğünüzde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Projenin net tanımlanması
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	Biraz Daha Önemli	Esit Önemde	Biraz Daha Az Önemli	→	→	İkinci Kriter
	Son Derece Önemli	9	7	5	3	1	3	5	Son Derece Önemli
Projenin net tanımlanması	○								○
Üst politikalara uyum	○								○
Projenin net tanımlanması	○								○
Lojistik ve altyapı hizmetlerine erişim	○								○
Projenin net tanımlanması	○								○
Kurumun personel/bilgi/tecrübe yeterliliği	○								○
Projenin net tanımlanması	○								○
Proje ortağıyla mutabakat sağlanması	○								○
Projenin net tanımlanması	○								○
Projenin süresi	○								○

* 25. Proje yönetimi ve uygulama sürecini düşündüğünüzde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Üst politikalara uyum
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	←	→	Biraz Daha Önemli	Esit Önemde	Biraz Daha Az Önemli	→	→	İkinci Kriter
	Son Derece Önemli	9	7	5	3	1	3	5	Son Derece Önemli
Üst politikalara uyum	○								○
Lojistik ve altyapı hizmetlerine erişim	○								○
Üst politikalara uyum	○								○
Kurumun personel/bilgi/tecrübe yeterliliği	○								○
Üst politikalara uyum	○								○
Proje ortağıyla mutabakat sağlanması	○								○
Üst politikalara uyum	○								○
Projenin süresi	○								○

18

* 28. Proje yönetimi ve uygulama sürecini düşündüğünüzde, sizce hangi kriter daha önemli ve ne derecede?

1. kriter: Proje ortağıyla mutabakat sağlanması
2. kriter: ... (sirasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece Önemli	←	→	Son Derece Önemli
7			7
Çok Önemli	←	→	Çok Önemli
5			5
Oldukça Önemli	←	→	Oldukça Önemli
3			3
Biraz Önemli	←	→	Biraz Önemli
1			1
Eşit Önemde			Eşit Önemde
3			3
Daha Önemli			Daha Önemli
5			5
Oldukça Önemli			Oldukça Önemli
7			7
Çok Önemli			Çok Önemli
9			9

Proje ortağıyla mutabakat sağlanması

Projenin süresi

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

9. Proje Sürecindeki Riskler

Kriterler ve Açıklamaları

Finansal riskler: Döviz kuru, enflasyon, faizler ve gelir fiyatlarındaki beklenmedik değişimler, bütçenin yetersizliği gibi olayların gerçekleşmesi.

Operasyonel riskler: Proje süreci yönetimindeki başarısızlıklar, iş sağlığı ve güvenliği, grev, doğal afetler gibi olayların gerçekleşmesi.

Politik riskler: Siyasi istikrarın sağlanmaması, ticari faaliyetlerde sınırlamalar, ihracat/ithalatta sınırlamalar, para cinsi ve transferi ile ilgili sınırlamalar gibi olayların gerçekleşmesi.

Hukuki riskler: İlgili mevzuatın değişmesi ve ilave emek, harcama, süre gerektirmesi, lisans ve patent haklarının ihlali edilmesi, organizasyon içi ve dışından gelen hukuk davaları gibi olayların gerçekleşmesi.

Sosyal riskler: Projeye ilişkin kamuoyu algısı, toplumsal tepki, protesto gibi olayların gerçekleşmesi.

Yukarıdaki kriterler ve açıklamaları lütfen aşağıdaki kıyaslamaları yapınız.

* 29. Proje sürecindeki riskleri düşündüğünüzde, sizce hangi tür risk daha önemli ve ne derecede?

1. kriter: Finansal riskler
2. kriter: ... (sirasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter
Son Derece Önemli	←	→	Son Derece Önemli
9			9
Çok Önemli	←	→	Çok Önemli
7			7
Oldukça Önemli	←	→	Oldukça Önemli
5			5
Biraz Önemli	←	→	Biraz Önemli
3			3
Eşit Önemde			Eşit Önemde
1			1
Daha Önemli			Daha Önemli
3			3
Oldukça Önemli			Oldukça Önemli
5			5
Çok Önemli			Çok Önemli
7			7
Son Derece Önemli			Son Derece Önemli
9			9

Finansal riskler

Operasyonel riskler

Finansal riskler

Politik riskler

Finansal riskler

Hukuki riskler

Finansal riskler

Sosyal riskler

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

10. Nihai Ürün ve Hizmet Kriterleri ve Açıklamaları

Proje sonucunda ortaya konulan nihai ürün/hizmetin;

Çeşitli standartları karşılayabilmesi: nihai ürün ya da hizmetin ulusal ve/veya uluslararası genel ya da sektörel standartları karşılayabilir olması.

Süreklilik arz ve bakım/onarım ihtiyacı duyulması: Nihai ürün ya da hizmetin kesintisiz kullanılabilmesi için sürekli üretimi, düzenli bakıma ve bozulma/aksama durumlarında onarım ihtiyacı duymaması.

Pazarlanabilmesi: Nihai ürün/hizmetin yurt içinde ve/veya dışında pazarlanabilmesi.

Patentinin alınabilmesi: Nihai ürün/hizmetin önceden var olmayan bir yenilik getirmesi.

Doğrudan kime fayda sağlayacağı: Kurum personeline, kurumun işleyişine, kamu ve/veya özel sektör kurumlarının işleyişine ya da vatandaşın hayatına, yaşam standartlarına fayda sağlaması.

Projenin, kurumun asli görevlerinden olması: Gerçekleştirilmek istenen yatırım projesi, kurumun mevzuatta belirtilen asli görevleri kapsamında olması.

Yukarıdaki kriterler ve açıklamaları çerçevesinde lütfen aşağıdaki kıyaslamaları yapınız.

* 30. Proje sürecindeki riskleri düşündüğümüzde, sizce hangi tür risk daha önemli ve ne derecede?

1. kriter: Operasyonel riskler
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter	
	Son Derece Önemli	9	7	Son Derece Önemli	9
	Biraz Daha Önemli	5	3	Biraz Daha Önemli	5
	Eşit Önemli	3	1	Eşit Önemli	3
	Biraz Daha Az Önemli	1	0	Biraz Daha Az Önemli	1
	0	0	0	0	0
Operasyonel riskler	<input type="radio"/>			<input type="radio"/>	
Politik riskler	<input type="radio"/>			<input type="radio"/>	
Operasyonel riskler	<input type="radio"/>			<input type="radio"/>	
Hukuki riskler	<input type="radio"/>			<input type="radio"/>	
Operasyonel riskler	<input type="radio"/>			<input type="radio"/>	
Sosyal riskler	<input type="radio"/>			<input type="radio"/>	

* 31. Proje sürecindeki riskleri düşündüğümüzde, sizce hangi tür risk daha önemli ve ne derecede?

1. kriter: Politik riskler
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter	
	Son Derece Önemli	9	7	Son Derece Önemli	9
	Biraz Daha Önemli	5	3	Biraz Daha Önemli	5
	Eşit Önemli	3	1	Eşit Önemli	3
	Biraz Daha Az Önemli	1	0	Biraz Daha Az Önemli	1
	0	0	0	0	0
Politik riskler	<input type="radio"/>			<input type="radio"/>	
Hukuki riskler	<input type="radio"/>			<input type="radio"/>	
Operasyonel riskler	<input type="radio"/>			<input type="radio"/>	
Sosyal riskler	<input type="radio"/>			<input type="radio"/>	

* 32. Proje sürecindeki riskleri düşündüğümüzde, sizce hangi tür risk daha önemli ve ne derecede?

1. kriter: Hukuki riskler
2. kriter: ... (Sırasıyla diğer kriterler)

	İlk Kriter	←	→	İkinci Kriter	
	Son Derece Önemli	9	7	Son Derece Önemli	9
	Biraz Daha Önemli	5	3	Biraz Daha Önemli	5
	Eşit Önemli	3	1	Eşit Önemli	3
	Biraz Daha Az Önemli	1	0	Biraz Daha Az Önemli	1
	0	0	0	0	0
Hukuki riskler	<input type="radio"/>			<input type="radio"/>	
Sosyal riskler	<input type="radio"/>			<input type="radio"/>	

* 33. Proje sonucunda üretilen nihai ürün ve hizmeti düşündüğünüzde, size hangi özelliği daha önemli ve ne derecede?

1. kriter: Çeşitli standartları karşılayabilmesi
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	→	←	Biraz Daha	Eşit	Biraz Daha	→	←	İkinci Kriter
	Derece	9	7	5	3	1	3	5	7
	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli
Çeşitli standartları karşılayabilmesi	○	○	○	○	○	○	○	○	○
Arz ve bakım onarım ihtiyacı duymaması	○	○	○	○	○	○	○	○	○
Çeşitli standartları karşılayabilmesi	○	○	○	○	○	○	○	○	○
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Çeşitli standartları karşılayabilmesi	○	○	○	○	○	○	○	○	○
Patentinin alınabilir olması	○	○	○	○	○	○	○	○	○
Çeşitli standartları karşılayabilmesi	○	○	○	○	○	○	○	○	○
Fayda sağlayacağı kitle	○	○	○	○	○	○	○	○	○
Çeşitli standartları karşılayabilmesi	○	○	○	○	○	○	○	○	○
Kurumun asli görevi olması	○	○	○	○	○	○	○	○	○

* 34. Proje sonucunda üretilen nihai ürün ve hizmeti düşündüğünüzde, hangi kriter daha önemli ve ne derecede?

1. kriter: Arz ve bakım onarım ihtiyacı duymaması
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	→	←	Biraz Daha	Eşit	Biraz Daha	→	←	İkinci Kriter
	Derece	9	7	5	3	1	3	5	7
	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli
Arz ve bakım onarım ihtiyacı duymaması	○	○	○	○	○	○	○	○	○
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Arz ve bakım onarım ihtiyacı duymaması	○	○	○	○	○	○	○	○	○
Patentinin alınabilir olması	○	○	○	○	○	○	○	○	○
Arz ve bakım onarım ihtiyacı duymaması	○	○	○	○	○	○	○	○	○
Fayda sağlayacağı kitle	○	○	○	○	○	○	○	○	○
Arz ve bakım onarım ihtiyacı duymaması	○	○	○	○	○	○	○	○	○
Kurumun asli görevi olması	○	○	○	○	○	○	○	○	○

* 35. Proje sonucunda üretilen nihai ürün ve hizmeti düşündüğünüzde, size hangi özelliği daha önemli ve ne derecede?

1. kriter: Pazarlanabilmesi
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	→	←	Biraz Daha	Eşit	Biraz Daha	→	←	İkinci Kriter
	Derece	9	7	5	3	1	3	5	7
	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Patentinin alınabilir olması	○	○	○	○	○	○	○	○	○
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Fayda sağlayacağı kitle	○	○	○	○	○	○	○	○	○
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Kurumun asli görevi olması	○	○	○	○	○	○	○	○	○

* 36. Proje sonucunda üretilen nihai ürün ve hizmeti düşündüğünüzde, size hangi özelliği daha önemli ve ne derecede?

1. kriter: Üst politikalara uyum
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	→	←	Biraz Daha	Eşit	Biraz Daha	→	←	İkinci Kriter
	Derece	9	7	5	3	1	3	5	7
	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli
Patentinin alınabilir olması	○	○	○	○	○	○	○	○	○
Fayda sağlayacağı kitle	○	○	○	○	○	○	○	○	○
Pazarlanabilmesi	○	○	○	○	○	○	○	○	○
Kurumun asli görevi olması	○	○	○	○	○	○	○	○	○

* 37. Proje sonucunda üretilen nihai ürün ve hizmeti düşündüğünüzde, ürüne ilişkin hangi kriter daha önemli ve ne derecede?

1. kriter: Fayda sağlayacağı kitle
2. kriter: ... (sırasıyla diğer kriterler)

	İlk Kriter	→	←	Biraz Daha	Eşit	Biraz Daha	→	←	İkinci Kriter
	Derece	9	7	5	3	1	3	5	7
	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli	Önemli
Fayda sağlayacağı kitle	○	○	○	○	○	○	○	○	○
Kurumun asli görevi olması	○	○	○	○	○	○	○	○	○

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

11. Nihai Ürün ya da Hizmetin Hedef Kütlesi Kriterleri ve Açıklamaları

Nihai ürün/hizmetin doğrudan kime fayda sağlayacağı.

- Yalnızca **kurum personeline**
- Yalnızca **proje sahibi kuruma** ve işleyişine
- **Kamu ve/veya özel sektör kurumlarına** ve işleyişine
- **Vatandaş,** vatandaşın hayatına, yaşam standartlarına

Yukarıdaki kriterler ve açıklamaları lütfen aşağıdaki kıyaslamaları yapınız.

* 38. Nihai ürün ya da hizmetin hedef kütlesini düşündüğümüzde, sizce hangi kitle/yapılara fayda sağlanması, hizmet sunması daha önemli ve derecede önemli?

1. kriter: Kurum personeli
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter				
Son Derece Önemli	9	7	Biraz Önemli	3	1	En Az Önemli	9

Kurum personeli	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kurum personeli	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kamu ve/veya özel sektör kurumlarının işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kurum personeli	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vatandaş	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 39. Nihai ürün ya da hizmetin hedef kütlesini düşündüğümüzde, sizce hangi kitle/yapılara fayda sağlanması, hizmet sunması daha önemli ve ne derecede önemli?

1. kriter: Kurumun işleyişi
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter				
Son Derece Önemli	9	7	Biraz Önemli	3	1	En Az Önemli	9

Kurumun işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kamu ve/veya özel sektör kurumlarının işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kurumun işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vatandaş	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 40. Nihai ürün ya da hizmetin hedef kütlesini düşündüğümüzde, sizce hangi kitle/yapılara fayda sağlanması, hizmet sunması daha önemli ve ne derecede önemli?

1. kriter: Kamu ve/veya özel sektör kurumlarının işleyişi
2. kriter: ... (sırasıyla diğer kriterler)

İlk Kriter	←	→	İkinci Kriter				
Son Derece Önemli	9	7	Biraz Önemli	3	1	En Az Önemli	9

Kamu ve/veya özel sektör kurumlarının işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kurumun işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kurumun işleyişi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vatandaş	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Kamu Yatırım Projelerinin Önceliklendirilmesi ve Seçilmesi

12. Kapanış

Bu formu doldurmak için değerli vaktinizi ayırdınız.

Teşekkür ederim.

Araştırmaya ilişkin iletişime geçmek istemeniz durumunda lütfen çekinmeyiniz.

Araştırmaya ilişkin (varsa) eklemek istediğiniz hususları, aşağıdaki metin kutusuna yazabilirsiniz.

41. Araştırmaya ilişkin (varsa) eklemek istediğiniz hususları yazabilirsiniz.

42. Bu çalışmanın sonuçları hakkında e-posta yolu ile bilgilendirilmek isterseniz, aşağıdaki metin kutusuna e-posta adresinizi yazınız.

Annex 2 – Conference Papers Extracted From the Thesis

KARAÇOLAK, Mehmet Baha (2019), “Kamu Yatırım Projelerinin Bulanık AHP ile Önceliklendirilmesi”, 39. Yöneylem Araştırması ve Endüstri Mühendisliği Ulusal Kongresi 12-14 Haziran 2019, Başkent Üniversitesi, Ankara.



HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SCIENCE AND ENGINEERING
THESIS/DISSERTATION ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SCIENCE AND ENGINEERING
TO THE DEPARTMENT OF INDUSTRIAL ENGINEERING.

Date: 26/06/2019

Thesis Title / ~~Topic~~: Prioritization of Public Investment Project Proposals Using Fuzzy Analytic Hierarchy Process


According to the originality report obtained by myself/my thesis advisor by using the *Turnitin* plagiarism detection software and by applying the filtering options stated below on 26/06/2019 for the total of 113 pages including the a) Title Page, b) Introduction, c) Main Chapters, d) Conclusion sections of my thesis entitled as above, the similarity index of my thesis is 9 %.

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I respectfully submit this for approval.


24.06.2019
Date and Signature

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Program: Industrial Engineering
Status: Masters Ph.D. Integrated Ph.D.

ADVISOR APPROVAL

APPROVED.



Prof. Dr. Özlem Müge Testik

Resume

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: