EVALUATION OF DIFFERENT URBAN TRANSFORMATION STRATEGIES THROUGH EFFECTIVENESS INDICATORS IN EARTHQUAKE-PRONE AREAS

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ABSTRACT

EVALUATION OF DIFFERENT URBAN TRANSFORMATION STRATEGIES THROUGH EFFECTIVENESS INDICATORS IN EARTHQUAKE-PRONE AREAS

In order to increase the urban resilience of disaster-prone areas in developing countries such as Türkiye, it is necessary to primarily ensure sustainable development while reducing the disaster risks of the physical structure. In this context, there are important problems in many categories such as physical, economic, social, environmental, legal, and institutional, planning and design, and technological. However, within the scope of this thesis, the focus has been on the decision-making problem in determining urban transformation strategies. In this context, the purpose is to develop a decision-making model, based on multi-criteria decision-making methods, which can be used by the responsible institutions for urban transformation in disaster-prone areas, and to carry out a pilot study on the working process of the model. For this purpose, the results of this research were evaluated with three hundred indicators/criteria contained in the literature, legislation, and urban transformation practice, and by using five decision alternative typologies for urban transformation processes [(1) Total Design Model, (2) All-of-a-Piece Model, (3) Piece-by-Piece Model, (4) Plug-in Model, (5) Plot-by-Plot Urban Transformation]. For this evaluation, the number of indicators was reduced by conducting a survey with institutions and a case study within the Aktepe-Emrez Districts Urban Transformation Project with twenty indicators identified as critical indicators after the survey analysis was tested with the officials of the relevant departments and the results were evaluated. The aim is to use the INTEMUS method, developed by using the DEMATEL and ENTROPI methods, based on the determination of criteria weights, developed on Microsoft Excel software, and the PROMETHEE and COPRAS methods, based on the ranking of decision alternatives, as a decision-making method that can be implemented by responsible institutions for urban transformation.

Keywords: Resilience, Disaster Management, Hazard Mitigation, Sustainability, Sustainable Urbanization, Urban Transformation, Multi-Criteria Decision-Making.

ÖZET

DEPREM RİSKİ OLAN ALANLARDA ETKİNLİK GÖSTERGELERİ YOLUYLA FARKLI KENTSEL DÖNÜŞÜM STRATEJİLERİNİN DEĞERLENDİRİLMESİ

Türkiye gibi gelişmekte olan ülkelerde afet riski altındaki alanların kentsel dayanıklılığını artırmak için öncelikle fiziksel yapının afet risklerini azaltırken sürdürülebilir kalkınmayı sağlamak gerekmektedir. Bu bağlamda Fiziksel, Ekonomik, Sosyal, Çevresel, Yasal ve Kurumsal, Planlama ve Tasarım ile Teknolojik gibi birçok kategoride önemli sorunlar bulunmaktadır. Ancak bu tez kapsamında, kentsel dönüşüm stratejilerinin belirlenmesinde yaşanan karar verme sorununa odaklanılmıştır. Bu bağlamda amaç, afet riskli alanlarda kentsel dönüşümden sorumlu kurumların kullanabileceği Çok Kriterli Karar Verme Yöntemlerine dayalı bir karar verme modeli geliştirmek ve modelin çalışma sürecine ilişkin bir pilot çalışma gerçekleştirmektir. Bu amaçla, literatürde, mevzuatta ve kentsel dönüşüm pratiğinde yer alan üç yüz adet gösterge/kriter ile tez kapsamında belirlenen beş adet kentsel dönüşüm sürecine [(1) Bütüncül Kentsel Dönüşüm ve Uygulama Modeli, (2) Bütüncül Kentsel Dönüşüm ve Parçalar Halinde Uygulama Modeli, (3) Parçacıl Kentsel Dönüşüm ve Uygulama Modeli, (4) Önemli Yatırımların Mevcut Yapıya Eklenmesi Modeli, (5) Parsel Bazlı Kentsel Dönüşüm Modeli] ilişkin karar alternatifi tipolojisi kullanılarak bu araştırma sonuçları test edilmiştir. Bu değerlendirme için kurumlarla anket çalışması yapılarak gösterge sayısı azaltılmış ve Aktepe-Emrez Mahalleleri Kentsel Dönüşüm Projesi kapsamında bir vaka çalışması yapılarak anketin analizinin sonrasında kritik göstergeler olarak belirlenen yirmi adet gösterge ilgili birimlerin yetkilileri ile test edilmiş ve sonuçlar değerlendirilmiştir. Microsoft Excel Programı üzerinde geliştirilen kriter ağırlıklarının belirlenmesine dayalı DEMATEL ve ENTROPI yöntemleri ile karar alternatiflerinin sıralanmasına dayalı PROMETHEE ve COPRAS yöntemleri kullanılarak geliştirilen INTEMUS yönteminin, kentsel dönüşümden sorumlu kurumlar tarafından uygulanabilecek bir karar verme yöntemi olarak kullanılması amaçlanmaktadır.

Anahtar Kelimeler: Dayanıklılık, Afet Yönetimi, Tehlike Azaltma, Sürdürülebilirlik, Sürdürülebilir Kentleşme, Kentsel Dönüşüm, Çok Kriterli Karar Verme.

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LIST OF ABBREVIATIONS

AHP	: Analytic Hierarchy Process
ANP	: Analytic Network Process
COPRAS	: COmplex PRoportional Assessment
DEMATEL	: DEcision MAking Trial and Evaluation Laboratory
DRR	: Disaster Risk Reduction
FEMA	: The Federal Emergency Management Agency
IMMDoUT	: Izmir Metropolitan Municipality Department of Urban Transformation
INTEMUS	: INTEgrated Model of Urban transformation Strategy
MCDA	: Multi-Criteria Decision-Analysis
MCDM	: Multi-Criteria Decision-Making
MoEUaCC	: Ministry of Environment, Urbanization and Climate Change
NGOs	: Non-Governmental Organizations
PROMETHEE	: Preference Ranking Organization METhod for Enrichment Evaluations
SUD	: Sustainable Urban Development
TOKİ	: Housing Development Administration of the Republic of Türkiye
URP	: Urban Regeneration Projects
UNISDR	: United Nations Office for Disaster Risk Reduction

CHAPTER 1

INTRODUCTION

The frequency of natural hazards that turn into disasters, as well as the magnitude of these disasters, is increasing every year. The damaging effects of such disasters include permanent damage to the physical, economic, social, and environmental structures of cities and metropolitan areas. The impact of these disasters is particularly severe in terms of the social structure and infrastructure of cities, and further exacerbates the economy at the national level, sometimes causing political and economic uncertainty.

Natural hazards have been shown to result in significant loss of life, physical infrastructure, and related structures, particularly in developing countries. This is compounded by the rapid and irregular urbanization that these countries are experiencing as part of their development process. A steady increase in the number of natural disasters experienced globally is evident when considering recorded natural disaster events from 1900 to 2018. For example, the number of recorded natural disaster events was 133 in 1980, increased to 411 by 2000, and declined to 282 in 2018 according to ourworldindata.org (WEB1 2020). The 2018 Review of Disaster Events report (CRED 2019) states that around 193 million people were affected by various types of disasters between 2000 and 2017. While global annual deaths from natural disasters have decreased, the economic losses from these disasters have increased each year. For instance, the economic loss amounted to $32.8 billion in 1980, escalated to $46.6 billion in 2000, and peaked at $107.8 billion in 2018 according to ourworldindata.org (WEB2 2022). It is noteworthy that the highest economic loss from natural disasters was recorded in 2011 and amounted to $364.1 billion. The data show that the demographic and economic impact of disasters has increased over the years, mainly due to the vulnerability of settlements, the economy, and the social structure. The Bureau for Crisis Prevention and Recovery (UNDP 2004) reported that from 1980-2000, 75% of the world's population lived in areas affected by at least one natural disaster. Between 1980-2000, 158.551 deaths were reported worldwide as a result of earthquakes and their indirect hazards. Türkiye accounted for approximately 12% of these deaths, despite having only 1% of the world's population, according to (UNDP 2004) These findings emphasize that Türkiye faces a high earthquake risk.

Disasters often result in vulnerability exacerbated by the loss of livelihoods and the damage to economic assets and critical infrastructure. Natural disasters are estimated to have caused economic losses of $75.5 billion in the 1960s, $659.9 billion in the 1990s, and $960 billion in the first decade of the 21st century. From 2000 to 2009, nearly 4,000 recorded disasters killed over 780,000 victims and affected more than 2 billion people, according to the Center for Research on Epidemiology of Disasters (CRED). The most destructive hazards in 2009 continued to be floods, windstorms, and earthquakes, while floods and windstorms continued to affect the greatest number of people. In addition, according to Munich Re (2002), global economic losses between 1992 and 2002 were 7.3 times greater than in the 1960s. According to the World Disasters Report of 2002, the average annual losses from natural disasters were estimated at US$ 69 billion. It reported that more than half of these losses occurred in countries with high levels of human development (UNDP 2004).

The United Nations Development Program Bureau for Crisis Prevention and Recovery (UNDP 2004) report highlighted the devastating impact of disasters during the beginning of this century. In particular, developing countries face significant disasters due to the exponential and unmanageable growth of cities. Especially, Türkiye was affected by several major earthquakes during the 20th century, resulting in at least 110,000 deaths, nearly 250,000 injuries, and damage to 600,000 buildings.

The graph shown in Figure 1, provides the number of deaths from natural disasters worldwide from the 1900s. The graph reveals that there has been a decrease in disaster-related deaths since the 1920s. However, an increase in the number of deaths from earthquakes is observed in the period of 2000 and 2010 decadal average period. Since the beginning of 2020, the impact of floods due to global climate change has increased the number of deaths in the world. (WEB1 2020)

On the other hand, Figure 2 shows that while the number of people who died due to natural disasters worldwide decreased, the economic losses are increasing. Especially, in 2021, 257.94 billion dollars of damage occurred in the world due to natural disasters, and 11.31 billion dollars of this occurred only because of earthquakes. (WEB2 2022)

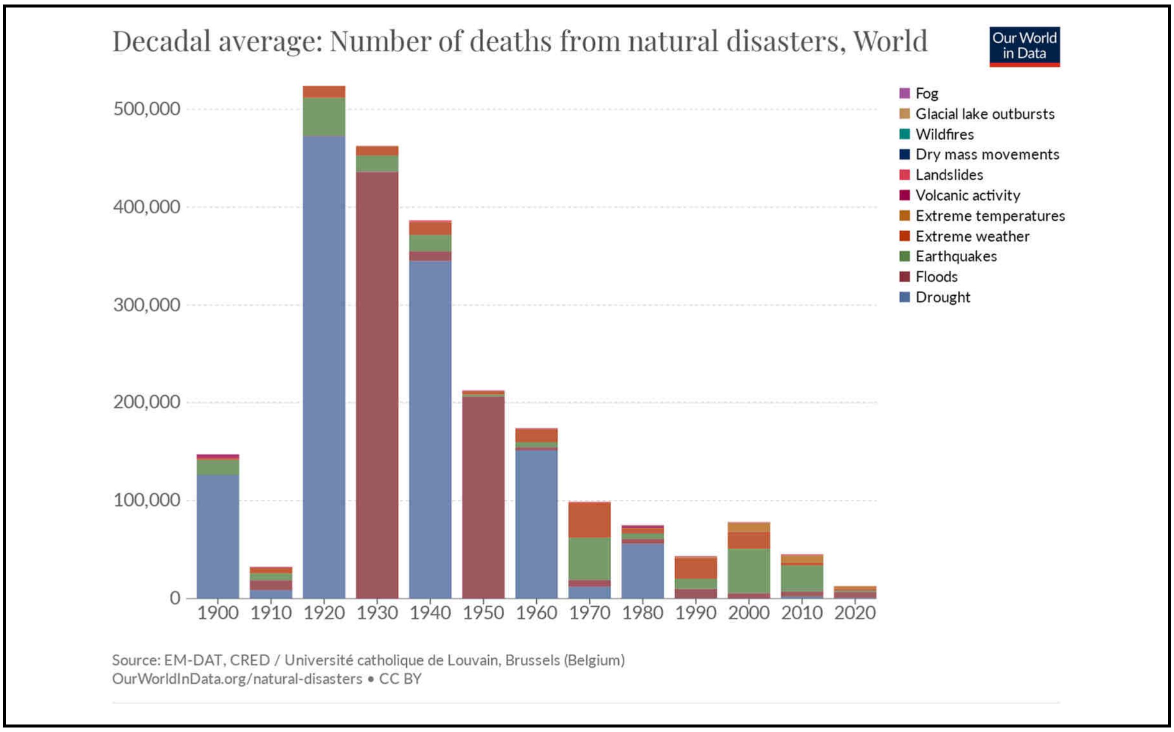


Figure 1: Decadal Average: Number of Deaths from Natural Disasters, World (Source: ourworldindata.org WEB1 2020) (accessed date: 10.07.2023)

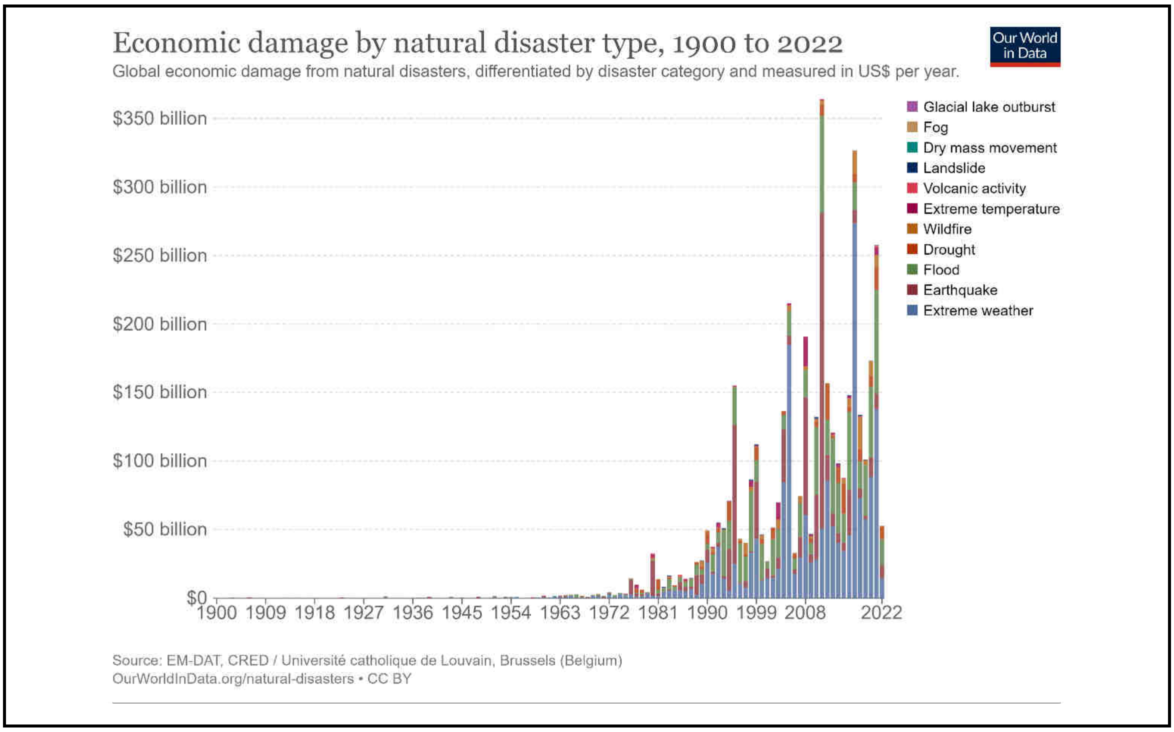


Figure 2: Economic Damage by Natural Disaster Type, 1900 to 2022 (Source: ourworldindata.org WEB2 2022) (accessed date: 10.07.2023)

The graphical representation of the direct economic losses due to disasters, spanning from the years 2005 to 2018, can be observed in Figure 3. Conversely, the economic losses caused by the disasters that occurred in Türkiye during the same period show an increasing trend from the level of $210.67 million in 2018. This escalation pattern is particularly evident after the second peak of $566.23 million in 2015. As the economic consequences in Türkiye highlight, addressing these escalating losses becomes essential. Given these urgent challenges, strategies such as hazard mitigation become a sought-after solution.

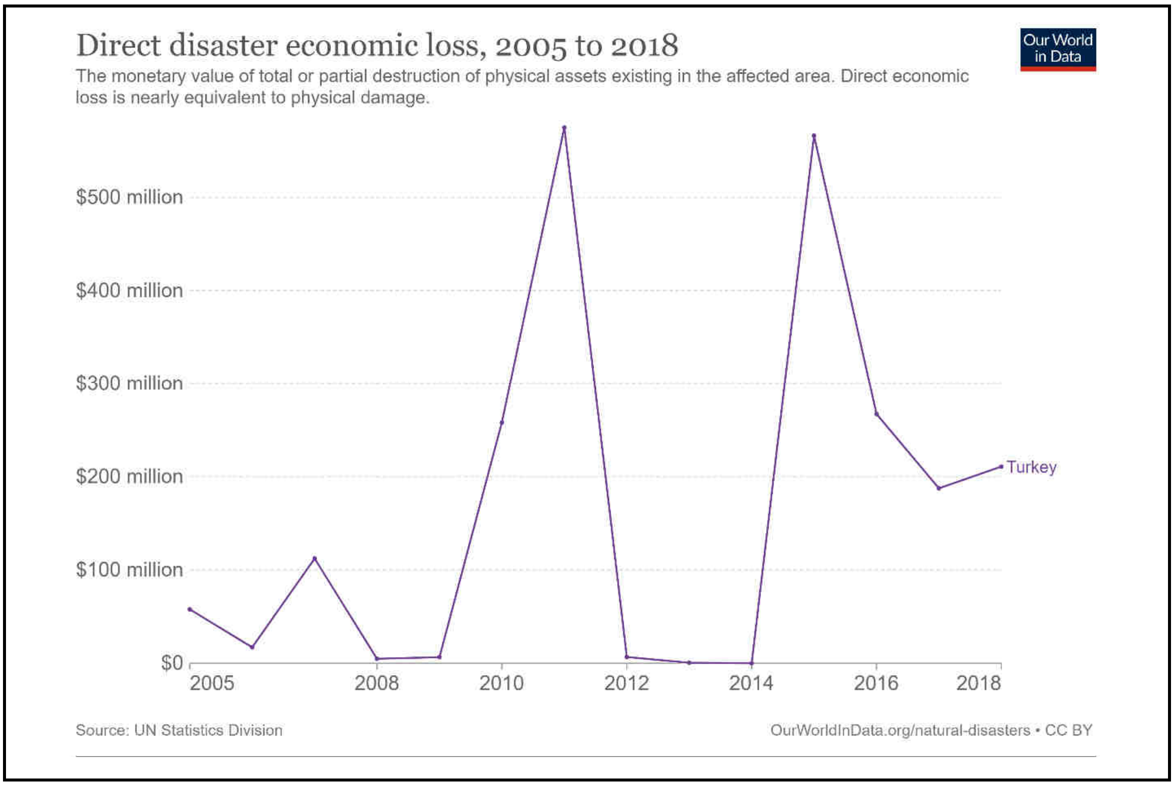


Figure 3: Direct Disaster Economic Loss, 2005 to 2018

(Source: ourworldindata.org WEB3 2021) (accessed date: 10.07.2023)

Hazard mitigation can be defined as a series of activities aimed at minimizing or eliminating the destructive effects of disasters. It is important to emphasize that the successful implementation of mitigation measures depends on a comprehensive risk assessment and an accurate determination of the potential impact of a disaster (Montoya 2003).

Implementing urban transformation strategies in disaster-prone areas within cities is considered one of the most effective measures to mitigate the impacts of disasters. However, in many developing countries, including Türkiye, governments are faced with inadequate budgetary allocations that would enable the resolution of this extensive predicament. Governments are developing various regulations aimed at finding solutions that would reduce this vulnerability. In most developing countries, the preference is to implement urban transformation initiatives in low-income areas, squatter settlements, or dilapidated parts of cities through private sector actors such as contractors or construction companies. In Türkiye, as an alternative approach to sustaining urban transformation within cities, the Housing Development Administration of the Republic of Türkiye (TOKİ), a public sector institution, carries out its housing production activities across the country with a focus on priorities and needs, and one of its goals is explicitly defined as *"Urban Regeneration and Slum Transformation Projects in cooperation with Municipalities"* TOKİ (2022) (Accessed date: 19.06.2017).

In Türkiye, Municipality Law (Law No. 5393) was enacted in 2005 and published in the Official Gazette on 13.07.2005 under no. 25874. One of its key provisions, Article 73, outlines the Urban Regeneration and Development Areas. This article grants municipalities authority to implement urban renewal and development projects aimed at creating residential, industrial, commercial, technological, public service, recreational, and social facilities. Moreover, these projects may include the preservation of the city's cultural and historical heritage or the implementation of measures to protect against earthquakes. A resolution of the Municipal Council is required to initiate these projects, and the designated area must align with one or more of the aforementioned purposes. The area must also be within the boundaries of the municipality or adjacent areas. However, a decree of the Council of Ministers is mandatory to declare areas owned or used by the public as urban renewal and development areas and to implement them accordingly. The Municipal Council has the exclusive authority to determine whether the area to be declared as an urban renewal and development zone should be a planned or unplanned area, with or without buildings on it, to determine the building height limits and density, to require that the area be a minimum of 5 hectares and a maximum of 500 hectares and that the renewal be carried out in phases. In addition, more than one area related to the project area may be designated as an urban renewal and development area, provided that the area is not less than 5 hectares (TBMM 2005).

According to Article 73, some Metropolitan Municipalities determined urban transformation areas. Some of these areas were approved by the Council of Ministers on a proposal from the Ministry of Environment and Urbanization, including Izmir.

On the other hand, The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) was introduced in 2012 to rehabilitate, clear and, renovate areas and buildings under disaster risks according to relevant standards for a healthy and safe living environment. The Regulation on the Implementation of the Law of Transformation of Areas under the Disaster Risks was issued in December 2012 to regulate the implementation procedure of the Law (MoEUaCC 2012b)

1.1 Statement of the Problem

The major challenges to hazard mitigation are the scale of the problem and the cost of mitigation. Investments required for repairing and reinforcing existing structures, reconstructing urban areas, and strengthening infrastructure are substantial. Unfortunately, governments and private organizations in developing countries often lack the economic resources needed to finance these comprehensive urban transformation projects. Therefore, the existing building stock of cities in developing countries has been considered vulnerable to hazards in the current situation based on some assessment reports prepared by different institutions and non-governmental organizations (NGOs).

Considering the importance and priority of urban transformation for the development of resilient communities and urban areas, the current practice has not been sufficiently developed in Türkiye. For instance, Fikirtepe in Istanbul, which is the most known urban transformation area, has been an unsolvable problem for years. On the other hand, there are many urban transformation projects completed by various construction companies and the Housing Development Administration of the Republic of Türkiye (TOKİ). While some projects are interpreted as successful, other projects are criticized as unsuccessful by experts and property owners.

According to the Ministry of Environment and Urbanization, there are 19 million residences in Türkiye, and at least 14 million of them will need to undergo risk assessment evaluations. Moreover, it is estimated that approximately 40% of this building stock, translating to roughly 6-7 million housing units will have to be reconstructed or reinforced against hazards, due to deficiency of building design, poor quality material, or illegal building status (WEB4 2017) (Accessed date: 26.06.2017). This information highlights the importance developing urban transformation projects immediately to ensure healthy and sustainable urbanization for disaster preparedness in Türkiye.

Urban transformation projects in vulnerable areas mostly face the challenge of decision-making. The main issue is conducting a proper and operational urban transformation strategy that satisfies all stakeholders of the project area. In general, areas with high economic value due to high demand are easier to decide on strategies for, whereas low value areas struggle to find investors. As a result, public authorities dealing with urban transformation projects often face obstacles in their executive decision-making process, which can be further complicated by unclear and ambiguous conditions. In fact, political considerations, rather than technical evaluations, heavily influence most urban transformation decisions.

The narrow scope of legislation, which does not clearly define the procedures and methods of urban transformation, is another problem for decision-makers and experts of public authorities. Interest groups often criticize most urban transformation projects for becoming politicized and ineffective.

From this viewpoint, the absence of a suitable decision-making framework may serve as an advantage for the public authorities in Türkiye to propose urban transformation initiatives that are effective, practical, and widely supported.

1.2 Aim and Objectives of the Research

This thesis focuses on urban transformation strategies as a critical component of natural disaster mitigation in the case of Türkiye, according to the aforementioned general problem description of the inadequacies of hazard mitigation. This research aims to investigate how urban transformation strategies can improve the administrative decision-making process of public authorities and thus increase the success and feasibility of the project implementation.

Urban regeneration has been accepted as a primary concept by researchers to address urban decay and building deterioration in cities. Additionally, methods such as urban renewal, urban redevelopment, urban rehabilitation, and urban revitalization involve the restoration and renewal of existing structures, developing buildings or parts of the city, or repurposing land.

The mitigation of hazards in urban areas can be achieved through a variety of strategies, including Building Rehabilitation, Building Restructuring, Urban Revitalization, Urban Rehabilitation, Urban Renewal, Urban Regeneration, and Urban Transformation. These strategies involve the reconstruction of buildings, plots, building blocks, or areas, as well as the reuse of urban land. Under The Law of Transformation of Areas under the Disaster Risks (Law No. 6306), these strategies are recognized as key approaches for mitigating risks in hazard-prone areas. To determine the most effective urban transformation strategy among the alternatives, public authorities can use an integrated evaluation model to make quantifiable and appropriate decisions. In the case of selected hazard-prone areas in Izmir, this model will be employed to evaluate the various strategies.

The aim of the research is to investigate an integrated evaluation model to compare the effectiveness of the different urban transformation strategies for public authorities and participants, using multi-criteria decision-making methods with critical indicators of planning in urban transformation procedures in earthquake-prone areas.

According to this purpose, this model sets forth several objectives to devise successful urban transformation strategies:

- Utilize sustainability indicators to enhance the effectiveness of urban transformation projects by means of sustainable development, which includes economic, social, physical, and ecological aspects.
- Define the decision-making process of urban transformation strategies with more measurable and technical content rather than political content to provide legitimacy of urban transformation procedures.
- Promote the negotiation procedure for urban transformation projects with measurable indicators ensuring effectiveness of the project for stakeholders.

1.3 Research Questions

This research addresses the following major research question for urban transformation strategies in cities that have seismic-hazard risk.

- How can the effectiveness of various urban transformation models be assessed and measured within hazard-prone urban areas?

Moreover, four supplementary questions can be mentioned to develop the scope of the research:

- What are the critical indicators of the effective urban transformation model?
- How can the critical indicators be measured?
- Do sustainable development indicators enhance the efficiency of urban transformation models more than other indicators?
- How effective is an integrated and measurable project evaluation model for evaluating urban transformation strategies in providing legitimacy for all interest groups in negotiation processes?

1.3.1 Characteristics of the Areas to be Studied.

The scope of the research was purposely limited in order to develop a comprehensive project evaluation model that can be used in urban areas. These areas may include land that is partially or fully suitable for human settlement, but the buildings are vulnerable to seismic hazards due to their unsuitability. In addition, such areas may include hazard zones located in close proximity to high-hazard urban areas, either in the city center or in industrial and commercial areas. It should also be noted that these urban areas may be inhabited by people who have inadequate economic and social resources to transform their seismic areas. These areas may also include illegal buildings and squatter settlements. However, it should be taken into consideration that certain urban areas may be subject to a new implementation plan or urban transformation project. Therefore, it is imperative to evaluate these urban areas based on the risk assessment and data collection methods adopted. It is evident that such urban areas are well-equipped with population data, land use data, and other relevant economic data that can be used for the proposed assessment.

1.3.2 Characteristics of the Areas not to be Studied.

The research limitations are varied and result from a combination of methodological and philosophical concerns. The problems are made more difficult by a variety of factors, such as areas designated for relocation, including but not limited to landslide areas, areas near major fault lines, and wetlands. In addition, there are urban areas that are potentially redevelopment opportunities, requiring development to meet the increasing demands of the population. Areas that are legally restricted or otherwise inaccessible also present challenges to researchers. In addition, areas experiencing a lack of demand for development are not conducive to research. Finally, natural, or cultural conservation or prevention areas require special policies that can further affect research in the region.

1.4 Methodology of the Research

This dissertation aims to establish a fundamental evaluation model using a Multi-Criteria Decision-Making (MCDM) method to validate the effectiveness of different urban transformation strategies in earthquake-prone areas.

The initial phase of the research includes the identification of the different types of urban transformation strategies used in Turkish municipalities to formulate the scope of the study. It is important to mention that the current legislation and past experiences have indicated two dominant strategies that can be used to address the issues at hand. The first strategy involves the preparation of an implementation plan by the Ministry of Environment, Urbanization and Climate Change, local governments, or municipalities in vulnerable areas to promote growth through the involvement of investors such as construction companies or developers. On the other hand, the second strategy focuses on the use of urban transformation strategies at different scales, which have been conceptualized in Figure 4 and Figure 5.

1.4.1 Literature Review

This dissertation requires a comprehensive literature review as the subject of study is in the field of interest of many disciplines. The focus is on urban transformation in areas vulnerable to disasters, encompassing themes like resilience, disaster management, hazard mitigation, and planning decisions. Such decisions are best analyzed through the lens of Decision Theory and Multi-Criteria Decision-Making (MCDM). In this context, MCDM Methods are studied in detail aiming to pinpoint those suitable for dynamic, field-specific criteria. An extensive examination of the literature has been conducted on MCDM Methods and their applications. Special attention has been given to their relevance to resilience, disaster management, urban planning, and urban transformation. The literature review section comprehensively discusses the advantages, disadvantages, and practical application methods of these methods.

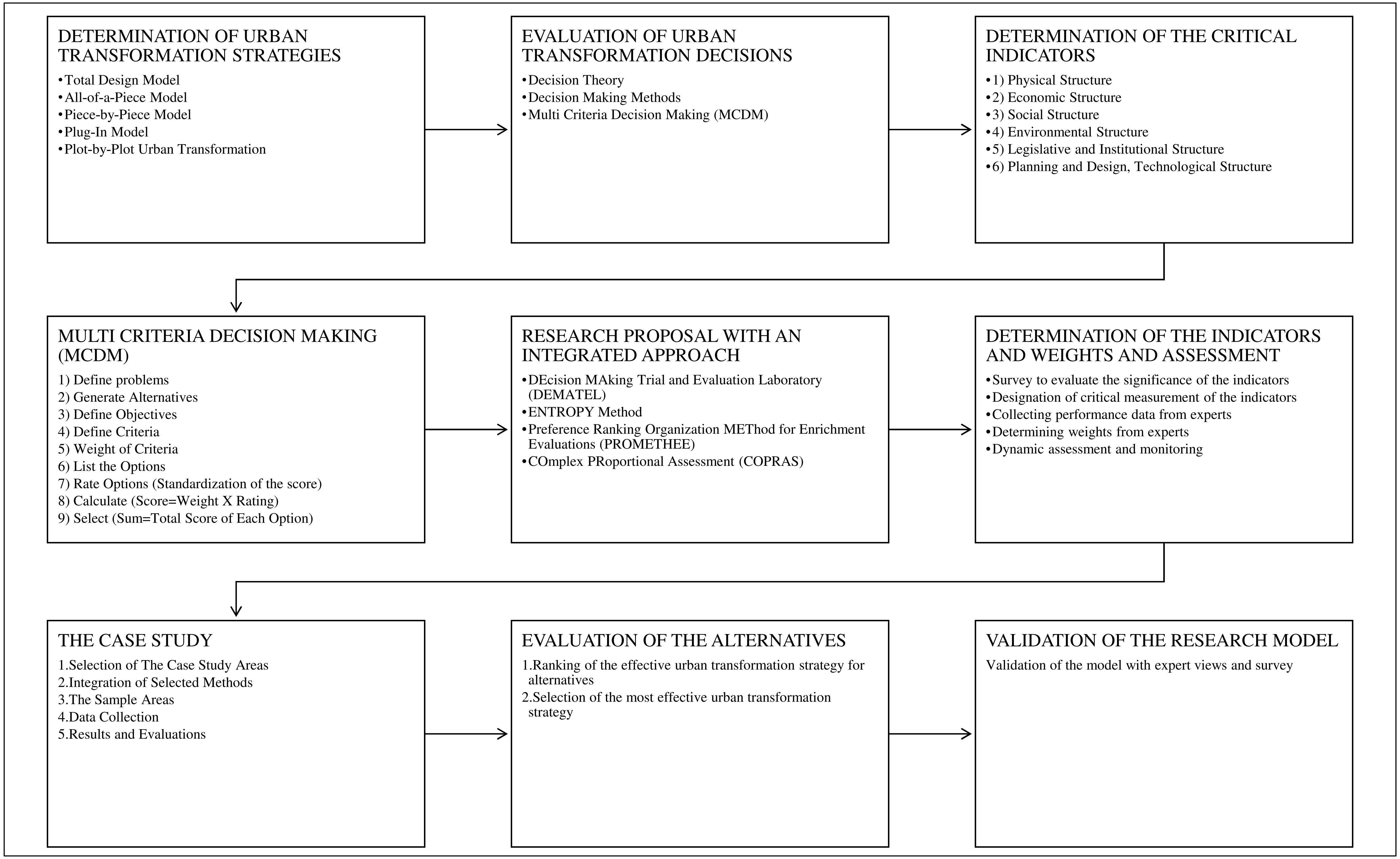


Figure 4: Conceptual Framework of the Research

(Prepared by Author)

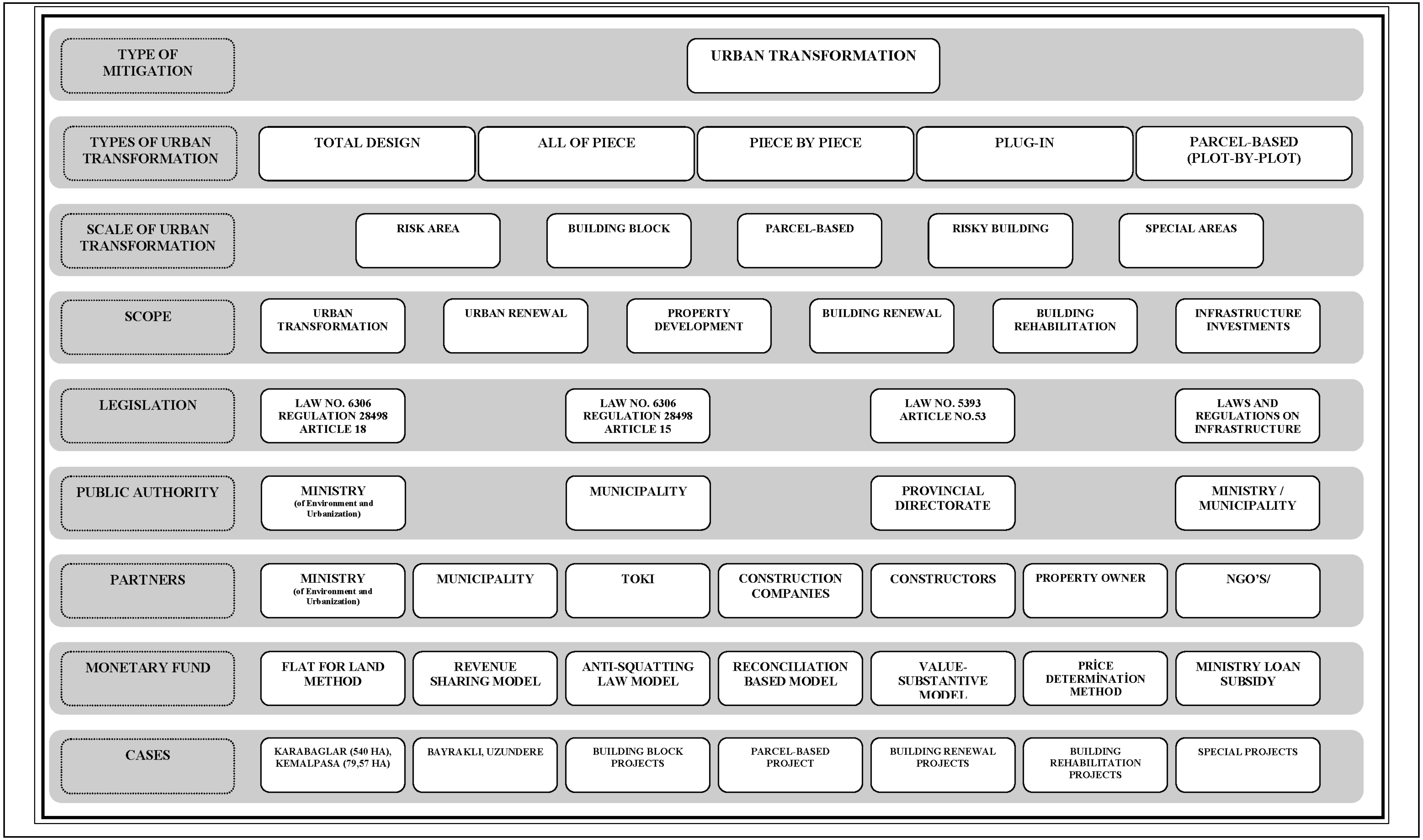


Figure 5: Scope of the Research

(Prepared by Author)

1.4.2 Strategies of the Urban Transformation

In this research, Urban transformation strategies are classified similarly, according to four procedural types of urban design determined by Lang (2005), which are listed below:

1) ***Total Design Model*** is a combination of large-scale projects involving the design of both the public realm and the buildings.
2) ***All-of-a-Piece Model*** devises a master plan and sets the parameters within which a number of developers work on components of the overall project.
3) ***Piece-by-Piece Model*** defines the general policies and procedures for a precinct of a city in order to steer development in a specific direction.
4) ***Plug-In Model*** creates an infrastructure so that subsequent developments can 'plug in' to it or, alternatively, a new element of infrastructure is plugged into the existing urban fabric to enhance a location's amenity level as a catalyst for development.
5) As a fifth model, ***Plot-by-Plot Urban Transformation*** can be described, which is a very common way to renewal of buildings and parcels using 'The Law of Transformation of Areas under the Disaster Risks' (Law No. 6306) in Türkiye (Figure 6).

1.4.3 Evaluation of Urban Transformation Decisions

The purpose of this research is to develop an evaluation model to compare the effectiveness of different urban transformation strategies to provide convenience for the planning and execution process of these strategies. The initial phase of developing a model is to determine a list of critical indicators for evaluating the effectiveness of the strategies for objective and measurable comparison. The second phase is to determine the weight of the critical indicators. The third phase is a dynamic evaluation model to show the bases of critical indicators and relevant weights for comparison.

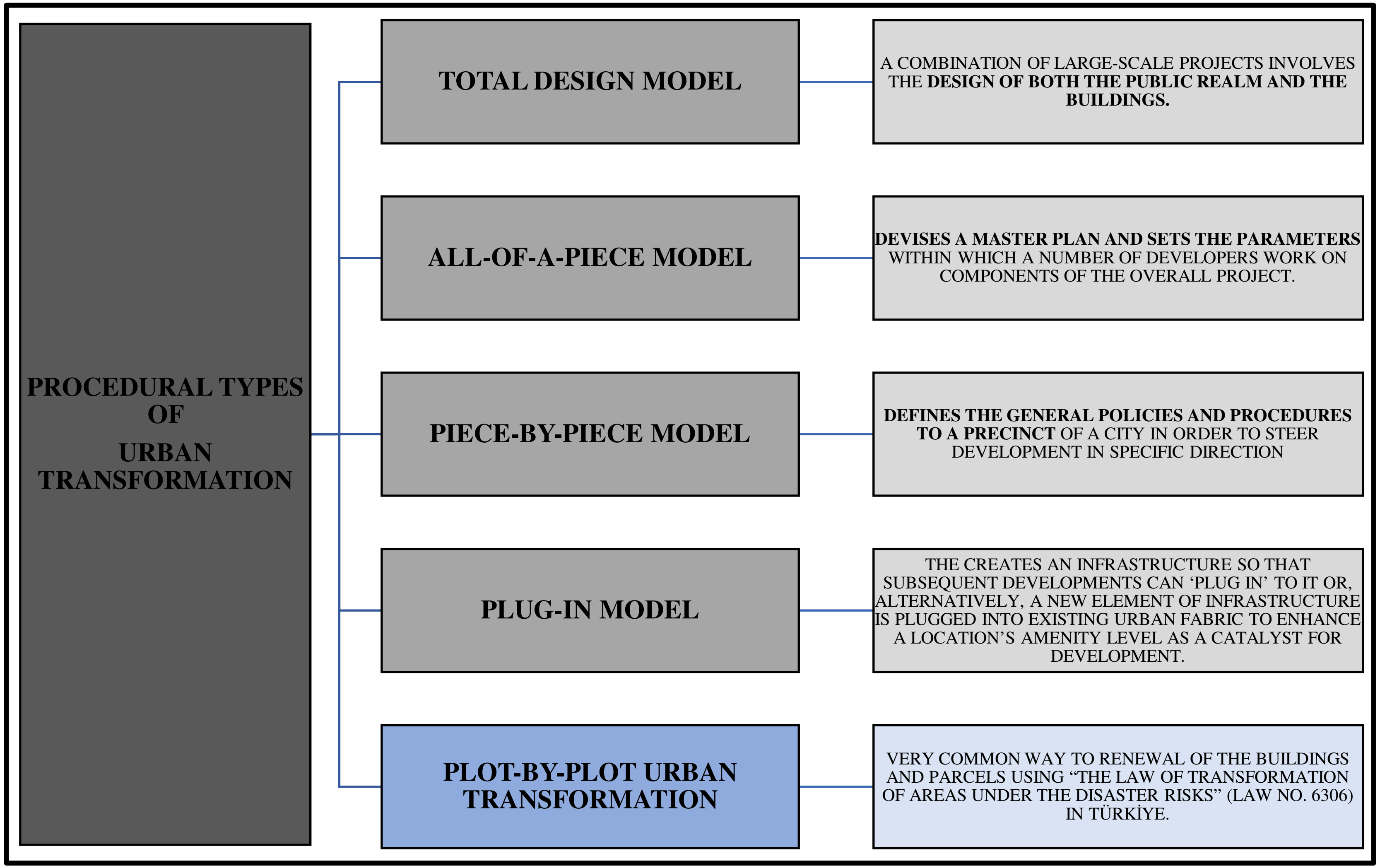


Figure 6: Procedural Types of Urban Transformation (Prepared by Author)

1.4.3.1 Decision Theory and Urban Transformation

Every stage of the urban transformation procedure involves a decision-making process which is in the context of Decision Theory, whose work focuses on the rationality of decisions; it is the combination of the mental, physical, and emotional processes involved in choosing between various purposes, objectives, instruments, and possibilities to achieve them. The basis of the theory is constituted by analytical techniques and knowledge. In order for a decision problem to exist, there must be more than one option, and the results of each option must be different from each other.

Multi-Criteria Decision-Making (MCDM) Methods are used in this decision-making process to evaluate urban transformation strategies based on a set of indicators. These indicators are selected from the literature on urban transformation, urban planning, sustainability, and hazard mitigation, as well as from sample cases. The use of MCDM methods is necessary due to the complexity of the problem and the multiple criteria involved in evaluating urban transformation strategies.

1.4.3.2 Multi-Criteria Decision-Making (MCDM)

The main objective is to use Multi-Criteria Decision-Making (MCDM) methods to determine the importance of indicators and select the most effective urban transformation strategy based the calculated score of each option. All criteria for urban transformation are defined and weighted according to expert opinion. Subsequently, urban transformation strategies are rated based on the selected Multi-Criteria Decision-Making (MCDM) Methods: DEcision MAking Trial and Evaluation Laboratory (DEMATEL) and ENTROPY Method for weighting the criteria, Preference Ranking Organization METhod for Enrichment Evaluations (PROMETHEE) and COmplex PRoportional Assessment (COPRAS) for ranking the strategic alternatives. These are integrated into the model, allowing for executive decisions to be based on the final score of measurable indicators.

In order to select an effective urban transformation strategy between alternative strategies, DEMATEL assists in calculating the weights of the critical indicators and

PROMETHEE is used to rank the alternative urban transformation strategies in research. Additionally, a hybrid MCDM method combining the ENTROPY Method calculates weights for critical indicators with COPRAS ranking the strategies, offering a dynamic alternative for public authority end-users.

1.4.4 Indicators of the Research

In the thesis of various indicators from domain literature such as resilience, disaster management, hazard mitigation, sustainability, sustainable urbanization, and urban transformation as well as relevant legislation, and urban transformation practices are examined under six main categories: Physical Structure, Economic Structure, Social Structure, Environmental Structure, Legislation and Institutional Structure, Planning and Design, and Technological Structure Figure 7. The aim is to determine the criteria for collecting the main headings of the subjects under the categories and to list them as indicators that can be measured or subjectively evaluated within the scope of the research.

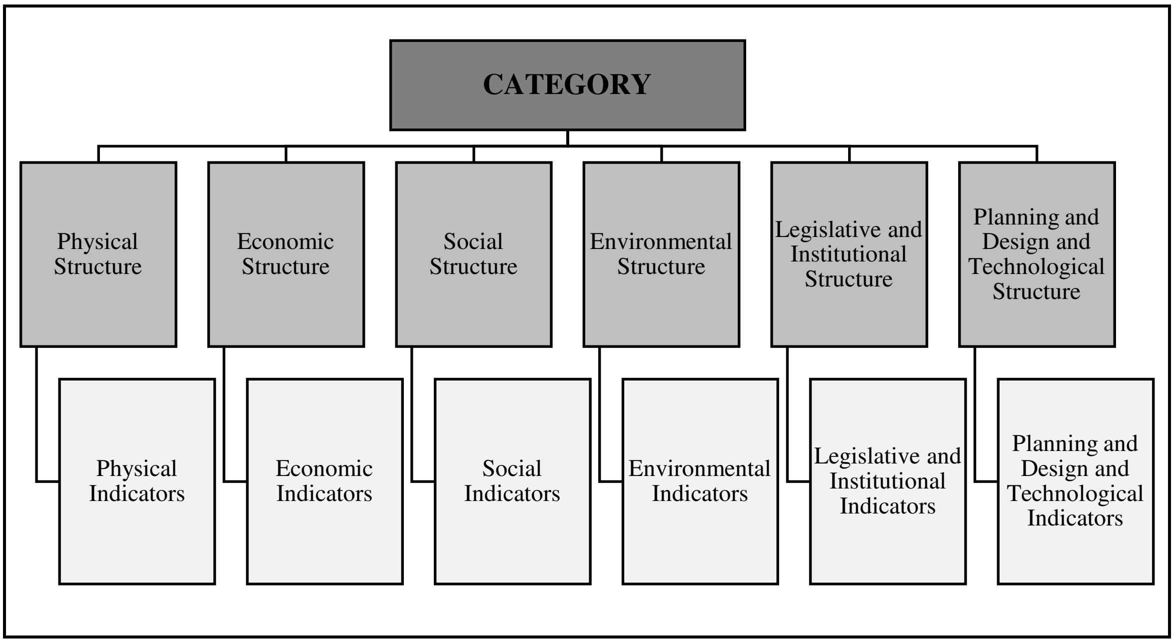


Figure 7: Classification of the Criteria and Indicators
(Prepared by Author)

1.4.5 Data Sources

Data collection is provided by government agencies, such as Izmir Metropolitan Municipality, Izmir Metropolitan Municipality Department of Urban Transformation, Municipalities, Ministry of Environment, Urbanization and Climate Change, Provincial Directorate of Ministry of Environment, Urbanization and Climate Change in Izmir, TOKI (Housing Development Administration) and their private initiatives, AFAD (Ministry of Interior Disaster and Emergency Management Presidency), research institutes and universities; construction companies and constructors who deal with urban transformation projects on different scales.

1.5 Organization of the Research

This thesis consists of the following seven chapters:

1. The first chapter introduces the problem to be addressed and provides definitions, concepts, and previous approaches within the literature review. The methodology and assumptions are then briefly described.
2. The second chapter attempts to investigate existing problems, in fields such as, Resilience, Urban Resilience, Disaster Management, and Hazard Mitigation as well as examine gaps in the current knowledge. This chapter attempts to provide general knowledge to provide an idea of the current situation on hazard mitigation and the role of urban transformation. This chapter also includes the literature on the theory and practice of Urban Transformation. Existing and past cases, studies, and theoretical approaches are also discussed in this chapter.
3. In the third chapter, the methodology of Decision Problems, Decision Theory, and Multi-Criteria Decision-Analysis (MCDA) and the selected methods are explained to evaluate the integrated model. The chapter also reviews urban transformation literature in detail in the context of Multi-Criteria Decision-Making (MCDM) Methods.
4. In the fourth chapter, sustainable development, land use management, and urban transformation approaches that include risk management strategies are evaluated

based on their concepts and methodologies to define the critical indicator of the urban transformation process.

5. The fifth chapter of this thesis focuses on the methodological structure used in the research, including the multiple methods and techniques used for data collection, analysis, and subsequently the evaluation of the results. A comprehensive decision-making approach for urban transformation strategies is developed in order to identify the most appropriate strategies necessary for effective and efficient decision-making.
6. The sixth chapter presents the cases examined in this study and provides an integrated evaluation model for the selection of an effective urban transformation strategy in earthquake-prone areas.
7. Lastly, the thesis concludes with a summary of the major conclusions of the research, a discussion of limitations, and recommendations for future studies in the field of urban transformation and hazard mitigation in disaster-prone areas. Applications of the methodology to case studies are demonstrated and recommendations made for future research work.

CHAPTER 2

THE NEED FOR URBAN TRANSFORMATION AS A SEISMIC HAZARD MITIGATION ACTION

This chapter starts by examining the problems observed within existing literature, legislative frameworks, and current practices concerning disasters and urban transformation, alongside insights from day-to-day experiences. It then discusses natural hazards, earthquakes, and earthquake-related disasters that are the main subject of this research. In this context, natural hazards, natural disasters, and related resilience concepts are discussed, and disaster management and hazard mitigation issues that need to be addressed to increase urban resilience are also discussed.

To enhance urban resilience, this chapter examines of the United Nations Sustainable Development Goals, focusing on the development of sustainable cities and communities. In this context, urban transformation is highlighted as a crucial tool for enhancing urban resilience and fostering sustainable cities. The definition, scope, classification, and typical applications of urban regeneration, as well as its management strategies, are detailed through both academic literature and real-world legislative and case examples.

2.1 Current Problems of the Vulnerable Parts of Urban Areas

The phenomenon of uncontrolled urbanization and extreme urban growth is a fundamental obstacle to the sustainable development of cities in the developing world. With the growth of urban settlements, population, and economic structures become over-concentrated, potentially raising the risk of natural disasters. Due to factors such as time, location, exposure, and vulnerability, the risk can change dramatically. Therefore, effective, and proactive policies must be developed by urban authorities and leaders to resolve the problem and reduce the potential catastrophe's damaging effects.

Despite significant efforts to reduce natural disaster risks, challenges, and implementation deficiencies, especially in developing countries, have hindered progress. In Türkiye, lack of adequate conditions for the development and management of hazard mitigation policies combined with inadequate implementation of projects is the result of this situation. As a result, the vulnerability of Turkish cities increases. Therefore, researchers in Türkiye must consider the above-mentioned problems and their consequences for the cities.

The escalating costs and losses from natural disasters highlight the need to revise the current urban planning process. Current land use planning methods, coupled with regulations, laws, and a disjointed central and local administration, call for a new management approach to hazard mitigation. Consequently, a comprehensive framework is essential to effectively mitigate the increasing risks of human, financial, and physical losses.

2.1.1 Physical Problems

The urban structure and existing building stock of cities in developing countries are not resilient against hazards according to assessment reports prepared by several organizations. Not only poor building design and construction standards, but also poorly implemented and controlled land use decisions have exacerbated the loss of building stock and human life. The poor and less informed in ecologically fragile areas are particularly vulnerable to hazards. Unfortunately, illegal construction continues with increasing numbers. As Balamir (2001) states that urban areas are home to a variety of unpermitted structures with no preparation, documentation, or oversight. Most of the legal buildings are inadequately inspected during construction, and there are no established standards or protocols for material selection and determination of durability and performance characteristics. The construction industry also lacks a clear understanding of acceptable levels of construction deficiencies, and geological assessments of construction sites are often cursory. Zoning codes are frequently amended to allow for higher densities, providing financial incentives for owners to add floors or make haphazard changes to existing structures. The majority of unauthorized structural modifications are carried out by building occupants and owners with little regard for safety or regulations.

According to the findings of Şengezer (2005), the existence of illegal constructions is a significant obstacle to the proper functioning of the planning system. Particularly, since the 1950s, a total of ten acts have been implemented in Türkiye to grant amnesty to illegal constructions, thereby allowing the unauthorized buildings to be registered and legitimized under the law. However, this method has only increased the problem of illegal construction in urban areas.

Bademli (2001) highlights the predicament of squatters in Turkish cities because of the mentioned situation. Typically, the spontaneously formed and subsequently legalized neighborhoods of the urban environment are characterized by dense population, various incompatible uses, insufficient open spaces, a significant number of precast concrete structures, problems of accessibility, undereducated and disorganized communities, and location on the fertile alluvial plain with a high-water table.

On the other hand, many legal buildings have modifications in their structure. Moreover, there are no documentations to view this information, which is vital in a hazard assessment modeling. Even the planned parts of the city have some structural and infrastructural deficiencies such as traffic congestions and insufficient parking areas.

As can be seen, there are great deficiencies of the building stock and information on the existing stock in terms of quality, number, and density. Moreover, the land features (soil, fault lines, etc.) of the micro-zoning areas do not have any proper information to determine any appropriate land use planning and hazard mitigation strategies in these parts of the cities.

Rapid urbanization has negatively impacted the configurations of roads, infrastructure, and land subdivisions, rendering the existing infrastructure insufficient for a healthy urban environment. The high costs associated with project preparation and implementation, combined with bureaucratic challenges, mean that many cities lack adequate engineering solutions. Consequently, especially among the low-income groups, buildings are often constructed without engineering projects.

Urbanization and industrialization are causing severe environmental degradation, consuming valuable agricultural land, coastal areas, natural landscapes, and other unique areas. These impacts not only increase environmental degradation, but also increase hazard risks such as floods and landslides.

Although land use management is accepted as one of the most sustainable ways of achieving the goal of natural hazard mitigation, land use decisions are still determined by market actors and politicians rather than the technical people. On the other hand, illegal building structures have still increased and are built in potential natural hazard areas such as close to or on top of fault lines.

2.1.2 Economic Problems

Economic problems of the developing countries could be viewed as the main cause of unhealthy urbanization processes. Rapid urbanization could not be prevented by central and local administrations because of the lack of resources. Moreover, public institutions have not mediated urbanization process in uncontrolled urbanization conditions.

In fact, the real estate sector is considered to be one of the most reliable investment opportunities in Türkiye. This causes an excessive demand for real estate market, especially in metropolitan areas, which increases pressure to develop new urban plans on municipalities. Furthermore, the political implications of the increasing demand for real estate serve as the primary motivation for many municipalities to promote highly urbanized development on rural areas, rather than creating economically viable and livable cities. This sprawl has exceeded actual development capacity (Sengezer and Koç 2005).

Urban land price dynamics frequently influence land use locations within cities. However, in developing countries, urban land speculation has led to improper land use plan implementations, contributing to unhealthy urban structures. Urban migration is an important factor leading to the increase of land speculation, especially in more desirable urban areas. Moderate-income groups buying properties in these speculative areas further drive environmental degradation.

Unfortunately, unreliability on the political structure is a great problem for economies in developing countries, such as Türkiye. These unreliable conditions trigger unstable economic development, and this affects long-term investment of cities negatively. This is the main problem for governments, who do not have adequate capital to develop comprehensive urban transformation projects. Consequently, both central and local governments anticipate private sector investments in cities.

2.1.3 Social Problems

The increase in environmental degradation and hazard risks in urban areas has been attributed to uncontrolled population growth. Social vulnerability to natural disasters has also increased due to several factors, as noted by Parker, Kreimer, and Munasinghe (1995). These include the use of inappropriate technologies, inadequate knowledge, and access to mitigation mechanisms, and the inability of public and private organizations to adopt lessons learned from the global disaster response experience.

Social structure of the cities is a determinant for the programming and the implementation of hazard mitigation strategies. Characteristics of the population cause different obstacles for hazard mitigation efforts. Characteristics of households, household incomes, age, genders, ethnicity, house ownership, and education are the main determinant factors for mitigation strategies. Hazard assessment methods utilize these social indicators to predict future hazard-risks. However, in developing countries, the complex and unclear urban structures impede accurate disaster risk estimation.

2.1.4 Environmental Problems

Due to overpopulation and unchecked growth, cities are increasingly susceptible to disasters. Current development and urbanization trends are adversely affecting rural areas, agricultural lands, forests, and other related ecosystems. Cities are becoming increasingly vulnerable to various environmental hazards such as extreme heat waves, extreme rainfall and hailstorms, floods, landslides, and droughts, particularly due to climate change. These hazards can have catastrophic effects on urban infrastructure, resulting in loss of life and displacement of people. In addition, environmental hazards can severely impact surrounding ecological regions by causing ecological disruptions and threatening biodiversity.

A variety of environmental problems are typical of cities that are vulnerable to disasters, including air pollution, water pollution, waste management, and land use change. Air pollution is a global urban challenge, with elevated levels of air pollution resulting from emissions from vehicles, industry, and built environment. Air pollution can have serious health effects, leading to such illnesses as respiratory problems, cardiovascular disease, and cancer. Urban areas are also characterized by elevated levels of water pollution from sewage, industrial effluent, and agricultural runoff. Water pollution can lead to several adverse environmental effects, including contamination of drinking water, pollution of waterways, and the death of coastal life. Waste disposal is another major problem facing urban centers, as they produce a significant amount of waste that is difficult to dispose of in a safe and environmentally sound manner. Waste disposal can lead to soil and groundwater contamination, greenhouse gas emissions, and the spread of pests and diseases. Changes in land use resulting from urban expansion can also have negative impacts on the surrounding environment, for example, deforestation of agricultural land leading to loss of biodiversity and increased risk of flooding. Environmental challenges in urban areas can also adversely affect adjacent ecosystems, such as air pollution that damages forests and vegetation, water pollution that contaminates rivers and lakes, and waste disposal that pollutes soil and groundwater, leading to ecological disturbances and threats to biodiversity.

As a result of the impact of these negative environmental effects on both cities and on the environment, there is a need to incorporate urban transformation strategies into urban planning processes by addressing the issues of sustainable development and urbanization to ensure the sustainable development of cities. However, there are major deficiencies and reluctance both in the legislation and in the implementation of the legislation by institutions. Due to urban poverty and limited financial resources in developing countries, exacerbated by the global economic crisis, there is a surge in urbanization, industrialization, tourism, and agricultural activities in natural areas to generate economic benefits.

In this context, urban transformation policies, which have become an important implementation tool for the redevelopment of cities, are expected to contribute to the reduction of environmental problems through investments in compact cities, sustainable urbanization, energy, water, and waste management in built areas.

2.1.5 Legislative and Institutional Problems

The structure and authority of central and local governments in different countries play a significant role in the emergence of unhealthy urban structures. Political power plays a decisive role in the planning, administration, and control of cities. However, inadequacies within the administrative structures of both central and local governments can lead to ineffective urban planning and hazard mitigation activities within cities. As Sengezer and Koç (2005) mentioned that political and institutional problems can include uncoordinated and conflicting policies, uncontrolled urban growth and the enlargement of slums, inadequate quality of design and construction techniques and monitoring of the construction process, lack of implementation of land-use regulations, lack of qualified technical expertise in developing areas, and inadequate financial resources that limit the capacity to reinforce existing buildings and use hazard-resistant construction technologies.

In Türkiye, there is confusion in the identification and differentiation of different planning responsibilities. Since 1985, local municipalities in Türkiye have been authorized to prepare plans, however, the central government and its local departments continue to have the right to make their autonomous decisions on the preparation of such plans. In some cases, autonomous planning decisions contradict those made by local governments. Qualified and experienced professionals are generally not available in most of the municipalities. Therefore, local planning groups frequently fail to include crucial data for the planning process (Sengezer and Koç 2005).

These conditions increase city risks due to inadequate planning efforts. Simultaneously, local governments struggle to oversee the construction and modification of buildings due to a lack of qualified personnel and financial resources. The technical staff, lacking adequate training on natural hazards and their effects, often fail to identify risks due to insufficient data and information.

In addition, another major problem in the field of urban planning is the legislative enactments produced by political means. According to Sengezer and Koç (2005), the recent enactment of the Construction Pardon Law, known as the 'İmar Affı Yasası', has brought about a novel approach to planning known as the 'Islah İmar Planı', which involves the upgrading of plans for illegally developed areas. This novel planning approach has legalized existing illegal constructions by exempting them from the usual formal planning requirements, such as compliance with upper-level plans or the provision of amenities that conform to legal standards. Traditional planning procedures require lower-level plans to be developed under the scope of upper-level plans. As a result, plans created by local municipalities must first be approved by the metropolitan municipality before they can be implemented. In the case of the 'Islah İmar Planı,' district municipalities have the power to implement the plan without acquiring such authorization. Consequently, the 'Islah İmar Planı' has been used to develop peripheral areas for speculative purposes.

On the other hand, political structures of the cities often lack the democratic mechanisms to encourage participation from various stakeholders, including central and local administrations, property owners, investors, developers, citizens, planners, architects, institutional specialists, and academicians in developmental processes. This gap hinders effective hazard mitigation, as the disjointed communication among these actors leads to fragmented implementations in the current situation.

2.1.6 Planning and Design, Technological Structure

Advancements in technology have enabled various analytical procedures to address complex urban planning issues. Computer-based methodologies have particularly simplified the process of data analysis. Despite this, data availability and reliability remain insufficient in developing countries, thus limiting the ability to conduct meaningful analyses. For instance, accurate information on population demographics, real estate inventory, hazardous areas, resource allocation, industrial capacity, among others is often difficult to obtain for most locations examined.

The limited expertise of specialized personnel, including Geographic Information System (GIS) specialists, planners, architects, and engineers, who use appropriate technological systems to construct hazard-resilient buildings and settlements, leads to poor performance and loss of effectiveness in various fields.

2.2 Natural Hazards and Disasters

Disasters are events that result in significant damage and loss of life due to natural or other causes. The Federal Emergency Management Agency (FEMA) categorizes disasters as either natural or technological, with natural disasters being the most common type of disaster worldwide. The world is entering a new era in which environmental conditions are degrading, leading to an increase in the occurrence and destruction of natural disasters (Kreimer and Arnold 2000).

The last three decades have seen a gradual increase in the number of natural disasters, particularly earthquakes. Natural disasters are usually divided into two categories: geological and meteorological. The second type is caused by atmospheric phenomena such as temperature, rain, pressure, and wind that exceed a certain threshold. Meteorological disasters include climate change, forest fires, droughts, fog, hail, lightning, blizzards, storms, frost, avalanches, and floods. Geological disasters, on the other hand, originate from the earth's crust or surface depth and include earthquakes, landslides, rockfalls, and mudflows. Every year, millions of people are affected by natural catastrophes and the global economic cost of these events is estimated at around $50 billion per year (Coppola 2006).

There are numerous definitions of concepts employed in research concerning disasters. However, the United Nations Office for Disaster Risk Reduction (UNISDR) has developed an extensive terminology in an effort to provide more comprehensive and relevant definitions for such concepts as disaster, hazard, vulnerability, and risk. This terminology aims to establish a unified and standardized language that can be used consistently throughout the field of disaster research, thereby facilitating greater clarity and precision in both academic and practical contexts.

The guides have been updated since the 2000s, with the most recent version released in 2017. Many researchers and policymakers refer to the UNISDR guide to ensure consistent use of terms. An analysis of the changes made to the guide will be of interest to regular users of the 2009 edition and provide an overview of the evolving conceptual landscape in Disaster Risk Reduction (DRR) work. Some of the basic concepts related to risk and resilience are listed below:

a) “Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.” (United Nations General Assembly 2016, 18) In the definition of hazard, there exist two categories of natural and human-made hazards.

b) “Natural hazard: Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.” (United Nations International Strategy for Disaster Reduction 2013, 9).

c) “Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.” (United Nations General Assembly 2016, 24).

d) Risk: “The probability of harmful consequences or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted, or environment damaged), resulting from interactions between natural or human-induced hazards and vulnerable conditions.” (Sonmez Saner 2015, 1388).

According to Staupe-Delgado (2019), the term 'risk' has been replaced by 'disaster risk' in the 2017 terminology guide. Previously, the guide defined both terms, as well as 'risk management' and 'disaster risk management'. The updated guide no longer lists either 'risk' or 'risk management'. The rationale for this decision is not clear. Because of that Disaster and Disaster Risk have more common usage in current terminology.

e) “Disaster: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.” (United Nations General Assembly 2016, 13).

f) “Disaster risk: The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.” (United Nations General Assembly 2016, 16).

g) “Disaster damage: occurs during and immediately after the disaster. This is usually measured in physical units (e.g., square meters of housing, kilometers of roads, etc.), and describes the total or partial destruction of physical assets, the disruption of basic services and damages to sources of livelihood in the affected area.” (United Nations General Assembly 2016, 13).

h) “Disaster impact: is the total effect, including negative effects (e.g., economic losses) and positive effects (e.g., economic gains), of a hazardous event or a disaster. The term includes economic, human, and environmental impacts, and may include death, injuries, disease and other negative effects on human physical, mental and social well-being.” (United Nations General Assembly 2016, 13).

i) “Disaster management: The organization, planning and application of measures preparing for, responding to and recovering from disasters.;” “Emergency management is also used, sometimes interchangeably, with the term disaster management, particularly in the context of biological and technological hazards and for health emergencies.” (United Nations General Assembly 2016, 14)

j) “Disaster risk management: Disaster risk management is the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.” (United Nations General Assembly 2016, 15).

k) “Disaster risk reduction: Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.” (United Nations General Assembly 2016, 16).

l) “Reconstruction: The medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing, facilities, and livelihoods required for the full functioning of a community, or a society affected by a disaster, aligning with the principles of sustainable development and “build back better”, to avoid or reduce future disaster risk.” (United Nations General Assembly 2016, 21).

m) “Rehabilitation: The restoration of basic services and facilities for the functioning of a community or a society affected by a disaster.” (United Nations General Assembly 2016, 22).

n) “Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.” (United Nations General Assembly 2016, 22).

o) “Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”(United Nations International Strategy for Disaster Reduction 2013, 12).

p) “Mitigation: The lessening or minimizing of the adverse impacts of a hazardous event. The adverse impacts of hazards, in particular natural hazards, often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures include engineering techniques and hazard-resistant construction as well as improved environmental and social policies and public awareness. It should be noted that, in climate change policy, “mitigation” is defined differently, and is the term used for the reduction of greenhouse gas emissions that are the source of climate change.” (United Nations General Assembly 2016, 20).

q) “Preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.” (United Nations General Assembly 2016, 21).

r) “Prevention: Activities and measures to avoid existing and new disaster risks.” (United Nations General Assembly 2016, 21).

s) “Recovery: The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural, and environmental assets, systems, and activities, of a disaster affected community or society, aligning with the principles of sustainable development and “build back better”, to avoid or reduce future disaster risk.” (United Nations General Assembly 2016, 21).

t) “Response: Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.” (United Nations General Assembly 2016, 22).

Especially Asian Disaster Preparedness Center ADCP (2010) focus on the increasing rate of urbanization has led to a rapid development of vulnerability towards natural disasters. The urban environment is characterized by several interrelated factors that contribute to increasing vulnerability, including but not limited to the location of settlements, haphazard urban development, population density, and the built environment. Poverty and inefficient governance also worsen the problem. In order to address these vulnerabilities with precision and the appropriate approach, it is imperative to understand the underlying causes, differences and similarities between them. Therefore, coping with disasters should include a phase of identifying risks, hazards, vulnerabilities, and factors affecting them, coupled with a method of managing them. This integrated system is commonly referred to as disaster risk management in disaster research.

Disaster risk management is a multilevel and complex task that involves the use of a variety of skills and knowledge in the implementation of strategies and policies to reduce or prevent the impact of hazards and the occurrence of disasters. Disaster Risk Management is defined by Cutter (2014) as a comprehensive process that comprises all activities, plans, and policies aimed at minimizing the damaging effects of disasters on human lives and properties. The process of disaster risk management includes various measures such as risk analysis, strategies for prevention, reduction, mitigation, recovery, or preparedness based on the findings. What distinguishes this process is its emphasis on assessing the effectiveness of decisions taken in each phase.

2.3 The Concept of Urban Resilience

In order to effectively apply the concept of resilience in the context of urban research and politics, it is essential to acknowledge and address the inherent tensions that arise. Meerow, Newell, and Stults (2016) provides a novel definition of urban resilience that explicitly incorporates six conceptual tensions while maintaining a level of adaptability that accommodates different disciplines and participants. The proposed definition is as follows:

> "Urban resilience refers to the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow, Newell, and Stults 2016, 39).

Urban resilience is a flexible concept that presents different approaches to achieving resilience, such as persistence, transition, and transformation as Meerow, Newell, and Stults (2016) mentioned. It accepts the importance of scales of time and supports general adaptation rather than specific adaptation. The urban fabric is seen as complicated and adaptive, consisting of socio-ecological and socio-technical linkages that operate across multiple spatial dimensions. Resilience is considered a desirable condition that should be negotiated formally among those who practice it empirically.

The approach of urban resilience considers cities as complicated adaptive social-ecological systems. The challenge for a new planning paradigm is to develop methods for identifying the vulnerability and adaptive capacity of urban ecosystems during disturbances, and to develop principles and opportunities for building resilience in urban systems. The ‘Urban Resilience’ Research Prospectus (2007) proposes that the characteristics of self-organization, adaptation and collapse, and dynamics occurring at different spatial and time-related scales indicate that studies of sustainable urbanization can benefit from using a resilience approach. The Prospectus proposes that understanding the resilience of urban systems requires recognition of the role of metabolic flows in sustaining urban functions, human well-being and quality of life, governance networks, and society's capacity to learn, adapt, and reorganize in response to urban challenges, as well as the social dynamics of urban residents and their relationship to the physical environment that defines the physical patterns of urban structure and their spatial relationships and connections. Reports and various research on resilience introduce the concept not only in ecological terms, but also in economic and social terms, as economic, social, and ecological systems are linked through synergistic and co-evolutionary conditions (Eraydin 2010).

The concept of urban resilience, originally formulated by the Resilience Alliance (2007), is a broad concept that interconnects four specific aspects of resilience within an urban system. These multi-dimensional factors include metabolic flows, governance networks, social dynamics, and the built environment (Figure 8). Metabolic flows refer to the ability of the city to sustain its functions, as well as the quality of life and well-being of society, and include all forms of production and consumption systems. Governance networks describe society's ability to learn, adapt, and identify urban challenges. In addition, social dynamics is a general term that encompasses all individuals, users, consumers, and communities that have a relationship with the built environment, while the built environment encompasses all urban forms and the spatial relationships and connections within them.

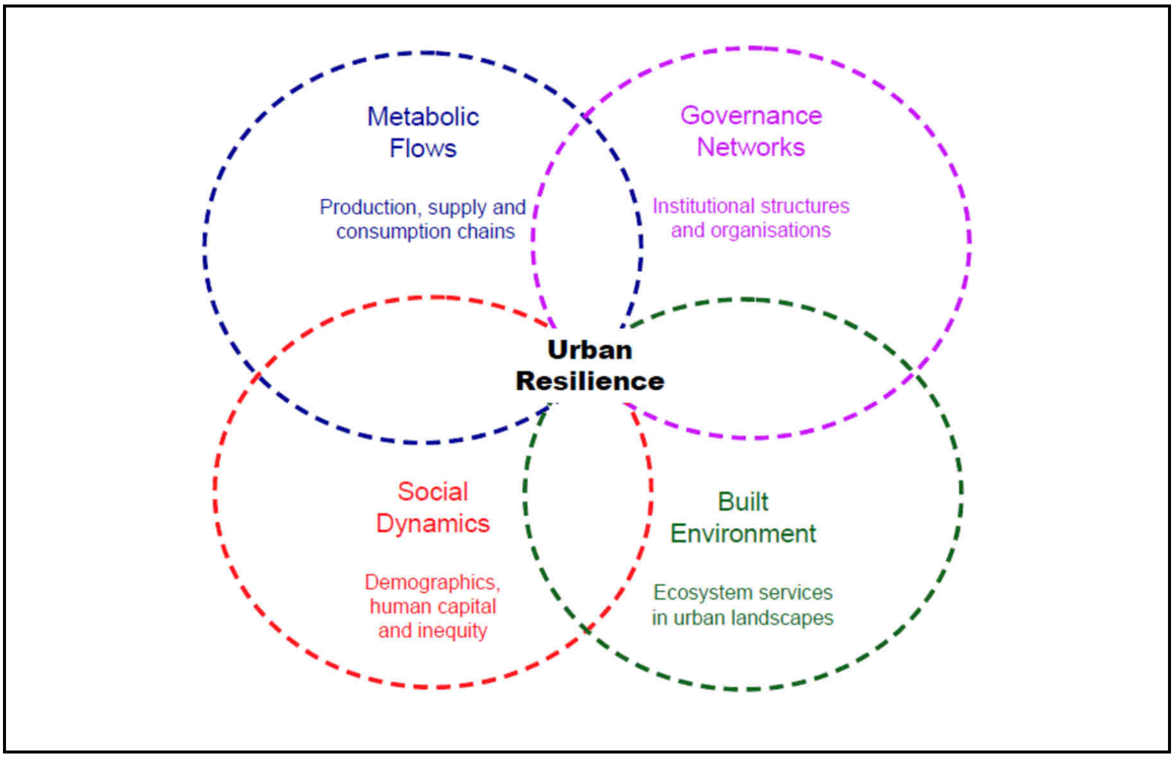


Figure 8: Research Themes for Prioritizing Urban Resilience
(Source: Resilience Alliance 2007, 10)

2.3.1 Principles of Urban Resilience

The concept of urban resilience, which refers to the ability of an urban system to sustain, adapt to, and recover from the impacts of various stresses and shocks, is a multidimensional and complex construct that encompasses dimensions that include social, economic, environmental, and physical aspects. As Jha, Miner, and Stanton-Geddes (2013) and Meerow, Newell, and Stults (2016) mentioned that the essence of resilience lies in the ability of a system, community or society exposed to risks to withstand, adapt, integrate, and recover from the effects of a risk in a timely and efficient manner. In addition to mitigating hazards, the concept of resilience also encompasses efforts to improve preparedness and responsiveness in the event of a disaster, with the goal of ensuring rapid recovery. It is also important to emphasize that the scope and ambition of resilience goes beyond mitigation. In addition, the vulnerability and exposure of people or assets to risk can be significantly reduced by limiting their location, designing the built and natural environment, establishing operational and institutional arrangements, and managing the financial impact of natural hazards. Finally, land-use planning and ecosystem management are relatively low-cost, no-regret strategies that can effectively manage disaster risk, particularly in small and medium-sized urban centers that lack resources and capacity.

2.3.2 Understanding of the Resilience Concept

The word ‘Resilience’ was initially introduced from an ecological perspective by Gunderson, Allen, and Holling (1973). Resilience, as defined, serves as a critical determinant of the strength of relationships within a system and represents a quantifiable indicator of the ability of the system to absorb and subsequently persist through changes in its state and driving variables and parameters. In this context, the characteristic of resilience is attributed to the system, while the outcome of persistence or likelihood of extinction is derived from the system. These principles form the basis of the concept of resilience and are essential for understanding its significance in various fields.

Originally introduced by Gunderson, Allen, and Holling (1973), the concept of resilience was employed to comprehend the capacity of ecosystems with alternative attractors to maintain their original state despite disturbances (Gunderson, Allen, and Holling 2009). Holling further developed this idea in 1986, presenting the adaptive cycle comprised of four system phases: exploitation, conservation, creative destruction, and renewal. This cycle offers a holistic understanding of ecological dynamics over time. The proto theory highlighting nonlinear dynamics in intricate systems involving humans and ecosystems is crucial. Holling (1986) accentuated the significance of scale. Meanwhile, the concept's initial identification was credited to Folke and colleagues in 1996, who also introduced the interrelated notions of the link between diversity and resilience (Gunderson, Allen, and Holling 2009).

These concepts have been reviewed by scholars such as Gunderson (2000), Folke (2006) and Scheffer (2009). The term resilience has been narrowly defined in certain fields, such as engineering resilience by Holling in (1996), to refer to the rate of return to equilibrium following a perturbation. However, many complex systems have multiple attractors, which can result in a disturbance causing the system to transition to an opposite state rather than returning to its original state. The concept of ecological or ecosystem resilience, as defined by Holling in (1996), emphasizes this distinction. Although the alternation of stable conditions with distinct attractors is an oversimplification of the reality of ecosystems, we can observe sharp shifts in ecosystems that are distinct from fluctuations around trends. These transitions are known as regime shifts and can have a variety of causes. When they correspond to a change between different domains of stability, they are called critical transitions. All these terms have precise definitions in the mathematics of dynamical systems (Folke et al. 2010).

The concept has been introduced into the social sciences through work on global environmental change, disaster studies, and political ecology, as Johnson and Blackburn (2014) mentioned. Within the disaster literature, it has been widely recognized that the occurrence of 'natural disasters' is the result of human-related processes of vulnerability creation, which has led to considerations of how society can take measures to reduce and withstand hazards - and thus increase its resilience. This concern is particularly pronounced in urban environments, where populations and assets are concentrated.

The term 'resilience' has gained significant traction in high-level policy arenas due to its positive and proactive association with terms such as 'vulnerability' or 'disaster mitigation' according to Johnson and Blackburn (2014). However, despite its prevalence in international policy discourse, there are still unresolved complexities and conflicts surrounding its definition, as well as agreement on its application or measurement. Resilience can be conceptualized as an idealized 'state of being', such as a 'resilient city', or as a dynamic process involving learning and adaptation as a management strategy to improve this state of being. It is essential for disaster mitigation and increasingly important for adaptation to climate change.

The concept of Resilience, originally rooted in the ecological sciences, has now become a widely accepted notion in various disciplines from the social sciences to engineering and development. Resilience is primarily characterized as a concept that describes the ability of complex systems to adapt, cope, and transform in the face of disturbance, shock, or change. As the concept has evolved, some scholars have argued that resilience thinking encompasses not only coping and adaptive capacities, but also a 'learning' capacity within systems. Therefore, resilience can be defined as the development of capacities through learning to sustain development in the face of unexpected or anticipated changes and disturbances.

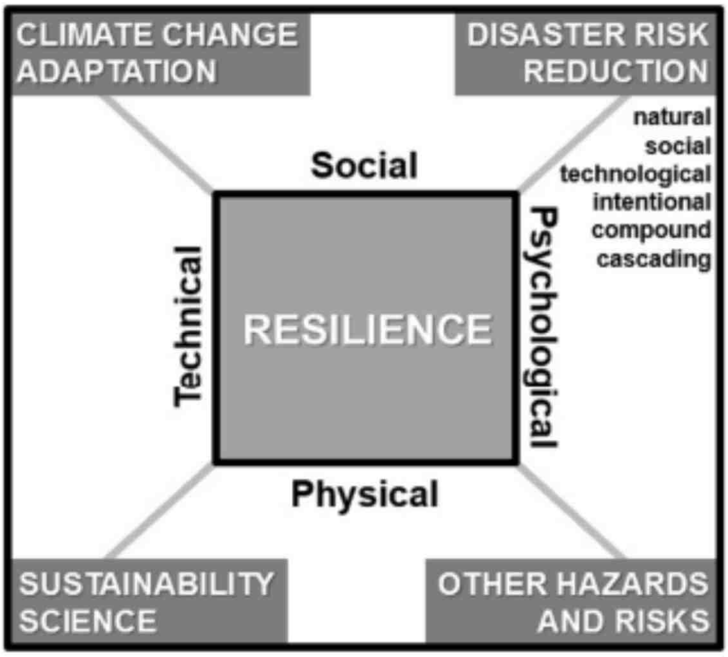


Figure 9: Position of Resilience Studies in The Sciences.
(Source: Alexander 2013, 2714)

The resilience thinking has been appropriately modified and adopted to effectively address emerging issues in urban areas, particularly those related to disaster risk management. Adopting this approach enables critical relationships to be established between disaster risk management, risk reduction, the overarching sustainable city goal, which in turn can be strengthened through a range of public policies and community-based initiatives. Specifically, in the field of disaster, resilience is defined as the comprehensive proactive measures designed to prevent potential losses and mitigate risks, while strengthening the ability to be prepared to recover from disruptive events such as catastrophes and disasters (Adıkutlu 2019).

Cutter (2014) point out that community resilience has become a widely recognized means of improving disaster preparedness, response, and recovery in the short-term, as well as climate change adaptation in the long-term. This subject is of primary concern, as demonstrated by recent prominent reports. These reports agree that disaster resilience enhances a society's ability to prepare for, tolerate, recover from, and adapt to adverse events in a timely and efficient manner. This involves restoring and enhancing fundamental functions and structures. In the original ecological concept of resilience, resilience refers to a return to the pre-impact conditions, but in the context of disasters, the term has evolved to include measures of progress and advancement rather than just recovery.

The concept of resilience has its origin in the ecological sciences and has been adapted by the social sciences as L. Figueiredo, Honiden, and Schumann (2018) mentioned. Cultural ecology compares social systems to ecological systems, where resilience is viewed as a systems concept. The social-ecological system is a complex adaptive system, and ecological principles can assist in understanding how societies function. Resilience has been applied in various fields, including psychology, geography, sociology, and planning. For example, psychology uses resilience as a mechanism to effectively cope with and overcome sudden shocks and stresses. The term 'resilience' is commonly used in the context of climate change adaptation, sustainability, disaster risk reduction, and poverty reduction. Additionally, it is increasingly being used in the fields of economics and planning. Three main approaches are used to conceptualize resilience: socio-ecological, sustainable development, and disaster risk reduction. However, the term 'resilience' has multiple meanings and definitions. As a result, scholars argue that existing definitions are inconsistent and underdeveloped. The definitions of urban resilience vary in the academic and policymaking literature (Table 1). However, they share the view that resilience is a positive attribute that can be built and acquired by cities, communities, households, organizations, or businesses. The OECD has prioritized resilient economies and societies, risk governance issues, and a comprehensive, territorial view of resilience. Urban resilience refers to the capacity of cities to absorb, adapt, transform, and prepare for shocks and stresses along economic, social, institutional, and environmental dimensions, with the goal of maintaining the functioning of a city and improving its ability to respond to future shocks.

Table 1: Definitions of Urban Resilience
(Source: L. Figueiredo, Honiden, and Schumann 2018, 10)

Institution	Definition
UN-Habitat	Resilience refers to the ability of any urban system to withstand and to recover quickly from multiple shocks and stresses and maintain continuity of service.
International Council for Local Environmental Initiatives (ICLEI)	A city that is prepared to absorb and recover from any shock or stress while maintaining its essential functions, structures and identity as well as adapting and thriving in the face of continual change. Building resilience requires identifying and assessing hazard risks, reducing vulnerability and exposure, and lastly, increasing resistance, adaptive capacity, and emergency preparedness.
United Nations Office for Disaster Risk Reduction (UNISDR)	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.
Rockefeller Foundation	Resilience is the capacity of individuals, communities, and systems to survive, adapt and grow in the face of stress and shocks, and even transform when conditions require it.
Resilientcity.Org	A resilient city is one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures to still be able to maintain essentially the same functions, structures, systems, and identity.
World Bank	Resilience is characterized by the ability of people, societies, and countries to recover from negative shocks, while retaining their ability to function.
USAID	Resilience is the ability of people, households, communities, countries, and systems to mitigate, adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth.
100 Resilient Cities	Urban resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt and grow regardless of what kinds of chronic stresses and acute shocks they experience.
Resilient Europe	Urban resilience is the capacity of urban systems, communities, individuals, organizations, and businesses to recover, maintain their function and thrive in the aftermath of a shock or a stress, regardless its impact, frequency, or magnitude.
Global Alliance for Resilience (AGIR)	The capacity of vulnerable households, families, communities, and systems to face uncertainty and the risk of shocks, to withstand and respond effectively to shocks, as well as to recover and adapt in a sustainable manner.

2.3.3 Development of Disaster Resilience

Cutter (2014) describes disaster resilience as a concept that goes beyond engineering and aims to link disaster risk management, disaster mitigation, and community sustainability through a variety of top-down and community-based measures. Resilience is a process that involves a series of actions aimed at achieving sustainability goals.

All definitions of disaster resilience can be represented in Figure 10 with a series of actions that result from various policies, strategies, and technical tools to build the concept of resilience in a society (Cutter 2014). These actions involve managing disaster risks, reducing vulnerability, developing a robust governance system through the implementation of institutional changes, establishing policies at all scales, strategies for capacity improvement, learning experiences, and monitoring and assessment of the system using new instruments.

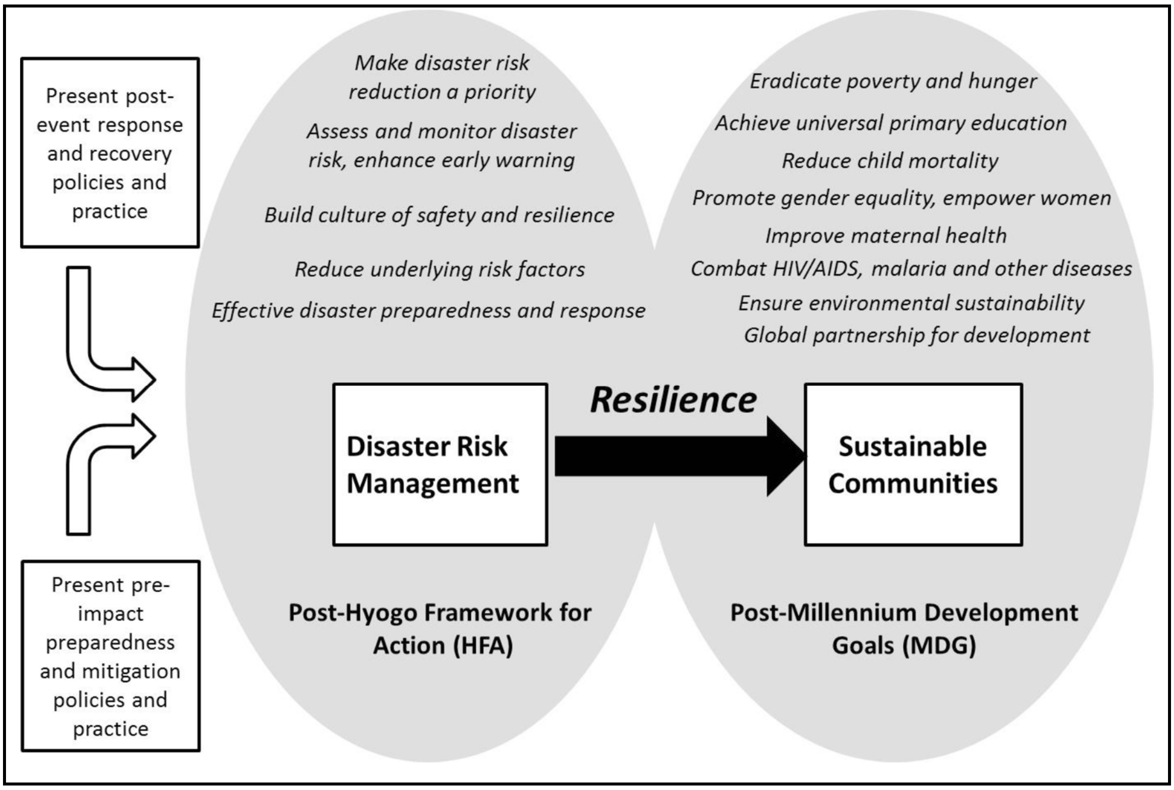


Figure 10: The Path to A Disaster-Resilient Future
(Source: Cutter 2014, 74)

2.4 Hazards and Disaster Management

The hazards research field involves various disciplines, such as climatology, economics, engineering, geography, geology, law, meteorology, planning, seismology, and sociology (Mileti 1999). In the field, researchers have focused on studying different aspects of natural disasters, such as the performance of engineering projects, early warning systems, land-use management strategies, response and recovery planning, insurance policies, and building codes. Through these investigations, specialists attempt to promote individual and collective adaptation to characteristic risks, while also attempting to limit the negative effects, such as deaths, injuries, costs, and social, environmental, and financial dislocation.

2.4.1 Disaster Management

The international disaster risk management agenda has recently been characterized by a variety of activities aimed at contributing to disaster risk reduction, as Şenol Balaban (2019). In this context, disaster risk reduction is primarily concerned with the adoption of precautionary measures prior to the occurrence of a disaster event, with the aim of reducing the magnitude and frequency of the activities that are expected to follow. This approach has gained traction around the world, with several countries taking the initiative to revise their disaster management strategies to implement the concept of disaster risk reduction. It is remarkable that since 2005, the progress of disaster risk reduction has been monitored through the National Progress Reports on the implementation of the Frameworks for Action, with an interval of 15 years. The overall goal of disaster risk reduction is to achieve a significant reduction in disaster risk and associated losses to human lives, livelihoods and economic, physical, social, cultural, and environmental assets owned by individuals, businesses, communities, and countries. This goal is to be achieved by 2030, and to facilitate its achievement, four priorities for action were proclaimed in Sendai, Japan, in 2015.

These priorities for action are: (i) understanding disaster risk; (ii) strengthening disaster risk governance to manage disaster risk; (iii) investing in disaster reduction for resilience and (iv) enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation, and reconstruction (UNISDR 2015).

Disaster risk management in cities and its relationship to the concept of resilience is important for understanding disaster resilience in cities. Therefore, the literature on disaster risk management is reviewed in terms of different approaches and international literature that has contributed to the development of the field. The relationship between the concept of resilience and disasters is analyzed.

The occurrence of negative physical, economic, social, and environmental consequences caused by disasters is directly related to the existence of factors that will be negatively affected by the disaster, the vulnerability of these factors and the concepts of hazard. After the occurrence of any hazard, the presence of elements that may be adversely affected by the hazard constitutes the concept of risk. Therefore, risk is defined as the totality of the losses that may occur in case of the occurrence of a possible hazard.

Within the scope of hazard mitigation, the disaster management process should operate in a sustainable manner. Disaster management process is defined as a multidimensional and interactive process that includes planning and execution of the measures to be taken and activities to be carried out before, during and after disasters in order to prevent disasters and mitigate their damages within the scope of creating a safe and developed living space.

Risk management studies, however, constitute the first stage of the disaster management process. Within the scope of risk management activities, there are two phases: response and mitigation. The mitigation phase covers risk reduction activities and constitutes the longest phase of the disaster management process. Within the scope of this phase, it is of critical importance to identify the risk sectors and to determine the relative risk degrees by performing risk analyses within these sectors because risk mitigation activities cannot be started without identifying risk sectors and relative risk. In addition to this, the activities within the scope of the mitigation phase are directly related to how the settlements are planned because the areas where the most damage is seen after any disaster are the built settlements. Hence, disaster-sensitive planning is crucial for risk reduction, especially during the initial phase of the disaster management process known as risk management. In settlements planned by taking a disaster-sensitive attitude, damages (risk) that may occur in the event of a disaster can be prevented.

Disaster sensitive planning is defined as the planning process that forms the basis of action plans by determining short-, medium- and long-term targets, strategies and activities prepared for the purpose of preventing these hazards and risks or minimizing possible damages within the framework of determining the hazards and risks in settlements. Within the scope of disaster sensitive planning, the process of identifying risks in the first stage is especially important. In this context, it is a critical issue to create avoidance plans within the scope of determining the risks that may be caused by possible disasters. It is possible to identify multidimensional risks in social, economic, and physical contexts in settlements through avoidance plans.

Mitigation efforts, being the initial phase of the disaster management process, and pre-disaster hazard mitigation plans, a key aspect of earthquake-sensitive planning, should be integrally linked and not viewed separately. Both concepts should be viewed as interdependent elements. Indeed, in both the risk management phase of mitigation studies—the initial phase of the disaster management process—and the starting phase of avoidance plans, which begins with identifying risk sectors, it is essential to pinpoint these sectors and assess relative risks. This ensures that risk mitigation efforts are aligned with the outcomes.

The field of disaster risk management can be considered from a comprehensive and systematic point of view, which includes numerous fields of action or operations that serve to mitigate risks, reduce the impact of disasters, and facilitate recovery while maintaining efficiency. This system consists of distinct phases, encompassing pre-disaster, disaster, and post-disaster stages. Each stage involves specific actions, namely mitigation, preparedness, response, and recovery. These approaches are described in a procedural framework under three main sections: pre-disaster approaches, which include diverse types of mitigation strategies and actions; disaster event response; and post-disaster approaches, which include post-disaster recovery, rehabilitation, and reconstruction (Adıkutlu 2019).

According to Şenol Balaban (2016) pre-disaster management policies are a critical component of disaster risk management and include the implementation of mitigation and preparedness measures. The mitigation concept consists of a range of actions implemented at diverse levels to reduce the impact of hazards and disasters. These efforts include hazard and risk assessment, vulnerability analysis for developing strategies and actions to reduce vulnerability, disaster risk reduction, and risk reduction.

Implementation of mitigation strategy involves a variety of policies at multiple levels. According to UNISDR (2015), mitigation strategies may involve building-based technical solutions like constructing hazard-resistant buildings. Alternatively, they can be nationwide efforts, such as improving environmental policies, raising public awareness, or macro-assessments of damage. Urban planning can be applied as a pre-disaster management strategy, integrating proactive and preventive actions to mitigate the impact of disasters. This can include the analysis of the properties of the land and the identification of suitable areas for cities, as well as the implementation of various safety regulations and zoning decisions, as pointed out by Balamir et al. (2008). Furthermore, planning and land management for safer and more livable cities can contribute significantly to risk reduction and vulnerability mitigation.

Mitigation planning is a modern approach to pre-disaster management that is gaining momentum. Although there is no specific methodology for mitigation planning, it involves a series of actions like micro-zoning, building robustness, retrofitting, density control, and classification of vulnerable land uses, as outlined by Balamir et al. (2008). The mitigation planning approach has the potential to encompass various measures related to risk avoidance, risk reduction and risk sharing.

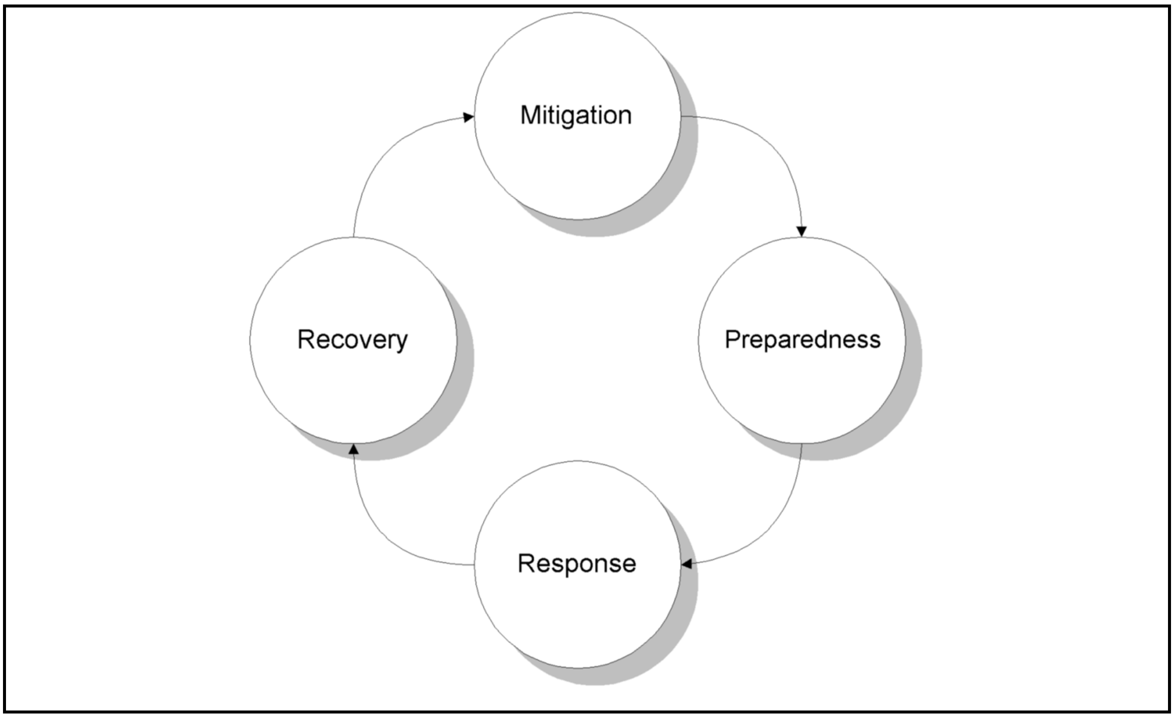


Figure 11: Four Phases of Emergency Management
(Source: FEMA 2023) (accessed date: 10.07.2023)

Hazards, as a natural phenomenon, are often intensified by the social structures that have been developed and implemented. In order to address the risks and consequences associated with disasters, disaster management must be applied. This management approach can be categorized into four distinct phases: (a) Preparedness, (b) Mitigation, (c) Response, and (d) Recovery. Given the complexity and scope of disaster management, it is essential to establish and maintain a multilateral and interdisciplinary framework. Within this framework, multiple entities, including private, national, and international institutions, exist in a multi-layered structure designed to effectively manage and respond to disaster (Figure 11).

In order to summarize the conceptual framework based on the literature in the field of disaster risk management and resilience, Adıkutlu's (2019) mental diagram for developing the concept of urban resilience to disasters is shown in Figure 12.

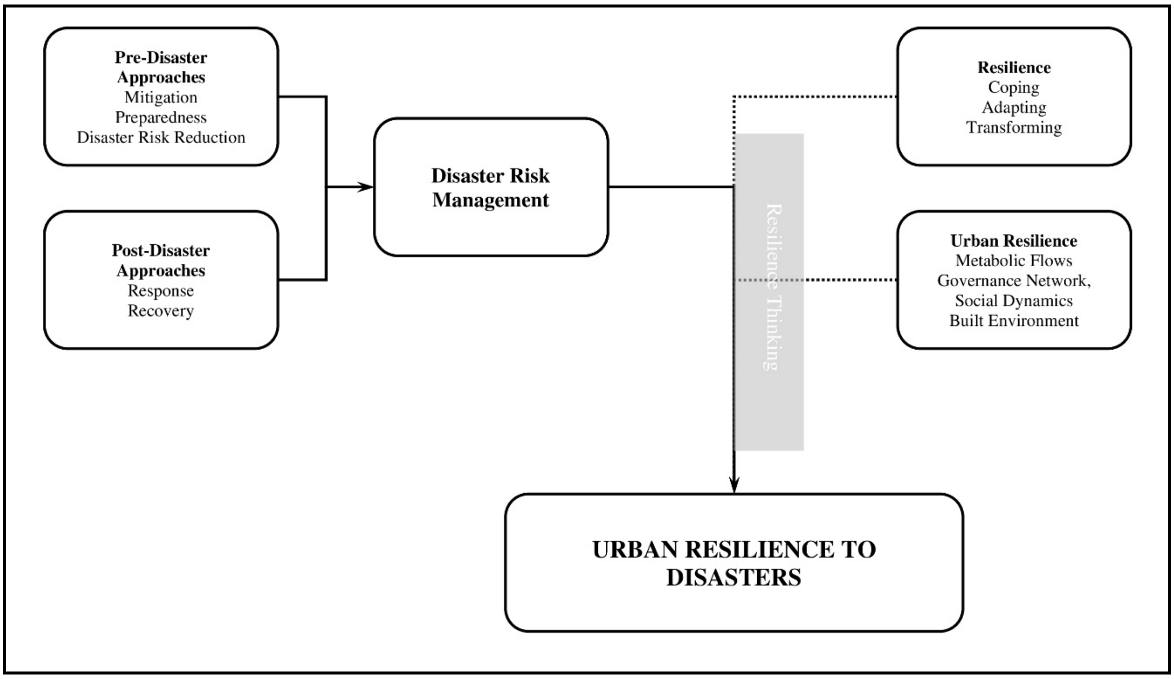


Figure 12: Conceptual Framework of Urban Resilience to Disasters
(Source: Redrawn from Adıkutlu 2019, 43)

The scope of disaster management can be described with a comprehensive three-dimensional matrix (Figure 13) that includes three categories of constituent elements, namely, levels of government, management phase, and implementation measure, as mentioned by Montoya (2003). This matrix provides an elaborated way of identifying and formulating a variety of potential implementation strategies that can be adopted to address disaster management. The implementation strategies can be broadly categorized into two distinct types, namely, structural, and non-structural. Structural measures refer to physical modifications made to the environment to reduce the damage caused by disasters, for example the strengthening or demolition of buildings, the construction of levees and drainage systems. Non-structural measures, on the other hand, focus more on strategies that do not involve physical modifications, but rather encompass various other facets such as education, awareness and training programs aimed at equipping individuals with the required knowledge and abilities to manage disasters.

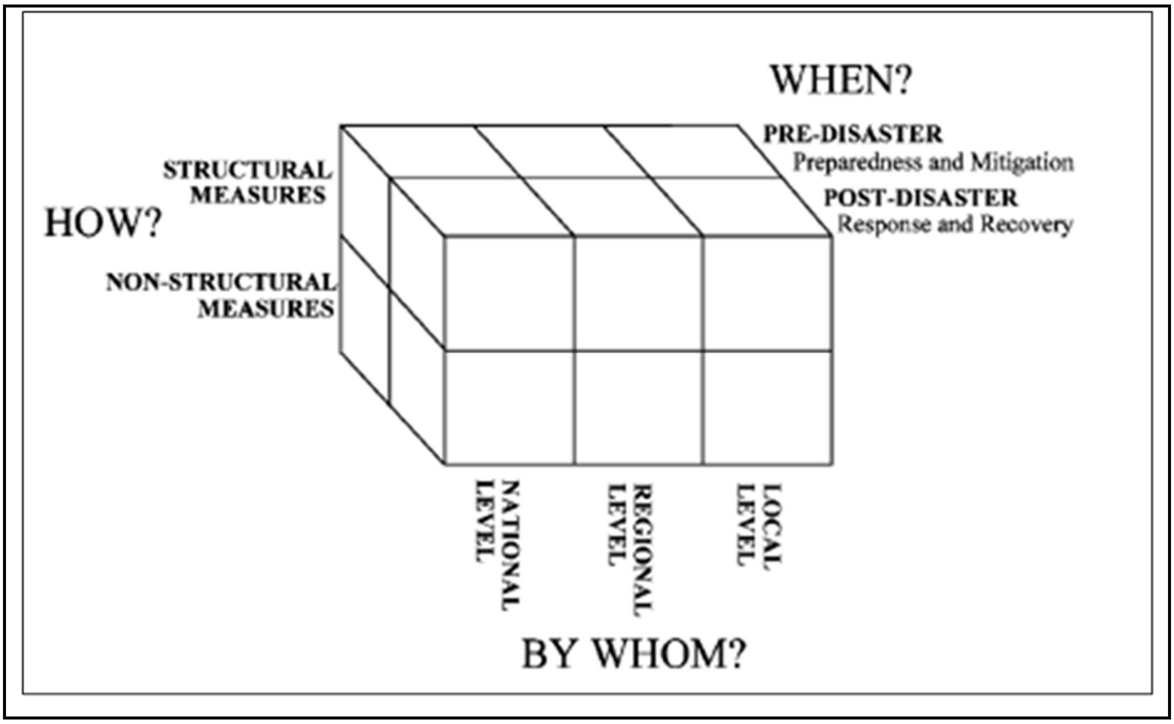


Figure 13: Scope of Disaster Management

(Source: Montoya 2003, 203)

This dissertation emphasizes the significance of pre-disaster activities over post-disaster activities based on this classification. Additionally, the research levels consist of the local level for physical, social, and economic implementation, and the national-regional level for institutional, legislative, and economic contexts.

2.4.1.1 Mitigation

Mitigation, which refers to the process of reducing the impact of disasters, encompasses a wide range of preparedness measures and activities. These activities are characterized by their long-term and interdisciplinary nature and require the involvement of multiple institutions and organizations to achieve a specific goal. The mitigation phase begins with the activities of the improvement phase and continues until a new disaster occurs. The activities undertaken during this phase have a wide range of application, from country level initiatives to regional and neighborhood level efforts.

Risk Mitigation Phase: As outlined by the Istanbul Greater Municipality in their approach (2003), it is essential to take into account the earthquake factor. Unfortunately, people and decision makers tend to forget this crucial element shortly after an earthquake. As a result, planning decisions are made as if the disaster will never happen again, resulting in construction that may or may not conform to a set plan. Furthermore, this approach does not allow for the preparation of a disaster-resilient environment, as structures cannot be strengthened or made disaster-resilient when the moment of disaster approaches. Various social, economic, and legal problems contribute to this situation. Nevertheless, settlements can be made sensitive and resilient to disasters under two conditions. First, the safety of the existing environment must be improved. Second, new environments must be designed to minimize the impact of disasters. However, this process is long-term, and its effectiveness hinges on cultivating behaviors and creating environments dedicated to this purpose in the intervals between two disasters. The development of plans and projects for risk reduction, the strengthening of infrastructure, the establishment of legal regulations that provide for the creation of a safe environment with a set of rules, the creation of institutional structures, the establishment of building inspection and standards, and the creation of disaster awareness among the public and those working in the construction sector are among the many issues that need to be addressed.

2.4.1.2 Preparedness

The objectives of disaster preparedness are multifaceted and include the acquisition of knowledge regarding appropriate post-disaster actions, the development of skills necessary to execute said actions, and the procurement of suitable equipment to ensure their effectiveness. Furthermore, this phase entails the establishment of principles and the configuration of applications relating to the definition of recruitment, as well as the provision of distribution services for the health-related, shelter-related, and daily consumption-related needs that arise in the aftermath of the disaster. In order to achieve these aims, periodic enforcement measures, the assignment of significant tasks to personnel, and the creation of contingency plans at both the city and district levels are imperative. These activities play a crucial role in minimizing loss of life and mitigating the destructive impact of the disaster. In preparation for post-disaster scenarios, contingency plans must be created at the governmental level, as there is insufficient time for planning once the disaster has occurred. Each government must be equipped to undertake a wide range of responsibilities and duties prior to the disaster. Government institutions must collaborate with other organizations to conduct studies that inform contingency plans. Both government and non-governmental institutions should possess comprehensive knowledge regarding the detailed actions to be taken following a disaster. National plans may enumerate various government agencies that have been assigned specific responsibilities in accordance with their regular missions and may delineate the tasks and functions that these agencies are expected to perform in the event of a disaster. Governments must wait until institutions have shared relevant data to facilitate efficient decision-making in the aftermath of the disaster. The contingency plans provide detailed information regarding what type of data will be shared as information. The estimation of damage assessment is an exceedingly critical component of the preparedness stage.

2.4.1.3 Response

The response period is critical to mitigating the adverse effects of disasters by minimizing the incidence from injuries, fatalities, and property damage. Among the four phases of disaster management, response is by far the most complex and multidimensional. This is primarily due to the fact that it is carried out during times of extreme stress, in an environment of extreme time constraints, and with limited information. The response phase involves the rapid re-establishment of critical infrastructure, such as the reopening of transportation routes, the restoration of communications and power, and the distribution of food and clean water. These actions are necessary to facilitate the recovery process, minimize loss of life, and restore normalcy to affected communities.

2.4.1.4 Recovery

In this phase, the process of reconstruction of facilities is carried out with the aim of eliminating the effects of the disaster. As with the other phases, the determination of the methods, timing, and way the facilities will be reconstructed should be advanced. Compared to the other functions of disaster management, recovery is undoubtedly the most expensive. It is also the least studied and least structured of all the functions of disaster management. Various activities take place during this phase, including, but not limited to, providing temporary housing or long-term shelter; assessing damages and needs; demolishing damaged structures; clearing, removing, and disposing of debris; inspecting damaged structures; and rebuilding. As in the response phase, cooperation with decentralized institutions is essential.

The Report of the United Nations Development Programme Bureau for Crises Prevention and Recovery (UNDP 2004) highlighted the costs incurred post-disaster as a critical component of disaster impacts, traditionally categorizing them as post-disaster losses.

The costs of a disaster can be classified into two main groups: direct and indirect costs. Direct costs are defined as physical damage, such as costs resulting from damage to structures such as residential areas, industrial facilities, public structures such as education and health facilities, roads, energy facilities and infrastructure facilities, and costs affecting productive capital such as stocks of agricultural and livestock structures and the like. Indirect costs refer to the damage caused to the flow of goods and services. These costs result from reduced production due to damaged or destroyed assets and infrastructure, as well as lost income due to the interruption of income-generating opportunities. Indirect costs also include medical expenses and lost productivity resulting from increased incidences of illness, injury, and death (UNDP 2004).

On the other hand, it should be noted that the gross indirect costs are partially compensated by the positive side-effects of rehabilitation and reconstruction investments. Especially increased development in the construction sector and the rebuilding of affected sectors can have a positive impact on the local economy. Besides these expenses, there are also secondary consequences in the short and long term-after a disaster. These impacts can influence the entire economy and socio-economic conditions, such as financial and monetary performance, domestic and national debt levels, income distribution, and the extent and occurrence of poverty. The consequences of moving or restructuring economic or labor force components can also be significant (UNDP 2004).

2.5 Importance of Hazard Mitigation

The significance of hazard risk, as well as the importance of hazard risk management and mitigation, has become increasingly recognized in recent years, not only in developed countries but also in developing and underdeveloped nations.

In recent years, the preparations for pre-disaster and post-disaster efforts are considered important to reduce damage and provide effective emergency response with strategies of Hazard Mitigation. According to this point of view, this important problem necessitates some interventions to reduce the hazard risks in settlements and critically for Metropolitan cities. Particularly, urban planning discipline, which is interested in prospective policy for future generations, has to prepare the urban systems against the consequences of natural hazards, such as economic and social structure, land use planning, legislative framework, infrastructure, and spatial arrangement of the urban areas.

2.5.1 Disaster Risk Assessment

Disaster risk assessment, a critical aspect of disaster management, as United Nations General Assembly determined (2016), involves the implementation of either a qualitative or quantitative method to identifying the nature and extent of disaster risk. This approach involves a systematic analysis of potential hazards that could result in harm to people, infrastructure, services, livelihoods, and the environment on which they depend. In addition, the assessment process includes an evaluation of existing conditions of exposure and vulnerability, which are critical determinants of the level of risk posed by a given hazard. In essence, the goal of this process is to provide decision makers with comprehensive information that will enable them to make informed decisions regarding disaster preparedness, response, and mitigation.

2.5.2 Vulnerability Assessment

Vulnerability assessment is an essential stage in reducing the consequences of natural hazards and, consequently, the risk of natural hazards as Fuchs, Birkmann, and Glade (2012) mentioned. The assessment of vulnerability requires the ability to both identify and understand the sensitivities of the critical sectors and, more broadly, of society to these hazards. The concept of vulnerability is used across multiple disciplines and embedded in various disciplinary theories, originating either from a technical or a social perspective, resulting in a range of paradigms for either qualitative or quantitative assessment of vulnerability.

According to Coburn and Spence (2002), two fundamental methods of vulnerability assessment can be identified: predicted vulnerability and observed vulnerability. (1) Predicted vulnerability consists of assessing the expected performance of construction based on calculations and engineering specifications. This approach is most appropriate for engineered structures and facilities where a reasonable estimate of resistance to hazards can be determined. (2) Observed vulnerability refers to evaluations based on statistics of damages from historical recorded. This approach is more appropriate for use with non-engineered constructions of low-strength materials for which hazard resistance performance is more complex to estimate.

In Türkiye, Istanbul is the city where the largest number and the most comprehensive pre-earthquake vulnerability studies have been conducted. A partnership between Istanbul Metropolitan Municipality and other organizations has led to an intensive scientific study of vulnerability since the Great Marmara Earthquake of 1999. Within the scope of the 2001-2002 study conducted by Istanbul Metropolitan Municipality and Japan International Cooperation Agency, (2002) the vulnerability of buildings and infrastructure elements to an earthquake that could affect Istanbul was examined on a district basis. The Earthquake Risk Analysis of Istanbul Metropolitan Area was conducted in (2003) by Boğaziçi University. The 'Istanbul Probable Earthquake Loss Estimates' study was conducted by the Istanbul Metropolitan Municipality, Department of Earthquake Risk Management and Urban Improvement and Boğaziçi University, Kandilli Observatory and Earthquake Research Institute in (2009), for estimating the earthquake losses of Istanbul at an urban scale. The most recent project, titled Istanbul Province Possible Earthquake Loss Estimates Updating Project (2019), was commissioned by the Istanbul Metropolitan Municipality and conducted by Boğaziçi University's Kandilli Observatory and Earthquake Research Institute. The project aims to determine the disaster risk and addresses the issues that are indicators for urban transformation decisions, which are discussed in this thesis.

The Istanbul Earthquake Master Plan (2003) extensively analyzed the different risk sectors and risk management strategies related to settlements. The analyses addressed risks in macroform and urban structure, as well as the assessment of non-compliance risks related to urban land use and production loss risks in the manufacturing sector. The plan also identified and managed risks in specific areas, such as spatial distribution risks of emergency officer staffing, analysis of special structures and areas, analysis of hazardous units and uses, and analysis and management of open areas risks. Each of these areas was systematically classified and examined to provide a comprehensive understanding of the potential risks and effective management approaches.

Urban Structure Vulnerability Assessment

The term 'urban structure' refers to the way in which the physical elements of a city (land, buildings, streets, parking lots, etc.) come together as The Istanbul Earthquake Master Plan (2003) mentioned. The dimensions of the road network and the width of its roads, their relationship with building height, configuration (whether hierarchical or grid), dimensions in accordance with density of buildings and populations, parcel sizes, building formations, densities, pedestrian circulation, presence of parking lots, type of ownership, and other related texture features, together with ground conditions, contribute to varying levels of risk within the urban fabric. Using this approach, the typical structure fragments are sampled from distinct parts of the city and the differences in risk factors are examined comparatively. Consequently, a topography of risk levels of structures is obtained for the city in general. This information can be integrated with the findings from engineering studies focused on individual buildings and the structural specifics of the buildings sampled.

Road and Transportation System

In analyzing risks related to urban development, it is crucial to consider transportation planning data, including the relationship of the road system to the entire system, as well as parking conditions. This group of data includes characteristics of the street network, relationships to the main transportation network, street cross-section, street/parking relationships, on-street parking, location, and characteristics of open/closed parking lots İstanbul Metropolitan Municipality Planning Department and Boğaziçi University (2003).

Urban Structure and Building Features

The Earthquake Master Plan of Istanbul Metropolitan Municipality (2003) created risk level indicators under the category 'Building Characteristics' based on a range of factors. These include the number of buildings, type of use, number of floors, number of regular and basement floors, number of units, number of workplaces, construction system, building form, total number of buildings, total number of independent units, total population, amount of open space per inhabitant, construction area, plot area, and total plot area. Building age, building quality, type of ownership and operation, and population data are other important topics that require the combined use of quantitative and qualitative methods.

According to The Earthquake Master Plan (2003), the type of use of the building, the combination of incompatible uses in buildings can be considered as a factor that increases the risks. The type of usage can introduce specific risks. These risks can be categorized based on the intended use such as residential, commercial, tourism, education, health, religious, administrative, industrial, storage, and mixed-use settings. The age of the building, physical aging due to the year of construction of the building should be considered as a risk factor. The construction conditions (zoning conditions/status) of the period in which it was built determines its state of change over time. Building quality includes the status of having received architectural and engineering services before construction, risks arising from errors and inadequacies during construction, and aging due to the age of the building. Building quality assessments consider characteristics such as building form, number of stories, construction system data, grading based on quality observations rated as good, fair, or poor, and the architect's design status. Ownership and Management Style, land and building ownership and management style is a principal factor in the organization of earthquake resistance and retrofitting works of buildings. The composition and dynamics of a building's population – including the number of women, men, children, elderly, disabled, and foreigners; the ratio of working to resident population; and the variations in usage patterns between day-night and summer-winter – are crucial data points for risk assessment. This group of data should form the basis for general demographic information, total population at municipality and district level, population density, day/night population, summer/winter population, female/male ratio, elderly, child, disabled population, population in vulnerable areas.

2.5.3 Hazard Mitigation Planning

According to Mileti (1999), a shift in policy towards 'sustainable hazard mitigation' is essential for the nation. The concept integrates the sensible management of natural sources with the resilience of the local economies and societies, considering hazard mitigation as an essential part of a broader perspective. The emphasis of 'sustainable hazard mitigation' component has been identified by Mileti to comprise six fundamental constituents. These include Environmental Quality, Quality of Life, Disaster Resilience, Economic Vitality, Intergenerational and Intragenerational Justice, and a Participation Oriented Approach. It is imperative to prioritize these components to achieve an effective and comprehensive hazard mitigation strategy.

2.5.3.1 Current Approaches for Hazard Mitigation

According to Ash (2005), widely accepted mitigation practices identified to date include 'Hazard Mapping', 'Land Use Planning', 'Building Codes', 'Risk Transfer and Risk Sharing'. On the other hand, Mileti (1999) has provided a more comprehensive list of mitigation tools that are essential to the pursuit of sustainable hazard mitigation. These tools include land use, which involves the implementation of sensible land use planning policies that effectively limit development in environmentally vulnerable areas and are critical to sustainable hazard mitigation. The concepts of land-use planning, hazard mitigation, and sustainable communities are closely interrelated, and their common vision is to keep people and property out of the disaster zone while preserving the mitigating characteristics of the natural environment and promoting development that is adaptive to natural hazards. In addition, Mileti has identified several other essential tools for sustainable hazard mitigation. These include warnings, engineering and building codes, insurance, and recent technologies.

Current hazard mitigation techniques in developed countries generally focus on better building codes, stronger code enforcement, and better building techniques and materials for new settlements. Some academic and official institutions have suggested relatively successful methodologies and organization schemes for hazard mitigation, some central and local governments and private co-operations have developed some projects and have generally started to implement these methodologies.

2.5.3.2 Seismic Hazard Mitigation Action

The concept of hazard mitigation is explained by Şengezer and Koç (2005), which refers to actions implemented to reduce or eliminate risks to people and property over time and includes a wide range of measures such as structural engineering, building codes, land use planning, and land acquisition. Although the specific building codes for vulnerable areas were amended in 1975 and 1998 from the original 1968 regulations, no significant reduction in the magnitude of earthquake damage has been observed in Türkiye. As a result, the researchers suggest that the issue of hazard mitigation should be considered as an enforcement/application concern rather than a regulatory problem.

According to Burby et al. (2000), decision-makers are increasingly understanding that different strategies are needed to reduce vulnerability to natural disasters. As, the National Research Council's Board on Natural Disasters (Iwan et al. 1999) has stated that communities can effectively reduce damages from natural disasters during the implementation phase of mitigation strategies by developing land use plans that not only protect from hazards, but also achieve environmental and other objectives. Mileti (1999) also mentioned, The Second National Assessment on Natural and Related Technological Hazards has declared that the most effective strategy for achieving sustainable hazard mitigation is the implementation of rational and equitable land use management, as no other approach currently offers sufficient potential.

As Burby et al. (2000) defined that land-use planning is a methodical approach to collecting and evaluating data on the appropriateness of natural vulnerability of land for development. It ensures that the conditions of vulnerable areas are properly recognized by citizens, the investment industry, and the authorities. In order to develop plans, local governments engage in a consensus-building approach that allows for the discussion of critical issues and concerns regarding the use of hazard-prone areas. However, in Türkiye, urban planning implementations do not appear to function properly and, in some cases, increase risks instead of reducing them.

2.6 Urban Sustainability

It is estimated that the trends in urbanization, which have caused global population growth and a proportional increase in urbanization, will accelerate for the near future, with 70% of the world's population living in cities by 2050 and 100% by 2092 (Batty 2011). Although urbanization is seen as positive for social and economic development in many areas, it also causes critical environmental and social challenges. In order to sustain urban life, scientific studies should be carried out and attention should be paid by policy implementers and decision makers. In this context, it is also important to implement the studies on sustainability or sustainable development that have been carried out since the seventies by the United Nations, international agencies, and researchers.

The origins of the contemporary sustainability movement can be dated back to the 1972 United Nations Conference on the Human Environment in Stockholm. This event is considered a significant breakthrough in the global recognition of sustainability and environmental conservation (Wu-Rorrer et al. 2022). The Brundtland Report, released in 1987, introduced the widely accepted concept of 'sustainable development' to international policy discussions. The commission arguably succeeded in integrating environmentalism with social and economic issues on the global development agenda. The principle is based on the idea that providing for the requirements of people today while maintaining the ecosystems that support them will ensure the welfare of future generations. Sustainability is not a static condition, but a changing and evolving process. The report states that sustainable development is a process that involves transforming resource use, investment patterns, technological progress, and institutional change in a coordinated and adaptive process that enhances the ability to support human demands and aspirations for today and the future. The timeline of Urban Sustainable Development can be found in Figure 14 (Huang, Wu, and Yan 2015).

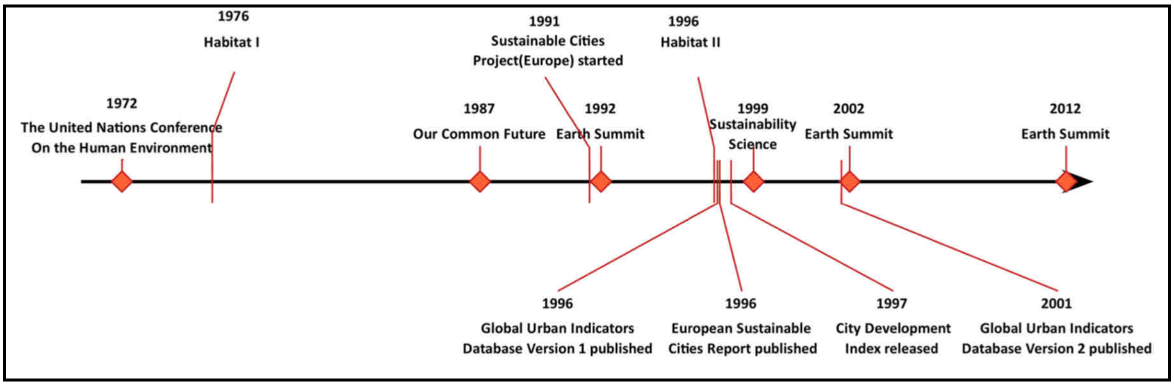


Figure 14: Timeline of Urban Sustainable Development
(Source: Huang, Wu, and Yan 2015, 1176)

The 1992 Rio Earth Summit resulted in the Rio Declaration and Agenda 21, and the development of sustainability indicators. The term 'Sustainability Science' was defined in the 1999 report of the US National Research Council. The 2002 Johannesburg Earth Summit reconfirmed the commitment to implementing Agenda 21 (Huang, Wu, and Yan 2015). Rio+20 Earth Summit, in 2012, gathered to develop a new set of goals to achieve, building on the many successes of the Millennium Development Goals (MDGs). At the UN Sustainable Development Summit meeting three years later, world leaders approved a new 2030 Agenda for Sustainable Development, a "*plan of action for people, planet and prosperity"* to "*shift the world onto a sustainable and resilient path*". Far more ambitious than the Millennium Development Goals (MDGs), the new Sustainable Development Goals (SDGs) framework includes multiple sets of targets (Wu-Rorrer et al. 2022).

The idea of sustainability is widely recognized to have three fundamental dimensions: environmental, economic, and social. However, the complex interactions and interdependencies between these dimensions represent the focus of the ongoing discussion between proponents of 'weak sustainability' and 'strong sustainability'. The level of interchangeability between natural and man-made capital is a key issue in this debate, as it determines the extent to which these dimensions can be considered interchangeable. Obviously, the question of substitutability requires casual consideration and a basic understanding of the factors and constants that do not contribute to it (Huang, Wu, and Yan 2015).

As a pervasive and fundamental concept in contemporary society, sustainability has brought together the interdisciplinary fields of ecology, geography, and social sciences, resulting in the development of landscape sustainability and land systems studies as Huang, Wu, and Yan (2015) mentioned. In particular, urban sustainability has been increasingly recognized as an inevitable and crucial objective in the field of landscape and urban studies. Gradually, a variety of urban sustainability indicators, characterized by their mathematical simplicity and ease of use, have been developed and become an integral part of the implementation of this goal.

Urban sustainability has become a focal point of sustainable development and has been the subject of growing policy and scientific interest during the past decades. Huang, Wu, and Yan (2015) notes that this increased awareness can be traced back to the United Nations Conference on the Human Environment in 1972, which led to the 1976 United Nations Conference on Human Settlements (Habitat I) in Vancouver, Canada. The following years saw the launch of several notable initiatives, including the European Commission-led Sustainable Cities Project in 1991 and the establishment of Sustainable Seattle, an internationally recognized community-based urban sustainability project, in 1992. The Second United Nations Conference on Human Settlements (Habitat II) was held in Istanbul, Türkiye, in 1996, and the European Commission released the European Sustainable Cities Report the same year, documenting previous achievements and defining goals to promote sustainability in the cities of Europe. In recent years, there has been a proliferation of urban sustainability measures around the world, underscoring the increasing urgency of this critical issue.

The definition of urban sustainability directly affects the identification of its indicators. As explained by Huang, Wu, and Yan (2015), urban sustainability is defined in a variety of contexts, each with its own criteria and priorities. The idea of sustainability aims to promote the long-term welfare of people by achieving a balance between the three dimensions of sustainability: minimum use of resources and environmental degradation, maximum efficiency of resource use, and equity and democracy. The European Environment Agency established five objectives for urban sustainability in 1995. These objectives aim to reduce consumption of land and natural resources, manage urban transport efficiently, protect the public health of its citizens, provide equitable distribution of resources and services, and preserve cultural and social diversity. The United Nations Center for Human Settlements (Habitat - 1997) defines a sustainable city as a place that maintains long-term social, economic, and physical development gains and has a continuous supply of the natural resources that support its growth. Community-based initiatives place greater emphasis on the involvement of residents, as the definition indicates: Sustainable city means that the community has reached an agreement on the principles of sustainability and furthermore committed to their achievement.

The Habitat program of the United Nations emphasizes the importance of urban sustainability, which requires a comprehensive vision for the development and management of urban settlements as Gomez-Insausti and Conte (2012) mentioned. It advocates the consideration of all features of the urban environment and their interdependence, with the aim of creating a livable city that provides for both present and future requirements. The production and management of urban spaces requires the cooperation of individuals and organizations and the recognition of the interdependence of natural and human processes. Developing an urban environment that supports sustainable living requires integrating environmental and social dimensions.

According to Vojnovic (2012), the concept of urban sustainability, like sustainability in general, is characterized by considerable ambiguity. Defining urban sustainability as a component of overall sustainability is crucial to maintain the interconnectivity between local and global scales. Thus, prioritizing socioeconomic processes that promote both local and global sustainability should be part of the concern for urban sustainability. Urban sustainability is the result of socially, economically, and physically organizing the urban community to meet the needs of present and future generations while preserving the quality of the natural environment and ecological systems over time. Nevertheless, the current definitions of urban sustainability are considered imprecise, which complicates their practical implementation in policymaking. On the other hand, the fuzziness of the definition of urban sustainability allows communities to conceptualize sustainability differently based on their values, conditions, and unique urban stresses. Consequently, sustainability initiatives within a country can differ among cities based on local conditions. Nevertheless, the absence of a well-defined sustainability definition has led to inefficiencies in implementing urban sustainability policies. Furthermore, much remains unknown regarding the promotion of sustainability, the design and implementation of successful urban sustainability initiatives, and the establishment of the institutional and social relationships required to support sustainable human behavior.

Recently, research on urban sustainability has increasingly focused on exploring the connection between ecosystem resources and the welfare of people. Wu (2014) defined that the academic discourse as a dynamic process involving the promotion and maintenance of a hypothetical cycle between ecosystem resources and the welfare of people, through collaborative environmental, economic, and social activities in response to changing conditions in and outside the urban environment. The literature on sustainability indicators, as Huang, Wu, and Yan (2015) mentioned, has identified a conceptual hierarchy or hierarchy of indicators, supported by a distinction between data, indicators, and indices. Data, the principal components of any indicator, are combined to form a composite index or a dataset of indicators, which is usually a grouping of non-aggregated indicators structured according to a specific indicator frame of a project. An indicator, which represents an attribute (quality, characteristic, or property) of a system, is a critical component of this hierarchy. Conversely, an index is a more complex measure that uses various normalization and weighting schemes to combine multiple indicators. To facilitate the selection, development, and interpretation of indicators, an indicator frame, a theoretical structure based on sustainability considerations, is available.

2.6.1 Sustainable Development Goal Indicators

The Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) developed the Global Indicator Framework for the Sustainable Development Goals and targets of the 2030 Agenda, which was subsequently agreed on at the 48th session of the United Nations Statistical Commission in 2017. The indicator framework includes annual refinements of the indicators as they are needed. Consistent with the group's mandate, the IAEG-SDGs recommended 36 major refinements to the framework in the format of replacements, revisions, additions, and eliminations as part of the 2020 Comprehensive Review, which was ultimately agreed at the 51st session of the United Nations Statistical Commission in 2020. The official list of indicators covers the global indicator framework included in A/RES/71/313, with refinements agreed by the Statistical Commission from 2018 to 2022. The latest improvements were made at the 53rd session of the Commission

(E/2022/24-E/CN.3/2022/41). It is essential to emphasize that the Global Indicators Framework is a vital component in the pursuit of sustainable development, and it is critical that the framework remain dynamic, responsive, and relevant to the evolving needs of society. It is imperative that the framework be regularly reviewed and refined in accordance with the IAEG-SDGs mission to ensure that it remains a reliable tool for tracking progress towards the Sustainable Development Goals and targets of the 2030 Agenda (United Nations 2018) (accessed date: 05.06.2023). Figure 15 displays the Sustainable Development Goals (SDGs) that are expected to change the world.

Figure 15: Sustainable Development Goals (SDGs)

(Source: United Nations 2015) (accessed date: 01.07.2023)

The United Nations Department of Economic and Social Affairs' SDG Country Profile (2019) (accessed date: 10.07.2023) presents data on Türkiye under the Sustainable Cities and Communities Indicator, which focuses on promoting accessible, safe, resilient, and sustainable cities and human settlements. According to the report, the percentage of the urban population that lives in squatter settlements reduced from 24.6% in 2000 to 14.1% in 2018. In 2021, there were 71,517 people affected by disasters and 16 people missing due to disasters. Additionally, there were 105 deaths attributed to disasters, resulting in a mortality rate of 0.1 per 100,000 population, and the number of people missing due to disasters was 121. The rate of people directly impacted by disasters was 84.4 per 100,000 population, and the rate of people injured or infected by disasters was 2,689. Furthermore, disasters damaged the dwellings of 61,654 people, and destroyed the dwellings of 7,174 people. In terms of economic losses, the direct economic cost of disasters as a percentage of GDP was 0.0%, while the direct agricultural loss from disasters decreased from $962,859,979.1 in 2015 to $59,306,297.5 in 2021. The direct economic cost of damaged or destroyed major infrastructure due to disasters is $3,525,258.0 in 2021. Finally, the percentage of local governments adopting and implementing local disaster mitigation strategies consistent with the national disaster mitigation strategy decreased from 100.0% in 2017 to 91.4% in 2021 (United Nations 2019) (accessed date: 05.06.2023).

2.6.2 Sustainable Urban Transformation

The concept of sustainable urban transformation can be categorized as a component of urban sustainability change. As Ernst et al. (2016) mentioned that the process involves an intentional, systematic, long-term, and visionary approach to achieving economic, social, cultural, organizational, governmental, and physical transformations that ultimately result in the establishment of sustainable cities and urban environments, along with related technologies, enterprises, and institutions. These transformations regulate patterns of resource production and consumption through governance strategies that prioritize long-term goals and flexible, adaptable, and reflective policies. Such policies aim to support proactive collaboration among all participants, to promote the integration of multiple viewpoints and knowledge bases, and to support learning and experimenting with alternative practices and strategies.

This comprehensive definition includes three main components:

As categorized by Ernst et al. (2016), the first component emphasizes sustainable urban areas that encompass their management and use. These areas are characterized by being resilient, climate-resilient, water-sensitive, pollution-free, eco-friendly, and attractive. They represent a meld of land, water, infrastructure, buildings, and technology inhabited by flora, fauna, and humans, creating a rich, innovative urban structure and environment (Peek and Troxler 2014) and (McCormick et al. 2013).

The second component revolves around the evolution of urban development policy. This shift transforms into a culture of participatory governance, which is cooperative, communicative, and collaborative. It involves political and community actors, stakeholders, and future residents working through both bottom-up and top-down strategies. Their approach emphasizes experience, innovation, and learning. This transformation is bolstered by the enhancement of local authorities and anchored in transition-focused planning systems, introducing new contract forms and property rights. As a result, new potentials emerge for existing and temporary land uses, birthing novel entrepreneurial models and adaptive, sustainability-centric visions for planning (Ernst et al. 2016).

The third component addresses sustainability transitions in societal sectors, especially concerning the management of water, energy, and transportation in urban regions (Ernst et al. 2016).

According to Yang (2010), the procedure of sustainable urban transformation is highly interactive and complicated that requires a distinct definition in advance of the objectives and scope required to determine the appropriate variables for modeling urban transformation. As sustainable urban transformation includes the similar criteria that are included in the concept of sustainable urban development, it is necessary to categorize the process of sustainable urban transformation, objectives and conditions that will ensure its realization, and to define the criteria, principles, and rules in the existing literature on sustainable development, as well as its framework.

Key principles are identified by Curwell and Symes (2005) as representing the fundamental aspects of Sustainable Urban Development (SUD). These principles can be classified into distinct categories. Firstly, SUD is a relative concept and cannot be considered absolute. Secondly, it is a continuous procedure and not an outcome or result. Thirdly, SUD entails several aspects such as ecological integrity, equity, participation, and the future of urban development. The planning, land development, design, construction, and operation of various sectors are all involved. Fourthly, SUD necessitates the integration of environmental, economic, and social issues underlying the urban development procedure and the sustainability of the urban areas. Fifth, this is integrated within a specific institutional framework. Sixth, the procedure involves the interplay of internal and external factors. Finally, this procedure aims to promote more sustainable methods of life and work.

2.7 Urban Transformation as A Tool for Hazard Mitigation

Urban planning is intended to analyze the current conditions of cities, solve fundamental problems, and make optimal usage of the potentials of the city with future projections. However, during these studies, it is also crucial to carefully examine the carrying capacity and potential disaster risks of the city and its surrounding natural environments. In this context, it is imperative to develop a disaster resilient urban planning approach by creating future scenarios within the multidisciplinary approach of urban planning, design, engineering, and social sciences.

The concept of resilience has received increasing attention since its conceptualization, including recent developments in the field of planning and fundamental developments in ecology and social and ecological systems as Pinho et al. (2012) mentioned. Especially during recent years, the concept of sustainability, with its social and environmental principles, has been steadily incorporated into the planning discipline and has begun to occupy a fundamental place in discussions of planning evaluation through the development of evaluation theory, including normative contexts, and the design of methods, techniques, and indicators. More recently, methods such as environmental impact assessment and strategic environmental assessments have been used to evaluate sustainability, especially in planning decisions related to infrastructure investments. In the UK, sustainability assessments have been mandatory since 2004, and they are required to promote sustainable development by integrating social, environmental, and economic considerations into the preparation of plan revisions. On the other hand, the concept of resilience is gradually becoming a part of the assessment process in urban planning.

The principle of resilience implies that cities should not be considered passive victims, as Nijkamp, Segale, and Finco (1999) emphasized, but rather must demonstrate resilience by adjusting their sustainability policies to challenges and opportunities. Therefore, it is crucial to identify, explore, and select options that promote balanced development under constantly changing external conditions, despite their complex and contradicting multidimensional character. Nowadays, policy strategies that support or enhance urban sustainability are diverse. These strategies include advanced environmental technologies, market incentives, precise land use decisions, and zoning policies, as well as informational campaigns.

According to Eraydin and Taşan-Kok (2012), urban planning theory focuses on the process-oriented dimensions of planning, however, practical problems and external developments are requiring changes in the urban planning discipline. It is argued that to create resilient cities, planning practice needs to be not only processes but also contents, and there needs to be a balance between the rights and responsibilities of different actors to create resilient cities.

The purpose of urban transformation projects mainly aims to revitalize and regenerate decaying areas, thereby enhancing the aesthetic appeal of cities, and promoting economic growth as Turkoglu and Kundak (2011) mentioned. Given the potential threat of natural disasters to densely populated metropolitan regions, urban transformation has emerged as a critical strategy for mitigating such risks. This multidimensional approach to urban transformation involves analyzing land use decisions in terms of hazards, risks, and vulnerabilities, as well as developing and implementing building codes that meet current standards and utilize urban transformation methods. Ideally, urban transformation methods should focus not only on improving the physical and economic aspects of urban areas, but also on improving social outcomes for residents in the affected regions.

It appears that the government in Türkiye views urban transformation as a primary tool for mitigating the risk of disasters by guiding urban development and improving the quality of housing stock. The Municipality Law gives municipalities the authority to initiate urban transformation projects aimed at rehabilitating urban areas or reducing disaster risks. Istanbul is the largest metropolitan area in Türkiye and is expected to experience a significant earthquake within the next 30 years, several urban transformations projects are expected to come to the agenda (Turkoglu and Kundak 2011).

The urban transformation strategies are one of the most critical issues in the research and practice of urban planning and urban politics nowadays. The implementation of policies and projects for urban transformation is currently mainly dictated by the demands of the urban rent and real estate industry, however, considering the magnitude of disaster risks, urban resilience is expected to be an important part of urban transformation strategies. Urban transformation strategy is used both as a mitigation measure in the hazard mitigation phase of urban planning practice and as an important tool in post-disaster reconstruction activities, as it enables broad authority for implementers in post-disaster reconstruction operations. Understanding the relationship between urban transformation and disaster management requires an acknowledgement of the evolution of the urban transformation conception and its development from its beginnings to the present. For this purpose, the sub-sections in this chapter discuss the development of urban transformation and the relationship between urban transformation and disaster management.

2.7.1 The Concept of Urban Transformation

The process of economic restructuring that started in Türkiye in the 1980s has been experienced in similar conditions throughout the developing world. Urban transformation policies have become a major urban policy instrument used by local governments to solve the challenges and problems in urban areas. Although it has been used as a tool to create new urban areas in deindustrialized cities, it has also been seen as a tool to solve urban problems such as the renewal of illegal construction and slum areas. Recently, urban transformation has been considered as a tool for disaster risk management, mitigation, or enhancement to reduce disaster risks in cities. Considering various examples of urban transformation around the world, it is observed that urban transformation helps to address urban problems in a multidimensional perspective, but urban transformation policies have not been sufficiently developed to increase resilience to disasters.

In the substantial literature, there are different definitions of the concept of urban transformation. As an initial reference, Roberts and Sykes (2000) describe urban regeneration as a holistic vision and corresponding actions aimed at discovering and implementing solutions to urban problems. The ultimate goal is to enable the progress and growth of cities in multiple domains, namely economic, physical, environmental, and social, in places where there is an urgent need for improvement or change. Furthermore, this concept can also be understood as the metamorphosis of any place experiencing any kind of deprivation. Other scholars have defined urban transformation as a domain of public policy. According to Adıkutlu (2019), this conceptual framework of urban transformation, the responsibility and the authority of the policies implemented to increase economic development, solve social problems, and improve the quality of the environment are also identified. In the discussion of these policies, the economic recession, social challenges, poverty, and environmental degradation are the result of economic restructuration and globalization. The definitions emphasize that urban transformation is not merely about physical structuring. It necessitates fostering social inclusion and economic competitiveness. For holistic development, it is essential to consider changes in social, economic, and physical structures through a comprehensive policy approach.

The urban transformation concept, as a pioneer of the policy, is a comprehensive urban policy that identifies several objectives to be achieved. As Hall and Barrett (2017) described, these objectives can be categorized into four distinctive groups, which are (1) Improving the physical environment, with a recent emphasis on promoting and ensuring environmental sustainability. (2) Improving the quality of life for targeted communities, either by improving the quality of existing physical conditions or enhancing community activities and amenities. (3) Enhancing the social well-being of specific groups through improved availability of essential social facilities. (4) Improving opportunities for selected communities through the creation of employment opportunities or the implementation of educational and professional training opportunities. The achievement of these objectives is critical to the overall success of an urban regeneration policy.

Urban transformation is a participatory approach to the redevelopment of a settlement. It usually begins with the identification of an area in need of improvement. This area may be characterized by physical deterioration, economic decline, or social problems. Once an area is identified, a plan for its redevelopment is developed. This may involve demolishing existing buildings, constructing new buildings, and providing new amenities. Redevelopment can be a long and complex process, often involving many stakeholders, such as government agencies, property developers, and community groups.

The urban transformation cycle typically consists of four distinct phases as a process that provides the opportunity for improving quality of life for communities where it takes place. The first is the inception phase, which involves a series of activities aimed at identifying areas in need of improvement. This critical phase can be initiated by government agencies, private developers, or community groups and serves as a critical foundation for subsequent planning and implementation. The next step in the urban transformation cycle involves the planning phase, during this phase a redevelopment plan is created for the identified area. Such a plan may include a range of activities, including the demolition on current structures, new construction, and creation additional amenities. The planning phase is typically informed by a comprehensive assessment of the area's structural, financial, and socio-economic conditions. While urban transformation has many benefits, the processes can also have negative consequences. For example, regeneration efforts can displace existing residents and businesses, resulting in the loss of historic buildings and neighborhoods. Therefore, before embarking on such efforts, careful consideration should be given to the potential benefits and drawbacks of urban transformation.

The benefits of urban renewal include improvements to the physical condition of the city or town, which can attract new businesses and residents and create employment opportunities. In addition, such efforts can significantly improve the quality of life for existing inhabitants. Some disadvantages of urban transformation, meanwhile, include the displacement of residents and businesses, the loss of historic buildings and neighborhoods, and the high cost of implementation, which can be devastating to society.

Before initiating any redevelopment project, it is therefore essential to thoroughly assess the potential benefits and disadvantages of urban regeneration. This can help ensure that such efforts are both effective and sustainable in the long term.

2.7.2 The History of Urban Transformation

The analysis of the evolution of urban transformation shows that it originated with the increase of public spaces and their sustainability and has reached the present day. In this sense, the main objectives of urban transformation are to reveal economic development policies that will increase the quality of social life and welfare, improve the methods that can use the physical condition of the city in the most effective way to find solutions to the social problems of the city, providing solutions to the need for physical transformation of the building blocks that constitute the settlement form of the city, ensuring the effective and efficient use of urban areas and establishing urban policies (P. W. Roberts and Sykes 2000).

The First Period Between the Industrial Revolution and the 1940s

According to Schubert, Wagenaar, and Hein (2022), poverty was characterized in the 19th century as an individual failure. In slum clearance projects, hygiene served as the justification for a fundamental strategy of urban health implemented through demolitions. The prestigious redevelopment of urban centers and the constructing of a sanitation infrastructure, in particular the clearance of land for new and wider roads, dominated the planning and urban renewal. The new roads generally passed through the oldest and most densely populated neighborhoods, inhabited mainly by low-income groups.

The initial phase of urban change was implemented prior to the 1940s and involved a strategy of 'clearance', 'renewal' and 'redevelopment'. These strategies, which involved the displacement of the entire former physical structure of cities, necessitated a shift in land ownership and were manifested as the 'slum clearance' policies of the 1930s in Europe and the 'federal bulldozer' in the United States of America (Düzcü 2006).

More specifically, Before World War I, two distinctive urban redevelopment agendas had emerged in England and Germany, with London and Hamburg leading the way. The first task was focused on 'improving living conditions' by clearing wide areas and rebuilding while conserving the housing function. The second initiative targeted a change in the use of central areas through the demolition of older buildings (mainly residential) and the construction of new ones (Welch Guerra et al. 2022).

The Second Period Between The 1940s And The 1960s

The 1950s was a second phase of transformative actions on the urban space, mainly focused on the strategy of 'reconstruction' as Düzcü (2006) mentioned. This approach involved a comprehensive overhaul of the physical structure of cities, although its relevance has diminished over time. During the 1940s and 1950s, cities were challenged to repair the damage caused by the Second World War and to rebuild cities, many parts of them abandoned for years. As a result, numerous 'urban renewal' initiatives were launched, typically developed according to a 'master plan' and viewed as a national undertaking. In addition to central and local governments, the private sector has been a major supporter of these reconstruction efforts. The third phase of urban transformation that began during the 1960s and continued into the 1970s was characterized by ‘revitalization’, ‘rehabilitation’, and ‘improvement’ strategies. These approaches were more modest in terms of their goals, primarily seeking to preserve existing patterns of property ownership and resident demographics within the target area.

The Third Period of the 1970s

The period of the 1970s is dominated by the implementation of the ‘urban renewal’ strategy, emerging as the main urban transformation strategy, which places an explicit emphasize on the coordinate between formerly separated economic, social, and physical components of urban policy. An additional characteristic of this approach is focusing on the communities, especially the smaller neighborhoods (Düzcü 2006).

The Fourth Period of the 1980s

During the 1980s, the primary approach to urban transformation was urban redevelopment, which emerged as the main strategy as Düzcü (2006) mentioned. During this period, the urban policy landscape underwent a major shift, with the government relinquishing its previous role of providing all the resources for policy development and interventions aimed at mitigating urban problems. Instead, there has been a noticeable shift towards a more prominent role for the private sector in urban redevelopment projects. Particularly in the United States and the United Kingdom, the key approach has been to use public authority to support the private sector while minimizing legislative and administrative action.

The Fifth Period Between the 1990s and the 2000s

Since the 1990s, ‘urban regeneration’ emerged as the main urban strategy, and it has undergone notable changes compared to the regeneration policies of previous periods. Firstly, during the 1990s a shift occurred to adopt a more integrated form that emphasized an integrating concept of both the policy and the implementation. During this phase, urban regeneration has been considered as a 'composite concept', involving several dimensions, namely economic, environmental, social, cultural, iconic, and political. Furthermore, the strategic planning approach to urban planning was widely adopted in urban regeneration projects (Düzcü 2006).

The Fifth Period After 2000s

The 21st century has brought significant technological and scientific advances that have impacted the social and spatial structures, economies, moreover quality of life of in urban areas. As Mutlu (2009) summarized that urban systems have had to adapt to changes in production and employment structures, globalization, and a knowledge-based economy. Supporting the heritage and quality of the environment has been considered as valuable in counteracting negative impacts. International concerns and charters have played a crucial role in the development of urban policies focusing on the conservation of natural and cultural heritage, participatory processes, and sustainability. Social exclusion and the weakening of traditional local economies were concerns. The ICOMOS Venice Charter set standards for heritage conservation and restoration. The importance of living in a healthy environment and local community issues were established by the United Nations Conference on the Human Environment in Stockholm in 1972 and the Habitat I Conference in Vancouver in 1976. The European Urban Charter aimed to improve European cities, while the Brundtland Report highlighted the limitations of the built environment and environmental and social issues. Habitat II focused on inner cities and defined minimum standards for adequate housing. The Rio Charter and the New Athens Charter both focused on creating sustainable and accessible environments. The concept of the networked city was emphasized as crucial in addressing urban problems such as unemployment, poverty, exclusion, crime, and violence. The New Urban Charter of Athens sees urban design as essential to the renaissance of tomorrow's cities. Social sustainability should also be considered to reduce inequalities and strengthen social cohesion. The Council of Europe has developed a new urban regeneration strategy and sustainable policies based on successful projects in European countries. They aim to preserve cultural and natural heritage and to promote both social integrity and the human rights. A guide has been developed to create European guidelines and comply with democratic principles. Urban regeneration with sustainable development is a priority in Central and Western Europe to protect urban heritage and housing conditions. Urban regeneration, as an expansion of urban policy, demands a cross-sectoral approach. The notion of urban rehabilitation has changed beyond heritage preservation to a multidisciplinary approach that integrates all urban policies.

2.7.2.1 The Turkish Experience of Urban Transformation in History

When analyzing the urban transformation evolution of Türkiye as shown in Table 2, there is a period that originated after the World War II era with increase in migration to urban areas due to economic growth that started in the 1950s and developed negatively due to physical, social and economic problems. In particular, until the 1980s, increasing industrialization and the pursuit of economic growth led to a rapid and uncontrolled increase in the urban population. Consequently, the infrastructure of the metropolitan areas, which was not prepared for the massive migration, and the great lack of existing buildings caused the rapid development of squatter settlements and then the problem of illegal construction in the metropolitan areas of Türkiye. These problems, which increased with the transition to liberal policies after the 1980s, were intensified by the obsolescence of the existing planned building stock. The zoning amnesties that were granted for various reasons and the unlicensed apartment buildings that were marketed by contractors in this process further complicated the problem of unplanned construction and became unsolvable for governments and municipalities.

After the Great Marmara Earthquake in 1999, the efforts for the renewal of the vulnerable cities and the building structures, although set in a certain framework with the legal regulations made, were not sufficient to solve the problem, and the two major earthquakes in the year 2023 and the great destruction and problems experienced in 11 provinces have clearly demonstrated the problematic structure of the building stock of Turkish cities.

Table 2: Urban Transformation Process in Türkiye
(Source: Ataöv and Osmay 2007)

I. Period (1950 - 1980)	Period II (1980-2000)	Period III (Post 2000)
Rehabilitation of squatter areas	Urban renewal in risky areas with reduced quality of life	Renewal in urban areas
Transformation of the city center into a depressed area	Rehabilitation and improvement plan implementations for rehabilitation	Rehabilitation of apartment areas
Reconstruction of squatter areas	Preservation and gentrification of areas of historical value	New housing estates and redevelopment of gated communities
Urban renewal practices in these areas		Gentrification of historic residential areas

In this context, when we look at the legal regulations in Türkiye, Candas et al. (2016) mentioned that there are various laws and regulations related to urban transformation in Türkiye. The first law mentioned is the Slum (Gecekondu) Law (Law No. 755) of 1966, which aimed to rehabilitate existing slums and is considered as the first legal regulation for urban transformation. The Mass Housing Law of 1984 aimed to transform squatter areas, protect, and renew historical patterns and vernacular architecture, as well as promote the development of disaster-proof settlements. The North Ankara Entrance Urban Regeneration Project Law of 2004 aimed at enhancing the physical structure and environmental quality of the North Ankara Entrance along with its periphery, to increase the quality of life and provide a healthier standard of living.

Since 03.07.2005, Municipality Law (Law No. 5393) (TBMM 2005) provides the authority for municipalities to implement urban regeneration and renewal projects for several goals, including forming residential, industrial, commercial, and public service areas, reconstructing, and restoring old parts of the city, protecting historical and cultural parts of the city, and taking precautions against disaster risks. On the other hand, the law on Conservation by Renovation and Use by Revitalization of the Deteriorated Historical and Cultural Immovable Property (Law No. 5366) aims to reconstruct and restore protected areas and their surroundings, to develop disaster-proof areas for housing, commerce, culture, tourism, and social welfare, to renovate and conserve heritage and to provide it for settlement.

Table 3: History of Legislations of Urban Transformation in Türkiye
(Source: Redrawn from Candas et al. 2016)

Date	**No of Law**	**Name Of Law**	**Responsible Authorities**
1966	775	Slum (Gecekondu) Law	Municipalities, TOKI
1984	2985	The Mass Housing Law	TOKI
2004	5104	The North Ankara Entrance Urban Regeneration Project Law	Ankara Metropolitan Municipality
2005	5393	Municipality Law	Municipalities, Metropolitan Municipalities
2005	5366	Law on Conservation by Renovation and Use by Revitalization of the Deteriorated Historical and Cultural Immovable Property	Municipalities, Ministry of Environment, Urbanization and Climate Change, The Ministry of Culture and Tourism
2012	6306	The Law of Transformation of Areas under the Disaster Risks	Ministry of Environment, Urbanization and Climate Change

In recent years, many Turkish cities have implemented multiple urban transformation plans as a comprehensive solution for urban problems. However, the focus of current discussions is on the implementation of these projects whether they receive participation and support during the process, and whether the profit and loss analysis is conducted accurately in terms of healthy urban development. The achievement of projects and positive results requires careful planning of the process, which includes several aspects such as project boundaries, legal basis, implementation procedures, and responsible parties.

Although the Law on Mass Housing No. 2985 of 1984, the Municipal Law No. 5272 of 2004, the Municipal Law No. 5393 of 2005 and the Law No. 5366 of 2005 on the Renewal, Preservation and Utilization of Abandoned Historical and Cultural Property do not explicitly refer to urban transformation, they establish the principles of urban transformation and the distribution of responsibilities. These laws have contributed to the increasing importance of the issue of transformation in our country since the 1980s, and their significance is reflected in urban laws and policies. In particular, the North Ankara Entrance Urban Regeneration Project Law No. 5104 of 2004 was the first law that was enacted directly under the name of urban regeneration in our country. In addition, the North Ankara Entrance Urban Transformation Project Regulation was published in 2006 in order to specify the implementation procedures and principles of the aforementioned law.

The latest iteration of the urban transformation legislation, in this context, is 'The Law of Transformation of Areas under the Disaster Risks (Law No. 6306)', which came into effect on 16.05.2012. It was complemented by the publication of 'The Regulation on the Implementation of Law of Transformation of Areas under the Disaster Risks' in the same year. In addition to the laws on urban transformation, the adoption of the implementation regulation to guide the process is an essential step in the implementation of urban transformation projects.

Table 4: The Evolution of Urban Transformation Policies

(Source: Adopted from P. W. Roberts and Sykes 2000, 14), (Düzcü 2006), and (Dişkaya and Emir 2021)

PERIOD	1940s	1950s	1960s	1970s	1980s	1990s	2000s
POLICY TYPE	**Clearance Renewal Redevelopment**	**Reconstruction**	**Revitalization Rehabilitation Improvement**	**Renewal**	**Redevelopment**	**Regeneration**	**Regeneration in recession**
Major Strategy and Orientation	Slum clearance; removal of the detrimental effects of Industrial Revolution and early attempts at suburban growth through redevelopment interventions.	Reconstruction and extension of older areas of towns and cities often based on a 'masterplan;' repairment of II. World War damages, suburban growth.	Continuation of 1950s theme; suburban and peripheral growth; some early attempts at rehabilitation and improvement	Focus on in-situ renewal and recognition of the 'inner city;' still development at periphery.	Many major schemes of development and redevelopment; flagship projects. And out of town projects.	A more comprehensive form of policy and practice; emphasis on integrated policy and interventions.	Restriction of some activities in growth areas
Key Actors and Stakeholders	National and local government.	National government; local governments, private sector developers and contractors.	Move towards a greater balance between national government and local government.	Growing role of private sector and decentralization in local government.	Emphasis on private sector and special agencies; establishment of many partnerships between public and private sectors.	Partnership between the public, private, voluntary and community sectors. Urban Regeneration Agencies operating at the regional level	More emphasis on private sector funding and voluntary effort
Spatial Level of Activity	Regional and local levels initially, later more local emphasis.	Emphasis on local and site levels.	Regional level activity emerged	Regional and local levels initially, later more local emphasis.	In Early 1980s focus on site, later emphasis on local level.	Reintroduction of strategic perspective, growth of regional activity and interventions.	Subregional studies with decentralization
Economic Focus	Public sector investment	Public sector investment with some private sector involvement.	Continuing from 1950s with growing influence of private investment.	Resource constraints in public sector and growth of private investment.	Private sector dominant with selective public funds.	Greater balance between public, private, and voluntary funding.	Private sector dominant with selective government funding.
Social Content	Improvement of urban living conditions.	Improvement in quality of housing and living standards.	Housing improvement, social and welfare improvement specially to fulfill the requirements of the immigrants of ethnic minorities.	Community-based action and greater empowerment.	Community self-help with very selective state support.	Emphasis on the role of community.	Promoting local initiatives and third sector
Physical Emphasis	Replacement of inner areas and peripheral development.	Replacement of inner areas and peripheral development.	Some continuation from 1950s with parallel rehabilitation of existing older residential areas.	More extensive renewal of older urban areas.	Major schemes of replacement and new development; 'flagship schemes'	Area-based schemes with the emphasis on the urban sustainability, and cultural and historical heritage conservation	Generally smaller scale schemes, but larger projects returning.
Environmental Approach	No concerns on the environmental issues.	Landscaping and some greening.	Selective improvements.	Environmental improvement with some innovations.	Growth of concern for wider approach to environment.	Introduction of broader idea of environmental sustainability.	General acceptance of sustainable development model

2.7.3 The Methods of Urban Transformation

The focus of this research is a comprehensive investigation of the effective implementation of urban transformation strategies, particularly in terms of their effect on the administrative decision-making procedures of public authorities. The overall goal of the research is to determine and promote successful project implementation through the application of effective urban transformation strategies. Urban transformation has been widely recognized by scholars and researchers alike as a fundamental and crucial concept towards solving the problem of urban decay and building deterioration in cities. In addition, various methodologies have been developed and used to manage these issues, such as 'urban renewal', 'urban redevelopment', 'urban rehabilitation' and 'urban revitalization'. These methodologies include the regeneration of structures, the redevelopment of buildings or urban fragments, or the adaptive use of urban areas. In addition, the reconstruction of buildings, land, building islands or areas, or reuse of urban areas, as outlined in Law No. 6306, are also important areas of consideration. The main titles and their place and purpose in the evolutionary process are reviewed in this study.

2.7.3.1 Urban Clearance

Urban clearance can be described as a policy of removing an unauthorized occupation and/or dilapidated structures in a dilapidated area as Kulshrestha (2018) mentioned. This strategy is arguably the first to be applied to the slums based on a slum clearance act. Under this strategy, an unauthorized settlement and/or dilapidated structure is removed from a slum area if it affects the use of the area according to the master plan, obstructs traffic, causes accidents, delays, and congestion, stands in the way of a road proposed in the master plan, or negatively affects the city's appearance, quality, and aesthetic value. This strategy removes the structures, demolishes the buildings, and develops the site for its intended use according to the master plan.

According to Kulshrestha (2018) as a relocation strategy, two scenarios are considered: (1) urban redevelopment and (2) slum clearance. Redevelopment refers to the temporary or permanent relocation of targeted communities to the same or a different location. When it comes to slum clearance, it refers to relocating targeting groups to a predetermined place, on a plot of land or in constructed apartments according to a resettlement program.

2.7.3.2 Urban Renewal or Renovation

Definition of Urban Renewal, according to Richards (2014) is an all-encompassing term that encompasses a series of carefully crafted and thoughtfully designed plans and activities specifically designed to improve and enhance neighborhoods and suburbs that have unfortunately found themselves in a state of distress or decay. The overall goal of urban renewal programs is to address the physical aspects of urban decay that have been identified as the root cause of the decay and distress that so many neighborhoods and suburbs currently face. These urban problems, which have been identified as the key issues plaguing these areas, include, but are not limited to, deteriorating housing, poor physical infrastructure, including water and sewer services, and inadequate community services, such as sports and recreational facilities. It is through the implementation of these carefully crafted and meticulously executed programs that we can begin to alleviate the burden of decay and distress that has weighed down so many of our neighborhoods and suburbs.

Carmon (1999) divided urban renewal policies into three generations, referring to time periods, with their unique characteristics in terms of social, economic, and political factors, and with various major stakeholders creating differentiated strategies. The first period was characterized by an emphasis on physical determinism and the built environment, and the poor conditions of old buildings in growing cities were considered. There was a shift towards optimizing land use in inner cities, accompanied by the notion of relocating the impoverished populations and clearing slums from these central areas. In the United Kingdom, this policy was initiated on a large scale with the Greenwood Act of 1930. In the United States, the 1937 Housing Act initiated the process. However, the 1949 Act was the first to recognize the public responsibility to provide "decent and affordable housing" for all families in the United States, and there are debates about whether the process began with that Act. The second period, on the other hand, is characterized by neighborhood redevelopment-a comprehensive approach that focuses on social challenges, as Carmon (1999) mentioned. Especially, in the 1960s in the United States, and subsequently in different nations, a new concept of helping neighborhoods in difficulty was developed and practiced. This approach was inspired by strong criticism of the first generation's bulldozer approach. The post-World War II era was marked by economic development and increased prosperity, as well as public support for large-scale public investment. Thus, social problems were addressed through a policy of increased social investments, while on the other hand, comprehensive rehabilitation programs aimed at improving the existing built environment began to be implemented. With these programs, attempts were made to carry out participatory processes, and "maximum feasible participation" became one of the principal slogans of the era. In the third period, under the influence of the business sector, the revitalization of city centers as part of economic development intensified. In the 1970s, the economic recession in Western countries and the failure of the 1960s social investment programs to produce the expected positive results caused a decrease in government investment programs and public interest in urban problems in city centers (Carmon 1999).

2.7.3.3 Urban Reconstruction

Urban Reconstruction involves the revitalization and rebuilding of neglected or destroyed urban areas, encompassing various aspects of planning and design. It involves physical, social, and economic reconstruction, with sustainability and inclusiveness as key factors. The rebuilt city should be resilient, environmentally friendly, accessible to all and culturally respectful. The preservation of historical and cultural landmarks and traditional building styles and materials is important.

2.7.3.4 Urban Revival or Revitalization

Urban revitalization can be explained according to the definition of Doratli (2005) as a multidimensional process that seeks to bridge the gap between the services provided by the existing built environment of historic neighborhoods and the current needs of the urban population. The goal of urban revitalization is to ensure the sustainability of a thriving economy in inner city areas, while at the same time attempting to reclaim declining neighborhoods by creating new functionalities within them. The implementation of urban revitalization projects has been a dominant phenomenon in the context of deteriorating urban centers since the 1960s.

2.7.3.5 Urban Rehabilitation

Urban rehabilitation is a multi-dimensional and comprehensive approach implemented to address the challenges posed by densely populated and unhealthy urban areas created as a result of uncoordinated and unplanned growth of physical infrastructure, which has led to the disappearance of the original functions of the built environment. The process of rehabilitation involves a wide range of interventions that operate at different scales, ranging from neighborhoods and urban areas, such as cities, districts, or streets, to individual buildings. The overall goal of rehabilitation projects is to improve the quality of the existing building stock and infrastructure while preserving the original character of the urban fabric, thereby eliminating the physical stock that has contributed to the overall decline of the urban environment (Düzcü 2006), (Mutlu and Şenol 2009).

2.7.3.6 Urban Redevelopment

According to the World Bank (2023), The notion of urban redevelopment is conceptually similar to land readjustment, except it takes place within pre-existing settlements and involves zoning efforts on the part of the local authority moving from low-density (predominantly single-family residential) to higher-density (mixed-use or commercial) development. Furthermore, such redevelopment efforts are accompanied by the provision of infrastructure improvements, such as mass transit systems like subway lines, which are capable of supporting such up-zoning efforts. In the process, the government assembles the individual private properties and implements a new, more advanced development plan by providing the necessary infrastructure. At the culmination of this process, the government allocates a proportionate share of the total new development to each landowner, according to their original land or property ownership. The government retains a portion of the development, which it can then sell to recover the cost of the infrastructure improvements.

2.7.3.7 Urban Regeneration

Urban regeneration is a subject that has been much studied recently, so it is important to identify urban regeneration as a strategy and to understand its basic foundations. Couch (1990) defines the process of urban regeneration is an effort by the state or community to attract investment, employment, and consumption back to an urban area and to improve the quality of life in that area. Roberts and Sykes (2000) summarized that Lichfield (1992) highlights the necessity of *“a better understanding of the processes of decline”* and an *“agreement on what one is trying to achieve and how”*. Hausner (1993, 526) argues for the limitations of regeneration approaches which are *“short-term, fragmented, ad hoc and project based without an overall strategic framework for city-wide development”*. Donnison (1993, 18) mentioned that *“new ways of tackling our problems which focus in a coordinated way on problems and on the areas where those problems are concentrated.”* Tallon (2020) states that urban regeneration is often performed in a fragmented approach and not all problems are being resolved.

Nowadays, the most popular definition about urban regeneration was provided by P. W. Roberts and Sykes in (2000) as below:

> “Comprehensive and integrated vision and action which seeks to resolve urban problems and bring about a lasting improvement in the economic, physical, social and environmental condition of an area that has been subject to change or offers opportunities for improvement.” (P. W. Roberts and Sykes 2000).

There are some important principles in the definition of urban regeneration presented by P. Roberts, Sykes, and Granger (2016). According to these principles, urban regeneration must be based on a thorough analysis of the state of an urban area. It is also stipulated that urban regeneration aims to simultaneously adapt the physical, social, economic, and environmental structure of an urban area. The urban regeneration strategy should focus on comprehensive and integrated problem-solving in alignment with sustainable development goals. Additionally, it should align with other initiatives, using partnerships or collaborations to ensure broad participation and consensus of all interested parties. It is acknowledged that an urban regeneration strategy's progress should be measured, and both internal and external impacts should be monitored. Further, emphasis is placed on the fact that the strategy may need to be revised to reflect changes in the path towards achieving the objectives, and that resources may need to be reallocated. Lastly, emphasis is placed on establishing arrangements for the long-term management of the regenerated area.

Urban regeneration is an alternative to the solution of the challenges of a built-up area and is associated with urban rehabilitation or urban renovation as Alpopi and Manole (2013) summarized. This involves tackling the factors contributing to issues such as traffic congestion, through the creation of green spaces, public areas, and road widening. Urban redevelopment initiatives involve revitalizing historical districts, enhancing living circumstances, upgrading public areas, and modernizing urban infrastructure. These complex projects can be achieved through cooperation between institutions, universities, urbanists, environmental associations, and developers. Urban rehabilitation policies are based on social, economic, and technical reasons. Social reasons, such as enhancing the quality of life and strengthening social relations, economic reasons, such as increasing the value of buildings and housing, and technical reasons, such as avoiding the long-term costs of ongoing maintenance. According to Figueiredo, Prim, and Dandolini_(2022), Mendes (2013) highlights that these principles can be both theoretical and methodological and are summarized in Table 5.

Table 5: Characteristics of Urban Regeneration
(Source: Mendes 2013) (quoted in: Y. D. dos S. Figueiredo, Prim, and Dandolini 2022)

Characteristics	Description
Scope	Seek to solve physical, economic, social, and environmental problems in the same project, and involve government issues.
Integration	Urban regeneration projects must integrate various spaces of the territory with different land uses, various actors, and the management of financing, using the complementarity of funds from different sources and the integration of policies from different government ministries or departments.
Strategy	The strategy arises from a problem or challenge. The actions are programmed according to the desired results and previously outlined objectives. It should be noted that actions can be subject to change and considered on a flexible priority scale depending on the context.
Flexibility	The forms of intervention defined to achieve the strategic objectives can be readapted during the implementation process.
Partnerships	It is the action of the various actors/partners of the projects.
Sustainability	Urban Regeneration must seek sustainability, and this implies admitting that it must remain viable without compromising its effectiveness.

Urban regeneration is a transformative strategy with distinct characteristics for urban areas. Urban regeneration is a policy that can be conducted jointly by the administration, the private sector, non-governmental organizations, and other citizens against the structural degradation of cities. A compromise method, which guarantees stakeholder participation and collaboration among the state, private sector, and other parties, should be incorporated. Consensus among stakeholders is crucial in ensuring the success of urban regeneration initiatives. To achieve lasting and effective solutions, urban regeneration must be approached through a comprehensive and integrated process that emphasizes long-term, large-scale solutions. Facilitating collective efforts toward achieving consensus is essential in managing the necessary changes and overcoming challenges in urban regeneration projects. It is essential to manage this process with the stakeholders that have a role in cities, otherwise, there would be a limited opportunity for sustainable implementation.

2.7.3.8 Urban Transformation

According to P. Roberts, Sykes, and Granger (2016), the conception of urban regeneration has not been well developed in a strategic context historically. Many urban policies before the 1990s had no strategic vision and long-term thinking, resulting in a predominance of piecemeal investments in fragmented areas of cities. Comprehensive planning was limited, and strategic long-term perspectives were not adequately developed. Healey (1997, 109) argues that it is *"no longer possible to approach urban regeneration through the promotion of urban transformation projects in isolation"* and *"the emphasis should be creating the conditions for economic, social and environmental regeneration"*. Therefore, success necessitates a strategic long-term perspective that enhances the connectivity between issues and those involved in their resolution P. Roberts, Sykes, and Granger (2016). In order to discuss this concern, Hussein (2015) explains that today, urban regeneration has developed as a tool of managing urban transformation, but despite its widespread application, urban regeneration is actually a poorly understood concept. This is largely because urban regeneration practices do not involve a unified methodology from the conceptual point of view, and the source of information does not come from a central authoritative source.

The Urban Transformation concept includes a comprehensive and constantly evolving process that involves significant changes in the physical, social, economic, and environmental dimensions of cities. This process is influenced by several factors, including globalization, urbanization, technological advances, and environmental degradation. Urban transformation is often a complex and controversial process in which different stakeholders may have different interests, goals, and priorities. It can also be a disruptive phenomenon, with significant impacts on the living conditions and livelihoods of citizens. However, urban transformation can also have positive effects, creating opportunities to enhance the quality of life in cities and promoting development towards more sustainable as well as resilient urban environments.

In Türkiye, following the enactment of the Law of Transformation of Areas under the Disaster Risks (Law No. 6306) in 2012, the term 'urban transformation' was officially adopted and has since been used in both academic literature and legal documents. Although the law primarily encompasses concepts like 'renewal', 'reconstruction', and 'building retrofitting’, it is execution pertaining to high-risk areas, vulnerable buildings, and reserve zones aligns with the stipulations of the law and its accompanying regulations.

2.7.4 The Strategies the Urban Development and Change

Due to the diverse definitions and methods of urban transformation found in literature, and the interchangeable use of these concepts across various countries and authorities, inconsistencies arise in practical applications. Therefore, there is a need for a conceptual framework to be used for the integrated Multi-Criteria Decision-Making Model to be produced within the scope of the dissertation. For this reason, Lang (2005), who defines the procedural types of urban design in the literature, is taken as a fundamental approach and the subject is analyzed.

According to Mcneill and While (2001), urban regeneration has evolved into a major sector for local leaders in their efforts to transform their cities. Governments have begun redesigning urban areas that have lost value due to capital migration and manufacturing decline. Consequently, abandoned industrial areas have become parks, waterfronts and canals have been transformed into residential and commercial areas, and warehouse renovations have made urban areas more stylish. Along with improving the quality of the urban landscape, the use of famous architects or pioneering urban designers has been an important marketing strategy to redefine the image of the city. Additionally, public-private collaborations or partnerships are playing a more active role in driving urban development and regeneration strategies, which is one of the defining characteristics of new forms of governance at the city level.

Hussein (2015), referring to the contributions of Carmona (1996), Gospodini (2002), Lang (2005), Beriatos and Gospodini (2006), Madanipour (2006), and Biddulph (2011), has argued that urban design policies are playing an important role in the urban transformation of many cities at present. Urban design has become increasingly popular not only for its ability to create better places for people, but also as a means of increasing the competitive capacity of cities and promoting their distinctive characteristics. Urban design is a valuable instrument for negotiating the interests of different stakeholders. The importance of urban design is that it provides quality of life for citizens and opportunities for development. Architects and urban planners are increasingly recognizing the need for urban design as a discipline, and local authorities are increasingly understanding the importance of this discipline.

2.7.5 Procedural Types of Urban Design as a Strategy for the Transformation

Lang (2005) defined that there are four fundamental typologies of urban design efforts that represent variations in the methodology employed and/or the degree of creative autonomy afforded to the designer, whether acting as an individual or as a collective enterprise. These typologies are below:

1. "Total design, where the urban designer is part of the development team that carries a scheme through from inception to completion.
2. All-of-a-piece urban design, where the urban design team devises a master plan and sets the parameters within which a number of developers work on components of the overall project.
3. Piece-by-piece urban design, in which general policies and procedures are applied to precinct of a city in order to steer development in specific directions.
4. Plug-in urban design, where the design goals is to create the infrastructure so that subsequent developments can 'plug in' to it or, alternatively, a new element of infrastructure is plugged into the existing urban fabric to enhance a location's amenity level as a catalyst for development." (Lang 2005, 27–28).

According to the Lang (2005), the boundaries between these categories are fuzzy. The first two types, total and all-of-a-piece urban design, have historically been at the core of urban design practice, but all four are considered, because they focus on the four-dimensional built environment and require the collaborative actions of all design disciplines. Lang (2005) defines the procedural types as their details.

2.7.5.1 Total Urban Design

Total Urban Design involves the entire public realm and its surrounding buildings within a framework that includes urban planning, large-scale architecture, and landscape architecture. According to Lang (2005), a team of specialists, including urban planners, architects, traffic engineers, and landscape architects, manages the design and overall structure. Discussions among the team on means and ends are critical and always are accepted by the team. While the total urban design category is a theoretical concept, some significant urban design projects have been developed in practice in accordance with the total urban design category. Examples of such projects range in size and scope, from the creation of entirely new cities to the design of neighborhoods, plazas, and urban open spaces.

Total Urban Design is achieved through the implementation of a comprehensive project within a specified area under the supervision of a responsible authority. Alternatively, this process can involve teams or individual designers from various disciplines managed by the authority. The development, design and implementation of real estate are carried out within this whole. Total urban design can comprise various projects with differing scopes. These projects may include the creation of new cities, renovation or redevelopment projects within urban areas, the development of new suburbs, residential districts, campus design, historic revitalization projects, mixed-use projects, and more (Lang 2005).

2.7.5.2 All-of-a-piece Urban Design

The subject of urban design has become increasingly complex in contemporary times, especially considering the numerous urban redevelopment projects and suburban developments that have arisen. In many cases, these projects are so large that individual developers and their financial backers are unable to finance them independently. Compounding this problem is the fact that landowners often find it difficult to bring a coordinated approach to the development process, whether due to regulatory constraints or administrative barriers. In order to address these challenges, a consulting team may be engaged to develop an illustrative three-dimensional design, typically referred to as a master plan or concept plan, which envisions the entire development. Once this design is established, the various components of the project are divided among the various developers and their design professionals for financing and design. Financing difficulties are not uncommon, however, especially given the number of projects that may need to be completed over several decades. In some cases, the primary contractor, either public or private, may take responsibility for building the entire infrastructure. Alternatively, sub-developers may be required to fund or contribute to the cost of the components associated with their individual projects. After the master planner approves the conceptual design, a program and a series of standards are prepared for each component to be built by a sub developer. This ensures that each component of the overall scheme is executed in a coordinated and consistent manner, which is critical to the project's achievement (Lang 2005).

In the approach of All-of-a-Piece Urban Design, the procedure is specified in terms of content, as Lang (2005) demonstrated in Figure 16. The design process must differ depending on what is being designed, the degree of control the authority has over the design, the components of the plan, and the freedom of action given to the designers. However, the level of control over the design process varies significantly, ranging from extremely controlled designs to those in which the developers and designers of the various components of a plan are given considerable freedom of action.

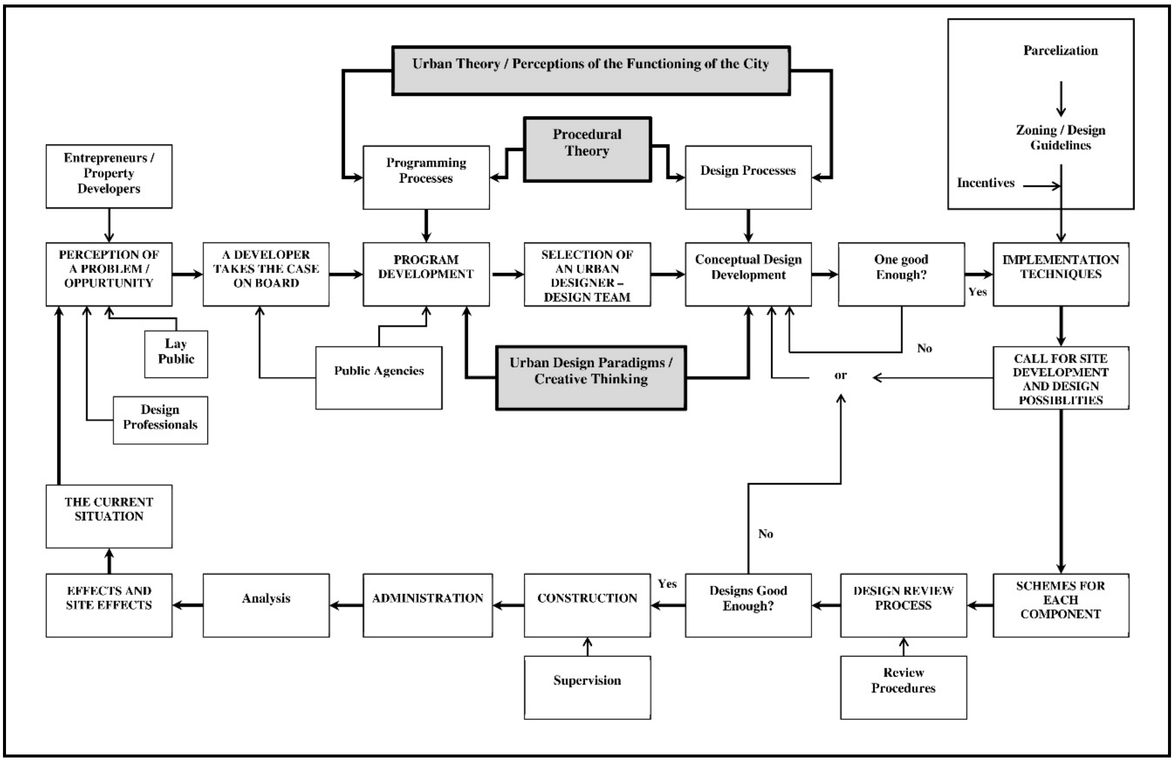


Figure 16: The Framework of All-of-a-piece Urban Design
(Source: Adopted from Lang 2005, 31)

2.7.5.3 Piece-by-piece Urban Design

Each city has a characteristic design that has been carefully crafted through a plurality of individual decisions made within the confines of investment decisions and a regulatory framework as Lang (2005) mentioned. It is worth noting that while total urban design tends to be large-scale architectural design, Piece-by-piece Urban Design is primarily urban planning. This type of urban design is district oriented, or quarter orientated and contrasts strongly with All-of-a-Piece Urban Design which is not place oriented or building orientated. The process of Piece-by-Piece Urban Design involves the establishment of goals for a given area and the subsequent development and design of strategies to achieve those goals. It is imperative to emphasize that the creation of these goals is highly idealistic, though often only purportedly grounded in the perceived public benefits. If the targets are agreed upon, the critical stage is designing instruments, also known as carrots and sticks, to ensure that the goals are achieved.

According to Lang (2005), the relationship between urban planning and urban design depends on factors such as the physical design of the environment, the details of activities and the public image. Urban planning is concerned with identifying site-specific activities and building types, while urban design is used to improve the quality of existing city districts. A district is an area with a similar building fabric and activities and gives a city a distinctive identity. Piece-by-piece Urban Design is used to encourage the construction of specific facilities in a given area, shaping its character. Such areas are called special planning zones and the incentives apply to facilities to be built anywhere. Piece-by-Piece Urban Design differs from zoning controls because it does not involve the design of specific buildings in the area. For this reason, some see it as part of planning, not as an aspect of urban design.

2.7.5.4 Plug-In Urban Design

Lang (2005) defines that Plug-In Urban Design means the planning and implementation of an infrastructure investment to achieve the desired development in the city Two types of plug-in urban design projects can be identified. the first type typically provides the infrastructure for a city or suburban area and the property that is sold to individual developers to develop. The other type provides infrastructure within an existing urban fabric and enhances its environmental value.

In this Plug-In Urban Design method, in addition to the investments to be made in the infrastructure of the city or suburb, the urban structure to be created must also be effectively controlled as Lang (2005) mentioned. When such control is exercised, this method becomes a variant of the All-of-a-Piece Urban Design method. With more flexible control, investors are allowed to integrate their investment projects into the existing infrastructure according to their market preferences. The second type of Plug-in Urban Design is aimed at encouraging new investment in an existing city and promoting the development of the real estate market in the area through the process of investing in some public infrastructure. Infrastructure design requirements in urban development vary at different scales. The regional and urban planning context extends the scope of urban design. The careful analysis of the profound impact of highway design on residents and their lives has prompted urban designers to be more attentive. Plug-in urban design strategically constructs the infrastructure facilities of a city. Infrastructure includes not only roads and other services, but also facilities such as commercial areas, educational institutions, libraries, and networks of information technology. Additionally, there is an increasing need for infrastructure in cities to encompass corridors of habitat. Infrastructure refers to the components that enable development and investment in particular types of structures anticipated to have a multiplier effect on development around them. Plug-in urban design pertains to the planning and building of an area in a manner that integrates its infrastructure into the whole.

2.7.5.5 Plot-by-Plot Urban Transformation

Particularly in developing countries, there have been many developments outside of zoning to respond to the increasing demand for housing as people migrate from rural to urban areas. In the case of Türkiye, urban areas with high density of slums and illegal structures can be seen. On the other hand, there are many economic and social problems in developing comprehensive urban transformation projects in building blocks that are parceled out with implementation plans. For this reason, it is seen that the 'build-and-sell'

(Yapsatçılık) model is still a widespread practice in both current construction practices and urban transformation practices. Due to the housing sector's inability to provide itself with a suitable financing model, increasing inflation and high construction costs, this contracting system specializes in the demolition and reconstruction of buildings on a construction agreement in return for land share.

The concept of 'build-and-sell' (Yapsatçılık), which is very common, and the efforts to reconstruct old buildings in exchange for new apartments continue under the current conditions. In particular, with The Law of Transformation of Areas under the Disaster Risks (Law No. 6306), the risky building process and the business agreements between citizens and constructers, these practices continue rapidly, especially in areas with high real estate value and rent expectations. In this context, these demands of citizens are evaluated by the Ministry of Environment, Urbanization and Climate Change.

In this perspective, in the article 'Plot by Plot: Plotting Urbanism as an Ordinary Process of Urbanization', Karaman et al.(2020) define that plotting urbanism as ordinary urbanization and introduce a new concept to the literature on the subject. Karaman et al. (2020) have proposed a definition for a novel term that denotes urban areas that have been developed plot by plot over a period of time, relying on speculative and sometimes exploitative land and housing markets with limited official planning. In order to examine this commonplace urban process, which has received little attention, they have introduced a new concept called 'plotting urbanism'. The main goal of their scientific article is to highlight the dynamics of an urbanization process by considering material interactions, territorial regulations, everyday experiences, and the dialectical relationships between these three dimensions.

In this context, one of the urban transformation strategies proposed by the dissertation is that this ongoing parcel-based system should be added to the model of the dissertation as one of the urban design process descriptions created by Lang for an alternative urban transformation strategy to be evaluated by public institutions.

2.7.6 Stakeholders and Their Interests of Urban Transformation

Stakeholders of urban transformation are described as the groups or individuals who have the ability to influence the achievement of the procedure throughout the life cycle of construction and operation of urban transformation. Wang et al. (2017) define urban transformation participants as officials, citizens, constructors, planning and engineering departments, investors, contractors, sub-contractors, research institutes, and the media, among others. Based on disparities between stakeholders in a project, the prioritization of benefits, and overall operational significance, Chen (2003) categorizes these stakeholders into two groups: primary and secondary stakeholders. As a result, in this thesis, central government, municipalities, residents and investors are accepted as the predominant stakeholders. In order to successfully implement urban transformation, the interests of these stakeholders need to be balanced.

a) Government Interests

The government, as a primary authority responsible for developing and implementing policies, has a crucial function in the process of urban transformation, as Wang et al. (2017) categorized. Its primary objective to provide societal benefits by mitigating and eliminating the various difficulties and obstacles posed by urban areas. In addition, the government aims to promote the urban development and improve the overall quality of the city. The government also aims to actively promote proper distribution of benefits and maintain equity and integrity in society. The government's overall goal is to maximize welfare and promote the coordination of the economy of the city. The administration also aims to enhance its prestige and increase its financial income, thereby further improving its ability to produce optimal results for the city.

b) Residents' Interests

As Wang et al. mentioned (2017), the people living in the area strongly hopes to resolve the pervasive problem of poor and unpleasant living conditions, coupled with a lack of security. Their immediate goal is to increase the rental value of the area after the redevelopment, thereby sustaining their future residential and economic interests. As a result, residents have a heightened level of concern about urban transformation in terms of relocation compensation, social security, sources of livelihood and redevelopment. In simplified terms, these interests can be grouped under the headings of interests of livelihood and development.

c) Developers' Interests

Developers play a crucial role in providing the financial resources needed for development. They also have a remarkable opportunity to build and maintain their businesses' brand and profile. The overriding objective of their involvement is to achieve a profitable economic benefit. The critical determinant of their participation in the urban regeneration process is their ability to guarantee reasonable profits while increasing the profile and visibility of their respective businesses. It is important to note that developers are primarily concerned with the efficiency ratio of profitability (Wang et al. 2017).

2.7.7 Law and Regulations of Urban Transformation in Türkiye

In Türkiye, legislative efforts to address the issue of illegal settlements, which surged after the 1940s due to increasing migration, began with the Slum (Gecekondu) Law (Law No. 755) in 1966. These efforts were further structured with the 73rd article of the Municipality Law (Law No. 5393) and The Law of Transformation of Areas under the Disaster Risks (Law No. 6306), a new procedure introduced in response to the 1999 Marmara Earthquake.

In practice, the implementation of urban transformation policies faces challenges due to the divided authority between central and local administrations, along with constrained budgetary resources. The Municipality Law (Law No. 5393) was enacted in 2005 (as published in the Official Gazette on 13.07.2005, no.25874), with Article 73 specifically outlining the 'Urban Regeneration and Development Areas.'

> "Municipalities may, by a resolution of the municipal council, carry out urban regeneration and development projects to create housing areas, industrial areas, business areas, technology parks, public service areas, recreation areas and all sorts of social facility areas, rebuild and restore worn-out parts of the city, preserve the historical and cultural heritage of the city, or take measures against earthquake. In order for an area to be designated as an urban regeneration and development area, it must be appropriate for the realization of one or more of the foregoing, be located within the boundaries of the municipality or adjacent areas. However, a decree of the Council of Ministers shall be required to declare those areas owned or used by the public as an urban regeneration and development area and implement accordingly." (WEB5 2005) (accessed date: 19.12.2018).

> "The municipal council shall have sole authority to decide that the area to be declared as an urban regeneration and development area should be planned or non-planned areas with or without buildings on, specify the building height limits and density, require that the area size be minimum 5 and maximum 500 hectares, and the regeneration be executed in phases. More than one piece of land associated with the project area may be designated as an urban regeneration and development area not to be less than 5 hectares in size." (WEB5 2005) (accessed date: 19.12.2018).

According to the Article 73 some Metropolitan Municipalities determined urban transformation areas and some of them approved by the Council of Ministers on a proposal from the Ministry of Environment and Urbanization, including Izmir.

On the other hand, The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) (MoEUaCC 2012a) entered into force in 2012 (published in the Official Gazette of 31.5.2012, no.28309). The aim of the Law No. 6306 is defined *"to determine the procedures and principles regarding the rehabilitation, clearance, and renovations of areas and buildings at disaster risks in accordance with relevant standards with a view to creating healthy and safe living environment."* (Directorate General for Infrastructure and Urban Transformation Services 2012) (accessed date: 19.06.2017). After that, The Regulation on the Implementation of Law of Transformation of Areas under the Disaster Risks published in the Official Gazette of 15.12.2012, as number of 28498 to regulate the implementation procedure of the Law No. 6306.

According to the website of the Directorate General for Infrastructure and Urban Transformation Services, which is responsible for implementing the regulations, the mission of the agency is stated as below,

> "To execute the processes and procedures for determining the transformation, renovation, and transfer areas; detecting the risky buildings; ensuring the relevant procedures for land development and assets valuation; carrying out the processes of right holders, negotiations, expropriation, and real estate assessment; reconciling with the right holders in the frame of the principles developed by the Ministry and peculiarities of the project; establishing and enrolling condominiums as well as transferring the development rights." (Directorate General for Infrastructure and Urban Transformation Services 2016) (accessed date: 19.06.2017).

2.7.7.1 Differences Between Law No. 5393 And Law No. 6306

In Türkiye, various regulations have been implemented throughout the evolution of urban transformation practices. These regulations have been adapted over time to ensure that the legislation in place remains relevant and effective. Therefore, new laws have been enacted in an effort to promote and facilitate urban transformation practices.

With the recent effects of earthquakes on the building stock, it has become increasingly important to regenerate cities rapidly. This in turn has increased the importance of convenient legislation in practice. When evaluated from this perspective, it is obvious that the provisions outlined in Article 73 of Municipality Law (Law No. 5393) and related articles, as well as The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) are strongly applicable and supportive of urban transformation implementations in Türkiye. The main differences between these two laws are compared under 8 criteria as (1) Declaration of urban transformation or risky area, (2) Plan making and approval processes., (3) Parceling and approval processes, (4) Determinations, demolition, and expropriation processes, (5) Rent subsidies., (6) Powers in the application, (7) Project approval and license procedures, (8) Exemptions shown in Table 6 (Özdemir et al. 2022).

The comparison highlights the broad authority vested in the Ministry of Environment, Urbanization, and Climate Change concerning urban transformation, especially in terms of financing. In contrast, both the Izmir Metropolitan Municipality and local municipalities grapple with challenges in overseeing urban transformation due to their limited authority and financial constraints.

Table 6: Comparison of Law Nos: 5393 And 6306 In the Context of The Urban Transformation Process

(Table has been prepared by the author from the Article Özdemir et al. 2022)

Type of Comparison	Under the Law No. 6306	Under the Law No. 5393
Declaration of urban transformation or risky area	TOKİ or the Administration may request the relevant Ministry to designate a risky area. Requests approved by the Ministry are submitted to the President of the Republic.	Municipality, taken by decision of the municipal council.
	Real or legal persons who own immovable properties in the target area may request the Ministry or the Administration to designate a risky area.	Residential, industrial, commercial areas and technology parks,
	Requests to be submitted to the Administration shall be notified to the Ministry.	To create areas for public service, recreation, and all kinds of social facilities,
	Requests approved by the Ministry shall be submitted to the President of the Republic.	Rebuilding and/or restoring aging parts of cities,
	After the President of the Republic declares a risky area, the decision is published in the Official Gazette.	It creates Urban Transformation and Development Projects to take measures against earthquake risk and to protect the historical and cultural texture of the city.
Plan making and approval processes.	After TOKI declares a risky area, the planning phase begins.	Zoning plan approval is made for the area declared as urban transformation.
	Municipalities may request the authority to make and approve plans from the Ministry of Environment and Urbanization.	If it is within the boundaries of the Metropolitan Municipality; following the approval of the district municipality council, it is submitted to the Metropolitan Municipality council. It is then sent to the district municipality for suspension procedures.
	The municipality is authorized to make plans and the Ministry is authorized to approve them.	In places outside of metropolitan municipalities, procedures are carried out based on the decision of the administrations to be taken by councils.
Parceling and approval processes	If the authority to make and approve parceling is not given to the relevant municipality by the Ministry; the procedures continue through the Ministry as in the planning procedures.	If it is within the borders of the Metropolitan Municipality, it is sent to the Metropolitan Municipality after the decision of the district municipality council. Following the decision of the Metropolitan Municipality's council, it is sent to the district municipality for the suspension procedures.
	In case it is given to the Administration, after the decision of the Administration's council, the suspension process and approval procedures are completed if there is no objection. It is then forwarded to Directorate of Land Registry and Cadastre for approval processes.	In places other than metropolitan municipalities, the procedures are carried out based on the decision to be taken by the administrations from their own councils. After the suspension procedures, it is sent to Directorate of Land Registry and Cadastres for registration procedures.
Determinations, demolition, and expropriation processes	The first goal is to reach a compromise and demolition is ensured.	Compromise is essential for the evacuation, demolition, and transfer of property rights to the public in urban transformation and development project areas.
	If there is a risky structure, the owners are given at least sixty days at the first stage and the demolition license is obtained from the relevant administration and the risky structures are requested to be evacuated and demolished.	Agreed structures are demolished or demolished by the building owners or the relevant administration.
	In the notification to be made to the right holders, if a tenant lives in the risky building, the right holder shall inform the tenant of the situation and state that the tenant must be evicted.	The biggest problem that arises in practice is the long duration of judicial processes regarding the structures that are referred to the court.
	If it is understood that the tenant is not notified of the evacuation situation through the right holder, the notification is made by the administration.	The valuation of immovables is determined in accordance with the provisions of Article 11 of the Expropriation Law dated 4/11/1983 and numbered 2942, in line with the information provided by real estate appraisers, institutions or organizations.
	In the following process, it is checked whether the risky buildings are demolished or not. The structures that have not been demolished are notified that they will be demolished by the relevant authorities and the situation is notified by granting an additional period of at least thirty days.	-
Rent subsidies.	The right holders of the properties in the application area evacuated by reconciliation may be provided with monthly rental support to be determined by the Ministry starting from the evacuation or demolition process.	There is no provision on rental assistance.
	Rent support is determined as 18 months for risky structures other than risky areas.	However, the relevant administration can aid under the name of moving or rent by taking a council decision
	In risky areas and reserve building areas, rental support is determined by the relevant institution for a maximum of 48 months.	-
Powers in the application	Implementation can be done both through the private sector and through an agreement with TOKİ.	Implementation can be done both through the private sector and through an agreement with TOKİ.
	Due to the exemptions in TOKİ's legislation, the relevant administrations generally choose to cooperate with TOKİ.	Due to the exemptions in TOKİ's legislation, the relevant administrations generally choose to cooperate with TOKİ.
Project approval and license procedures	Zoning Law No. 3194 and related regulations.	Zoning Law No. 3194 and related regulations.
Exemptions	Paragraph 10 of Article 7 of the Law stipulates that, regardless of the change of function for the new construction area, in the event that the transformation process is realized on the parcels where the risky area, reserve area or risky building is located, the fees and fees are not charged until the construction area of the new building is more than one and a half times the existing building construction area.	Buildings constructed in accordance with Article 26 of the Zoning Law No. 3194 are exempt from the building construction fee pursuant to Additional Article 2 of Law No. 2464.
Exemptions	Exemption conditions are realized with the criteria of the ratio of the square meter of the building area of the residence and workplace.	In urban transformation and development project areas, one fourth of the taxes, duties, and fees to be collected for individual buildings to be transformed are collected.
	In the case of the unification of the parcel where the risky building is located and the empty parcels, in the exemptions of title deed fees and charges, the area of the parcel where the risky building is located and the area of the new parcel resulting from the unification are utilized according to the ratio.	If it is TOKİ; fees are exempt from the minimum value.
	Fees, taxes, and charges that should not be collected; (Notary fees, Land Registry and Cadastre fees, Fees levied by municipalities, Stamp tax, Inheritance and transfer tax, Banking and insurance transactions tax, Fees within the scope of revolving capital fee, all fees made mandatory by the decision of the municipal council).	-
	Fees, taxes, and charges that should not be collected if the ownership is public; (In the structures built in accordance with Article 26 of the Zoning Law No. 3194, there is an exemption from the building construction fee in accordance with Additional Article 2 of the Law No. 2464).	-

2.7.7.2 Procedures In Urban Transformation Under the Law

In Türkiye, The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) is used as the main tool in urban transformation practices, and all kinds of procedures to be carried out on reserve building areas, risky areas and risky buildings are based on the procedures within the scope of this law.

Considering Article 2 of The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) enacted on May 31, 2012:

c) Reserve Development Area refers to a region designated by the Ministry, either upon TOKİ or the Administration's request or by its own discretion. This area is earmarked for use as a new residential zone following the guidelines set by this law.

ç) Risky Area is a zone identified by the President of the Republic. This classification is based on either the area's soil composition or the constructions therein, both of which could pose a threat to life and property.

d) Risky Building is any structure, whether within or outside a risky area, that either has outlived its economic viability or is deemed prone to collapse or significant damage, as determined by scientific and technical evaluations (MoEUaCC 2012a)

On April 14, 2016, Law No. 6704 expanded the scope of the Risky Area. Additional Article 1 (a) now includes areas where public order or security has deteriorated to the point of disrupting everyday life. This also applies to areas lacking proper planning or infrastructure services, as well as those with constructions contrary to zoning legislation, or damaged structures or infrastructure.

With Additional Article 1 (b), the President has the authority to classify areas as 'risky' under the following conditions:

1) If at least 65% of the total buildings in the area violate zoning legislation.
2) If the area comprises structures built without initial building permits but later received both building and settlement permits.

The purpose of such designations is to ensure a healthy and safe living environment, consistent with scientific and artistic standards. Furthermore, it aims to guarantee efficient delivery of public services, including health, education, and transportation (MoEUaCC 2012a)

Article 3 of the Law states that building owners are responsible for determining the risk of their buildings at their own expense. This is to be done according to procedures set by regulations to be prepared by the Ministry, primarily by institutions licensed by the Ministry, and the results are to be reported to the Ministry or the Administration (MoEUaCC 2012a)

Article 4 of the Law states that the Ministry, TOKİ, or the Administration are authorized to temporarily prohibit any kind of development and construction in risky areas and reserve development areas for a period of two years. If necessary, the temporary suspension of development and construction can be extended for another year (MoEUaCC 2012a).

According to item 5 of Article 6 of the Law, the Ministry is authorized to: a) Carry out all kinds of transactions related to risky areas, reserve development areas and properties where risky buildings are located, b) Purchase properties located in these areas, use the right of pre-purchase, exchange properties including independent sections, transfer ownership or zoning rights to another area, c) Convert ownership related to the same areas into securities provided that an agreement is reached, ç) To implement procedures based on public and private sector cooperation, to construct constructions including flat or in return for revenue procedures, to determine land shares, d) To allocate, separate or merge shares according to the principles in the Condominium Law No. 634, to establish limited rights in accordance with the Turkish Civil Code No. 4721, e) Properties owned by the Treasury and allocated to the Ministry under this Law; properties expropriated by the Ministry within the scope of the Law and properties that fall to the share of the Ministry as a result of the implementations carried out, to lease and sell them in order to generate income for the special account of transformation projects, f) To purchase and transfer ready-made houses and workplaces to be used within the scope of this Law, g) In the parceling plans, if deemed necessary, to make deductions from the arrangement common share to complete the arrangement common share rate in the first application, if any (MoEUaCC 2012a).

Article 6, Item 6 of the Law authorizes the Ministry to determine the standards that will form the basis of planning transactions of all types and scales, including those related to areas stipulated by special laws, and to determine these standards with plan decisions if deemed necessary, or to make, have made and approve plans and urban design projects containing special standards in order to be used in the applications in risky areas, reserve building areas and parcels where risky structures are located. Article 6, Item 7 of the Law provides that the Ministry, TOKİ or the Administration is authorized to carry out the valuation of the properties subject to transformation, including the dilapidated structures on them, and the valuation of the properties that will be created by the transformation. Article 6, Item 10 of the Law regulates that if real persons and private legal entities carry out applications in risky areas, reserve development areas and parcels where risky buildings are located, municipalities shall not charge any fees and charges for the new construction area up to one and a half times the existing construction area, regardless of the change of function. With Article 6, Item 12 of the Law, the Ministry is authorized to delegate authority to TOKİ or the Administration regarding the works and transactions specified in this Law and to determine which of these works and transactions will be carried out by TOKİ or the Administration (MoEUaCC 2012a).

Article 1 of the Regulation on the Implementation of the Law of Transformation of Areas under Disaster Risks, which came into effect on 15.12.2012 (MoEUaCC 2012b), outlines its objective. The regulation aims to:

1. Determine procedures and principles related to the identification of risky buildings, risky areas, and reserve development zones.
2. Oversee the demolition of hazardous structures.
3. Guide the planning processes.
4. Establish the valuation of properties subject to transformation.
5. Dictate the terms of agreements with rights holders.
6. Define the assistance provisions.
7. Govern the reconstruction of facilities.
8. Oversee other implementations within the scope of Law No. 6306.

Article 4 of the Regulation regulates that the determination of the reserve development area a) may be determined by the Ministry alone, b) TOKİ or the Administration may request the Ministry to determine the reserve development area based on the portfolio containing the information and documents, c) Real or private legal entities may request the Ministry to determine the reserve development area based on the portfolio containing the information and documents (MoEUaCC 2012b). The process in this regard is shown in Figure 17.

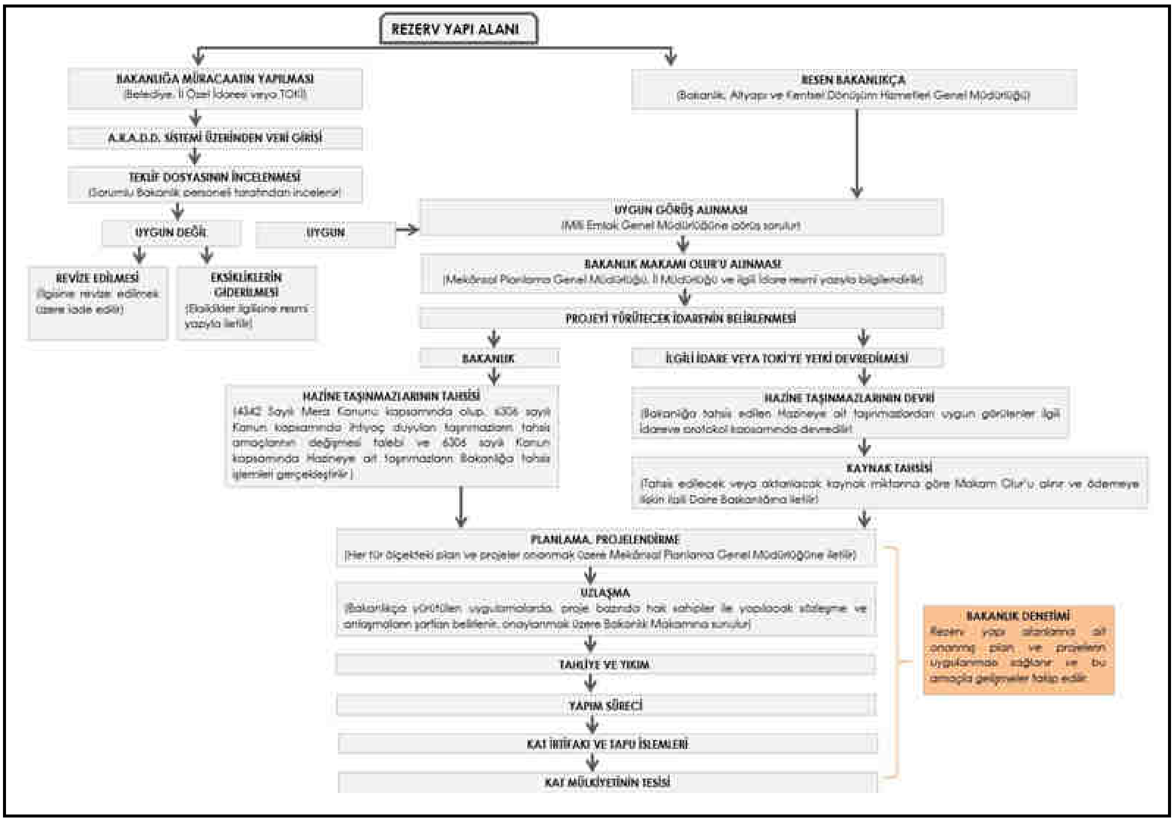


Figure 17: Procedure of Reserve Development Area

(Source: Ministry of Environment Urbanization and Climate Change 2019) (accessed date: 13.07.2023)

Article 5, item 2 of the Regulation states that the determination of the risky area is made by the Ministry; a) In places where public order or security is disrupted in such a way as to stop or interrupt ordinary life, in the event that planning or infrastructure services are inadequate, there is construction contrary to the zoning legislation, damage has occurred to the infrastructure or superstructure, or b) In areas where at least 65% of the total number of buildings on it is contrary to the zoning legislation or consists of buildings that were built without a building license but later obtained a building and settlement license, the areas determined by considering the integrity of the application are submitted to the President to be determined as risky areas. Article 5, item 3 of the Regulation regulates that TOKİ or the Administration may request the determination of the risky area from the Ministry with the portfolio related to the determination of the risky area and that the Ministry will submit the requests deemed appropriate to the President of the Republic. Article 5, item 4 of the Regulation states that real or private legal entities who own immovable property in the area for the determination of a risky area may request a risky area determination request from the Ministry or the Administration with the portfolio related to the determination of a risky area, and the requests deemed appropriate by the Ministry will be submitted to the President (MoEUaCC 2012b). The process in this regard is shown in Figure 18.

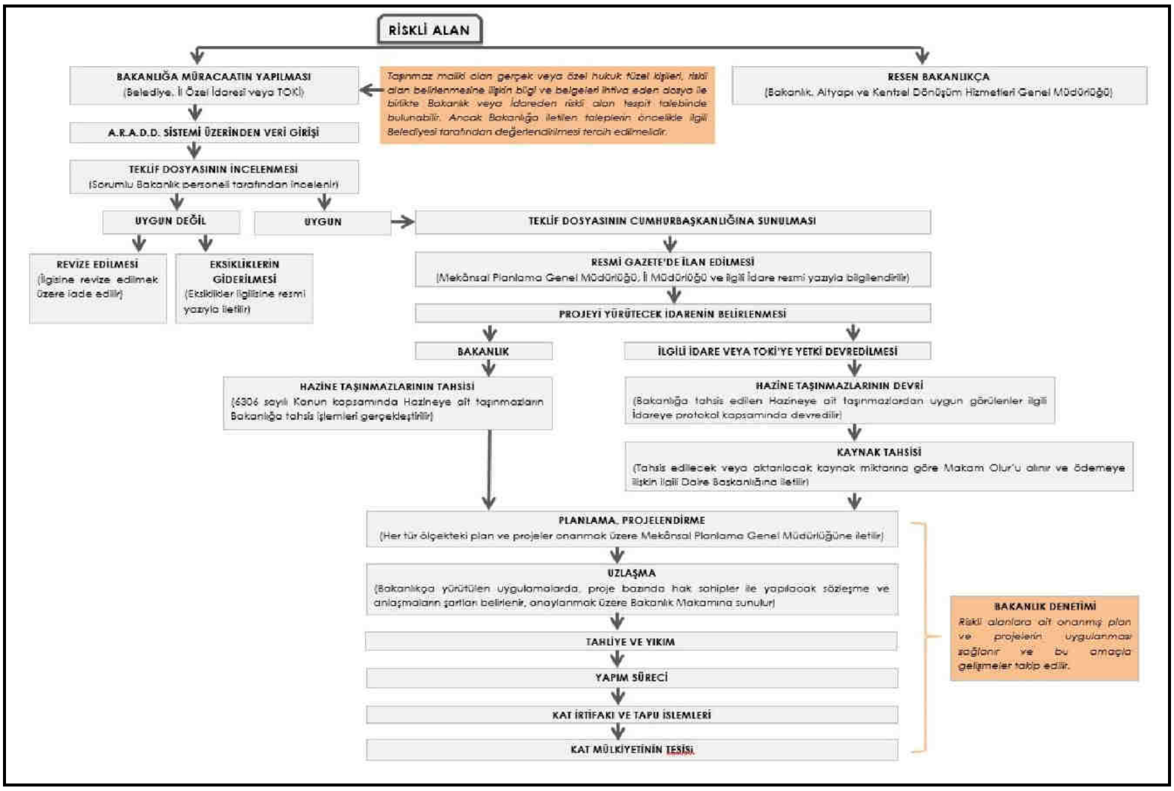


Figure 18: Procedure of Risky Area

(Source: Directorate General for Infrastructure and Urban Transformation Services 2019a) (accessed date: 13.07.2023)

Candas et al. (2016) described the steps involved in the urban transformation process for risky areas in line with the provisions of The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) and the relevant regulation which can be found in Figure 19.

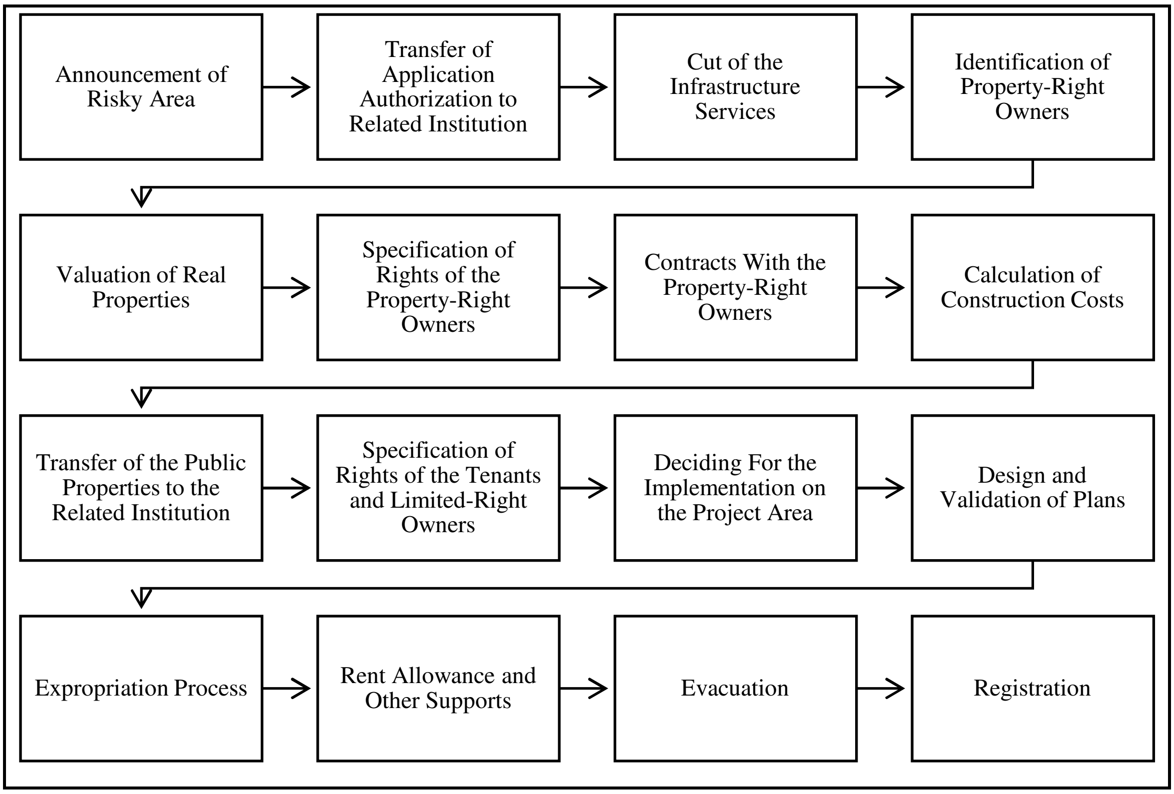


Figure 19: Implementation Procedure of Urban Transformation in Risky Areas.
(Source: Redrawn from Candas et al. 2016)

In Article 6, Item 1 of the Regulation, the institutions and organizations that will take part in the determination of risky buildings are a) the Ministry, b) the Administration, c) the institutions and organizations licensed by the Ministry which are, 1) Public institutions and organizations, 2) Universities, 3) Companies with at least forty percent of their capital belonging to public institutions and organizations, 4) Non-governmental organizations operating in the fields of earthquake protection, mitigation of earthquake damages and contributing to the development of earthquake engineering, 5) Building inspection institutions and laboratory institutions that have obtained a permit from the Ministry according to the Law No. 4708 on Building Inspection, 6) Pursuant to Law No. 6235 on the Union of Chambers of Turkish Engineers and Architects, the institutions and organizations that have registered their offices with the Chambers of Civil, Geological and Geophysical Engineers have been identified. The risky building process is shown in Figure 20 and starts with the identification of risky buildings upon the request of the citizen (MoEUaCC 2012b).

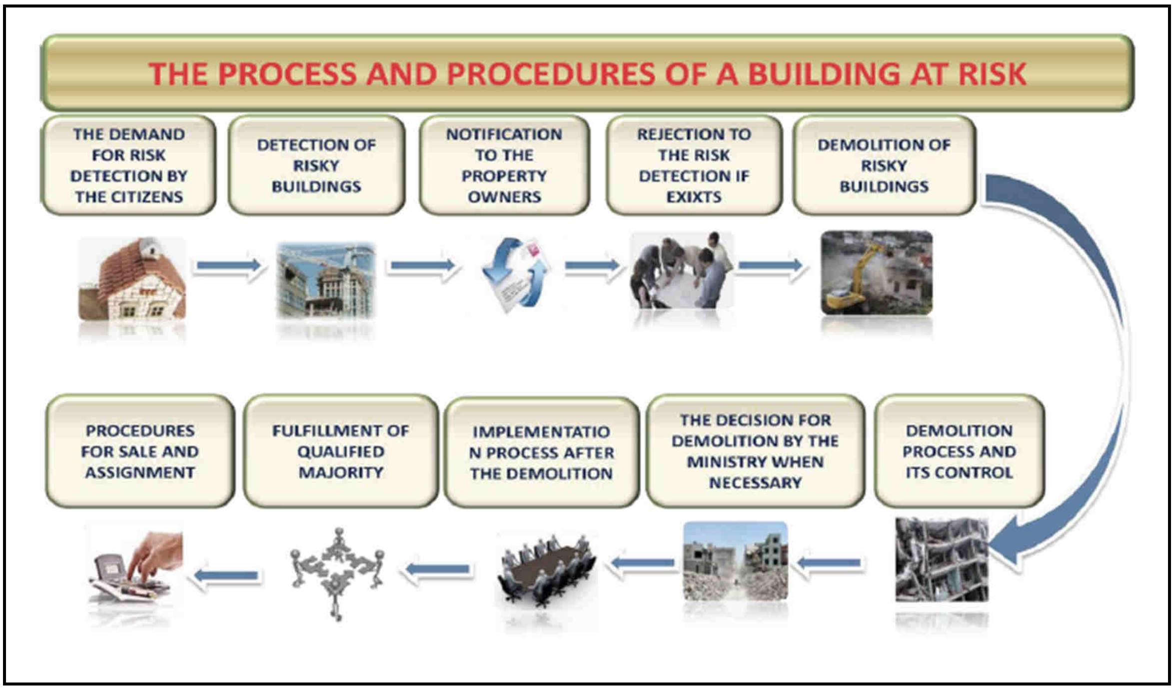


Figure 20: The Procedure of Risky Building

(Source: Directorate General for Infrastructure and Urban Transformation Services 2022) (accessed date: 13.07.2023)

Article 15 of the Regulation defines the applications to be made in the parcels where risky buildings are located, risky areas and reserve development areas. Article 15, Item 1 of the Regulation stipulates that in risky areas, reserve development areas and risky buildings, it is essential that the owners are primarily responsible for the implementation within the scope of the Law and that the relevant institutions are obliged to assist the owners in the works and transactions related to these applications to be made within the scope of the Law. Article 18, Item 1 of the Regulation specifies that in the plans to be made for the implementation area for the planning process, it is essential to reduce disaster risks, improve, protect, and develop the physical environment, ensure social and economic development, increase the quality of life with energy efficiency and climate sensitivity, according to the characteristics of the area (MoEUaCC 2012b).

According to Article 18, Item 2 of the Regulation, the Ministry is authorized to: a) make decisions by itself, prepare and approve all types and scales of plans related to risky areas, reserve development areas and properties where risky structures are located, b) Determine the standards that will constitute the basis for all types and scales of planning procedures, including those related to areas stipulated by special laws, to be utilized in the applications in risky areas, reserve development areas and parcels where risky structures are located; c) In parcellation plans, if deemed necessary, to make deductions from the arrangement partnership share to complete the arrangement partnership share rate in the first application, if any (MoEUaCC 2012b).

2.7.7.3 Strategy Document for Urban Transformation

The Strategy Document for Urban Transformation is a guideline for urban transformation prepared at the provincial and municipal level, which includes the main decisions on urban transformation practices to be carried out by metropolitan municipalities, provincial municipalities and/or municipalities and special provincial administrations within their jurisdictional boundaries, is related to master plans, brings a comprehensive approach to the corresponding development in terms of transformation practices by prioritizing area-based transformation, and presents conceptual studies that will reflect transformation strategies on maps of appropriate scale within a determined program Directorate General for Infrastructure and Urban Transformation Services (2019b) (accessed date: 13.07.2023).

The Strategy Document for Urban Transformation, which is to be crafted and presented to the Ministry, is a responsibility of metropolitan municipalities, provincial municipalities, and/or municipalities, as well as Special Provincial Administrations. In this context, a) Metropolitan municipalities shall prepare the Strategy Document for the entire administrative boundary, and provincial and city municipalities and special provincial administrations are responsible for the preparation of the Strategy Document. b) Municipalities located within the metropolitan municipality boundary are responsible for the preparation of the Strategy Document for the entire administrative boundary of the district if they obtain the consultation of the metropolitan municipality. c) Outside the boundary of the municipality and its adjacent area, it shall be prepared under the leadership of Special Provincial Administrations with the cooperation of all local municipalities.

Content of the Strategy Document

The Strategy Document for Urban Transformation should consist of sections containing the following information, documents, analyses, and other materials can be listed as (1) Analysis of the overall city and data collection, (2) Prioritization of transformation areas, (3) Determination of the legal basis, (4) Determination of financial management, (5) Establishment of the calendar for the implementation of the urban transformation, (6) Definition of design principles.

2.7.8 Current Urban Transformation Situation in Literature

The literature reveals that there are a wide variety of concepts and discussions on urban transformation. Here, issues such as what the concept of urban transformation is and how it matches with the concepts of resilience and sustainable development in terms of theory and practice are discussed intensively. The main purpose of this thesis is to explain how urban transformation can be used as a hazard mitigation strategy and to clarify the implementation methods and strategies. In this context, the previous sections have tried to explain disaster, sustainability, and urban transformation concepts. In this section, the recent concept of prioritizing the enhancement of social values over the interests of real estate and construction investors in the current system will be discussed, followed by a brief overview of the state of urban transformation in Türkiye and Izmir.

2.7.8.1 The Need to Transition from Investor Capital to Social Capital

Rapid urbanization has long recognized that real estate development is at the heart of urban transformation and identified real estate investment as the primary driver of such transformation. The main sources of financing based on land capital include a number of different strategies. According to T. Shen, Yao, and Wen (2021), these strategies include, but are not limited to, increasing the floor area ratio to generate funds through the sale of excess building areas, changing property rights (particularly in relation to rural collective land and state land) to improve the market liquidity of assets, changing land use types to generate a premium (i.e., converting land with a lower market price - such as industrial or commercial land - to land with a higher market price, such as residential land), increasing the use value without changing the land use (e.g., by converting low-income communities into high-income communities) to generate capital gains from gentrification. Although these approaches have played an important role in urban transformation projects, they are not equally applicable to the renewal of old residential areas.

Initially, increasing the floor area ratio as the primary means of financing urban renewal tends to focus on land financing for prime land development. The capital for urban transformation is derived from the sale of the increased building area in the real estate sector. However, this funding channel is not sustainable for older urban settlements. On the one hand, increasing the floor area ratio often requires extensive demolition, reconstruction, and relocation, which is extremely difficult in old settlements that have been in use for many years and have high population densities. On the other hand, the redevelopment of old settlements is a continuous process that involves not only renovation and reconstruction in the early phase, but also operation and maintenance in the later phase. Even if increasing the floor area ratio can achieve financial equilibrium in the early renovation phase, there are hidden financial risks in the later maintenance and operation phase. Increasing the floor area ratio usually increases the population density of the community. For example, the educational services of the community's elementary schools are initially balanced with the educational needs of the community's residents, but with more residents, this balance is upset, increasing the future fiscal burden instead of creating new tax sources. The same is true for other public services, from transportation, public safety and fire protection to water and sewer. If there is no new source of revenue to cover the shortfall resulting from increased utility expenditures, the result will be a fiscal imbalance in the operations and maintenance phase (T. Shen, Yao, and Wen 2021).

The primary dynamic in the development of society can be traced to the transition from the accumulation of property rights to the formation of social rights. This transition has been a critical component in the advancement of the civilization of humanity and the development of modern societies. The shift from land capital to social capital has been a defining characteristic of societal evolution over time. It has irrevocably changed the way society’s function and relate to each other. This change has been the indispensable driving force behind the advancement of human society and has played an influential role in determining the direction of history. (T. Shen, Yao, and Wen 2021).

In addition to increasing the floor area ratio, it is also difficult to change property rights in inner-city districts with complex property rights and multiple stakeholders with conflicting interests. In addition, the main goal of urban redevelopment is to improve the living conditions of residents. Converting residential areas to commercial functions is difficult and has high social costs. Finally, gentrification, which has been an urban regeneration trend in western countries in recent years, is emerging as a serious problem for Türkiye. The rehabilitation of disaster-prone and dilapidated residential areas should be considered a public project, and the increase in property value resulting from the rehabilitation should be given to the legitimate property owners. Gentrification, where low-value property owners are replaced by high-value property owners, leads to serious social and economic problems. (T. Shen, Yao, and Wen 2021).

It is obvious from this analysis that financing sources based on real estate investment and real estate finance cannot be applied to the regeneration of existing settlements. The key to solving this problem is to find a driver other than land capital that can provide sustainable development for the regeneration of existing settlements. Social enterprises need to be engaged to improve the social environment, facilities, and services, and to strengthen networks of relationships between different social actors. Increased social capital allows the social enterprise to charge a reasonable fee during the operation and maintenance phase, while reducing costs as more participants are involved in community governance. Thus, the accumulation and development of social capital provides a sustainable engine for transformation. (T. Shen, Yao, and Wen 2021).

2.7.9 Current Urban Transformation Situation in Türkiye

Recently, there has been an unprecedented emphasis on the integral role of municipalities in the urban transformation of our cities (Demirkan 2022). Nevertheless, the frequent change of municipal administrations often leads to the suspension, delay or even cancellation of certain projects initiated in previous periods. In order to avoid this situation, it is essential that the urban transformation projects initiated by the municipalities in each political period are continued in the new period. In the event that urban transformation projects are extended to different political periods, it is imperative that they be continued in the new period after cursory evaluations. The decisions made prior to the implementation phase are of paramount importance for the efficient implementation of the plans and projects formulated in the sectors designated for urban transformation, to mitigate the conflicts of power and ownership between institutions and organizations, and to facilitate the rapid and effective implementation of the applications.

Demirkan (2022) has some recommendations which are proposed for the area in which the urban transformation project is to be studied: First, it is essential to conduct a thorough analysis of the suitability for transformation in the designated areas and prioritize implementation accordingly. Second, the nature of the project (whether it is renewal, revitalization, redevelopment, or other) must be fully disclosed, along with objective justifications and the perspectives of all stakeholders. Third, the conditions of the urban space must be scrutinized, highlighting the strengths, weaknesses, opportunities, and potential risks, using a strategic planning technique known as SWOT. Fourth, urban transformation plans, and design schemes must be developed with a variety of alternatives. Fifth, the implementation area should be selected from the options where consensus can be reached with the highest possible participation. Sixth, a comprehensive strategy should be adopted to address the challenges in the transformation area in a balanced, organized, and constructive manner. In addition, the optimal use of urban resources (including land, buildings), the economy, natural resources, and human resources should be ensured, considering the existing potential in the implementation areas. In addition, the expected value creation from transformation projects should be determined and a systematic implementation plan for value-based applications should be formulated. In addition, the participation and distribution of value in urban transformation practices should be established, and the resulting value should be shared transparently and equitably with all stakeholders. Finally, it is crucial to be able to update and revise implementation expectations as needed according to differentiated needs and changing conditions.

2.7.10Current Urban Transformation Situation in Izmir

According to the Provincial Directorate of Ministry of Environment, Urbanization and Climate Change in Izmir, the average building age in Izmir Province is 25 years or older. Notably, approximately 65% of these buildings are classified as illegal or squatter, as indicated in chamber of accounts reports. The institution has identified a 918.2-hectare area under Law No. 6306 and a 305.47-hectare area under Law No. 5393 – Article No.73 as 'hazard-prone' or designated for 'urban transformation and redevelopment'. These areas in Izmir are targeted for transformation of risky zones, as of data up to 2017 (Provincial Directorate of Ministry of Environment 2016) (accessed date: 19.06.2017). In this 1223.67-hectare area Ministry of Environment, Urbanization and Climate Change, The Izmir Metropolitan Municipality, in collaboration with the Provincial Directorate of the Ministry of Environment, Urbanization, and Climate Change, has set forth to devise urban renewal strategies. Their objective is to methodically transform these designated areas through various projects and methodologies.

Conversely, a status report on individual risky buildings from the Provincial Directorate of the Ministry of Environment, Urbanization, and Climate Change in Izmir, dated 22.02.2016, reveals some startling numbers. As per the report, accessible at (Provincial Directorate of Ministry of Environment 2016) (accessed date: 13.07.2023), there are 9,271 buildings categorized as 'risky'. These buildings collectively house a total of 21,263 independent units, encompassing both residential dwellings and workplaces.

Izmir Metropolitan Municipality Department of Urban Transformation is another responsible authority that carries out large-scale urban transformation projects in Izmir. The website of the Department of Urban Transformation (IMMDoUT 2023) outlines the main objectives of its projects as follows. The Department of Urban Transformation operates on the foundational principle of revamping socio-economically disadvantaged areas that are burdened with insufficient infrastructure and superstructure. The department targets built-up regions with structures that deviate from established urbanization principles, master plans, zoning regulations, and building construction standards. The plan is to demolish these non-compliant buildings and infrastructures and subsequently reconstruct them in adherence to recognized scientific and artistic norms. The projects are carried out through a participatory process and are planned with the approval of 100% of the neighborhood residents and in a way that ensures that they can resettle within their neighborhood boundaries without losing any of their rights. Izmir Metropolitan Municipality acts as a guarantor and intermediary between the citizens and the construction companies in accordance with the projects prepared and the sharing model determined. The title deeds of the beneficiaries are temporarily transferred to the name of the Metropolitan Municipality for urban transformation, and upon completion of the construction of the new houses, the condominium title deeds are registered and delivered to the beneficiaries. The projects aim to preserve the existing cultural and historical heritage while reorganizing the residential areas into healthy urban neighborhoods and sustainable structures.

According to Izmir Metropolitan Municipality Department of Urban Transformation (2023), the Municipality continues urban transformation works on a total area of 248 hectares in 6 regions, the smallest of which is 7 hectares and the largest of which is 122 hectares. In the ongoing reconciliation negotiations in the transformation areas, the construction works is started in stages to realize the project quickly in the areas where 100% reconciliation is achieved. During the ongoing reconciliation negotiations in the transformation areas, the construction works will be initiated on the one hand, and in the completed construction phases, the deliveries will be made, and the life of the rightful owners will begin in their new residences.

2.7.11 The Role of Urban Transformation in Hazard Mitigation

This chapter argues that the challenges faced by areas requiring urban transformation go beyond mere urbanization issues. While urban deterioration, obsolescence, the emergence of abandoned regions, and the devaluation of urban areas are pressing concerns, especially in developed countries, it is imperative to also consider broader themes. These include Resilience, Disaster Management, Hazard Mitigation, Sustainability, and Sustainable Urbanization. A holistic approach ensures a comprehensive understanding and solution framework for these urban challenges.

Within this context, the vulnerabilities of specific urban segments are categorized under headings such as Physical Problems, Economic Issues, Social Concerns, Environmental Dilemmas, Legislative and Institutional Challenges, and matters related to Planning, Design, and Technological Structures. The discourse further delves into

Natural Hazards, Disasters, Urban Resilience, Disaster Management, and Hazard Mitigation, offering a detailed exploration. Concepts like Sustainability, Urban Sustainability, and Sustainable Development are elucidated. An emphasis is placed on understanding Urban Transformation as a mechanism for Hazard Mitigation. The discussion presents an overview of urban transformation, exploring its definition, historical context, methodologies, and strategies. This is further illuminated through the lens of Procedural Types of Urban Design, identifying it as a strategy for city transformation. Additionally, the legal frameworks governing Urban Transformation in Türkiye are elaborated upon, and a brief analysis of the current state of urban transformation in both Türkiye and Izmir is provided.

Following this section, there will be an in-depth discussion on Multi-Criteria Decision-Making (MCDM). This will provide insights into how urban transformation can be assessed in relation with MCDM methodologies.

CHAPTER 3

URBAN TRANSFORMATION AND MULTI-CRITERIA DECISION-MAKING METHODS

In the third chapter, methodology of the Decision Problems, Decision Theory and Multi-Criteria Decision-Making (MCDM) and the selected methods will be clarified to evaluate the integrated model.

In daily life, people face a variety of decision problems for an infinite of purposes. The act of decision-making involves the function of selecting among a variety of available alternatives with the ultimate goal of realizing predetermined goals and achieving established objectives. There are various definitions of decision-making, each with its own unique perspective. One such definition states that a decision is a choice between two or more alternatives that involves an irrevocable allocation of resources. Another definition emphasizes that decision-making is a process of selecting among alternative courses of action in a situation of uncertainty.

The characteristics of decision-making are diverse and can be described by Karagöz and Tecim (2018) as follows: (1) The decision is future-oriented, with the ultimate goal of achieving predetermined objectives; (2) The decision maker assumes responsibility for the decision process, with the costs associated with such a decision being considered a critical element; (3) The decision function is a critical component of the overall decision process, with the decision itself representing the culmination of that process.

In cases where one does not have complete information about the issue to be decided, certain methods can be used to facilitate the decision-making process. Common features of these decision techniques include decision points, variables, and variable weights.

The stages of the decision process can be categorized by Yaralıoğlu (2010) as follows: (1) Defining the problem; (2) Gathering information about the problem; (3) Classifying and analyzing the information gathered; (4) Exploring available options; (5) Determining the most appropriate option; (6) Making a decision about the chosen option;

(7) Implementing the chosen option; (8) Evaluating the implementation of the chosen option.

A variety of factors can influence the decision-making process when attempting to solve a particular problem. For example, decision points (also known as decision preferences) must be evaluated, each with a unique set of parameters or variables. When only one variable affects the decision problem, the problem can be easily solved using simple methods. However, as the number of variables involved in the problem increases, the problem becomes more complex, leading to multi-criteria decision problems.

3.1 Decision Problems

In comprehensive research cited by Ishizaka and Nemery (2013), Roy (1981) outlined four principal decision problem categories:

1. Choice Problem: This involves identifying the optimal choice from a range or narrowing down to a subset of equally viable options.

2. Sorting Problem: Options are categorized into pre-established, sequential groups based on common attributes. Ideal for routine tasks, this method can also preliminarily filter options for later consideration.

3. Ranking Problem: Here, options are sequenced from best to worst through scores or comparisons. This sequence can be either partial, with some options being incomparable, or complete.

4. Description Problem: This focuses on detailing options and their outcomes, typically serving as an initial step in comprehending a decision issue.

In addition to the four primary categories of decision problems, the MCDA community has proposed two additional types of problems.

1. Elimination Problem: Introduced by Costa (1996), this is a subcategory of the sorting problem, focusing on the exclusion of certain options (cited by: Ishizaka and Nemery 2013).

2. Design Problem: As proposed by Keeney (1992), it is centered on pinpointing or devising new strategies aligned with a decision-maker's objectives (cited by: Ishizaka and Nemery 2013).

Ishizaka and Nemery (2013) also suggest incorporating the 'elicitation problem', which seeks to retrieve preference specifics or subjective details for an MCDM approach. When multiple decision-makers are involved, adopting a suitable group decision technique becomes crucial. Notably, a plethora of decision problems can merge various aforementioned challenges.

Multi-Criteria Decision-Making (MCDM) methods support the decision maker in their unique decision-making journey. Acting as decision aids, MCDM approaches guide towards balanced solutions, emphasizing the central role of the decision maker. Unlike one-size-fits-all methods, MCDM adapts solutions based on the decision maker's subjective or preference information. Spanning across fields like mathematics, management, computer science, and social sciences, MCDM's is an interdisciplinary field. It addresses both strategic and tactical decisions, adaptable to the time scale of the outcomes (Ishizaka and Nemery 2013).

Table 7: Category of Decision Problems
(Source: Ishizaka and Nemery 2013, 2)

Decision	**Time Perspective**	**Novelty**	**Degree of Structure**	**Automation**
Strategic	long term	new	low	low
Tactical	medium term	adaptive	semi-structured	middle
Operational	short term	everyday	well defined	high

The field of multi-criteria problem-solving is continuously evolving, emphasized by studies like those by Wallenius et al. (2008, cited by Ishizaka and Nemery 2013). The rising volume of MCDM research highlights the effectiveness of these techniques adapted for specific challenges. Tools, from spreadsheets to specialized software and mobile applications, have further boosted the accessibility and popularity of MCDM methods among both researchers and practitioners (Ishizaka and Nemery 2013).

3.2 Decision Theory

Decision theory is a field of immense importance and relevance in our time, with roots in applied probability theory and analytic philosophy. This field is concerned with the intricate and complex process of decision-making, which involves assigning probabilities to various factors and determining the numerical consequences of the outcome. (Wikipedia contributors 2023)

There are three distinct branches of decision theory, namely, normative decision theory, prescriptive decision theory, and descriptive decision theory. (Wikipedia contributors 2023)

(1) Normative decision theory is concerned with identifying optimal decisions, where optimality is often determined by considering an ideal decision maker who is able to calculate with perfect accuracy and is fully rational. This branch of decision theory is of great importance and relevance today, as it provides insight into the ideal decision-making process. (2) Prescriptive decision theory, on the other hand, is concerned with describing observed behavior using conceptual models, under the assumption that decision makers behave according to some consistent rules. Finally, (3) descriptive decision theory analyzes how individuals make the decisions they make. (Wikipedia contributors 2023)

Decision theory is an interdisciplinary field studied by management scholars, medical researchers, mathematicians, data scientists, psychologists, biologists, social scientists, philosophers, and computer scientists. The empirical applications of this theory are typically done using statistical and discrete mathematical approaches from computer science. Normative and descriptive theory is concerned with the identification of optimal decisions, where optimality is often determined by considering an ideal decision maker who is able to calculate with perfect accuracy and is fully rational. The practical application of this prescriptive approach is called decision analysis, which aims to find tools, methods, and decision support systems to help people make better decisions. (Wikipedia contributors 2023)

In contrast, descriptive decision theory is concerned with describing observed behavior, often under the assumption that decision makers follow some consistent rules. These rules may, for example, have a procedural or axiomatic framework that reconciles the von Neumann-Morgenstern axioms with behavioral violations of the expected utility hypothesis, or they may explicitly give a functional form for time-inconsistent utility functions. Prescriptive decision theory is concerned with behavioral predictions made by positive decision theory to allow further testing of the kind of decision-making that occurs in practice. In recent decades, there has also been a growing interest in 'behavioral decision theory', which has contributed to a reevaluation of what is required for useful decision-making (Wikipedia contributors 2023).

3.3 Decision-Making

The process of reaching a decision is complex and multidimensional, requiring the recognition of difficulties, the evaluation and creation of alternatives, and the selection of the most advantageous course of action. Decision theories can help us understand the cognitive processes involved. The decision-making process involves a series of steps that individuals must follow to reach conclusions. The quality of decisions can be assessed through decision analysis. Decision-Making involves problem solving to arrive at a satisfactory or optimal solution, which may be based on logical or illogical reasoning, as well as explicit or implicit understandings and beliefs. Implicit knowledge is often used to fill gaps in complex decision-making processes, and both implicit and explicit knowledge may be used.

A key aspect of decision-making is the evaluation of a finite set of alternatives based on evaluative criteria. The alternatives may need to be ranked in terms of their attractiveness to the decision makers when all criteria are considered simultaneously, or the best alternative may need to be identified, or the relative overall priority of each alternative may need to be determined when all criteria are considered simultaneously. The field of MCDM is dedicated to addressing such issues. Although an emergent field, MCDM still continues to interest and be debated by many researchers and practitioners because different MCDM methods can produce different results when applied to the same data. This leads to a decision paradox. Rational reasoning is a fundamental component of all science-based professions, where professionals use their expertise to make informed decisions. However, research on social decision-making shows that in situations of increased time pressure, higher uncertainty, or increased complexity, experts may use intuitive decision-making rather than structured approaches. In such situations, they may follow a cognitive decision based on their experience and decide without weighing alternatives.

3.3.1 Characteristics of Decision-Making

Ramasamy (2008) outlines the primary features of the decision-making process as follows:

1) Decision-making is a systematic selection process, choosing the best from multiple alternatives. If only one clear option exists, decision-making is not necessary.
2) It is the culmination of discussions and evaluations of these alternatives.
3) Decision-making largely engages intellectual capabilities; only a profoundly intelligent person can consistently make wise decisions.
4) Gathering pertinent information enhances the satisfaction derived from decision-making.
5) It is a dynamic process, with numerous decisions required daily.
6) Decisions are always contextual, based on current situations. Different situations might prompt different decisions for the same problem due to evolving circumstances.
7) The primary aim of making decisions is to fulfill organizational objectives.
8) Decision-makers have the autonomy to allocate and utilize resources as they see fit.
9) The process involves critically assessing the available alternatives.
10) Decisions can be directive or prohibitive, instructing others to execute or refrain from a particular action.

3.3.2 Decision Support System

Decision Support Systems (DSS) are advanced computer-based information systems that assist decision makers in selecting one of many alternative solutions to a problem. The majority of decision processes can be analyzed in a computer based DSS that quickly analyzes comprehensive and large amounts of data. DSS helps organizations make decisions that improve effectiveness, reduce costs, increase profitability, and improve quality. A computer-based information system known as a CIS is interactive and consists of an organized collection of models, people, processes, software, databases, telecommunications, and devices. CIS helps decision-makers solve unstructured or semi-structured decision problems (Tripathi 2011).

A Decision Support System (DSS) is a computer-based information system that is interactive, adaptable, and customizable as Tripathi (2011) mentioned. It uses rules, models, and model bases for decision making, including a comprehensive database and the opinion of the decision maker, to generate specific, feasible decisions for solving problems that do not conform to administrative scientific models. A DSS enhances the efficacy of complex decision-making processes.

Sprague (1980) defines a properly identified decision support system as follows:

1. It is conformed for the complex, less-defined challenges often encountered by top-tier managers.

2. It integrates both analytical tools and traditional data retrieval systems.

3. It is designed to be user-friendly, catering to those without extensive computer expertise.

4. It prioritizes adaptability and flexibility, allowing it to accommodate changes in both the external environment and the user's decision-making style.

Particularly, knowledge-based systems are a subset of DSS. At its core, a well-designed DSS offers an interactive platform that combines data, business models, documents, and personal expertise to facilitate problem-solving and decision-making.

According to Zopounidis and Doumpos (2000), since decision problems are often complex, a pragmatic and flexible approach is required. It is crucial to consider all relevant factors. Multi-criteria decision analysis (MCDA) presents a useful methodology for addressing the multidimensional nature of these problems. MCDA involves analyzing and modeling the preferences of the decision maker. Therefore, it is recommended to develop a model that meets the requirements of the decision maker rather than building a comprehensive model of the decision situation. However, constructing this model necessitates an ongoing effort until the preferences of the decision maker are represented in a more comprehensive approach.

3.4 Multi-Criteria Optimization (MCO) Techniques

Historically, the focus of problem solving has been on the optimization of a single criterion. However, several researchers have emphasized the importance of considering two or more criteria simultaneously, thus creating the need for the application of Multi-Criteria Optimization (MCO) techniques. This type of optimization, which involves the consideration and analysis of policies, has been extensively studied in the literature relevant to this particular aspect of the optimization problem. Sabaei et al. conducted a review of Multi-Criteria Decision-Making (MCDM) techniques with the objective of improving supply, and specifically focused on the Multi-Attribute Decision-Making (MADM) class of methods (Syan and Ramsoobag 2019).

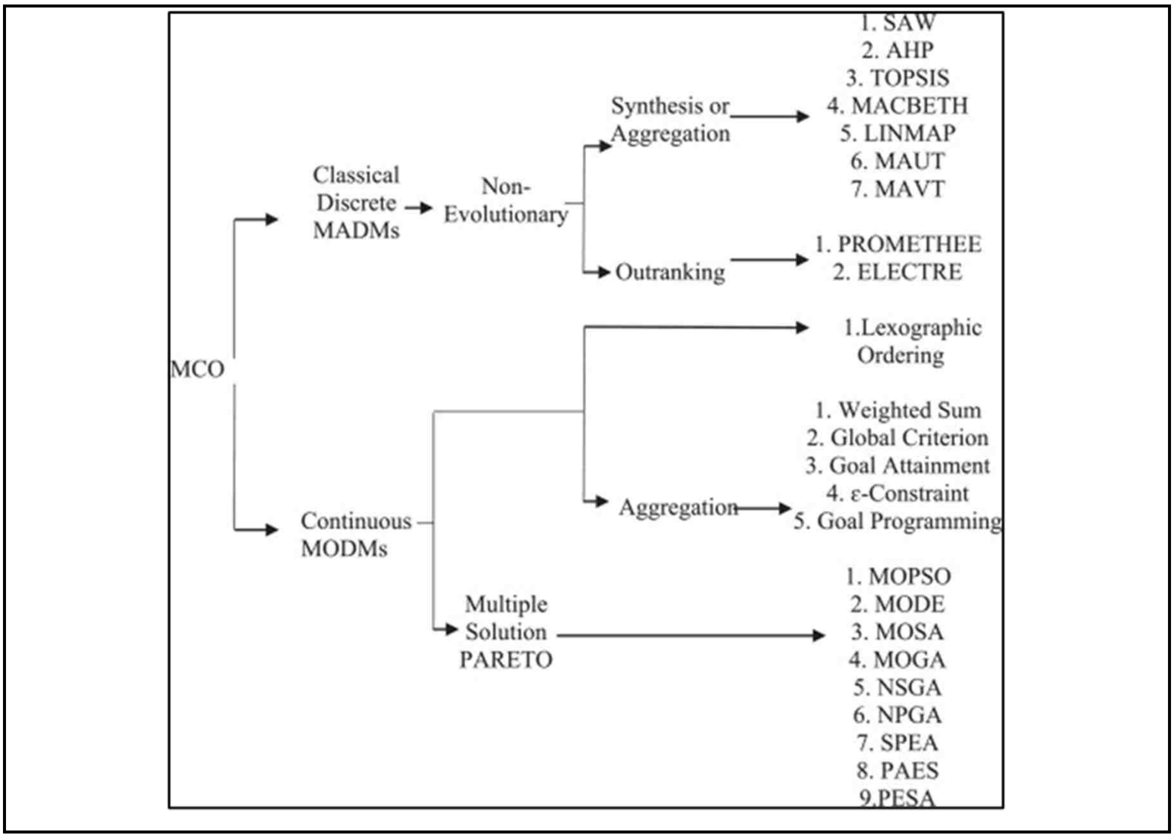


Figure 21: Classifications of MCOs found in the literature.
(Source: Syan and Ramsoobag 2019, 4)

The techniques used in the context of Multi-Criteria Optimization (MCO) have been classified into two broad categories, namely Multi-Attribute Decision-Making (MADMs) and Multi-Objective Decision-Making (MODMs) techniques. Classical discrete MADMs techniques have been further classified into three subcategories, namely non-evolutionary synthesis, aggregation, and outranking. It is worth noting that a total of nine MADMs have been identified, of which seven are aggregation techniques. Moreover, PROMETHEE and ELECTRE were identified as the two outranking techniques. On the other hand, continuous MODMs have been categorized as Multiple Solution Pareto techniques or have also been applied through aggregation or lexicographic ordering methods. It is significant that a total of fourteen MODMs have been identified, of which nine are Pareto-based techniques and five are aggregation methods. In the process of MCO, it is essential to perform a comprehensive analysis of the process, which can be divided into four key stages, namely MCO problem definition, selection of criteria and alternatives, constraints selection (Syan and Ramsoobag 2019).

Table 8: Techniques Applied for Multi-Criteria Optimization
(Source: Redrawn from Syan and Ramsoobag 2019, 6)

	Technique Name	Key Principles	Reference/Authors	Application/s
1	AHP	Pairwise hierarchical structure for prioritization	Babashamsi et al., Mancuso et.al., Zaim et al, Parmar et al, Nwogbe, Nordgard et al, Maletic et al, Muinde et al., Goossens and Basten, Chandrahas et al, Cai et al.	Pavement Maintenance Activities, Machines in a Newspaper printing house, Wire Manufacturing Industry, Offshore Compressor, Norwegian Power Equipment, Paper Mill production system, Cement Industry
				Naval Ship Maintenance
2	VIKOR	Ideal point technique applied based on a Minimized distance evaluation from Positive Ideal Solution (PIS)	Babashamsi et al.	Pavement Maintenance Activities
3	ANP	Applied using a Super Matrix for relative importance, Weighted Super Matrix for assessing the value of each cluster and Limit Matrix for producing the limit value and scoring	Zaim et al., Pourjavad et al.	Machines in a Newspaper printing house
				Mills in the Mining Industry
4	PROMETHEE	Outranking principles are applied	Ighravwe and Oke	Cement Production plant maintenance planning
5	TOPSIS	Ideal Point technique: Distance Minimization from Positive Ideal Solution (PIS) and Distance Maximization from Negative Ideal Solution (NIS)	Shahin et al.; Siew-Hong & Kamaruddin	PM planning of Coating machines to produce electronic circuit panels
				Mills in the Mining Industry
6	COPRAS	Determines solutions with the ratio to the best solution.	Fouladgar et al.	Dump Truck Maintenance strategies for a Copper Mine
7	MAVT	Performance scales are assigned to the decision alternatives and assessed.	Mancuso et al.	RBM planning for Pipeline networks
8	MACBETH	An interactive approach based on cardinal measurement	Carnero and Gómez	Thermal Energy Production Systems
9	MOGA	Utilizes the basic principles of GA, including population initialization, Crossover, and Mutation.	Busacca et al.	Offshore Separator Vessel
			Siddiqui et al.	Naval Ship Systems
			Gao et al.	Pressure Safety Injection System
			Chikezie et al.	Coil Fire Boiler System
				Pavement Maintenance
				Gas Turbines

(cont. on next page)

Table 8 (cont.)

	Technique Name	Key Principles	Reference/Authors	Application/s
10	NSGA II	Utilizes a Fast Non-Dominated Sorting technique, Crowding distance calculation to eliminate the need for parameter specification, an Elitist Preserving approach	Piasson et al.	Electrical Transmission System
				Hubcap Production System
			Yang et al.	Pavement Management System
			Goti and Garcia	Substation Components
			Compare et al.	
11	SPEA II	Improved Fitness assignment scheme	Wang et al.	Rail System
		External Archiving	Liu et al.	Water Pumping Distribution
		Nearest neighbor for precise guiding and diversity of the estimation process	Lesinski	
12	MOPSO	Utilizes the natural evolution particle swarm theory	Chalabi et al.	Wind Turbine Components
			Abdollahzadeh et al.	

3.5 Multi-Criteria Decision-Making (MCDM)

Multi-Criteria Decision-Making (MCDM), also known as Multi-Criteria Decision Analysis (MCDA), is a vital branch of Operations Research. Its primary role is to assess and navigate multiple conflicting criteria during decision-making. In many situations, evaluating different options often brings about conflicting criteria, demanding a comprehensive and systematic approach to making informed decisions.

While several ad hoc techniques have emerged over time to address these challenges, certain MCDM methods have gained widespread recognition, especially those that come with supporting software packages. These key methods, along with their specific variants, are given in detail in Table 8. It is crucial to understand, however, that the landscape of decision-making methods is vast, and the ones discussed represent just a fraction of the available techniques (Ishizaka and Nemery 2013).

Two basic approaches to multiple criteria decision-making (MCDM) problems can be observed in the literature: multiple attribute decision-making (MADM) and multiple objective decision-making (MODM). MADM problems differ from MODM problems in that they involve the design of the ‘best’ alternative by considering the tradeoffs within a set of interacting design constraints. On the other hand, MADM refers to making choices among different courses of action in the presence of a large number of usually conflicting attributes. In MODM problems, the number of alternatives is effectively infinite, and the tradeoffs among design criteria are typically described by continuous functions (Kahraman and Du 2008).

MADM is the best-known branch of decision-making, as it is a branch of a general class of operations research models that deal with decision problems in the presence of multiple decision criteria. The MADM approach requires that the choice (selection) be made among decision alternatives described by their attributes. MADM problems are assumed to have a predetermined, limited number of decision alternatives. Solving a MADM problem involves sorting and ranking. MADM approaches can be viewed as alternative methods for combining the information in a problem's decision matrix with additional information from the decision maker to determine a final ranking, screening, or selection among the alternatives. In addition to the information contained in the decision matrix, all but the simplest MADM techniques require additional information from the decision maker to arrive at a final ranking, screening, or selection (Kahraman and Du 2008).

Unlike the MADM approach, the MODM approach does not have predetermined decision alternatives. Instead, MODM provides a mathematical framework for generating a set of decision alternatives. Each alternative, once identified, is evaluated based on how close it comes to meeting one or more objectives. In the MODM approach, the number of potential decision alternatives can be large. Solving a MODM problem involves making a selection (Kahraman and Du 2008).

3.5.1 Multiple Attribute Decision-Making (MADM)

MADM methods can be classified as compensatory or non-compensatory based on their management of attribute information. According to Aghajani Bazzazi, Osanloo, and Karimi (2009), compensatory methods allow for trade-offs between criteria, while non-compensatory methods do not. The decision maker may believe that high performance on one attribute can compensate for low performance on another attribute, but only compensatory methods incorporate this trade-off (Figure 23).

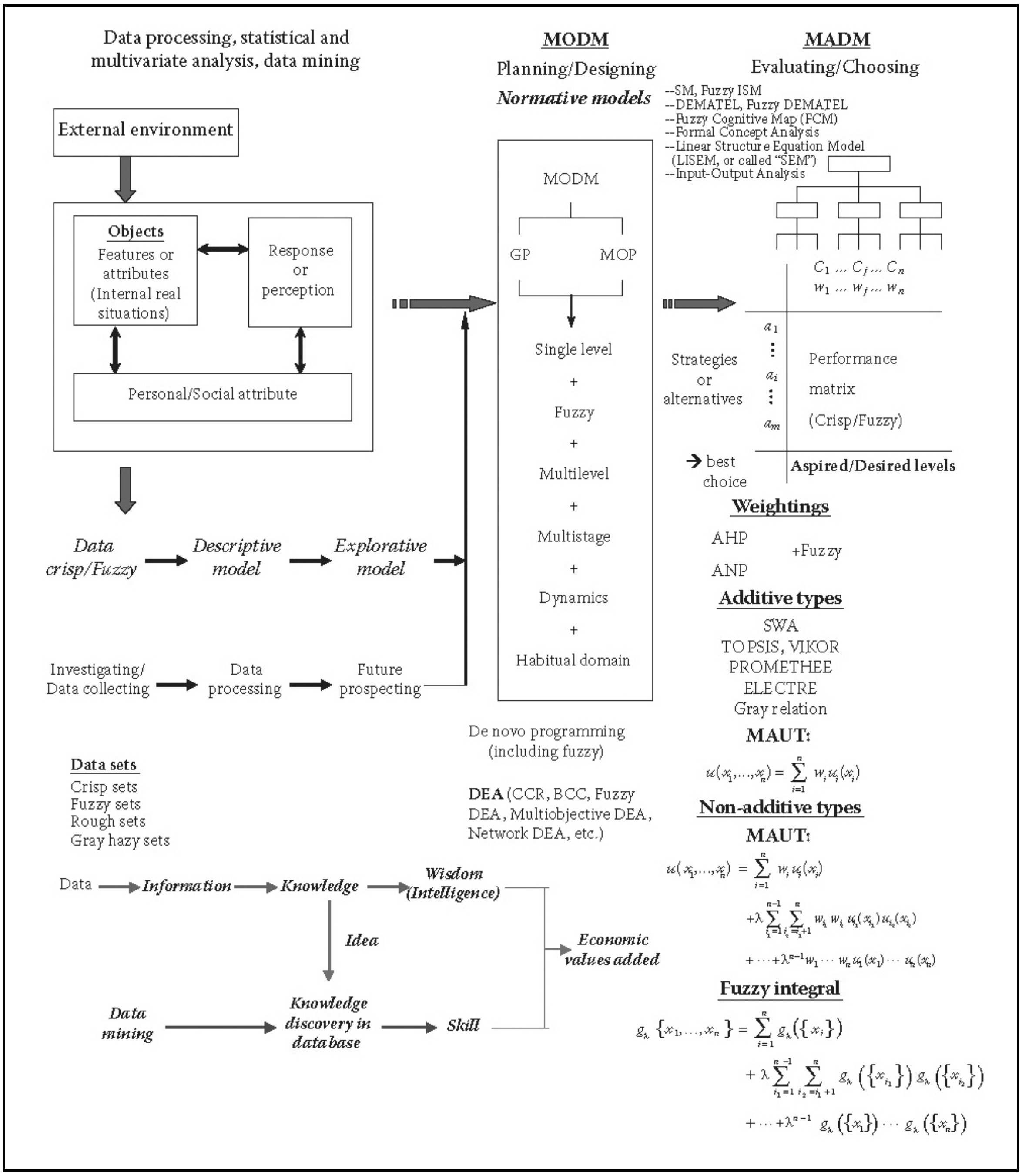


Figure 22: Profile of MCDM

(Source: Tzeng and Huang 2011, 3)

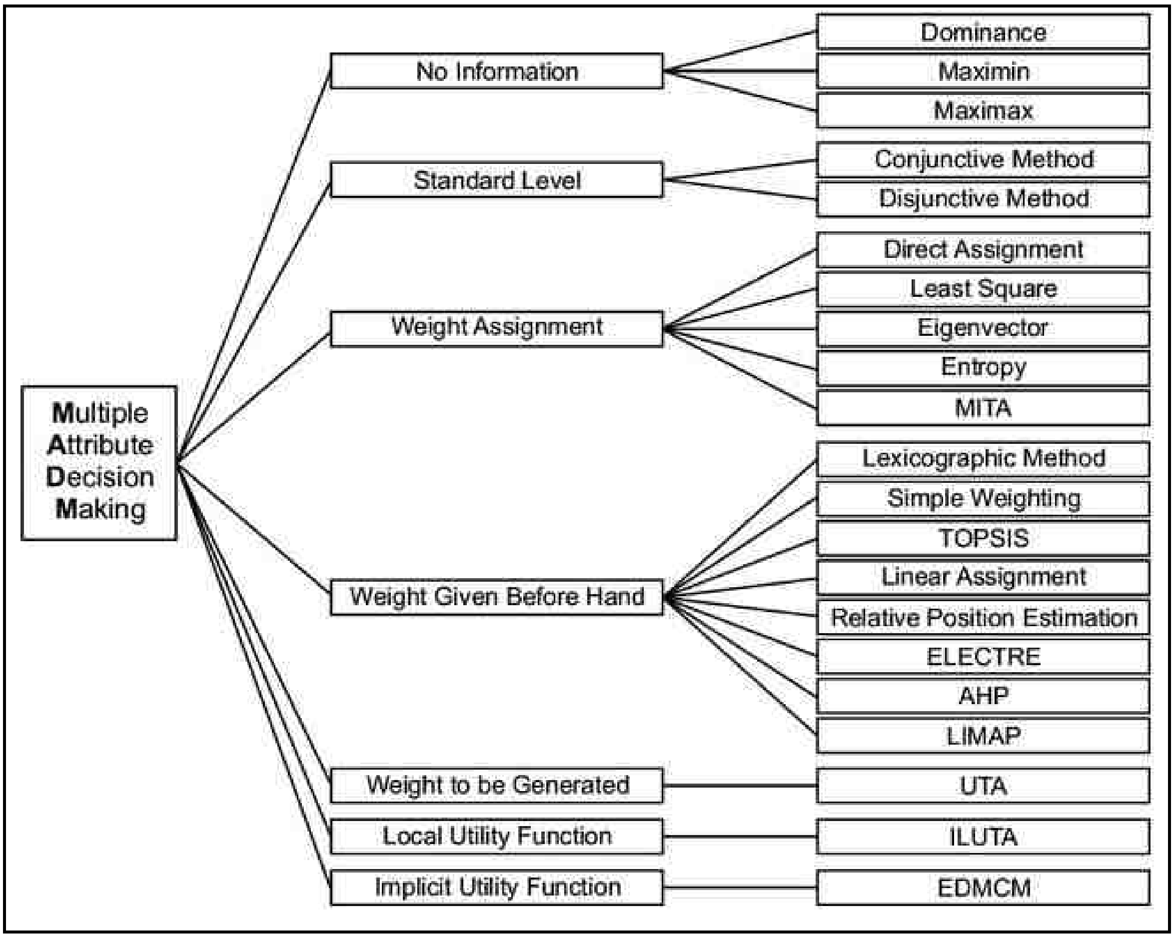


Figure 23: Classification of MADM Methods
(Source: Aghajani Bazzazi, osanloo, and Karimi 2009, 304)

It is common for criteria to interact in MCDM problems. Thus, instead of constructing complicated utility functions, ranking methods are utilized to determine the best alternative. Research has been conducted on determining fuzzy criteria when comparing preference relationships between alternatives. Although outranking methods have been suggested to address the practical issues with the utility function, the criticisms about these methods mainly revolve around the lack of axiomatic foundations, such as classical sum problems, structural problems, and non-compensatory problems. In 1965, fuzzy sets were introduced as a probable solution to linguistic or uncertain information predicaments, while also broadening the traditional set theory. Fuzzy sets have been recently integrated into MADM to solve MADM problems under subjective uncertainty, and the overall evolution of widely used MADM methods is shown in Figure 24.

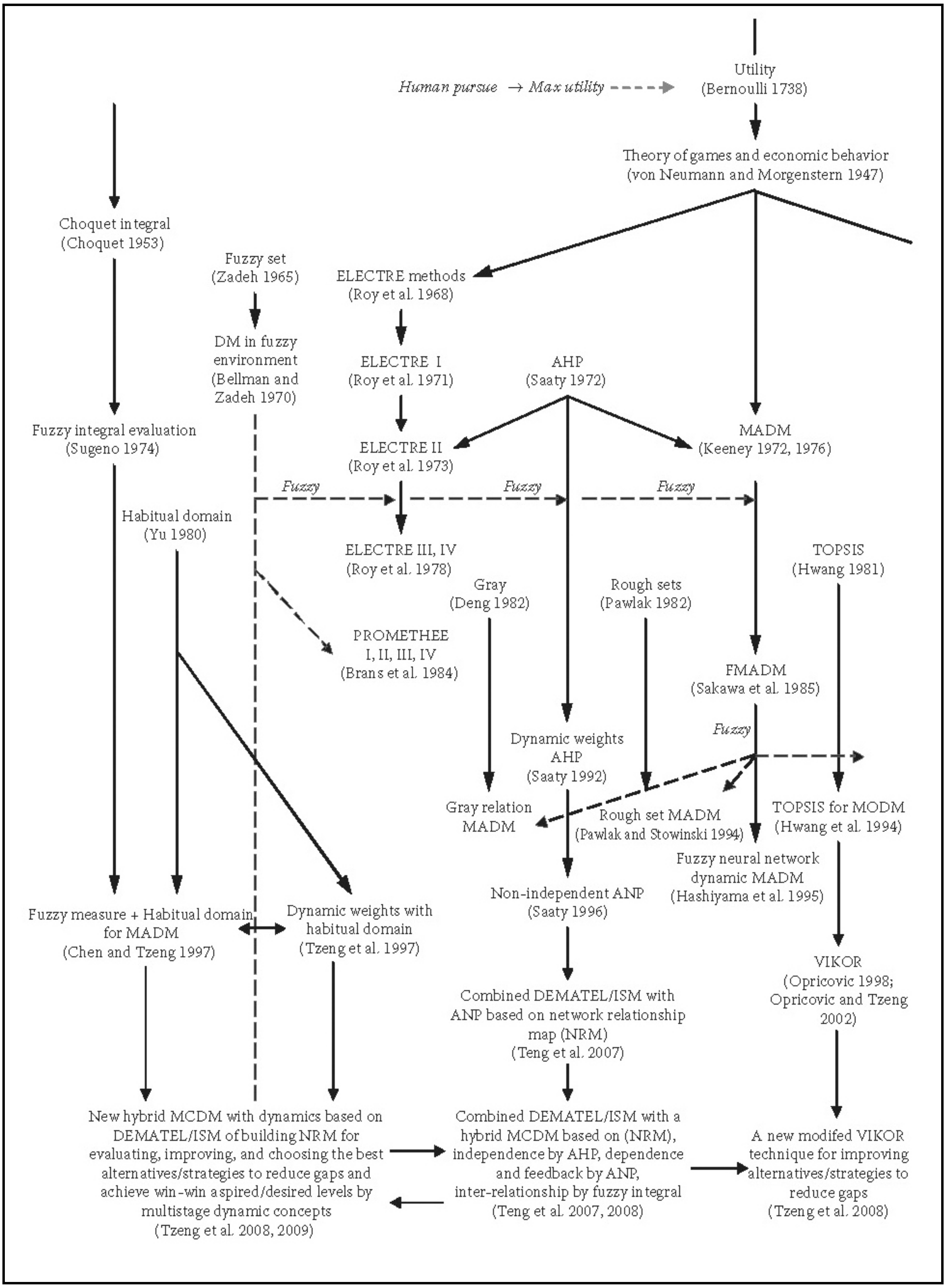


Figure 24: Development of MADM

(Source: Tzeng and Huang 2011, 5)

3.5.1.1 The Procedures of MADM

Since Bernoulli introduced the utility function concept in 1738 to highlight humanity's pursuit of utmost satisfaction, the field of human economic behavior has significantly evolved, as noted by Tzeng and Huang (2011). The 1947 game and economic behavior model by von Neumann and Morgenstern enhanced this development, laying the groundwork for Multiple Attribute Decision-Making (MADM) studies (Table 9). With the growing focus on this field, there is an increase in related literature. To provide a clearer understanding, MADM procedures can be summarized in five core steps.

First, the nature of the problem is defined. This is followed by constructing a hierarchy system for evaluation. Next, the most suitable evaluation model is selected. The fourth action consists of deriving the relative weights and performance scores for each attribute pertaining to every alternative. Subsequently, the best alternative is determined based on synthetic utilities, which aggregate the relative weights and scores of the alternatives. If these scores are indistinct, a sixth step is initiated to rank the alternatives using their synthetic fuzzy utility values (Tzeng and Huang 2011).

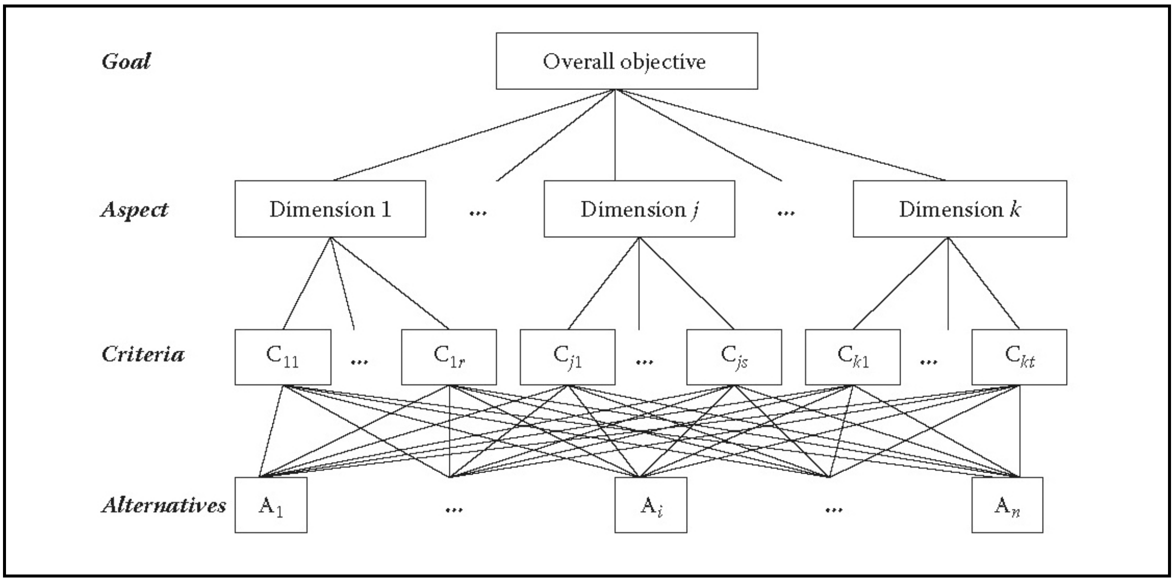


Figure 25: Hierarchical system for MADM

(Source: Tzeng and Huang 2011, 16)

Table 9: Commonly used MADM Methods.

(Source: Mitra 2022, 7520)

MCDM Methods	Acronym	Proposed by	Year	Brief Description
Weighted Sum Model	WSM	Fishburn	1967	Oldest and simplest MCDM method, also known as SAW (Simple Additive Weighting).
Elimination Et Choix Traduisant la Realite	ELECTRE	Roy	1968	Pairwise comparison based outranking method to define concordance and discordance sets of stochastic variables
Weighted Product Model	WPM	Miller and Starr	1969	Similar to WSM. Only difference is that multiplication is used instead of addition.
Analytic Hierarchy Process	AHP	Saaty	1981	Hierarchical pairwise comparison method, most widely used subjective weighting method for stochastic variables.
Preference Ranking Organization METHod for Enrichment of Evaluations	PROMETHEE	Brans and Vincke	1985	Pairwise comparison based outranking method considering stochastic variables.
Technique for Order Preference by Similarity to Ideal Solution	TOPSIS	Hwang and Yoon	1990	Universal, widely used approach which measures distance of alternatives from positive and negative ideal solutions. Highly subjective.
COmplex PRoportional ASsessment	COPRAS	Zavadskas and Kaklauskas	1996	very popular, simple and transparent approach based on utility degree of alternatives, which represents the extent to which one alternative is better or worse than the other.
VIseKriterijumska Optimizacija I Kompromisno Resenje	VIKOR	Opricovic	1998	Method to determine compromise ranking-list using stochastic variables for a set of alternatives.
Multi-Objective Optimization by Ratio Analysis	MOORA	Brauers and Zavadskas	2006	Based on two components, namely ratio system and reference point approach. Non-subjective, quite robust.
Multi-Objective Optimization by Ratio Analysis plus the full MULTIplicative form	MULTIMOORA	Brauers and Zavadskas	2010	Extended version of MOORA with full multiplicative form which embodies maximization and minimization of purely multiplicative utility function.
Additive Ratio ASsessment	ARAS	Zavadskas and Turskis	2010	Based on utility theory and quantitative measurements, it finds the utility function value as a measure of complex efficiency of a feasible alternative, which is directly proportional to the values and weights of the attributes.
Weighted Aggregated Sum Product Assessment	WASPAS	Zavadskas et al.	2012	Unique combination of WSM and WPM method.
Evaluation based on Distance from Average Solution	EDAS	Keshavarz Ghorabaee et al.	2015	Distance-based approach to calculate appraisal score of each alternative from an average solution.
Combinative Distance-based ASsessment	CODAS	Keshavarz Ghorabaee et al.	2016	Distance-based quantitative approach. Assessment score for each alternative is calculated using Euclidean and Taxicab distances from the negative ideal solution.

3.5.2 Multiple Objective Decision-Making (MODM)

The purpose of Multiple Objective Decision-Making (MODM) is to address optimal design problems that involve the simultaneous achievement of multiple and often conflicting objectives. The defining characteristics of MODM are a collection of well-defined constraints and a set of conflicting objectives. This makes it a natural fit for mathematical programming methods aimed at solving optimization problems (Kahraman and Du 2008).

In multi-objective decision-making, application functions play a critical role in measuring the degree of satisfaction of the decision maker's requirements, as Kahraman and Du (2008) mentioned. These requirements may include goal achievement, proximity to an ideal point, satisfaction, and so on. Application functions are used extensively in the process of finding 'good compromise' solutions. MODM methods can be classified in several ways, including the form of the model (linear, nonlinear, or stochastic), the characteristic of the decision space (finite or infinite), or the solution process (prior specification of preferences or interactive).

Among the many MODM methods, some noteworthy ones include Multi-Objective Linear Programming (MOLP) and its variants such as Multi-Objective Stochastic Integer Linear Programming, interactive MOLP, and mixed 0-1 MOLP. Alternative techniques include Multi-Objective Goal Programming (MOGoP), Multi-Objective Geometric Programming (MOGeP), Multi-Objective Nonlinear Fractional Programming, Multi-Objective Dynamic Programming, and Multi-Objective Genetic Programming (Kahraman and Du 2008).

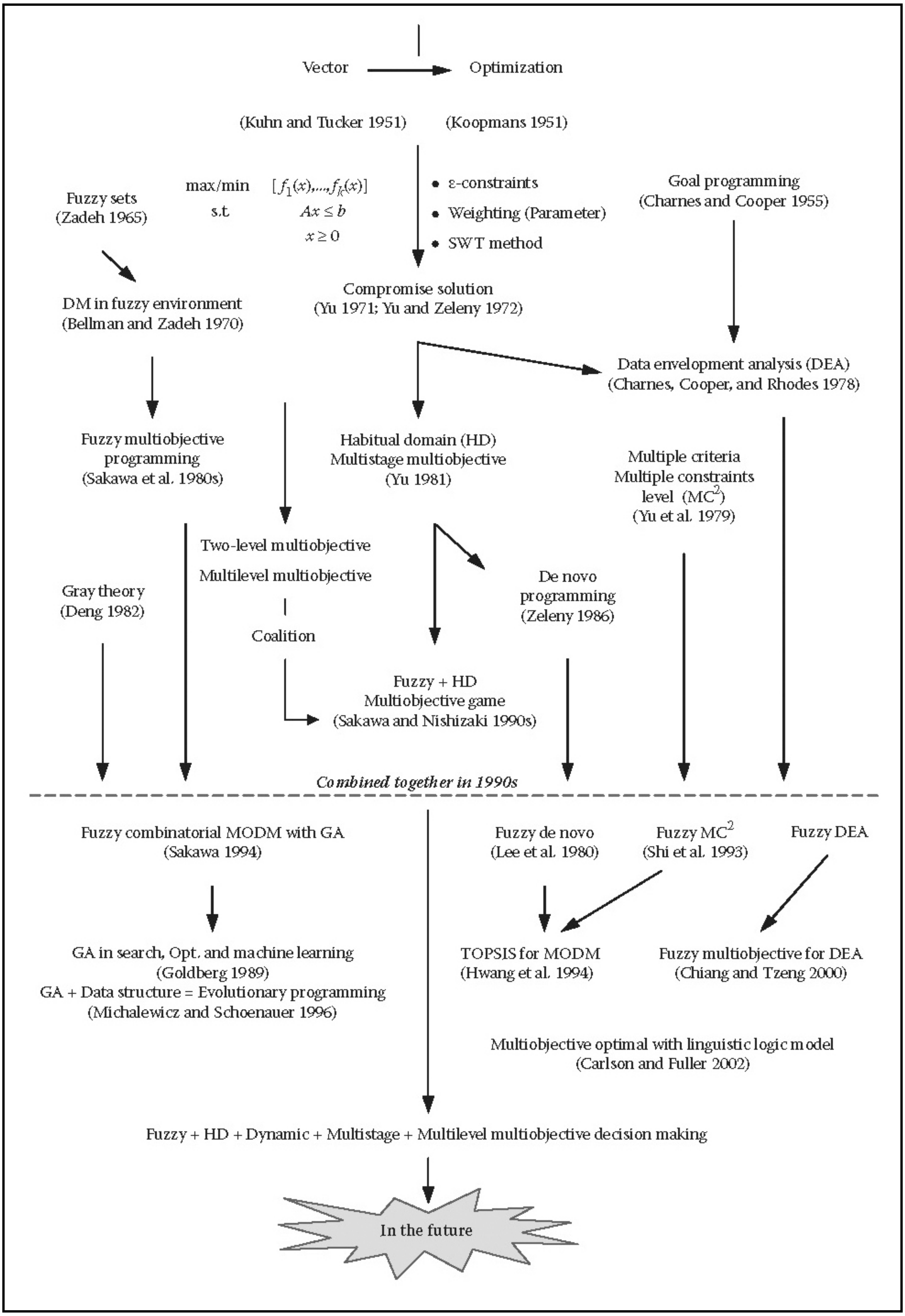


Figure 26: Development of MODM

(Source: Tzeng and Huang 2011, 6)

3.5.3 Selection of MCDA Methods

Real-world decision problems are often too complex and unstructured to be analyzed from a single criterion or perspective, as this approach would not lead to an optimal decision. According to Zavadskas and Turskis (2010), operating in the marketplace requires an understanding of the areas that create critical situations and insolvency. It is crucial to learn about the criteria that determine both the development and the demise of feasible alternatives. In a mono-criterion approach, an analyst creates a single criterion that captures all relevant aspects of the problem. However, such a one-dimensional approach oversimplifies the true nature of the problem. In many real-world decision problems, a decision maker has a number of conflicting objectives. Therefore, all new ideas and possible decision variants must be compared based on different criteria.

The decision maker's problem is to evaluate a finite set of alternatives to find the best one, to rank them from best to worst, to group them into predefined homogeneous classes, or to describe how well each alternative satisfies all criteria simultaneously. There are several methods for ranking a set of alternatives with respect to a set of decision criteria. In a multicriteria approach, the analyst seeks to construct multiple criteria from multiple perspectives. Multicriteria decision-making is one of the most widely used methods in academia, business, and government because it is based on the assumption of a complex world and can improve the quality of decisions by making the decision-making process more explicit, rational, and efficient as Zavadskas and Turskis (2010) mentioned.

In real life, a decision maker must first understand and describe the situation. According to Zavadskas and Turskis (2010), this stage includes identifying and evaluating stakeholders, feasible alternatives, a variety of different and important decision criteria, the type and quality of information, and more. This stage is the key point that defines MCDM as a formal approach. Decision criteria are rules, measures, and standards that guide decision-making. A general definition of a criterion is a tool for comparing alternatives from a particular point of view. When constructing a criterion, the analyst should keep in mind that it is necessary for all actors in the decision process to adhere to the comparisons that are derived from this model. Criteria (relatively precise, but usually contradictory) are measures, rules, and standards that guide decision-making and also incorporate a model of preferences among the elements of a set of real or fictitious actions.

Classical methods for multicriteria optimization and the determination of priorities and utility functions were first introduced by Pareto in 1896. These methods were closely related to economic theory and concerned the averages of thousands of decisions. The development of multicriteria analysis techniques was aimed at meeting the growing demands of society and the environment. Raiffa and Keeney_(1975) provided representation theorems for determining multicriteria utility functions under the assumptions of preference and utility independence. Saaty (1977) emphasized the global importance of using multicriteria models to solve problems with conflicting objectives and introduced models for decision-making with incomplete information. Keeney and Winterfeldt (2001) outlined the basic features and concepts of decision analysis, formulated axioms, and major stages. Keeney and Winterfeldt (2001) proposed to follow the principle of prudence in decision-making, to make decisions precisely, and to evaluate all possible alternatives, the objectives of interested parties, the consequences of decision outcomes, and value changes, thereby minimizing the risk associated with decision-making Zavadskas and Turskis (2010).

The variety of available techniques for solving MCDM problems, which vary in complexity and possible solutions, can be confusing for potential users, leading to inconsistencies in problem ranking when different MCDM methods are used (Table 10). A major criticism of MCDM methods is that different techniques yield different results when applied to the same problem due to differences in the algorithms, such as different use of weights, different selection of the best solution, attempts to scale objectives, and the introduction of additional parameters that affect the solution Zavadskas and Turskis (2010).

The classification of Multi-Criteria Decision-Making (MCDM) methods based on the type of information is presented by Zavadskas and Turskis (2010) as below:

- Methods based on quantitative measurements. This category includes methods based on multi-criteria utility theory, including TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), SAW (Simple Additive Weighting), LINMAP (Linear Programming Techniques for Multidimensional Analysis of Preference), MOORA (Multi-Objective Optimization by Ratio Analysis Method), COPRAS (Complex Proportional Assessment), COPRAS-G (Complex Proportional ASsessment method with Grey interval numbers).

- Methods based on qualitative baseline measurements. This set includes two widely recognized categories of methods, Analytic Hierarchy Process (AHP), fuzzy set theory methods.
- Comparative preference methods based on pairwise comparison of alternatives. This cluster includes modifications of ELECTRE, PROMETHEE, TACTIC, ORESTE.
- Methods based on qualitative measurements that are not transformed into quantitative variables. This group includes methods of verbal decision analysis and uses qualitative data for decision-making scenarios with a high degree of uncertainty.

Table 10: MCDA Problems and Methods
(Source: Ishizaka and Nemery 2013, 4)

Choice Problems	**Ranking Problems**	**Sorting Problems**	**Description Problems**
AHP	AHP	AHPSort	GAIA, FS-Gaia
ANP	ANP	UTADIS	
MAUT/UTA	MAUT/UTA	FlowSort	
MACBETH	MACBETH	ELECTRE-Tri	
PROMETHEE	PROMETHEE		
ELECTRE I	ELECTRE III		
TOPSIS	TOPSIS		
Goal Programming	DEA (Data Envelopment Analysis)		
DEA (Data Envelopment Analysis)			
Multi-methods platform that supports various MCDA methods			

Selecting an appropriate decision support tool from the variety of MCDA methods can be challenging and often tough to justify. No single method is universally perfect or applicable across all scenarios. Every method comes with its unique strengths, limitations, and assumptions. As Roy and Bouyssou (1993) note, the vast array of MCDA methods can be a double-edged sword - a strength and a weakness. To date, there is no definitive measure to determine which method is best suited for a particular situation. A comprehensive axiomatic analysis of decision-making procedures and algorithms has yet to be conducted, as highlighted by (Ishizaka and Nemery 2013).

Guitouni et al. (1999) offer a preliminary framework to guide the choice of the right multicriteria procedure, though it is best suited for experienced researchers. For a broader audience, Ishizaka and Nemery (2013) recommend basing method selection on the nature of the decision problem to avoid making arbitrary choices.

To determine the best MCDA method for specific problems, considering factors such as the necessary input information -data and method parameters- and the corresponding modeling efforts is necessary. Additionally, evaluating the results and their level of detail, as presented in Table 8 and Table 10, can also be beneficial (Ishizaka and Nemery 2013).

When the 'utility function' for each criterion is known, representing the perceived utility based on an option's performance on that criterion, the Multi-Attribute Utility Theory (MAUT) is typically recommended. Constructing this function demands significant effort. If it proves challenging, other methods are available. For instance, Analytic Hierarchy Process (AHP) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) both supports pairwise comparisons between criteria and options. AHP uses a ratio scale for evaluations, while MACBETH utilizes an interval scale. It is crucial for decision-makers to understand which scale best reflects their preferences, but this approach often requires extensive information, as noted by Ishizaka and Nemery (2013).

Another option, as highlighted by Ishizaka and Nemery (2013), is to set key parameters. PROMETHEE demands only indifference and preference thresholds, whereas ELECTRE needs indifference, preference, and veto thresholds. Several elicitation methods can assist in defining these parameters. For those looking to sidestep these methods or parameters, TOPSIS is ideal as it only needs the ideal and anti-ideal options. Should the criteria be interdependent, ANP or the Choquet Integral can be considered.

The depth of the modeling effort usually determines the richness of the output. By defining utility functions, each option in the decision problem receives a global score. This score facilitates the comparison of all options, allowing them to be ranked from best to worst, including equal rankings. This complete ranking process, as outlined by Ishizaka and Nemery (2013), is termed full aggregation. Here, a low score on one criterion can be compensated by a high score on another.

Outranking methods rely on pairwise comparisons, comparing options in pairs to determine an outranking or preference degree. This degree indicates the superiority of one option over another. However, some options might not be directly comparable due to varying criteria profiles. One option could excel in one criterion while another in a different area. This variance can lead to incomparability, meaning a full ranking is not always possible, resulting in a partial ranking. This lack of comparability stems from the non-compensatory nature of these methods. Therefore, when tackling a decision problem, it is important to initially determine the desired output type, as provided in Table 8 and Table 10 as Ishizaka and Nemery (2013) mentioned.

Table 11: Required Inputs for MCDA Sorting Methods
(Source: Ishizaka and Nemery 2013, 8)

	Inputs	**Effort Input**	**MCDA Method**	**Output**
Sorting Method	utility function	HIGH	UTADIS	Classification with scoring
	pairwise comparisons on a ratio scale		AHPSort	Classification with scoring
	indifference, preference, and veto thresholds	↑ ↓	ELECTRE-TRI	Classification with pairwise outranking degrees
	indifference and preference thresholds	LOW	FLOWSORT	Classification with pairwise outranking degrees and scores

Within the MCDM family, Goal Programming and Data Envelopment Analysis (DEA) offer distinct analytical tools for specific purposes. Goal programming sets an ideal goal while considering feasibility constraints. In contrast, DEA is tailored for performance evaluation and benchmarking, eliminating the need for subjective inputs (Ishizaka and Nemery 2013).

Table 12: Required Inputs for MCDA Ranking or Choice Method
(Source: Redrawn from Ishizaka and Nemery 2013, 7)

	Inputs	Effort Input	MCDA Method	Output
Ranking/Choice Problem	utility function	Very HIGH	**MAUT**	Complete ranking with scores
	pairwise comparisons on a ratio scale and interdependencies		**ANP**	Complete ranking with scores
	pairwise comparisons on an interval scale		**MACBETH**	Complete ranking with scores
	pairwise comparisons on a ratio scale		**AHP**	Complete ranking with scores
	indifference, preference, and veto thresholds		**ELECTRE**	Partial and complete ranking (pairwise outranking degrees)
	indifference and preference thresholds		**PROMETHEE**	Partial and complete ranking (pairwise preference degrees and scores)
	ideal option and constraints		**Goal Programming**	Feasible solution with deviation score
	ideal and anti-ideal option	↑ ↓	**TOPSIS**	Complete ranking with closeness score
	no subjective inputs required	Very LOW	**DEA**	Partial ranking with effectiveness score

3.5.3.1 Analytic Hierarchy Process

The Analytic Hierarchical Process (AHP) is a decision-making approach developed by Thomas L. Saaty. This method has gained considerable traction in the analysis and construction of complex decision problems. Notably, AHP is based on human perception, and its primary inputs are variables, projects (decision points), and variable importance level values. In his 2008 study, Ho observed that the AHP technique has been widely used in recent years in studies focusing on multi-criteria decision-making. Therefore, AHP is a modeling method that can be structured hierarchically to illustrate the relationship between the primary objective, criteria, sub criteria, and alternatives of multi-criteria decision problems. The AHP technique has several advantages, including its ease of use and suitability for solving complex decision problems that may require both subjective and objective judgments. In particular, AHP allows the reduction of multidimensional problems to a single dimension by determining the significance level values of criteria and sub-criteria. According to Saaty (2008), the AHP process is a four-step approach that includes defining the problem, identifying information, ranking variables from lowest to highest number based on the main objective, creating pairwise comparison matrices, and determining the priority of variable importance levels.

Arora, Adholeya, and Sharan (2021) have identified the AHP as a useful tool for solving complex multi-criteria problems. This technique is particularly suitable for decision situations characterized by uncertainty and complexity and is often used in micro-tasks and problems to facilitate task completion. The construction of the hierarchy according to means-ends is important because it allows the examination of critical performance variables. AHP is a simple and robust tool that can be easily integrated into decision-making processes for both tangible and intangible capabilities. Consequently, it can be considered as an important decision support tool as it provides a weight to each of the decision alternatives. The AHP methodology can be divided into three main steps, which include: (1) construction of hierarchies; (2) comparative evaluation of comparisons; and (3) synthesis of weights. This approach enables decision makers to make fair and informed decisions and is particularly useful for addressing complex problems in a structured approach through the use of a structured hierarchy.

Structured Hierarchy is a critical step in the decision-making process, especially for addressing complex problems. This approach is based on a hierarchy that is applied in descending order with the overall goal in mind. The hierarchy is constructed using "criteria" and "sub-criteria" that contribute to the decision characteristics and are represented at the lower and middle levels of the hierarchy. The final level of the hierarchy is determined by the decision features/alternatives, which are based on the user's perspective in creative thinking, recall, and evaluation of the construction of the hierarchy. It is important to note that there is no set of ways or procedures for building the hierarchy or structure level. The structure/hierarchy depends on the decision of the owners or managers involved in the task, as well as the nature and type of work. In addition, the level and number of hierarchical units depends on the complexity of the problems, which means that every detail of the problem should be solved by the analyst. Thus, the hierarchical representation and details required may vary from one person to another (Arora, Adholeya, and Sharan 2021).

Comparative evaluation is a critical aspect of structured tasks, as it helps to prioritize the elements at each level. As Satty noted, it is important for each member to be included in the hierarchy and to participate in the decision. The comparison matrices of all items at a level of the hierarchy consider the immediate level, take into account the construction of comparative judgments, and prioritize ratio scale measures for pairwise comparisons. Preferences are weighted with nine points relative to pairwise comparisons (Arora, Adholeya, and Sharan 2021).

The homogeneity and precedence measures are scaled by pairwise comparisons. A comparative ranking matrix is then formulated for all levels of the hierarchy, starting from the top down. Correspondingly, matrices are constructed and formulated at each level, which are then linked to the next higher level. The relative weights or eigenvectors are assigned once all the matrices have been constructed. The relative significance is mandatory in global weights and eigenvalues are evaluated. The critical validation parameter in AHP, λ_{max}, is determined. This eigenvector is used as a benchmark index that facilitates the calculation of the consistency ratio (CR), i.e., the predicted vector. To validate the pairwise comparison matrix as a fully consistent evaluation, the CR calculation is performed in AHP (Arora, Adholeya, and Sharan 2021).

Table 13: Scales for Pairwise Comparison in AHP
(Source: Redrawn from R. W. Saaty 1987, 163)

SCALES FOR PAIRWISE COMPARISON	
Verbal Scale (important, likely, or preferred)	**Numerical Values**
Equal	1
Moderately more	3
Strongly	5
Very strongly	7
Extremely	9
Intermediate not considered as they are compromise values	2, 4, 6, 8
Reciprocals for inverse comparison	Reciprocals

3.5.3.2 Analytic Network Process

The Analytical Network Process (ANP) is a method that extends the Analytical Hierarchy Process (AHP) originally developed by Professor Saaty at the University of Pittsburgh. ANP offers several advantages of AHP, including the ability to use both qualitative and quantitative criteria, simplicity, and the ability to assess the consistency of judgments. Unlike AHP, ANP goes beyond hierarchical structures and considers the relationships between criteria. This feature allows all elements in a network to communicate with each other, leading to more reliable results. Zhong (2008) implemented ANP to build a network with five criteria: risk source, disturbance, primary control, secondary control, and receptor. ANP is more reasonable than AHP in determining the weight of the main criteria and emphasizes the importance of improving the risk resistance ability of the receptor (Ding et al. 2020).

In the ANP method, similar to AHP, decision elements are compared pairwise at each cluster, considering their importance with respect to their control criteria, as well as between clusters with respect to the study objective. Experts in the field of study are consulted to evaluate the relative importance of criteria and sub-criteria. They are asked to evaluate the impact of each criterion on other criteria, sequentially, and to indicate the relative importance of each sub-criterion. The intensity of preference between two items is rated using Saaty's basic 1-9 verbal scale (Table 13), where 1 represents equal importance and 9 represents extreme importance of one item over the other. ANP performs pairwise comparisons in the context of a matrix, like AHP (Qazi and Abushammala 2020).

3.5.3.3 Additive Ratio ASsesment Process

In decision-making, the Multi-Criteria Decision-Making (MCDM) problem arises frequently. It entails assessing and ranking a set of decision alternatives based on various simultaneous criteria. The ARAS method hypothesizes that an alternative's relative efficiency is measured using a utility function value, which is tied directly to the combined impact of the values and weights of the primary criteria in a specific project (Zavadskas and Turskis 2010).

3.5.3.4 COmbinative Distance-based Assessment

The CODAS (COmbinative Distance-based Assessment) technique, introduced by Keshavarz et al. (2016), distinguishes itself from other Multi-Criteria Decision-Making (MCDM) approaches. It aims to rank alternatives based on defined criteria. The method measures the appeal of alternatives using both the Euclidean and taxi distances from the negative ideal point. A threshold parameter determines the relevance of the Euclidean distances. The combined evaluation score leverages both these distance measures: Euclidean for l2-norm and taxicab for l1-norm indifference spaces. Uncertainty plays a pivotal role, greatly influencing decision outcomes. To address this, the fuzzy MCDM approach is tailored to manage the ambiguity inherent in decision problems (Jafarzadeh Ghoushchi et al. 2023).

3.5.3.5 CRiteria Importance Through Intercriteria Correlation

Methods for assigning weights to criteria fall into two main categories: subjective and objective. Subjective methods like AHP are popular in decision analysis but depend largely on the expertise and perceptions of decision makers (DMs), which can raise concerns about reliability. Objective methods, developed to mitigate such concerns, include the notable entropy method and the CRITIC method. The latter, introduced by Diakoulaki, Mavrotas, and Papayannakis in 1995, is favored for its simplicity, as it demands fewer mathematical computations than the entropy method. As a correlation method, the CRITIC approach analytically evaluates the decision matrix to discern the information each criterion holds when assessing alternatives. This objective method taps into the contrast and conflict inherent in the decision problem structure. It determines criteria contrast using the standard deviation of normalized values for each criterion and considers correlation coefficients of all criterion pairs. Due to its advantages, the CRITIC method is employed in the current study for weight determination (Mitra 2022).

3.5.3.6 DEcision MAking Trial and Evaluation Laboratory

Introduced by the Battelle Memorial Institute through its Geneva Research Centre Gabus and Fontela (1973), the DEcision MAking Trial and Evaluation Laboratory (DEMATEL) method constructs interrelations between factors or criteria. This process creates an impact network relation map, allowing for a deeper understanding of connections and influences among variables (Tzeng and Huang 2011).

3.5.3.7 ELimination Et Choix Traduisant la Realite

Introduced by Roy (1968) and Benayoun et al. (1966), the ELimination Et Choice Translating REality (ELECTRE) method employed outranking relations to facilitate decision-making. Over time, various ELECTRE models have emerged, catering to different problem types, objectives, and criteria importance levels. These models also consider various preference information such as weights, concordance index, discordance index, and the veto effect (Tzeng and Huang 2011).

Roy's (1968) ELECTRE I model focuses on identifying the kernel solution when presented with true criteria and limited outranking relations. This model does not rank alternatives; it provides a kernel set. The model employs two indices, the concordance and discordance, to evaluate relations between objects. To address the ranking limitation of ELECTRE I, Roy and Bertier (1973) introduced ELECTRE II. This model not only identifies the kernel set but also ranks alternatives by employing both strong and weak outranking relations (Tzeng and Huang 2011).

Later, to accommodate fuzzy conditions in decision-makers' preferences, Roy (1977, 1978) presented ELECTRE III. While a brief overview of ELECTRE III is provided here, readers can delve deeper into its evaluation procedures through works by Hwang and Yoon (1981), Roy (1991), Tzeng and Wang (1993), Tsaur and Tzeng (1991), and Teng and Tzeng (1994). To further streamline the process, Roy and Bouyssou (1983) proposed ELECTRE IV. The key difference between ELECTRE III and ELECTRE IV lies in the ELECTRE IV's omission of a specific weight criterion, challenging to quantify in practice. Still, this doesn't imply equal criteria weights; instead, ELECTRE IV uses pseudo criteria, similar to ELECTRE III (Tzeng and Huang 2011).

3.5.3.8 Entropy Method

The application of the entropy method, originally used in thermodynamics, was introduced to the information management discipline by Shannon in 1948 as a means of expressing information or uncertainty. This method is based on the principle that the greater the uncertainty in outcomes, the more uniform the probability associated with them (Jha & Singh, 2008). To date, this method has been widely used in various fields, including engineering, economics, finance, and other disciplines (Zou, Yun, and Sun, 2006). In addition, the application of this method has been extended to urban ecosystems, such as water management, energy use, landscape analysis, and the quality of economic growth (Antrop 1998, Balocco and Grazzini 2000, Herrmann-Pillath et al. 2002, Larsen and Gujer 1997). Previous research and current practices have also acknowledged that this method can be effectively used for performance evaluation based on a group of indicators by correctly determining the weights of evaluation indicators (L. Shen et al. 2015).

The entropy method calculates criterion weights in the decision problem using data from the decision matrix. It is highly convenient as it does not require any further subjective evaluation. By solely utilizing data on decision alternatives, the method provides objective results without requiring any assessments from decision makers (Ayçin 2020).

3.5.3.9 COmplex PRoportional ASsessment

The method was developed in 1996 by Kaklauskas, one of the researchers at Vilnius Gediminas Technical University. The method can be used according to both maximization and minimization criteria (Podvezko 2011). In the COmplex PRoportional Assessment (COPRAS) method, decision points are subjected to a step-by-step ranking and evaluation process in terms of their importance and utility (Yaralıoğlu 2015). When decision makers are aware of the physical implications of the decision, they can apply the COPRAS method to find the most appropriate choice for their system (Zdravkovic 2014). COPRAS can be easily applied to problems with complex variables and a large number of alternatives. For this reason, it has been used in many studies (Karagoz and Tecim 2018).

3.5.3.10 Multi-Objective Optimization by Ratio Analysis

The MOORA method was developed in 2009 by Brauers and Zavadskas. The goal is to optimize two or more decision points simultaneously under certain criteria. MOORA is used in many studies because of the following advantages as mentioned by Karagoz and Tecim (2018). (1) Evaluating all objectives, (2) Simultaneously considering alternative choices and interactions between goals, (3) Using non-subjective normalization procedures.

3.5.3.11 Multi-Objective Optimization on the basis of Simple Ratio Analysis

The MOOSRA method stands out among multi-objective optimization techniques. Unlike the MOORA method, which can display negative performance outcomes, MOOSRA is less susceptible to extensive fluctuations in criteria values (Jagadish and Ray 2014). This method has been employed in diverse applications, such as: (a) Establishing a multi-criteria decision framework. (b) Determining optimal cutting parameters for surface roughness (Bhowmik 2014). (c) Choosing the best cutting fluid for gear hobbling from three options (Jagadish and Ray 2014). (d) Material selection (Kumar and Ray 2015). (e) Selecting non-traditional machines. (Aytaç Adalı and Tuş Işık 2017).

Following similar steps as the MOORA method, MOOSRA's initial phase involves creating the decision matrix, followed by its normalization. In assessing the comprehensive performance score for each alternative (***y* i***), MOOSRA employs a straightforward ratio. It calculates this by dividing the sum of normalized performance scores for favorable criteria by the sum for unfavorable criteria (Aytaç Adalı and Tuş Işık 2017).

3.5.3.12 Preference Ranking Organization METhod for Enrichment Evaluations

The PROMETHEE I (partial ranking) and PROMETHEE II (complete ranking) were developed by J.P. Brans and first presented in 1982 at a conference organized by R. Nadeau and M. Landry at the Université Laval, Québec, Canada (L'Ingéniérie de la Décision Elaboration d'instruments d'Aide à la Décision). After the initial presentation, the methodology was applied to various domains, including health care by G. Davignon. Subsequently, J.P. Brans and B. Mareschal extended the methodology by developing PROMETHEE III (ranking based on intervals) and PROMETHEE IV (continuous case). Furthermore, in 1988, the authors proposed the visual interactive module GAIA, which provides an exceptional graphical representation supporting the PROMETHEE methodology. In 1992 and 1994, J.P. Brans and B. Mareschal presented two further extensions: PROMETHEE V (MCDA including segmentation constraints) and PROMETHEE VI (representation of the human brain) Brans et al. (2005).

The PROMETHEE methodology has demonstrated its efficacy in various domains and has been used by numerous researchers to solve decision problems. As a multi-criteria decision-making technique, PROMETHEE is preferred by decision makers due to its simplicity of application and avoidance of complex mathematical computations. The approach focuses on pairwise comparisons of decision alternatives with respect to individual evaluation criteria. What distinguishes it from other multicriteria decision techniques is that it allows the decision maker to construct distinct preference functions for each criterion. Consequently, the decision maker is not limited to ranking each criterion equally. To utilize the PROMETHEE approach, two essential data types are needed: the criteria's relative importance (weights) and the preference functions set by the decision maker for each criterion when evaluating decision alternatives (Table 14).

As Sotiropoulou and Vavatsikos (2021) mentioned, the PROMETHEE methods are widely recognized as multi-attribute decision analysis approaches using outranking techniques. It suggests that these methods are highly suitable for land planning purposes, while PROMETHEE is the most attractive outranking method due to its mathematical simplicity and transparency, as pointed out by (Malczewski and Rinner 2015). However, the integration of outranking methods in a Geographical Information Systems (GIS) environment is not common due to computational limitations associated with the number of decision alternatives as discussed. As an outranking approach, PROMETHEE requires the pairwise or global comparison of alternatives for each evaluation criterion. Therefore, PROMETHEE quickly reaches its computational limits in a raster-based GIS suitability analysis, where each raster cell is considered as a site alternative.

Table 14: Versions of the PROMETHEE Methods
(Prepared by Author)

Name of The PROMETHEE Method	Content of The Method	References
PROMETHEE I	This method provides partial ranking of the alternatives	(Brans 1982)
PROMETHEE II	This method enables complete ranking of the alternatives	(Vincke and Brans 1985)
PROMETHEE III	This method uses for ranking based on interval	(Vincke and Brans 1985)
PROMETHEE IV	This method uses for partial or complete rankings of alternatives when the selection of alternatives is continuous	(Vincke and Brans 1985)
PROMETHEE V	This method uses for decision-making problems with segmentation constraints	(Brans and Mareschal 1992)
PROMETHEE VI	This method uses for human brain representation	(Brans and Mareschal 1995)
PROMETHEE GDSS	This method uses for group decision-making situations	(Macharis et al. 1998)
GAIA (Geometrical Analysis for Interactive Aid)	This method provides graphical representation	(Mareschal and Brans 1988; Brans and Mareschal 1994)
PROMETHEE TRI	This method uses for sorting problems	(Figueira et al. 2004)
PROMETHEE CLUSTER	This method uses for nominal classification	(Figueira et al. 2004)

According to Atkinson (2018), the advantages of PROMETHEE compared to other techniques include its ease of use and the fact that it does not assume proportionality of criteria. However, there are also disadvantages, such as the lack of a clear process for assigning criteria weights. Despite requiring the assignment of values, PROMETHEE does not provide a clear method for assigning these values.

3.5.3.13 Simple Additive Weighting

The Simple Additive Weighting (SAW) method is a clear and intuitive approach to tackle Multi-Criteria Decision-Making (MCDM) problems, as its linear additive function effectively represents decision makers' (DMs) preferences. However, its validity rests on the assumption of preference independence or separability. SAW is a prominent and widely used method for multiple attribute decision-making (MADM). Owing to its simplicity, it is the preferred choice for addressing MADM challenges, facilitating the derivation of the most optimal alternative (Tzeng and Huang 2011).

3.5.3.14 Step-wise Weight Assessment Ratio Analysis

Introduced by Keršuliene et al. in 2010, the SWARA management approach is a highly effective multi-criteria decision-making technique suitable for diverse problems. Central to any multi-criteria decision-making is the weighting of criteria, as their significance can differ. The main feature of the SWARA method lies in leveraging expert insights to understand the importance of each criterion. In this method, decision-makers rank the criteria, placing essential criteria first and less significant ones later. When multiple decision-makers are part of the process, individual rankings are consolidated using the geometric mean to derive the final ranking (Ünlü, Çağıl, and Gezmişoğlu 2023).

3.5.3.15 Technique for Order Preference by Similarity to Ideal Solution

Originally introduced by Hwang and Yoon in 1981, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) aims to identify the optimal alternative through the principles of compromise solution. Central to TOPSIS is the idea of compromise, which seeks an alternative closest to the ideal solution and farthest from the negative ideal solution using Euclidean distances. This method has been widely used across diverse sectors for decision-making (Tzeng and Huang 2011).

3.5.3.16 VIse Kriterijumska Optimizacija I kompromisno Resenje

The VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method was developed by Opricovic in 1998 for solving complex systems. In 2004, it was reorganized by Opricovic and Tzeng for solving multi-criteria problems, making it a method applicable to multi-criteria decision problems. The method evaluates many criteria together and allows to find the closest compromise solution to the optimal result by ranking the alternatives according to their performance. After measuring the closeness of each alternative evaluated under the criteria to the ideal in order to reach the compromise result, the compromise is expressed as the common acceptance within the criteria, the compromise solution optimal solution (Ünlü, Çağıl, and Gezmişoğlu 2023).

The VIKOR method is a multicriteria optimization technique designed to handle complex systems. It provides a compromise ranking list, identifies the compromise solution, and establishes weight stability intervals to maintain the preference stability of the solution with given weights. Essentially, the method's primary purpose is to rank and select among alternatives among conflicting criteria. It employs a multicriteria ranking index based on a measure of 'closeness' to the 'ideal' solution (Tzeng and Huang 2011).

3.5.3.17 Weighted Aggregated Sum Product Assessment

In 2012, Zavadskas et al. introduced the WASPAS technique in their seminal article, *"Optimization of the evaluation of the weighted sum product, electronics and electrical engineering."* This work set the stage for the method's broad application in various disciplines (Kiani Sadr et al. 2023).

The current study employed the WASPAS model for urban development zoning. Known for its precision and dependability, the WASPAS model combines the Weighted Sum Model (WSM) and the Weighted Product Model (WPM) into the Weighted Aggregated Sum-Product evaluation. Literature indicates that the integrated models' accuracy surpasses that of the individual models. The WASPAS model excels in intricate decision-making scenarios (Kiani Sadr et al. 2023).

Interestingly, multi-criteria methodologies address the intricate nature of zoning problems and qualitative indicators not easily represented mathematically. As Turskis et al. highlighted in 2019, implementing multi-criteria decision-making can be streamlined, as shown in Figure 27. In conclusion, the WASPAS technique has significantly advanced multi-criteria decision-making, consistently delivering highly accurate outcomes (Kiani Sadr et al. 2023).

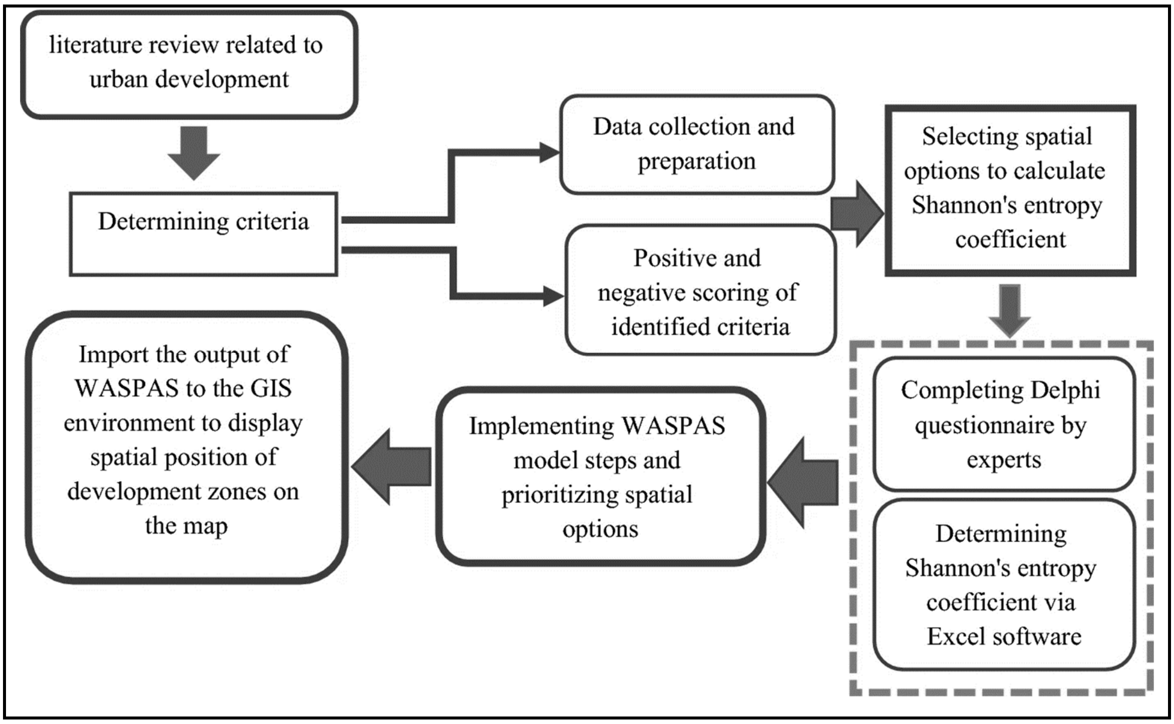


Figure 27: Workflow of the Methodology
(Source: Kiani Sadr et al. 2023, 7)

3.5.3.18 Weighted Euclidean Distance Based Approach

The Euclidean distance concept is a fundamental idea in mathematics, as stated by Dattorro (2008) and Gower (1982). The Weighted Euclidean Distance-based Approach (WEDBA) hinges on this principle, focusing on the weighted distance of alternatives from the optimal (ideal) and non-optimal (anti-ideal) situations.

Practically, the ideal and anti-ideal points are defined by the best and worst attribute values, respectively. The ideal point represents the best attribute values, whereas the anti-ideal point represents the worst. In some cases, an alternative might possess either all best or all worst attribute values. Within WEDBA, both ideal and anti-ideal points serve as feasible solutions, providing reference points for quantitative comparisons of other options. The resulting numerical differences from these comparisons give the 'effectiveness' or 'index score' of the alternatives. A lower index score suggests an alternative is nearer to the optimal state.

The most important part of WEDBA is to identify a solution closest to the ideal point. The approach considers three attribute weight types: objective, subjective, and integrated weights, as detailed by Rao (2012).

3.5.3.19 Weighted Product Method

Introduced by Triantaphyllou in (2000), the WPM (Weighted Product Method) methodology transforms normalized measurements into weighted multiplicative values, subsequently ranking alternatives based on their importance. According to Rahayu and Mukodimah (2019), The Weighted Multiplication Method (WP) employs multiplication to connect attribute values and criteria, with each attribute or criterion value first multiplied by the respective criterion's weight.

3.5.3.20 Weighted Sum Method

The Weighted Sum Model (WSM) is a prominent decision-making method, especially suited for one-dimensional problems. According to Fishburn (1967) and Chen and Hwang (1992), in decision scenarios with M alternatives and N criteria, the optimal alternative (A^*) adheres to a specific equation in a maximization context. The formula indicates: *"A^*WSM is the score of the ideal alternative, a_{ij} is the performance of the i_{th} alternative concerning the j_{th} criterion, and w_j signifies the weight of the j_{th} criterion's importance"* (Atkinson 2018), It is crucial to transform minimizing criteria to maximizing criteria for this method's application (Atkinson 2018).

Based on the additive utility assumption, the WSM states that an alternative's total value is equal to the summation of products from the aforementioned calculation (Triantaphyllou 2000). Though WSM is effective in one-dimensional problems with consistent units across all criteria, it can pose challenges in multidimensional decision scenarios due to this additive assumption (Atkinson 2018).

3.6 The Multi-Actor Multi-Criteria Analysis

The increasing focus on environmental and social impacts has increased the significance of multi-criteria decision-making (MCDM) methods. These methods offer a systematic framework to address multifaceted problems marked by various stakeholders, conflicting objectives, diverse data types, and evolving socioeconomic systems. While various MCDM methods exist, not all are universally applicable. Some cater to specific issues, while others can be adapted across diverse scenarios. The range-based Multi-Actor Multi-Criteria Analysis (range-based MAMCA) stands out in this context. It aids in participatory decision-making in situations demanding a balance of numerous conflicting values with high uncertainties (Baudry, Macharis, and Vallée 2018).

MAMCA is a methodology developed to support group-based complex decision-making. Unlike traditional Multi-Criteria Decision Analysis (MCDA) methods, MAMCA actively involves the stakeholders throughout the process. The methodology incorporates stakeholder views right from problem identification to alternative evaluation, adding different actors to the MCDA approach. Each stakeholder has an individual multi-criteria analysis (MCA) model, which ultimately converges in the final assessment (Hadavi, Macharis, and Van Raemdonck 2018).

3.6.1 The MAMCA Methodology and Its Applications

The MAMCA, proposed by Macharis, Turcksin, and Lebeau (2012), evaluates alternatives against stakeholder objectives. Unlike the traditional MCA, it integrates the diverse perspectives of these stakeholders. The methodology is a seven-step process, blending both analytical and synthetic approaches.

1) Problem Definition and Alternatives Identification: Outlining the core issue and recognizing the potential solutions.
2) Stakeholder Identification: Recognizing individuals or groups with vested interests in the outcomes.
3) Objective Identification and Weighting: Determining key objectives of stakeholders and assigning them relative importance.

4) Indicator Construction: Establishing one or more metrics for each criterion. These could be quantitative (like land value or population) or ordinal (high/medium/low). Each indicator's measurement technique is also outlined.
5) Evaluation Matrix Creation: The alternatives are determined and translated into scenarios. These scenarios are compared to each stakeholder group's objectives, resulting in a multi-actor view ranking the alternatives.
6) Strengths and Weaknesses Analysis: This phase assesses the stability of the rankings through sensitivity evaluations.
7) Implementation: Using the analysis' findings, an implementation strategy that respects the preferences of the stakeholders is developed.

In summary, MAMCA provides a comprehensive and robust framework for evaluating various alternatives in line with stakeholder objectives. The seven-step process ensures a well-balanced approach to decision-making, as provided by Macharis, Turcksin, and Lebeau (2012).

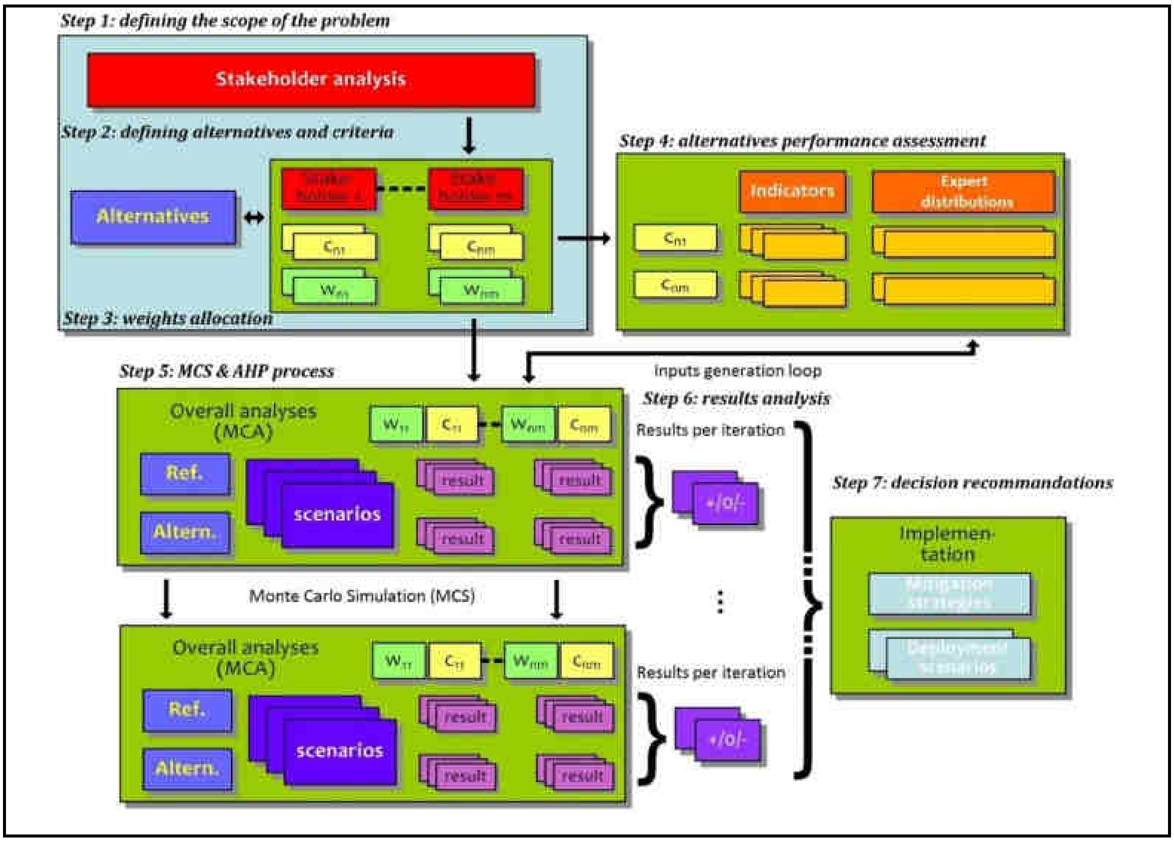


Figure 28: Range-based MAMCA process.
(Source: Baudry, Macharis, and Vallée 2018, 260)

The integration of Social Multi-Criteria Analysis (SMCA) and Multi-Group Decision-Making (MGDM) techniques has enabled the active participation of stakeholders or social actors in the decision-making process. Most applications have used a common value tree that has proven to be effective for all stakeholders involved Macharis, Turcksin, and Lebeau (2012). In the Multi-Actor Multi-Criteria Analysis (MAMCA) methodology, each stakeholder group has its own set of criteria. Further research is needed to determine the weights of stakeholders and how this information can be used to influence the outcome. In addition, there is a need to analyze potential strategic biases in more detail. In the context of group decision models, strategic bias occurs when individuals submit preference information that they believe will improve their own outcomes rather than those of the group. Within MAMCA, the strategic bias is avoided at critical stages of the methodology, such as the selection of stakeholders, criteria, and their respective weights (Macharis, Turcksin, and Lebeau 2012).

CHAPTER 4

RESEARCH ON DECISION-MAKING FOR URBAN TRANSFORMATION AND INDICATORS

In the fourth chapter, it aims to discuss the methods of determining the indicators used in the research fields of disaster management, hazard mitigation, sustainability, sustainable development, land use management, urban planning, and urban transformation in addition to explain the research conducted to determine the list of critical indicators to be used in the methodology of the thesis on urban transformation strategies in areas under disaster risk.

The term 'indicator' in Arabic means 'pointer', indicating that it is meant to refer to a desired condition or action as Westfall and Villa (2001) mentioned. Indicators represent cause and effect, social norms, progress, policies, and outcomes. Unlike other types of data, indicators have an explicit link to policy. Indicators address the relationship among policies and data, and more time is spent figuring out what kind of data to collect and why. The people who develop and collect indicators are more likely to be practitioner users of such information and policy analyzers than statistical experts. Indicators are models that simplify complexity into several numeric measures that are easy for decision-makers and the public to interpret and understand. Indicators should provide actionable information and be highly aggregated, where variations or differentiations in an indicator's value are more significant than its actual quantity. The principal categories of indicators commonly encountered within policies are measures of effectiveness, issue-based indicators, and demand indicators. They are further categorized by the context in which the indicator scheme is developed.

4.1 Literature On Decision-Making in The Context of Urban Transformation

The literature review on urban transformation classified and analyzed studies on hazard-prone areas, decision-making processes, sustainability, and identification of indicators with their brief explanations.

In their research, Luria and Aspinall (2003) proposed a model based on AHP as an MCDM method that allows the use of expert opinions, complementary skills, and expertise from different disciplines together with traditional quantitative analysis in an experimental model for critical hazard assessment. This method aims to evaluate the risk of the current situation and three future scenarios in a dynamic approach. As a result, MCDM is considered as a technique that allows measuring and aggregating performances according to both qualitative and quantitative criteria into a single value (Figure 29).

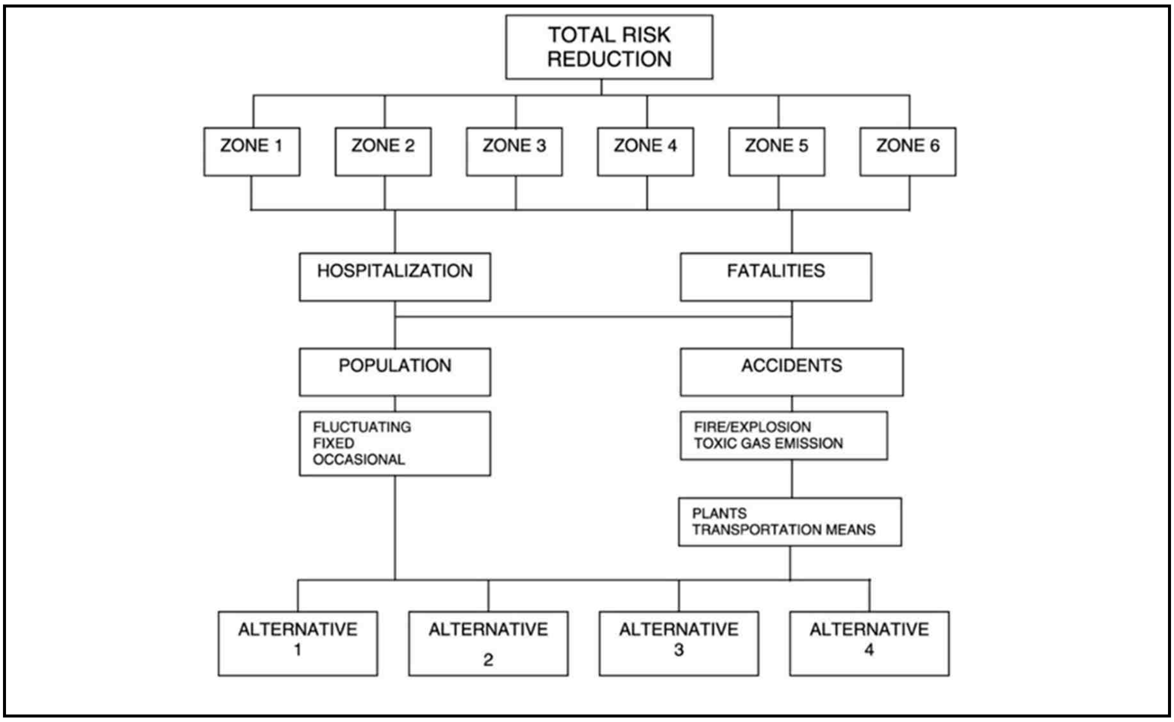


Figure 29: The Hierarchy of the Method
(Source: Luria and Aspinall 2003, 645)

Yau and Chan (2008), in their research, state that Hong Kong has long been concerned about urban decay, for which there are two different approaches: building rehabilitation and redevelopment. He states that although redevelopment was common before, with the concept of sustainability, the building rehabilitation alternative has also become popular. For this reason, the model was evaluated by interviewing a total of thirty-four building inspectors and thirty-one urban planners using structured questionnaires with the Non-structural Fuzzy Decision Support System (NSFDSS) they developed to make a rational decision (Figure 30).

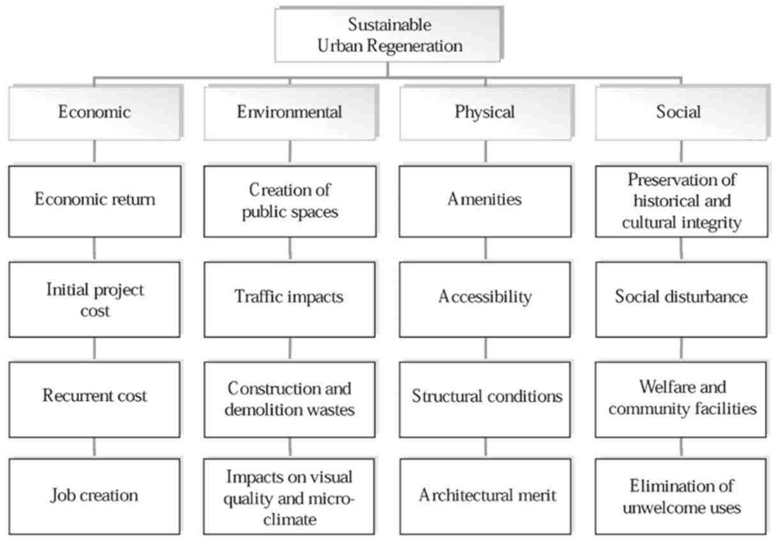


Figure 30: Criteria Matrix for URP
(Source: Yau and Chan 2008, 277)

In their 2008 article, Wey and Wu (2008) developed a model for selecting urban renewal projects in Taiwan. They used the fuzzy Delphi method, ANP, and ZOGP to identify the most cost-beneficial projects that could maximize public net benefits and efficiently allocate resources (Figure 31). The model employed a hierarchical network to evaluate various factors and their interdependencies. The aim was to guide the government in determining urban renewal strategies.

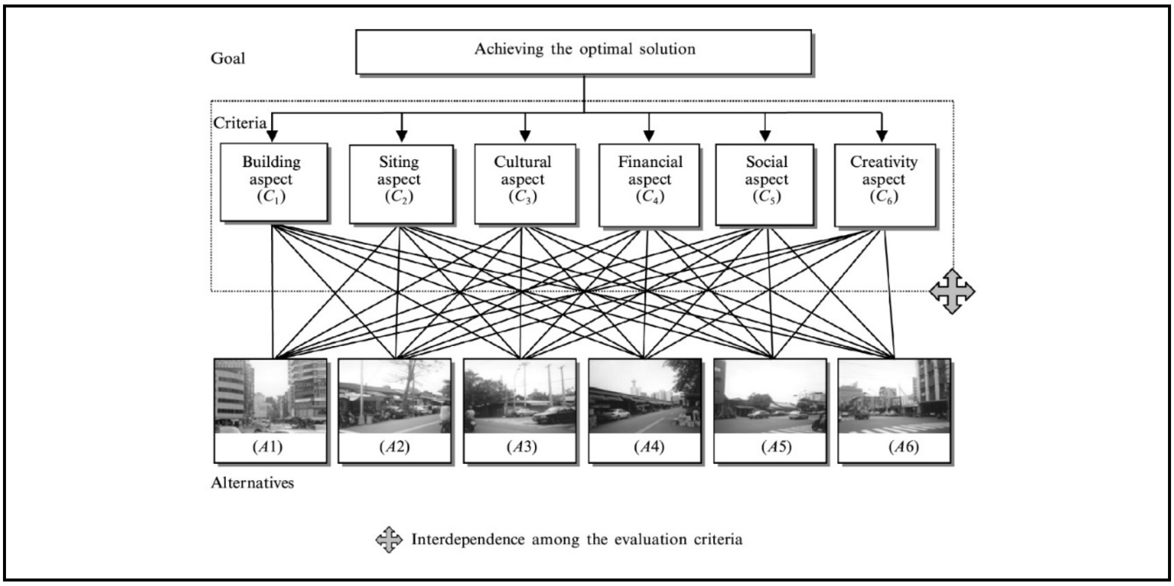


Figure 31: Network Between the Criteria
(Source: Wey and Wu 2008, 133)

Polat et al. (2016) stated that urban renewal projects constitute a considerable majority of the projects implemented by construction companies in Türkiye. With their research, they intend to develop an integrated method for the evaluation of urban renewal projects. The AHP method is applied to find the weights of the selection criteria and the PROMETHEE method is applied to rank the alternative projects in the suggested method to help construction companies to select the appropriate urban renewal projects. Here, a case study was conducted to solve the project selection problem of a Turkish construction company that specializes primarily in urban renewal projects. Within the scope of this research, the factors identified in seven main groups (project, cost, contract, profit, management capacity, financing) were evaluated with sub-criteria identified in seventeen sub-groups in Figure 32. The study's results established that the proposed approach can be a beneficial tool especially for construction companies specialized in urban renewal projects.

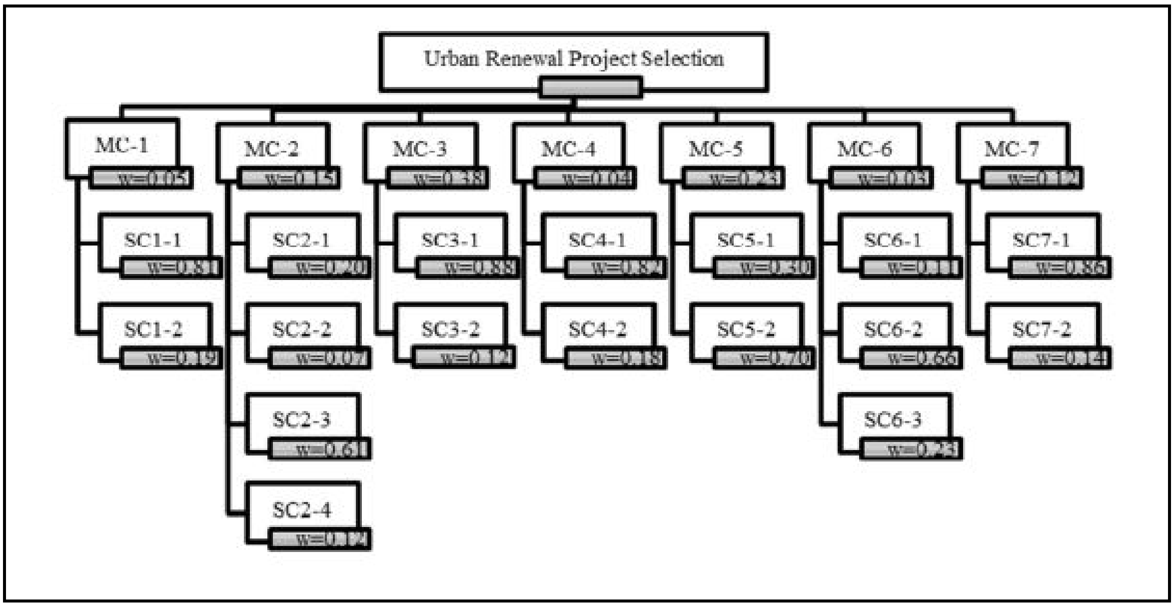


Figure 32: Decision Hierarchy of the Method
(Source: Gul Polat et al. 2016, 342)

Manupati, Ramkumar, and Samanta (2018) identified seven primary criteria and twenty-seven accompanying sub-criteria from socio-technical literature in Figure 33. These guidelines aim to facilitate urban area management within the framework of the smart cities mission in India and address difficulties stemming from population growth and the subsequent challenges of urban regeneration. Using DEMATEL and ANP methods to analyze interrelationships between criteria and sub-criteria, the case study results aim to assist decision-makers in urban renewal decision-making processes.

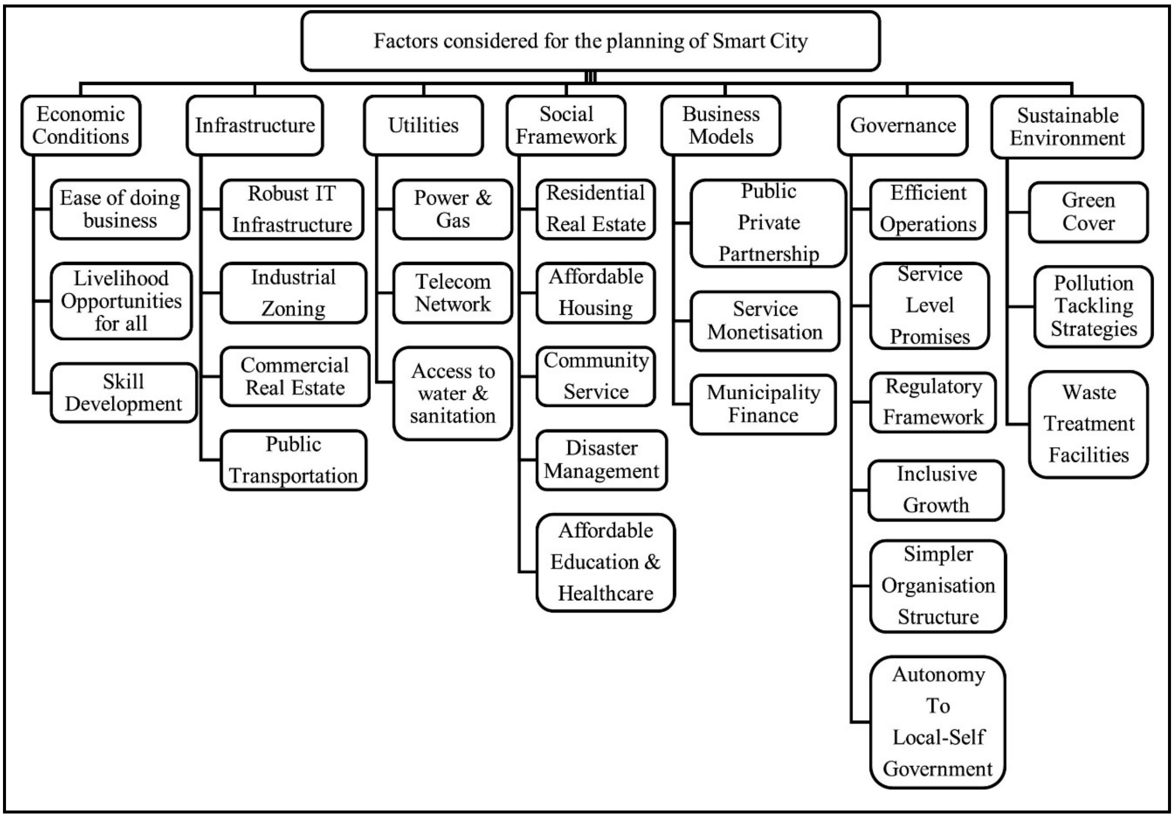


Figure 33: Proposed Framework of the Research
(Source: Manupati, Ramkumar, and Samanta 2018, 476)

Gül Polat et al. (2019) develops their previous research to present new integrated model using different MADM methods for the selection of urban transformation projects in Türkiye and to compare the results of the methods. Within the scope of this research, AHP method was used with TOPSIS, VIKOR, COPRAS and EDAS methods. In the proposed approach, AHP is used to calculate the weights of the criteria that may affect the urban renewal project selection decision and other MADM methods are used to rank alternative projects. A model comparing twelve different urban renewal project alternatives with seven main criteria and seventeen sub-criteria is used here in Figure 34. The results obtained from the use of the methods are compared with the case study and the results show that the application of the proposed approach can be a useful tool in the selection of urban renewal projects.

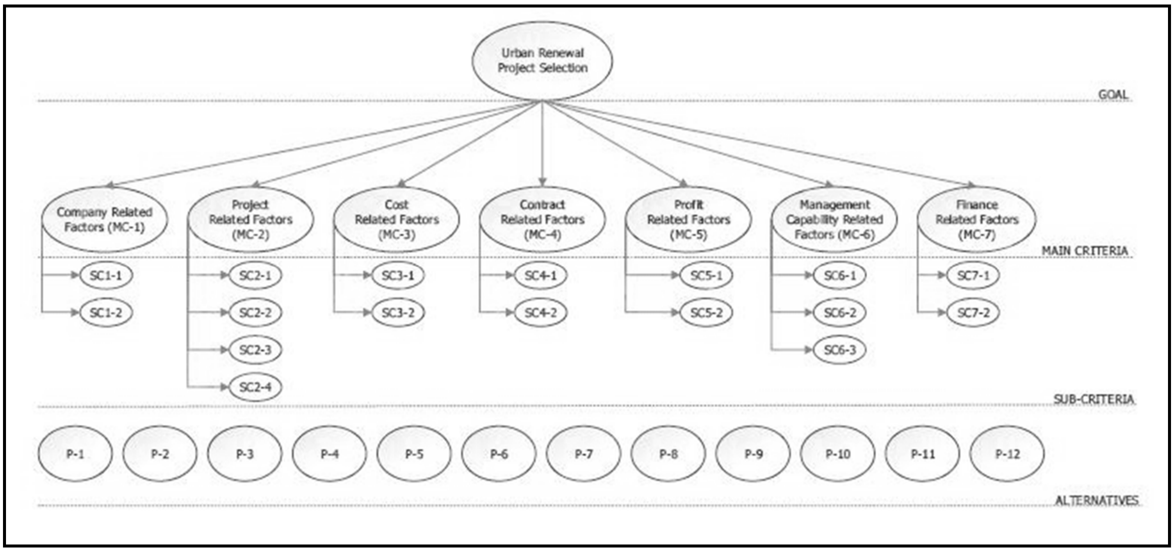


Figure 34: Decision Hierarchy of the Project Selection Problem
(Source: Gül Polat et al. 2019, 137)

Doğan et al. (2020) stated in their article that awareness and expectation studies on urban renewal are generally evaluated with statistical results generated by surveys and that decision-making processes in planning decisions regarding sustainable urban renewal could not be healthy because spatial modeling cannot be done in these studies. The researchers conducted a study to analyze the awareness and expectations of the local population regarding urban renewal in thirteen different neighborhoods using Fuzzy DEMATEL and Fuzzy TOPSIS. By displaying the results with statistical analysis in the GIS program on satellite photographs, it has been determined that there has been a higher level of awareness and expectation with the participation of the local community in residential areas where urban renewal projects have been implemented compared to other residential areas.

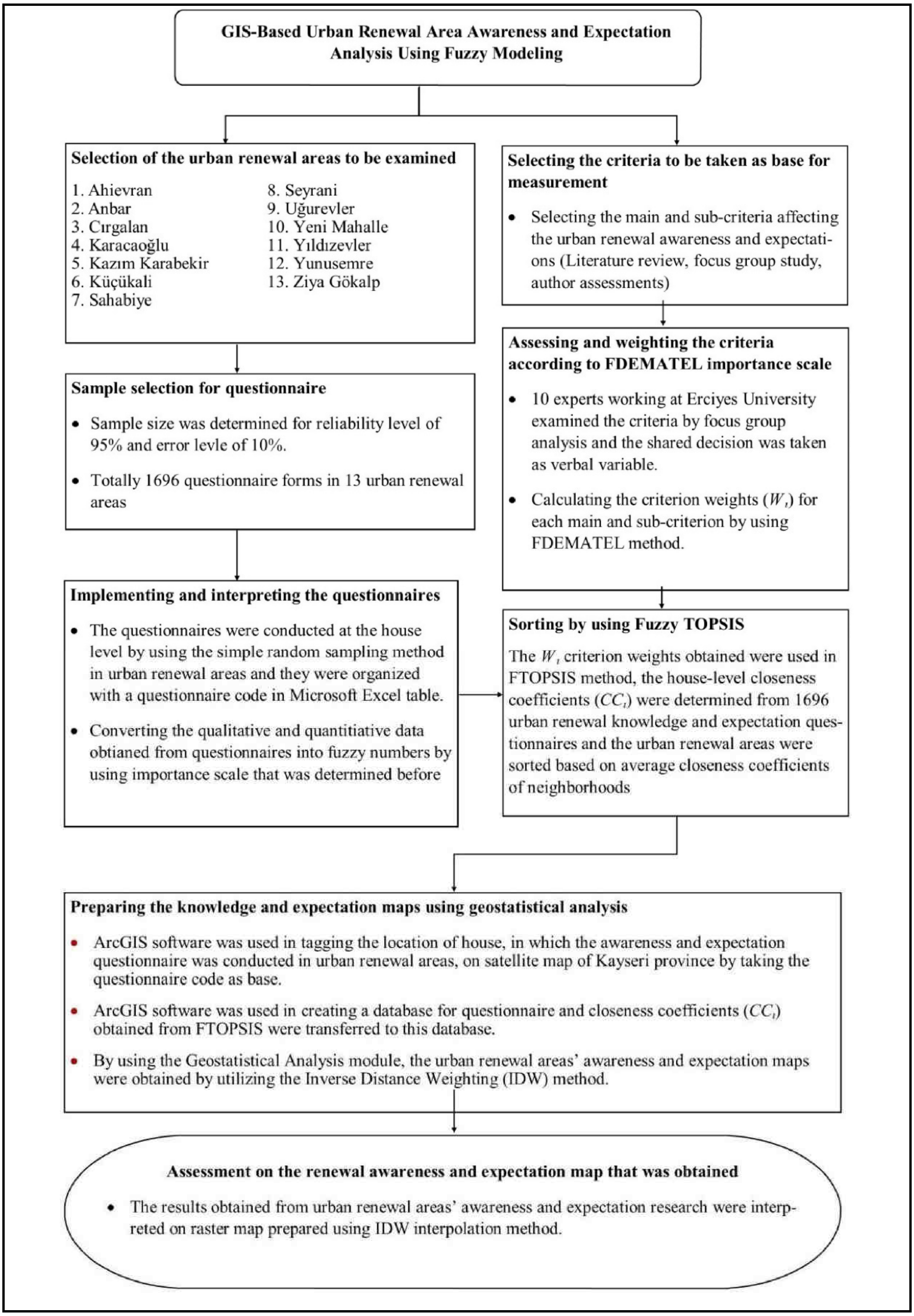


Figure 35: Flow-chart of the Study

(Source: Doğan et al. 2020, 2)

In their study, Ilıcalı and Giritli (2020) focused on the environmental performance dimension of sustainable project performance and aimed to scientifically measure the environmental performance of urban transformation projects. Nine performance criteria and fifty-five key performance indicators obtained through literature review and field research were evaluated using the AHP model. As a result, the direct impact on the environment has an important place for the stakeholders of urban regeneration projects.

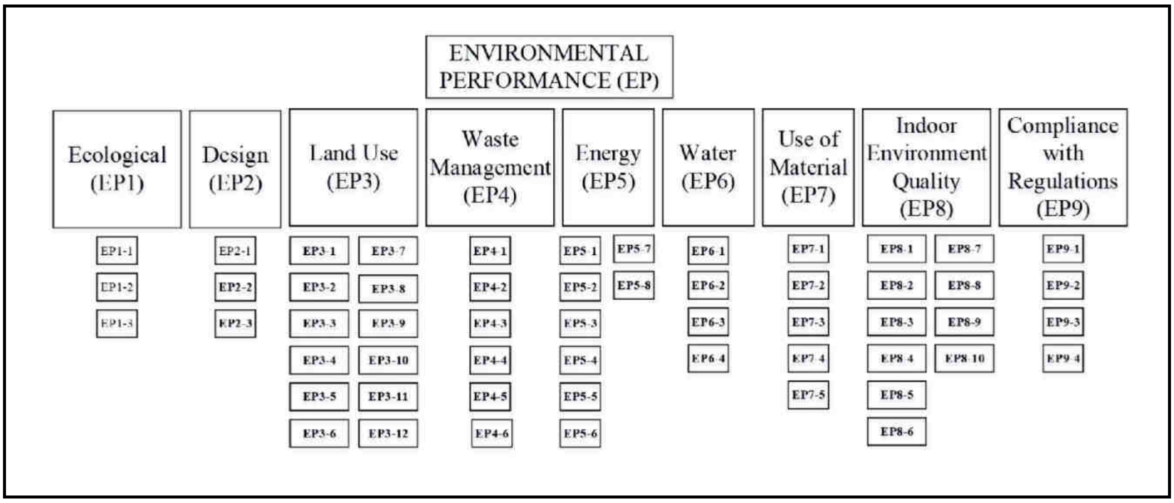


Figure 36: Environmental Performance for URP
(Source: Ilıcalı and Giritli 2020, 132)

In their article published in Sütçüoğlu and Önaç (2022), they claim that previous studies have only focused on the physical aspects of urban regeneration and ignored the social structure, climate change, and urban adaptation. Therefore, they conducted a case study using AHP and GIS approaches in the site selection phase of urban regeneration, including the MCDM process based on all physical and social components of the study area and environmental, economic, and social sustainability (Figure 37).

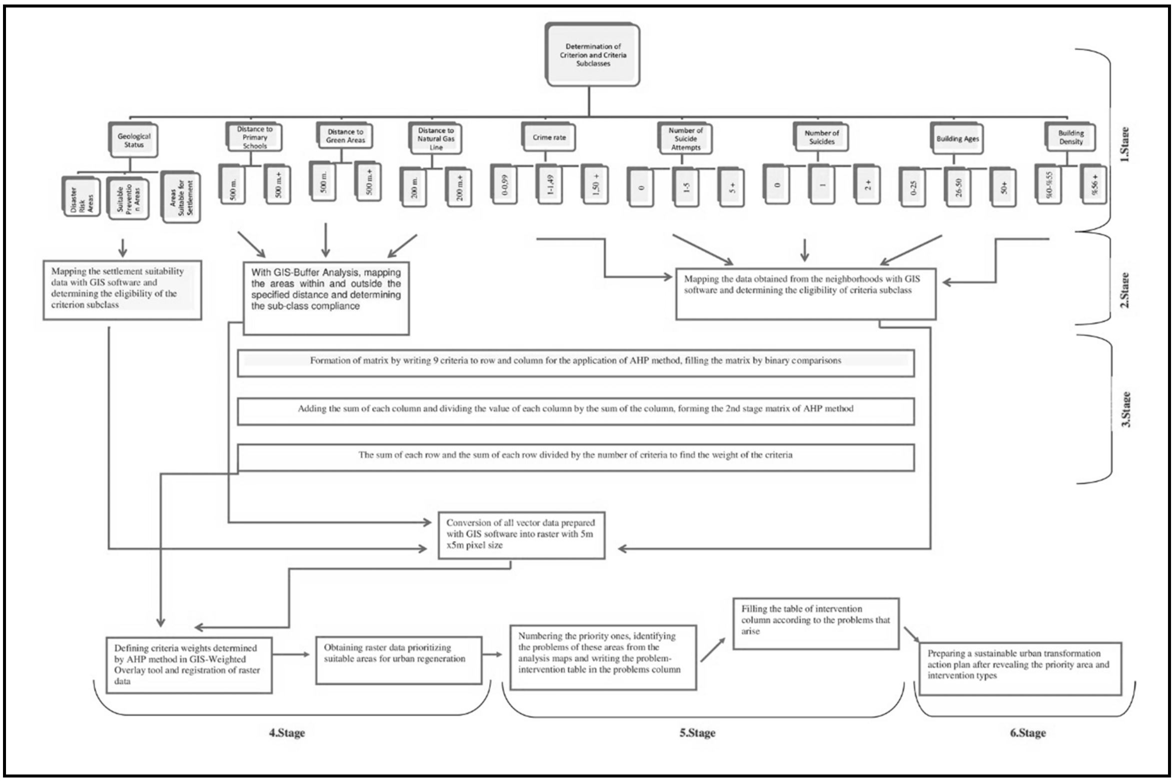


Figure 37: Determination of Criteria and Sub-Criteria

(Source: Sütçüoğlu and Önaç 2022, 378)

In the literature, a comprehensive study exists concerning the determination of criteria and sub-criteria and their weighting. The aim is to provide information on the scope of resilience, disaster management, hazard mitigation, sustainability, sustainable urbanization, and urban transformation by briefly summarizing recent studies that can act as examples. By examining comparable studies in the context of this thesis, the goal is to develop content concerning the critical indicators to be used in the context of this thesis and their evaluation.

4.2 Method of Determination of Critical Indicators

As a result of comprehensive literature review, this thesis reviewed and grouped criteria and related indicators under the categories of Physical Structure, Economic Structure, Social Structure, Environmental Structure, Legislative and Institutional Structure, Planning and Design and Technological Structure in the context of the disciplines of resilience, disaster management, hazard mitigation, sustainability, sustainable urbanization, and urban transformation. As explained in the following sections, a survey was conducted to determine the number of criteria and identify critical indicators.

4.2.1 Sustainable Urban Development Indicators

In the literature, there has been a considerable number of research to measure the sustainability of urban transformation. According to Peng et al. (2015), an indicator system approach is a commonly used method for assessing urban regeneration in terms of economic, ecological, and social sustainability. However, the indicators determined to reflect the opinions of researchers generally cause inconsistencies in existing studies. For this reason, conducting surveys, interviews, and gathering information from past records are commonly used methods to obtain relevant data during the evaluation phase.

According to L. Y. Shen et al. (2011), Indicators have an essential role to play in any measurement of performance, especially in the evaluation of urban sustainability, which requires measurable indicators. Several approaches have been developed to assess urban sustainability using indicators. In the literature, different techniques have been explored to assess different aspects of sustainability through the use of indicators. For this purpose, a classification has been proposed based on the methodological foundations of assessment methods, dividing them into systems engineering, monetary valuation, and biophysical groups. The use of indicators has been widely explored in research to assess the sustainability of cities and to identify the practical challenges encountered in the process. However, it is important to note that the process of selecting indicators should be based on selective analysis of the most fundamental ones that are likely to provide accurate information about the state of practice, rather than collecting information for all indicators.

While the research in the literature makes a significant contribution to the evaluation of the sustainability of urban regeneration, the evaluation process needs to be improved as Peng et al. (2015) claimed. The first reason is the subjective and fuzzy application of the indicator system, which is often ignored in the studies. Secondly, the indicator system is usually prepared with specific concerns and local content to measure the sustainability of targeted urban regeneration projects. Finally, existing research makes a static assessment based on the current performance of urban regeneration. However, urban regeneration has long-term impacts on the physical structure as well as on environmental, social, and economic development and therefore the evaluation process should be dynamic and based on the use of time series data. Peng et al. (2015) developed a list of preliminary indicators measuring sustainability of urban transformation at the project level for their research and the list shown in Table 15.

Table 15: Indicators Measuring Sustainability of Urban Regeneration
(Source: Redrawn form Peng et al. 2015, 3)

Category	Indicator	Reference
Building performance	Energy efficiency of building layout and design	Hemphill et al., 2004, Boyko et al., 2012, Siddall and Grey, 2013
	Energy efficiency of building materials/construction methods	Hemphill et al., 2004, Boyko et al., 2012, Siddall and Grey, 2013
	Reclamation of building materials	Hemphill et al., 2004, Cheng and Lin, 2011, Turcu, 2012
	Residential density levels in relation to plot size	Hemphill et al., 2004, Cheng and Lin, 2011, Turcu, 2012
Environmental development	Waste disposal percentage household waste recycled	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011, Turcu, 2012, Siddall and Grey, 2013
	Waste minimization percentage firms undertaking waste audits	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011, Turcu, 2012, Siddall and Grey, 2013
	Average emission of noise a day	Rydin, 2007, Laprise et al., 2015
	Percent of site as green space	Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011
Social development	Community group involvement	Hemphill et al., 2004, Boyko et al., 2012, Turcu, 2012, Siddall and Grey, 2013
	Access to housing affordability and choice	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Boyko et al., 2012;
	Access to leisure facilities average journey time by foot	Hemphill et al., 2004, Rydin, 2007, Wedding and Crawford-Brown, 2007, Laprise et al., 2015
	Access to retail facilities average journey time by foot to CBD	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011, Laprise et al., 2015
	Access to educational needs average journey time by foot	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Turcu, 2012, Laprise et al., 2015
	Access to medical facilities average journey time by foot	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Laprise et al., 2015
	Access to cultural facilities average journey time by foot	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Laprise et al., 2015
	Access to open space average journey time by foot	Hemphill et al., 2004, Rydin, 2007, Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011, Boyko et al., 2012, Laprise et al., 2015
	Public transport links walking distance to nearest facilities	Hemphill et al., 2004, Rydin, 2007, Cheng and Lin, 2011, Siddall and Grey, 2013, Laprise et al., 2015
Economic development	Number of jobs created per 1000 square meters	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Turcu, 2012
	Net jobs created percentage of employees from local area	Hemphill et al., 2004, Wedding and Crawford-Brown, 2007, Turcu, 2012
	Number of new enterprises created	Hemphill et al., 2004, Siddall and Grey, 2013
	Net population density	Hunt et al., 2008, Cheng and Lin, 2011, Boyko et al., 2012, Laprise et al., 2015
	Net employment density	Hunt et al., 2008, Wedding and Crawford-Brown, 2007, Cheng and Lin, 2011, Boyko et al., 2012, Laprise et al., 2015

4.2.1.1 List of Measurement Indicators

In order to assess the sustainability of urban regeneration, a number of different sets of indicators have been developed for use at either the project or city level. Identifying the appropriate level of measurement is critical, as studies at both levels are highly relevant. However, it is worth noting that project-level sustainability indicators are particularly useful for comparative purposes. Consequently, the current study will focus its attention on the sustainable urban regeneration practices observed in practice. Specifically, a substantive examination will be conducted to explore the available indicators of measurement that have been determined at this level. In order to achieve this, four different categories are used to categorize the identified indicators, namely building performance, environmental development, social development, and economic development. It is important to note that the primary criterion for selecting indicators is their measurability. All indicators are combined, and similar indicators are eliminated creating a comprehensive initial list of measurable indicators (Peng et al. 2015)

$$x = \{x_{11}, x_{12}, x_{13}, \dots, x_{ij}\}, \quad (1)$$

According to Peng et al. (2015), the set of indicators measuring the sustainability of urban renewal at a given level is represented in Equation (1) by the variable $\boldsymbol{x}$. In addition, $\boldsymbol{i}$ represents the sequence of the category, where $\boldsymbol{i = 1}$ represents building performance, $\boldsymbol{i = 2}$ represents environmental development, $\boldsymbol{i = 3}$ represents social development, and $\boldsymbol{i = 4}$ represents economic development. In addition, $\boldsymbol{j}$ represents the order of the indicators under the respective category. In order to better understand the aforementioned indicators, the research team meticulously sorted the preliminary indicators measuring the sustainability of urban renewal at the project level according to Peng et al. (2015).

4.2.1.2 Using Delphi Method to Judge the Significance of Indicators.

The initial set of indicators for measurement must be extensive, encompassing a range of research contexts and objectives. It is essential to establish a consensus on the importance of these indicators in measuring the sustainability of urban transformation at a predetermined level. In this regard, surveys are considered an appropriate research method to organize different opinions and obtain the views of researchers and experts (Peng et al. 2015). In order to design the questionnaire appropriately, it should include a brief introduction of the research purpose and a discussion of the main section. Experts should indicate the level of significance for each preliminary indicator. Measure the level of significance using Likert or similar scales. The survey should be targeted at government officials, researchers, and practitioners in the field of urban regeneration and similar stakeholders.

4.2.1.3 Expert Choice Method

Due to constraints on time and data, providing specific examples of the conceptual model is challenging. Therefore, the analytical process and framework for decision making can also be validated using the expert panel method. The qualified experts for evaluating the proposed model are those with experience in urban transformation and those who will ultimately use the model. After introducing the model and research methodology to the experts, objective evaluations should be sought regarding the usefulness, benefits, and shortcomings of the model. The first question should focus on the clarity of the model's purpose, assumptions, activities, and process. Any issues raised by the experts regarding the research content may suggest an inability to meet the key performance objective. The experts should be asked objectively whether the proposed model can be applied in other regions and if it performs better than previously encountered models. Clear structure and precision in word choice consistent with technical terms are necessary. The methodology study should be finalized by requiring the experts to identify both the advantages and disadvantages of using the proposed model and methodology (Peng et al. 2015).

4.2.2 Evaluation Index Selecting Principle

In the study, Wang et al. (2017) aimed to select the government, residents and developers as the main stakeholders that can influence the realization of urban renewal objectives throughout the life cycle of urban renewal construction. In this context, based on the analysis of the literature summary on urban renewal and through the survey, thirty impact factors of comprehensive benefits in urban renewal are verified. A 16-factor evaluation index system, consisting of three subsystems -- government benefits, residents' benefits, and developer benefits -- was developed using factor analysis theory. Weights were assigned to the criteria and macro criteria using the entropy method. An evaluation model for the comprehensive benefit of urban regeneration was subsequently constructed. Fuzzy theory calculates the evaluation values of Lieder village regeneration, resulting in a comprehensive benefit assessment of village regeneration. This evaluation model proved effective for the comprehensive benefit assessment of urban regeneration.

According to Wang et al. (2017), The Index System utilized in the research carries the content of the comprehensive benefit assessment of urban regeneration. Maclaren (1996) proposed applying three main principles when selecting evaluation indicators for indicator design.

1. “Scientific and feasible. Truly reflecting the connotation of comprehensive benefit of urban renewal, collection of data should be based on objective fact, and easy to acquire and control. Data processed should be regulated to ensure the data sources scientific and accuracy.”

2. “Systematic and integrity. Selecting metrics should consider direct and indirect impact. From the perspective of the overall and systematic, it should comprehensively evaluate the characteristics of the object and the overall situation of urban renewal.”

3. “Representative and independent. Index system must be excluded as much as possible strong correlation index, the representative and independent indicators should be involved in the evaluation process.” (Wang et al. 2017, 164).

4.2.2.1 Choice Of Evaluation Index

Wang et al. (2017) argue that indicators have the role of measuring performance, and the creation of an index system in the evaluation stage is the basis for comprehensive evaluation. They also argue that the results of urban regeneration are closely related to the sustainable development of cities.

Wang et al. (2017) state that the United Nations Commission on Sustainable Development (UNCSD) developed a new sustainable development indicator system in 2001, which included fifteen items and thirty-eight sub-items, covering all aspects of society, economy, environment and system, and the Ministry of Science and Technology of the People's Republic of China (MOST) studied China's sustainable development index system and created one hundred ninety-six descriptive indices and one hundred evaluation indices. In 2002, the Chinese government agency MOST released a program aimed at promoting sustainable science and technology development in China, with the goal of coordinating economic, social, population, resource, environmental, and developmental factors. In 2016, the Ministry of Housing and Urban Development of the People's Republic of China (MOHURD) introduced an index system for evaluating China's habitat environment award. The primary index system comprises sixty-five indicators, including six main categories: living environment, ecological environment, social harmony, public security, economic development, and resource conservation.

According to L. Y. Shen et al. (2011), a comprehensive literature review was conducted in books, academic journals, government and institutional reports, sustainable urban development plans and websites, and the data compiled from these were used. Within the scope of the research, a list of urban sustainability indicators was created utilizing indicator sets from international and regional organizations including the United Nations (2007), UN Habitat (2004), the World Bank (2008), the European Foundation (1998), the European Commission for Science, Research and Development (2000), and the European Commission for Energy, Environment and Sustainable Development (2004). These indicators serve as a point of reference for numerous countries and communities when developing their own sustainable urbanization system.

L. Y. Shen et al. (2011) combined six different sets of indicators into a comprehensive list called the International Urban Sustainability Indicators List (IUSIL). The comprehensive list encompasses a variety of indicators to evaluate a city's urban sustainability performance and to analyze variations between practices. IUSIL categorizes one hundred and fifteen indicators into thirty-seven categories to better structure the indicators within four dimensions of sustainable development: environmental, economic, social, and governance. The purpose of IUSIL is to serve as a comparative tool for analyzing how it aligns with its indicators in terms of environmental, economic, social, and governance aspects throughout the implementation phases.

In their article, Wang et al. (2017) identified thirty factors for comprehensive benefit assessment of urban regeneration through literature research, and opinions of academics and practitioners working in the field of urban regeneration, as well as screening from existing indicator lists.

4.2.3 Indicators Selected from the Research of the Ministry

Under the protocol signed between the former Ministry of Environment and Urbanization and Istanbul Technical University on May 22, 2017, the goal is to establish planning principles and criteria for zoning plans aimed at renewing unsafe and unhealthy building stocks as part of the "Development of Planning Principles and Criteria in Urban Transformation Applications Project". A comprehensive project report has been prepared by Ocakçı, Türk, and Terzi (2017).

The project conducted a study using the logical framework approach with the participation of actors and stakeholders involved in transformation processes in six areas identified as urban transformation areas in Istanbul, Izmir, and Bursa. The principles and criteria for transforming residential areas were developed through research group meetings and surveys. The results, comprising 50 principles and 197 criteria, were presented in the book under 16 components developed for residential area transformation (Ocakçı, Türk, and Terzi 2017).

The components identified within the scope of the project are grouped under sixteen main headings, which include: Location and environmental integration, sustainability in natural structure and resources, sustainability, land use, compact settlement and density, settlement layout and housing diversity, centric design, human scale, public open space use and design, transportation-accessibility, infrastructure, technology, social structure and livability, local identity, economic building and financial sustainability, governance and maintenance (Figure 38) (Ocakçı, Türk, and Terzi 2017).

Figure 38: Planning Principles and Criteria in Urban Transformation Practices (Source: Rearrange from Ocakçı, Türk, and Terzi 2017, 111)

The study has identified 50 principles that include Integration, Harmony, Topography, Climate, Materials, Ecology, Water, Local Food, Function, Mixed Use, Balance, Urban Facilities, Form, Density, Settlement Typology, Housing Typology, Location and Access, Trade and Service Areas, Size and Proportion, Hierarchy, Continuity, Type and Quality, Transportation Demand Management, Public Transportation and Integration, Pedestrian and Bicycle Transportation, Road Network and Traffic Circulation, Parking, Energy, Existing Urban Infrastructure, Wastewater, Storm Water, Other Infrastructure Systems, Smart City Technology, Efficient Use, Smart

Systems, Priority to Vulnerable Groups, Social Inclusion, Employment, Cultural Diversity, Social Services, Image, Character, Economic Contribution, Incentives, Funding, Management-Operation, Participation. (Ocakçı, Türk, and Terzi 2017).

While most of the 197 criteria developed are related to planning and design principles, 32 of these criteria are considered to be related to the urban transformation process within the scope of this thesis and are included in the list of indicators within the scope of this thesis.

Selected criteria list can be mentioned as Transportation Distances and Mixed-Use Ratio, Selection of Appropriate Building Typology and Settlement Layout, Allowing municipalities to fund urban transformation projects with long-term bond issuance, Development of Financial Instruments such as Transfer of Development Rights, Transformation Certificates, etc. that can be converted into Real Estate Certificates, Deepening of Real Estate Certificate markets and public institutions becoming stakeholders in transformation projects, Funding Opportunities to Balance between High Return and Low Return Regions in Project Finance, Access to Educational Needs - Average Journey Time by Foot, Enhancing Employment Opportunities, Planning Common Areas in Neighborhoods and Building Groups, Development of Social Programs for Poverty Reduction, Connecting Natural and Open Spaces, Defining and Establishing the Participation Model in the Process, Ensuring Effective Use of Green Settlement and Green Building Certificates, Planning by Considering Disaster Risks, Planning of Disaster Muster Areas and Evacuation Corridors, Considering and Designing the Area with a Neighborhood Approach, Planning The Area in Harmony with The Land Use Pattern in Its Immediate Surroundings, Ensuring a Balanced Distribution of Social and Technical Infrastructure Equipment Areas in the Near Environment of the Area at the Settlement Level, Protection of the Natural Water Cycle and Habitat Areas, Conservation of Natural Topography, Planning Affordable/Rentable Housing Types for Low and Middle-Income Groups, Preservation and Enhancement of City Skyline, Preferring Regions with 5-15% Slope Priority for Settlement in Urban Transformation Areas, Urban Transformation Plan Decisions Are Compatible with Upper Scale Plan Decisions, Housing Areas are at a Walkable Distance to Public Transportation Systems, Access to Cultural Facilities - Average Journey Time By Foot, Access to Medical Facilities - Average Journey Time by Foot, Location Selection of Social and Technical Infrastructure Areas Suitable for Population Density and Accessibility, Development of Housing Typologies Compatible with Social-Cultural Life and Local Architectural Heritage, Density Gradation Compatible with Topography and Land Use Factors, Compliance of the Transportation Structure of the Settlement with the Existing Zoning Plan and Transportation Master Plan, Designing The Settlement at A Density Compatible with The Human Scale (Ocakçı, Türk, and Terzi 2017).

4.3 Selection of the Indicators of Urban Transformation

The list of indicators to be applied in Multi-Criteria Decision-Making (MCDM) methods in the process of determining urban transformation strategies in disaster-prone areas is given in Table 16.

This table only indicates the names and ID numbers of the indicators. In this context, in the main table of indicators, indicators are listed as; ID, Number of Criteria, Name of the Criteria, Number of Indicator, Name of the Indicator, Unit, min/max, Weight of Criteria, preference function, thresholds, q (min value), p (max value), s (standard deviation), System, Number of Category, Name of the Category, Number of Subcategory, Subcategory, Number of Component, Component, Number of Principle, Principle, Principle of Content, Subject Scope, Existence Law, Existence Regulations, Reference, Citation, Description of the Indicator, References of Description of the Indicator, Selection Status, where the information obtained from the literature, academic publications, laws and regulations, and implementation practice is classified.

In the detailed table, indicators are classified under six categories. These are physical structure, economic structure, social structure, environmental structure, legal and institutional structure, planning and design, and technological structure, and are shown in Table 17, Table 18, Table 19, Table 20, Table 21, and Table 22 including the relevant categories, indicator descriptions and related references.

Table 16: List of Indicators for Urban Transformation

(Prepared by Author)

NO	Name of the Indicator	NO	Name of the Indicator	NO	Name of the Indicator
1	Ratio of Open Space	101	Housing Affordability Rate	201	Water Consumption Per Capita Per Day
2	Building Stock Status of the Area	102	Housing Subsidies	202	Presence of Air Pollutants
3	Amount of Shopping District	103	Access to Housing, Affordability and Choice	203	The Degree of Improvement in Urban Landscape Features
4	Land Use Pattern	104	Loan Payment Period	204	Electricity Consumption Per Capita
5	Land Use Rate	105	Credit and Financing Support	205	Possibility to Reuse and Recycle Materials
6	Residential Density Levels in Relation to Plot Size	106	Reputation and Income of Corporate Improvement	206	Making the Right Design for Minimum Waste
7	Building Density	107	Budget and Staff Structure of the Institution	207	Prevention of Soil Pollution
8	Bicycle Road Network Status	108	Net Employment Density	208	Choice of Local/Regional Materials
9	Gross Density	109	Net Population Density	209	Green Energy Applications
10	Landfill Site	110	Correct Calculation of Final Estimates	210	Opportunity to Sort Hazardous Wastes Before and During Demolition
11	Earthquake Risk Analysis Status	111	Number of New Enterprises Created	211	Rate of Inclusion in the Scope of Law No. 2981
12	Circulation Pattern	112	Median Family Income	212	Disaster Risk Status
13	Access to Nearest Parks	113	Retail Impact Assessment	213	Area Size to be at least 5 ha and at most 500 hectares
14	Accessibility to Nearest Health Services	114	Funding Opportunities to Balance between High Return and Low Return Regions in Project Finance	214	Whether at least 65% of the total number of buildings in the area consists of buildings that have obtained a building and occupancy license
15	Accessibility to Nearest Sports Facility	115	Interim Payments Received During the Project Implementation	215	Legal Status of the Area
16	Existence of Slum Settlement	116	Construction Cost of the Projects	216	Whether the area is suitable for construction
17	Amount of General Parking Lot	117	Amount of Rent Subsidy in Risky Buildings (TL)	217	Damage to Infrastructure or Superstructure
18	Existence of Light Rail System	118	Correct Calculation of Requested Cost	218	Municipality Council Decision-Making
19	Ratio of Dilapidated Housing	119	The Level of Compensation and Resettlement Cost	219	Existence and Status of Building Regulations
20	Area Size or Proportion of Immovables Belonging to the Treasury	120	Number of Jobs and Enterprises Created	220	Whether there is a Construction with Risk of Loss of Life and Property
21	Amount of Undeveloped Land	121	Net Jobs Created (Percentage of Employees from Local Area)	221	Whether there is a Ground Structure with Risk of Loss of Life and Property
22	Commuter Distance	122	Rate of Return on Investment (ROR)	222	Existence and Status of Environmental Impact Assessment
23	Geological Structure (Suitability for Settlement)	123	Investment Cost	223	Existing Of Nature Reserve
24	Cadastral Parcel Ratio	124	Time Management	224	Beneficiary Identification and Real Estate Valuation Status
25	Existence and Condition of Public Buildings	125	Access to Open Space - Average Journey Time by Foot	225	Ensuring Public Participation
26	Public Good	126	Ratio of Active Population	226	Shared Ownership Asset
27	Existence and Condition of Public Open Spaces	127	Socio Economic Status of the Area	227	Whether there is an Improvement Plan
28	Ratio of Public Space	128	Historical and Cultural Value Data of the Area	228	Evaluation of Spatial Regional Plan, Strategy Plan, Sectoral Investment Decisions of Relevant Public Institutions
29	Existence and Status of Sewerage System	129	Segregation	229	Political Preference of the Head of the Relevant Institution
30	Mixed-Use Ratio	130	Dependency Ratio	230	Ratio of By-Low Housing
31	Amount of Residential Area	131	The Existence of Interdependent Communities	231	Easement
32	Central Business Height Index (CBHI)	132	Cultural and Local Characteristics of the Region	232	Development Plan
33	Accessibility Of Subway	133	Growth Rate	233	Public-Private Partnership
34	Existing Number of Independent Units and Structures	134	Birth Rate	234	Protection of the Public Interest (Effective, Efficient and Transparent Use of Resources)
35	Building Quality Status of Existing Buildings	135	Life Expectancy at Birth (In Years)	235	Compulsory Purchase
36	Existing Residential Differentiation	136	Occupancy Rate	236	Whether Urban Transformation Works Can Meet the Existing Building Density
37	Existing Housing Conditions, Business Activities	137	Access to Educational Needs - Average Journey Time by Foot	237	Existence and Status of Protected Areas
38	Existing Retail Floor Space	138	Access to Leisure Facilities - Average Journey Time by Foot	238	Neighborhood Organization Status
39	Net Residential Area	139	Accessibility to Nearest Child Care Centre	239	Whether it is one of the areas subject to special laws
40	Average Noise Pollution Level	140	Life Without Disabilities	240	Whether it is a Special Status Area
41	Status of Strategic Structures and Infrastructures (Military Facility, Airport, Port, etc.)	141	Integration and Social Inclusion	241	Status of Groups to Participate in the Planning Process
42	Water Supply System	142	Owner Occupation	242	Inadequate Planning or Infrastructure Services
43	Proximity to Water Coasts (Sea, Lake, River, etc.)	143	Activity Rate	243	Risk Status (Loss of Life, Economic Loss, Environmental Impacts, etc.)
44	Sustainability	144	Extended Family	244	Necessity of Zoning Right Transfers for Right Holders in the Risky Area
45	Land Coverage	145	Hidden Household	245	Presence of Social Infrastructure and Technical Infrastructure Area
46	Status of Technical Infrastructure	146	Immigration Status	246	Defining and Establishing the Participation Model in the Process
47	Traffic Improvement Status (Traffic Volume)	147	Demographic, Socio-Economic Structure of the People	247	Existence and Status of Implementation Plan
48	Transportation Distances and Mixed-Use Ratio	148	Public Needs and Expectations	248	Ensuring Effective Use of Green Settlement and Green Building Certificates
49	Selection of Appropriate Building Typology and Settlement Layout	149	The Degree of Public Participation	249	Public Transport and Car Ownership Per 1,000 Capita
50	Energy Efficiency of Building Materials / Construction Methods	150	Public Concerns and Anxieties	250	Planning by Considering Disaster Risks
51	Reclamation of Building Materials	151	Mobility (Ability to Change Location)	251	Planning of Disaster Muster Areas and Evacuation Corridors

(cont. on next page)

Table 16 (cont.)

NO	Name of the Indicator	NO	Name of the Indicator	NO	Name of the Indicator
52	Risk Status of Structures	152	Enhancing Employment Opportunities	252	Participation of Actors in the Process
53	The Coordination Degree of New and Old Buildings	153	Ratio of Tenants	253	Considering and Designing the Area with a Neighborhood Approach
54	Ground Condition (Soil Classification)	154	Average No. of Rooms Per Person	254	Current Usage Functions of the Area
55	Land Compensation	155	The Degree of Improvement in Culture and Education	255	Planning The Area in Harmony with The Land Use Pattern in Its Immediate Surroundings
56	Land Speculation	156	Planning Common Areas in Neighborhoods and Building Groups	256	Ensuring a Balanced Distribution of Social and Technical Infrastructure Equipment Areas in the Near Environment of the Area at the Settlement Level
57	Land Value	157	Current Population Density and Distribution	257	Land Use Intensity
58	Land Revenue Condition	158	The Perfect Degree of Base and Public Facilities	258	Capacity of Information Systems (Database Management)
59	Allowing municipalities to fund urban transformation projects with long-term bond issuance	159	Population (Economically Active Population)	259	Buildings Constructability
60	Gross Development Value	160	Population (Economically Inactive Population)	260	Vacant Parcel Rate
61	Growth (Rate of Profitability, the Shareholder Gain, Increase in the Rate of Sales, Cash Flow)	161	Population (Night Population)	261	Protection of the Natural Water Cycle and Habitat Areas
62	Dynamic Investment Payback Period	162	Population (Youth Population)	262	Conservation of Natural Topography
63	Economic Efficiency	163	Population (Day Population)	263	Planning Affordable/Rentable Housing Types for Low and Middle-Income Groups
64	Real Estate Fair Values	164	Population (Total Population)	264	Number of Parcels Implemented According to Article 18 of the Zoning Law and Attrition Rates (%)
65	Amount of Property Tax	165	Population Decrease	265	Human Scale
66	Energy Consumption	166	Population Risk Status (day and night)	266	Floor Area Ratio
67	Inflation Rate	167	Post-Secondary Education Rate	267	Preservation and Enhancement of City Skyline
68	Opportunity Cost	168	Student-Teacher Ratio	268	Preferring Regions with 5-15% Slope Priority for Settlement in Urban Transformation Areas
69	Financial Internal Rate of Return (FIRR)	169	Access to Retail Facilities - Average Journey Time by Foot to CBD	269	Urban Renewal Development Potential
70	Financial Net Present Value (FNPV)	170	Social Values that the Projects will Provide to the City	270	Urban Transformation Plan Decisions Are Compatible with Upper Scale Plan Decisions
71	Financial Sustainability	171	Social Permeability Condition	271	Creating Urban Center/Attraction Point
72	Financing Requirement	172	Social Cost	272	Public Green Area Per Capita
73	Gross National Product	173	The Degree of Social Welfare Improvement	273	Residential Floor Area Per Capita
74	Development of Financial Instruments such as Transfer of Development Rights, Transformation Certificates, etc. that can be converted into Real Estate Certificates	174	Social Harmony and Stability	274	Housing Areas are at a Walkable Distance to Public Transportation Systems
75	Deepening of Real Estate Certificate (REIC) markets and public REIT institutions becoming stakeholders in transformation projects	175	Proximity to Crime Scenes (Hotspots)	275	Housing Stock Conditions
76	Income Level	176	Historical and Cultural Values and Inheritor of Urban Style	276	Access to Cultural Facilities - Average Journey Time by Foot
77	Income and Expense Analysis	177	Public Transport Links - Walking Distance to Nearest Facilities	277	Observing Spatial Harmony
78	Repayment Period	178	Community Group Involvement	278	Existing Zoning Status (Construction Conditions etc.)
79	Existence of Shadow Prices	179	Community Satisfaction	279	Number of Floors of Existing Buildings
80	Household Expenditure Rate	180	Cleanliness, Safety and Belonging of the Community	280	License Status and License Years of Existing Buildings
81	Number of Jobs Created Per 1000 Square Meters	181	Consensus Building	281	Current Occupancy-Vacancy Status
82	Return of the Construction and Operating Costs	182	Access to Free Education	282	Request for Increase in Existing Development Rights
83	Employment Structure	183	Citizens' Expectations and Approaches from Urban Transformation	283	Existing Implementation Plan Rights
84	Labor Opportunities	184	The Degree of Living Conditions Improvement	284	Number and Size Distribution of Existing Parcels
85	Operation Cost	185	The Degree of Living and Entertaining Improvement	285	Building Construction Area Status of Existing Buildings
86	Unemployment Rate	186	Sense of Place	286	Property Structure - Cadastral Status
87	Female Employment Rate	187	Development of Social Programs for Poverty Reduction	287	Capacity and Distribution of Parking lots
88	Public Finance	188	Number of Trees in the Area and Tree Fee Amount (TL)	288	Proposed Implementation Plan Rights
89	Profitability (Increase in Market Share and Return on Resources)	189	Separation of Waste at Source and Possibility of Recycling	289	Number of Independent Units of the Buildings According to the Proposed Plan
90	Amount of Value Added Tax	190	Building Energy Efficiency	290	Distance to Proposed Reserve Building Areas
91	Redevelopment and Revitalization of the Lost Economic Activity	191	Building Efficiency Accelerator (BEA)	291	Access to Medical Facilities - Average Journey Time by Foot
92	Informal Economy	192	Energy Efficiency of Building Layout and Design	292	Location Selection of Social and Technical Infrastructure Areas Suitable for Population Density and Accessibility
93	Economic Values to be Provided to the City	193	Biological Diversity	293	Development of Housing Typologies Compatible with Social-Cultural Life and Local Architectural Heritage
94	Urban Renewal Cycle	194	Protection of Environmental Values	294	Technological Capability
95	Cost of Urban Transformation	195	Environmental Quality Improvement	295	Technological Resources (People, Equipment, Information, Money, etc.)
96	Rent	196	Connecting Natural and Open Spaces	296	Density Gradation Compatible with Topography and Land Use Factors
97	The Level of Rental Income	197	Ecological Footprint	297	Increasing Life Quality and Urban Prosperity
98	Personal Disposable Income	198	The Degree of Ecological Environment Impact	298	Horizontal Architecture
99	Housing Finance	199	Ensuring land use integrity to protect the ecological balance and ecosystem	299	Compliance of the Transportation Structure of the Settlement with the Existing Zoning Plan and Transportation Master Plan
100	Mortgage Loan	200	Energy Storage and Energy Efficiency	300	Designing The Settlement at A Density Compatible with The Human Scale

4.3.1 Physical Structure

In the framework of the thesis, fifty-four criteria were identified that attempt to explain the physical characteristics of urban transformation. Their sources are summarized in the following distribution in Table 17.

Ministry of Environment and Urbanization (2019) requested information about 'Building Stock Status of the Area, Area Size or Proportion of Immovables Belonging to the Treasury, Existing Housing Conditions, Business Activities, Sustainability.'

Ocakçı, Türk, and Terzi (2017) mentioned 'Transportation Distances and Mixed-Use Ratio, Selection of Appropriate Building Typology and Settlement Layout.'

Peng et al. (2015) claimed 'Residential Density Levels in Relation to Plot Size, Energy Efficiency of Building Materials / Construction Methods, Reclamation of Building Materials.'

Sajjad, Chan, and Chopra (2021) mentioned 'Access to Nearest Parks, Accessibility to Nearest Health Services, Accessibility to Nearest Sports Facility, Average Noise Pollution Level.'

Wang et al. (2017) listed 'Land Use Rate, Traffic Improvement Status (Traffic Volume), The Coordination Degree of New and Old Buildings.'

Arkon (2006) explained that 'Ratio of Open Space, Amount of Shopping District, Land Use Pattern, Building Density, Bicycle Road Network Status, Gross Density, Landfill Site, Earthquake Risk Analysis Status, Circulation Pattern, Existence of Slum Settlement, Amount of General Parking Lot, Existence of Light Rail System, Ratio of Dilapidated Housing, Amount of Undeveloped Land, Commuter Distance, Geological Structure (Suitability for Settlement), Cadastral Parcel Ratio, Existence and Condition of Public Buildings, Public Good, Existence and Condition of Public Open Spaces, Ratio of Public Space, Existence and Status of Sewerage System, Mixed-Use Ratio, Amount of Residential Area, Central Business Height Index, Accessibility Of Subway, Existing Number of Independent Units and Structures, Building Quality Status of Existing Buildings, Existing Residential Differentiation, Existing Retail Floor Space, Net Residential Area, Status of Strategic Structures and Infrastructures, Water Supply System, Proximity to Water Coasts (Sea, Lake, River, etc.), Land Coverage, Status of Technical Infrastructure, Risk Status of Structures, Ground Condition (Soil Classification).'

Table 17: List of Physical Indicators (Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
1	Ratio of Open Space	1) Physical Structure				
2	Building Stock Status of the Area	1) Physical Structure				(CSB 2019)
3	Amount of Shopping District	1) Physical Structure				
4	Land Use Pattern	1) Physical Structure				
5	Land Use Rate	1) Physical Structure				(Wang et al. 2017)
6	Residential Density Levels in Relation to Plot Size	1) Physical Structure	Building Performance			(Peng et al. 2015)
7	Building Density	1) Physical Structure				
8	Bicycle Road Network Status	1) Physical Structure				
9	Gross Density	1) Physical Structure				
10	Landfill Site	1) Physical Structure				
11	Earthquake Risk Analysis Status	1) Physical Structure				
12	Circulation Pattern	1) Physical Structure				
13	Access to Nearest Parks	1) Physical Structure	Resiliency			(Sajjad et al. 2021)
14	Accessibility to Nearest Health Services	1) Physical Structure	Resiliency			(Sajjad et al. 2021)
15	Accessibility to Nearest Sports Facility	1) Physical Structure	Resiliency			(Sajjad et al. 2021)
16	Existence of Slum Settlement	1) Physical Structure				
17	Amount of General Parking Lot	1) Physical Structure				
18	Existence of Light Rail System	1) Physical Structure				
19	Ratio of Dilapidated Housing	1) Physical Structure				
20	Area Size or Proportion of Immovables Belonging to the Treasury	1) Physical Structure				(CSB 2019)
21	Amount of Undeveloped Land	1) Physical Structure				
22	Commuter Distance	1) Physical Structure				
23	Geological Structure (Suitability for Settlement)	1) Physical Structure				
24	Cadastral Parcel Ratio	1) Physical Structure				
25	Existence and Condition of Public Buildings	1) Physical Structure				
26	Public Good	1) Physical Structure				
27	Existence and Condition of Public Open Spaces	1) Physical Structure				
28	Ratio of Public Space	1) Physical Structure				
29	Existence and Status of Sewerage System	1) Physical Structure				
30	Mixed-Use Ratio	1) Physical Structure				
31	Amount of Residential Area	1) Physical Structure				
32	Central Business Height Index (CBHI)	1) Physical Structure				
33	Accessibility Of Subway	1) Physical Structure				
34	Existing Number of Independent Units and Structures	1) Physical Structure				
35	Building Quality Status of Existing Buildings	1) Physical Structure				
36	Existing Residential Differentiation	1) Physical Structure				
37	Existing Housing Conditions, Business Activities	1) Physical Structure				(CSB 2019)
38	Existing Retail Floor Space	1) Physical Structure				
39	Net Residential Area	1) Physical Structure				
40	Average Noise Pollution Level	1) Physical Structure	Resiliency			(Sajjad et al. 2021)
41	Status of Strategic Structures and Infrastructures (Military Facility, Airport, Port, etc.)	1) Physical Structure				
42	Water Supply System	1) Physical Structure				
43	Proximity to Water Coasts (Sea, Lake, River, etc.)	1) Physical Structure				
44	Sustainability	1) Physical Structure				(CSB 2019)
45	Land Coverage	1) Physical Structure				
46	Status of Technical Infrastructure	1) Physical Structure				
47	Traffic Improvement Status (Traffic Volume)	1) Physical Structure				(Wang et al. 2017)
48	Transportation Distances and Mixed-Use Ratio	1) Physical Structure				(Ocakçı et al. 2017)
49	Selection of Appropriate Building Typology and Settlement Layout	1) Physical Structure				(Ocakçı et al. 2017)
50	Energy Efficiency of Building Materials / Construction Methods	1) Physical Structure	Building Performance			(Peng et al. 2015)
51	Reclamation of Building Materials	1) Physical Structure	Building Performance			(Peng et al. 2015)
52	Risk Status of Structures	1) Physical Structure				
53	The Coordination Degree of New and Old Buildings	1) Physical Structure				(Wang et al. 2017)
54	Ground Condition (Soil Classification)	1) Physical Structure				

4.3.2 Economic Structure

There are seventy criteria identified in this thesis that attempt to elucidate the economic characteristics of urban transformation. The distribution of these criteria, as per the sources, is summarized below and in Table 18.

According to Işik and Aladağ (2017), indicators to consider for success of the strategy include; 'Growth (Rate of Profitability, the Shareholder Gain, Increase in the Rate of Sales, Cash Flow), Financial Sustainability, Repayment Period, Return of the Construction and Operating Costs, Profitability (Increase in Market Share and Return on Resources), Redevelopment and Revitalization of the Lost Economic Activity, Rent, Correct Calculation of Final Estimates, Interim Payments Received During the Project Implementation, Correct Calculation of Requested Cost, Number of Jobs and Enterprises Created, Time Management.'

Ministry of Environment and Urbanization (2019), requested that 'Real Estate Fair Values, Financing Requirement, Income and Expense Analysis, Economic Values to be Provided to the City, Credit and Financing Support, Construction Cost of the Projects.'

Ocakçı, Türk, and Terzi (2017) identified 'Allowing municipalities to fund urban transformation projects with long-term bond issuance, Development of Financial Instruments such as Transfer of Development Rights, Transformation Certificates, etc. that can be converted into Real Estate Certificates, Deepening of Real Estate Certificate (REIC) markets and public REIT institutions becoming stakeholders in transformation projects, Funding Opportunities to Balance between High Return and Low Return Regions in Project Finance.'

Peng et al. (2015) suggested that 'Number of Jobs Created Per 1000 Square Meters, Access to Housing, Affordability and Choice, Net Employment Density, Net Population Density, Number of New Enterprises Created, Net Jobs Created (Percentage of Employees from Local Area).'

Sajjad, Chan, and Chopra (2021) mentioned 'Energy Consumption, Household Expenditure Rate, Unemployment Rate, Female Employment Rate, Housing Affordability Rate, Median Family Income.'

Wang et al. (2017) referred 'Land Revenue Condition, Dynamic Investment Payback Period, Financial Internal Rate of Return (FIRR), Financial Net Present Value (FNPV), Urban Renewal Cycle, Cost of Urban Transformation, The Level of Rental

Income, Loan Payment Period, Reputation and Income of Corporate Improvement, The Level of Compensation and Resettlement Cost, Rate of Return on Investment (ROR).'

Yang (2010) mentioned 'Personal Disposable Income.'

Arkon (2006) listed 'Land Compensation, Land Speculation, Land Value, Gross Development Value, Economic Efficiency, Amount of Property Tax, Inflation Rate, Opportunity Cost, Gross National Product, Income Level, Existence of Shadow Prices, Employment Structure, Labor Opportunities, Operation Cost, Public Finance, Amount of Value Added Tax, Informal Economy, Housing Finance, Mortgage Loan, Housing Subsidies, Budget and Staff Structure of the Institution, Retail Impact Assessment, Amount of Rent Subsidy in Risky Buildings (TL), Investment Cost.'

Table 18: List of Economic Indicators

(Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
55	Land Compensation	2) Economic Structure				
56	Land Speculation	2) Economic Structure				
57	Land Value	2) Economic Structure				
58	Land Revenue Condition	2) Economic Structure				(Wang et al. 2017)
59	Allowing municipalities to fund urban transformation projects with long-term bond issuance	2) Economic Structure				(Ocakçı et al. 2017)
60	Gross Development Value	2) Economic Structure				
61	Growth (Rate of Profitability, the Shareholder Gain, Increase in the Rate of Sales, Cash Flow)	2) Economic Structure				(Aladağ & Işık 2016)
62	Dynamic Investment Payback Period	2) Economic Structure				(Wang et al. 2017)
63	Economic Efficiency	2) Economic Structure				
64	Real Estate Fair Values	2) Economic Structure				(CSB 2019)
65	Amount of Property Tax	2) Economic Structure				
66	Energy Consumption	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
67	Inflation Rate	2) Economic Structure				
68	Opportunity Cost	2) Economic Structure				
69	Financial Internal Rate of Return (FIRR)	2) Economic Structure				(Wang et al. 2017)
70	Financial Net Present Value (FNPV)	2) Economic Structure				(Wang et al. 2017)
71	Financial Sustainability	2) Economic Structure				(Aladağ & Işık 2016)
72	Financing Requirement	2) Economic Structure				(CSB 2019)
73	Gross National Product	2) Economic Structure				
74	Development of Financial Instruments such as Transfer of Development Rights, Transformation Certificates, etc. that can be converted into Real Estate Certificates	2) Economic Structure				(Ocakçı et al. 2017)
75	Deepening of Real Estate Certificate (REIC) markets and public REIT institutions becoming stakeholders in transformation projects	2) Economic Structure				(Ocakçı et al. 2017)
76	Income Level	2) Economic Structure				
77	Income and Expense Analysis	2) Economic Structure				(CSB 2019)
78	Repayment Period	2) Economic Structure				(Aladağ & Işık 2016)
79	Existence of Shadow Prices	2) Economic Structure				
80	Household Expenditure Rate	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
81	Number of Jobs Created Per 1000 Square Meters	2) Economic Structure	Economic Development			(Peng et al. 2015)
82	Return of the Construction and Operating Costs	2) Economic Structure				(Aladağ & Işık 2016)
83	Employment Structure	2) Economic Structure				
84	Labor Opportunities	2) Economic Structure				
85	Operation Cost	2) Economic Structure				
86	Unemployment Rate	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
87	Female Employment Rate	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
88	Public Finance	2) Economic Structure				
89	Profitability (Increase in Market Share and Return on Resources)	2) Economic Structure				(Aladağ & Işık 2016)
90	Amount of Value Added Tax	2) Economic Structure				
91	Redevelopment and Revitalization of the Lost Economic Activity	2) Economic Structure				(Aladağ & Işık 2016)
92	Informal Economy	2) Economic Structure				
93	Economic Values to be Provided to the City	2) Economic Structure				(CSB 2019)
94	Urban Renewal Cycle	2) Economic Structure				(Wang et al. 2017)
95	Cost of Urban Transformation	2) Economic Structure				(Wang et al. 2017)
96	Rent	2) Economic Structure				(Aladağ & Işık 2016)
97	The Level of Rental Income	2) Economic Structure				(Wang et al. 2017)
98	Personal Disposable Income	2) Economic Structure				(Yang 2010)
99	Housing Finance	2) Economic Structure				
100	Mortgage Loan	2) Economic Structure				
101	Housing Affordability Rate	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
102	Housing Subsidies	2) Economic Structure				
103	Access to Housing, Affordability and Choice	2) Economic Structure	Social Development			(Peng et al. 2015)
104	Loan Payment Period	2) Economic Structure				(Wang et al. 2017)
105	Credit and Financing Support	2) Economic Structure				(CSB 2019)
106	Reputation and Income of Corporate Improvement	2) Economic Structure				(Wang et al. 2017)
107	Budget and Staff Structure of the Institution	2) Economic Structure				
108	Net Employment Density	2) Economic Structure	Economic Development			(Peng et al. 2015)

(cont. on next page)

Table 18 (cont.)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
109	Net Population Density	2) Economic Structure	Economic Development			(Peng et al. 2015)
110	Correct Calculation of Final Estimates	2) Economic Structure				(Aladağ & Işık 2016)
111	Number of New Enterprises Created	2) Economic Structure	Economic Development			(Peng et al. 2015)
112	Median Family Income	2) Economic Structure	Resiliency			(Sajjad et al. 2021)
113	Retail Impact Assessment	2) Economic Structure				
114	Funding Opportunities to Balance between High Return and Low Return Regions in Project Finance	2) Economic Structure				(Ocakçı et al. 2017)
115	Interim Payments Received During the Project Implementation	2) Economic Structure				(Aladağ & Işık 2016)
116	Construction Cost of the Projects	2) Economic Structure				(CSB 2019)
117	Amount of Rent Subsidy in Risky Buildings (TL)	2) Economic Structure				
118	Correct Calculation of Requested Cost	2) Economic Structure				(Aladağ & Işık 2016)
119	The Level of Compensation and Resettlement Cost	2) Economic Structure				(Wang et al. 2017)
120	Number of Jobs and Enterprises Created	2) Economic Structure				(Aladağ & Işık 2016)
121	Net Jobs Created (Percentage of Employees from Local Area)	2) Economic Structure	Economic Development			(Peng et al. 2015)
122	Rate of Return on Investment (ROR)	2) Economic Structure				(Wang et al. 2017)
123	Investment Cost	2) Economic Structure				
124	Time Management	2) Economic Structure				(Aladağ & Işık 2016)

4.3.3 Social Structure

Sixty-three criteria have been identified in the context of the thesis that attempt to explain the social characteristics of urban transformation. The sources indicate their distribution as summarized below and in Table 19.

According to Işik and Aladağ (2017), Community Satisfaction is an important indicator.

Castanheira and Mateus (2013) mentioned 'Integration and Social Inclusion.' are indicators has importance.

Ministry of Environment and Urbanization (2019) defined 'Socio Economic Status of the Area, Historical and Cultural Value Data of the Area, Cultural and Local Characteristics of the Region, Life Without Disabilities, Demographic, Socio-Economic Structure of the People, Public Needs and Expectations, Public Concerns and Anxieties, Social Values that the Projects will Provide to the City, Citizens' Expectations and Approaches from Urban Transformation' as necessary.

Ministry of Environment and Urbanization (2014) mentioned 'Current Population Density and Distribution.'

Ocakçı, Türk, and Terzi (2017) mentioned 'Enhancing Employment Opportunities, Planning Common Areas in Neighborhoods and Building Groups, Development of Social Programs for Poverty Reduction.'

Peng et al. (2015) identified 'Access to Open Space - Average Journey Time by Foot, Access to Leisure Facilities - Average Journey Time by Foot, Public Transport Links - Walking Distance to Nearest Facilities, Community Group Involvement.'

Peng et al. (2015) and Ocakçı, Türk, and Terzi (2017) mentioned 'Access to Educational Needs - Average Journey Time by Foot.'

Peng et al. (2015) and Sajjad, Chan, and Chopra (2021) mentioned 'Access to Retail Facilities - Average Journey Time by Foot to CBD.'

Sajjad, Chan, and Chopra (2021) mentioned 'Accessibility to Nearest Child Care Centre, Immigration Status, Average No. of Rooms Per Person, Population (Youth Population), Population (Total Population), Post-Secondary Education Rate, Proximity to Crime Scenes (Hotspots), Access to Free Education, Sense of Place.'

Wang et al. (2017) mentioned 'The Degree of Public Participation, The Degree of Improvement in Culture and Education, The Perfect Degree of Base and Public Facilities, The Degree of Social Welfare Improvement, Social Harmony and Stability, Cleanliness, Safety and Belonging of the Community, The Degree of Living Conditions Improvement, The Degree of Living and Entertaining Improvement.'

Wang et al. (2017) and Ministry of Environment and Urbanization (2019) mentioned 'Historical and Cultural Values and Inheritor of Urban Style.'

Yang (2010) mentioned 'Life Expectancy at Birth (In Years), Student-Teacher Ratio.'

Arkon (2006) identified 'Ratio of Active Population, Segregation, Dependency Ratio, The Existence of Interdependent Communities, Growth Rate, Birth Rate, Occupancy Rate, Owner Occupation, Activity Rate, Extended Family, Hidden Household, Mobility (Ability to Change Location), Ratio of Tenants, Population (Economically Active Population), Population (Economically Inactive Population), Population (Night Population), Population (Day Population), Population Decrease, Population Risk Status (day and night), Social Permeability Condition, Social Cost, Consensus Building.'

Table 19: List of Social Indicators (Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
125	Access to Open Space - Average Journey Time by Foot	3) Social Structure	Social Development			(Peng et al. 2015)
126	Ratio of Active Population	3) Social Structure				
127	Socio Economic Status of the Area	3) Social Structure				(CSB 2019)
128	Historical and Cultural Value Data of the Area	3) Social Structure				(CSB 2019)
129	Segregation	3) Social Structure				
130	Dependency Ratio	3) Social Structure				
131	The Existence of Interdependent Communities	3) Social Structure				
132	Cultural and Local Characteristics of the Region	3) Social Structure				(CSB 2019)
133	Growth Rate	3) Social Structure				
134	Birth Rate	3) Social Structure				
135	Life Expectancy at Birth (In Years)	3) Social Structure				(Yang 2010)
136	Occupancy Rate	3) Social Structure				
137	Access to Educational Needs - Average Journey Time by Foot	3) Social Structure	Social Development			(Peng et al. 2015) (Ocakçı et al. 2017)
138	Access to Leisure Facilities - Average Journey Time by Foot	3) Social Structure	Social Development			(Peng et al. 2015)
139	Accessibility to Nearest Child Care Centre	3) Social Structure	Resiliency			(Sajjad et al. 2021)
140	Life Without Disabilities	3) Social Structure				(CSB 2019)
141	Integration and Social Inclusion	3) Social Structure				(Castanheira & Mateus 2013)
142	Owner Occupation	3) Social Structure				
143	Activity Rate	3) Social Structure				
144	Extended Family	3) Social Structure				
145	Hidden Household	3) Social Structure				
146	Immigration Status	3) Social Structure	Resiliency			(Sajjad et al. 2021)
147	Demographic, Socio-Economic Structure of the People	3) Social Structure				(CSB 2019)
148	Public Needs and Expectations	3) Social Structure				(CSB 2019)
149	The Degree of Public Participation	3) Social Structure				(Wang et al. 2017)
150	Public Concerns and Anxieties	3) Social Structure				(CSB 2019)
151	Mobility (Ability to Change Location)	3) Social Structure				
152	Enhancing Employment Opportunities	3) Social Structure				(Ocakçı et al. 2017)
153	Ratio of Tenants	3) Social Structure				
154	Average No. of Rooms Per Person	3) Social Structure	Resiliency			(Sajjad et al. 2021)
155	The Degree of Improvement in Culture and Education	3) Social Structure				(Wang et al. 2017)
156	Planning Common Areas in Neighborhoods and Building Groups	3) Social Structure				(Ocakçı et al. 2017)
157	Current Population Density and Distribution	3) Social Structure				(Regulation for the Preparation of Spatial Plans 2014)
158	The Perfect Degree of Base and Public Facilities	3) Social Structure				(Wang et al. 2017)
159	Population (Economically Active Population)	3) Social Structure				
160	Population (Economically Inactive Population)	3) Social Structure				
161	Population (Night Population)	3) Social Structure				
162	Population (Youth Population)	3) Social Structure	Resiliency			(Sajjad et al. 2021)
163	Population (Day Population)	3) Social Structure				
164	Population (Total Population)	3) Social Structure	Resiliency			(Sajjad et al. 2021)
165	Population Decrease	3) Social Structure				
166	Population Risk Status (day and night)	3) Social Structure				
167	Post-Secondary Education Rate	3) Social Structure	Resiliency			(Sajjad et al. 2021)
168	Student-Teacher Ratio	3) Social Structure				(Yang 2010)
169	Access to Retail Facilities - Average Journey Time by Foot to CBD	3) Social Structure	Resiliency			(Peng et al. 2015) (Sajjad et al. 2021)
170	Social Values that the Projects will Provide to the City	3) Social Structure				(CSB 2019)
171	Social Permeability Condition	3) Social Structure				
172	Social Cost	3) Social Structure				
173	The Degree of Social Welfare Improvement	3) Social Structure				(Wang et al. 2017)
174	Social Harmony and Stability	3) Social Structure				(Wang et al. 2017)
175	Proximity to Crime Scenes (Hotspots)	3) Social Structure	Resiliency			(Sajjad et al. 2021)
176	Historical and Cultural Values and Inheritor of Urban Style	3) Social Structure				(Wang et al. 2017) (CSB 2019)
177	Public Transport Links - Walking Distance to Nearest Facilities	3) Social Structure	Social Development			(Peng et al. 2015)
178	Community Group Involvement	3) Social Structure	Social Development			(Peng et al. 2015)
179	Community Satisfaction	3) Social Structure				(Aladağ & Işık 2016)
180	Cleanliness, Safety and Belonging of the Community	3) Social Structure				(Wang et al. 2017)
181	Consensus Building	3) Social Structure				
182	Access to Free Education	3) Social Structure	Resiliency			(Sajjad et al. 2021)
183	Citizens' Expectations and Approaches from Urban Transformation	3) Social Structure				(CSB 2019)
184	The Degree of Living Conditions Improvement	3) Social Structure				(Wang et al. 2017)
185	The Degree of Living and Entertaining Improvement	3) Social Structure				(Wang et al. 2017)
186	Sense of Place	3) Social Structure	Resiliency			(Sajjad et al. 2021)
187	Development of Social Programs for Poverty Reduction	3) Social Structure				(Ocakçı et al. 2017)

4.3.4 Environmental Structure

In the context of the thesis, twenty-three criteria have been identified that attempt to explain the environmental characteristics of urban transformation. Their distribution by sources is outlined below and in Table 20.

Işik and Aladağ (2017) mentioned 'Ecological Footprint, Energy Storage and Energy Efficiency, Making the Right Design for Minimum Waste, Prevention of Soil Pollution, Choice of Local/Regional Materials, Green Energy Applications.'

Bayraktar and Üzümoğlu (2016) mentioned 'Building Efficiency Accelerator (BEA).'

Ministry of Environment and Urbanization (2019) identified 'Separation of Waste at Source and Possibility of Recycling, Protection of Environmental Values, Possibility to Reuse and Recycle Materials, Opportunity to Sort Hazardous Wastes Before and During Demolition.'

Ministry of Environment and Urbanization (2014) mentioned 'Ensuring land use integrity in order to protect the ecological balance and ecosystem.'

Ocakçı, Türk, and Terzi (2017) mentioned 'Connecting Natural and Open Spaces.'

Peng et al. (2015) mentioned 'Energy Efficiency of Building Layout and Design.'

Wang et al. (2017) identified 'Building Energy Efficiency, Environmental Quality Improvement, The Degree of Ecological Environment Impact, The Degree of Improvement in Urban Landscape Features.'

Yang (2010) mentioned 'Water Consumption Per Capita Per Day, Presence of Air Pollutants, Electricity Consumption Per Capita.'

Arkon (2006) mentioned 'Number of Trees in the Area and Tree Fee Amount (TL), Biological Diversity.'

Table 20: List of Environmental Indicators

(Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
188	Number of Trees in the Area and Tree Fee Amount (TL)	4) Environmental Structure				
189	Separation of Waste at Source and Possibility of Recycling	4) Environmental Structure				(CSB 2019)
190	Building Energy Efficiency	4) Environmental Structure				(Wang et al. 2017)
191	Building Efficiency Accelerator (BEA)	4) Environmental Structure				(Bayraktar & Üzümoğlu 2016)
192	Energy Efficiency of Building Layout and Design	4) Environmental Structure	Building Performance			(Peng et al. 2015)
193	Biological Diversity	4) Environmental Structure				
194	Protection of Environmental Values	4) Environmental Structure				(CSB 2019)
195	Environmental Quality Improvement	4) Environmental Structure				(Wang et al. 2017)
196	Connecting Natural and Open Spaces	4) Environmental Structure				(Ocakçı et al. 2017)
197	Ecological Footprint	4) Environmental Structure				(Aladağ & Işık 2016)
198	The Degree of Ecological Environment Impact	4) Environmental Structure				(Wang et al. 2017)
199	Ensuring land use integrity in order to protect the ecological balance and ecosystem	4) Environmental Structure				(MoEaU 2014)
200	Energy Storage and Energy Efficiency	4) Environmental Structure				(Aladağ & Işık 2016)
201	Water Consumption Per Capita Per Day	4) Environmental Structure				(Yang 2010)
202	Presence of Air Pollutants	4) Environmental Structure				(Yang 2010)
203	The Degree of Improvement in Urban Landscape Features	4) Environmental Structure				(Wang et al. 2017)
204	Electricity Consumption Per Capita	4) Environmental Structure				(Yang 2010)
205	Possibility to Reuse and Recycle Materials	4) Environmental Structure				(CSB 2019)
206	Making the Right Design for Minimum Waste	4) Environmental Structure				(Aladağ & Işık 2016)
207	Prevention of Soil Pollution	4) Environmental Structure				(Aladağ & Işık 2016)
208	Choice of Local/Regional Materials	4) Environmental Structure				(Aladağ & Işık 2016)
209	Green Energy Applications	4) Environmental Structure				(Aladağ & Işık 2016)
210	Opportunity to Sort Hazardous Wastes Before and During Demolition	4) Environmental Structure				(CSB 2019)

4.3.5 Legislative and Institutional Structure

Thirty-eight criteria were identified in the scope of the thesis, with the aim of elucidating the legislative and institutional aspects of urban transformation. A summary of their distribution according to the sources is provided below and in Table 21.

Ministry of Environment and Urbanization (2019) mentioned ‘Rate of Inclusion in the Scope of Law No. 2981, Disaster Risk Status, Area Size to be at least 5 ha and at most 500 hectares, Whether at least 65% of the total number of buildings in the area consists of buildings that have obtained a building and occupancy license, Legal Status of the Area, Whether the area is suitable for construction, Damage to Infrastructure or Superstructure, Municipality Council Decision Making, Whether there is a Construction with Risk of Loss of Life and Property, Whether there is a Ground Structure with Risk of Loss of Life and Property, Ensuring Public Participation, Whether Urban Transformation Works Can Meet the Existing Building Density, Whether it is one of the areas subject to special laws, Whether it is a Special Status Area, Status of Groups to Participate in the Planning Process, Inadequate Planning or Infrastructure Services, Risk Status (Loss of Life, Economic Loss, Environmental Impacts, etc.), Necessity of Zoning Right Transfers for Right Holders in the Risky Area, Presence of Social Infrastructure and Technical Infrastructure Area.’. On the other hand , Ministry of Environment and Urbanization (2019) and Işik and Aladağ (2017) mentioned ‘Beneficiary Identification and Real Estate Valuation Status.’ Ministry of Environment and Urbanization (2014) mentioned ‘Evaluation of Spatial Regional Plan, Strategy Plan, Sectoral Investment Decisions of Relevant Public Institutions, Protection of the Public Interest (Effective, Efficient and Transparent Use of Resources).’

Ocakçı, Türk, and Terzi (2017) mentioned ‘Defining and Establishing the Participation Model in the Process, Ensuring Effective Use of Green Settlement and Green Building Certificates.’ Arkon (2006) mentioned ‘Existence and Status of Building Regulations, Existence and Status of Environmental Impact Assessment, Existing of Nature Reserve, Shared Ownership Asset, Whether there is an Improvement Plan, Political Preference of the Head of the Relevant Institution, Ratio of By-Low Housing, Easement, Development Plan, Public-Private Partnership, Compulsory Purchase, Existence and Status of Protected Areas, Neighborhood Organization Status, Existence and Status of Implementation Plan.’

Table 21: List of Legislative and Institutional Indicators

(Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
211	Rate of Inclusion in the Scope of Law No. 2981	5) Legislative and Institutional Structure				(CSB 2019)
212	Disaster Risk Status	5) Legislative and Institutional Structure				(CSB 2019)
213	Area Size to be at least 5 ha and at most 500 hectares	5) Legislative and Institutional Structure				(CSB 2019)
214	Whether at least 65% of the total number of buildings in the area consists of buildings that have obtained a building and occupancy license	5) Legislative and Institutional Structure				(CSB 2019)
215	Legal Status of the Area	5) Legislative and Institutional Structure				(CSB 2019)
216	Whether the area is suitable for construction	5) Legislative and Institutional Structure				(CSB 2019)
217	Damage to Infrastructure or Superstructure	5) Legislative and Institutional Structure				(CSB 2019)
218	Municipality Council Decision Making	5) Legislative and Institutional Structure				(CSB 2019)
219	Existence and Status of Building Regulations	5) Legislative and Institutional Structure				
220	Whether there is a Construction with Risk of Loss of Life and Property	5) Legislative and Institutional Structure				(CSB 2019)
221	Whether there is a Ground Structure with Risk of Loss of Life and Property	5) Legislative and Institutional Structure				(CSB 2019)
222	Existence and Status of Environmental Impact Assessment	5) Legislative and Institutional Structure				
223	Existing Of Nature Reserve	5) Legislative and Institutional Structure				
224	Beneficiary Identification and Real Estate Valuation Status	5) Legislative and Institutional Structure				(CSB 2019) (Aladağ & Işık 2016)
225	Ensuring Public Participation	5) Legislative and Institutional Structure				(CSB 2019)
226	Shared Ownership Asset	5) Legislative and Institutional Structure				
227	Whether there is an Improvement Plan	5) Legislative and Institutional Structure				
228	Evaluation of Spatial Regional Plan, Strategy Plan, Sectoral Investment Decisions of Relevant Public Institutions	5) Legislative and Institutional Structure				(MoEaU 2014)
300	Political Preference of the Head of the Relevant Institution	5) Legislative and Institutional Structure				
229	Ratio of By-Low Housing	5) Legislative and Institutional Structure				
230	Easement	5) Legislative and Institutional Structure				
231	Development Plan	5) Legislative and Institutional Structure				
232	Public-Private Partnership	5) Legislative and Institutional Structure				
233	Protection of the Public Interest (Effective, Efficient and Transparent Use of Resources)	5) Legislative and Institutional Structure				(MoEaU 2014)
234	Compulsory Purchase	5) Legislative and Institutional Structure				
235	Whether Urban Transformation Works Can Meet the Existing Building Density	5) Legislative and Institutional Structure				(CSB 2019)
236	Existence and Status of Protected Areas	5) Legislative and Institutional Structure				
237	Neighborhood Organization Status	5) Legislative and Institutional Structure				
238	Whether it is one of the areas subject to special laws	5) Legislative and Institutional Structure				(CSB 2019)
239	Whether it is a Special Status Area	5) Legislative and Institutional Structure				(CSB 2019)
240	Status of Groups to Participate in the Planning Process	5) Legislative and Institutional Structure				(CSB 2019)
241	Inadequate Planning or Infrastructure Services	5) Legislative and Institutional Structure				(CSB 2019)
242	Risk Status (Loss of Life, Economic Loss, Environmental Impacts, etc.)	5) Legislative and Institutional Structure				(CSB 2019)
243	Necessity of Zoning Right Transfers for Right Holders in the Risky Area	5) Legislative and Institutional Structure				(CSB 2019)
244	Presence of Social Infrastructure and Technical Infrastructure Area	5) Legislative and Institutional Structure				(CSB 2019)
245	Defining and Establishing the Participation Model in the Process	5) Legislative and Institutional Structure				(Ocakçı et al. 2017)
246	Existence and Status of Implementation Plan	5) Legislative and Institutional Structure				
247	Ensuring Effective Use of Green Settlement and Green Building Certificates	5) Legislative and Institutional Structure				(Ocakçı et al. 2017)

4.3.6 Planning and Design, Technological Structure

In the framework of the thesis, fifty-two criteria have been identified that represent the Planning and Design, Technological features of urban transformation. The sources summarize their distribution as follows and in Table 22.

Işik and Aladağ (2017) mentioned 'Capacity of Information Systems (Database Management), Buildings Constructability, Creating Urban Center/Attraction Point, Housing Stock Conditions, Request for Increase in Existing Development Rights, Technological Capability, Technological Resources (People, Equipment, Information, Money, etc.).'

Ministry of Environment and Urbanization (2019) listed 'Participation of Actors in the Process, Current Usage Functions of the Area, Existing Zoning Status (Construction Conditions etc.), Existing Implementation Plan Rights, Property Structure - Cadastral Status, Proposed Implementation Plan Rights, Number of Independent Units of the Buildings According to the Proposed Plan, Distance to Proposed Reserve Building Areas, Horizontal Architecture.'

Ministry of Environment and Urbanization (2014) mentioned 'Observing Spatial Harmony, Capacity and Distribution of Parking lots.'

Ministry of Environment and Urbanization (2014) and Işik and Aladağ (2017) mentioned 'Increasing Life Quality and Urban Prosperity.'

Ocakçı, Türk, and Terzi (2017) identified 'Planning by Considering Disaster Risks, Planning of Disaster Muster Areas and Evacuation Corridors, Considering and Designing the Area with a Neighborhood Approach, Planning The Area in Harmony with The Land Use Pattern in Its Immediate Surroundings, Protection of the Natural Water Cycle and Habitat Areas, Conservation of Natural Topography, Planning Affordable/Rentable Housing Types for Low and Middle-Income Groups, Preservation and Enhancement of City Skyline, Preferring Regions with 5-15% Slope Priority for Settlement in Urban Transformation Areas, Urban Transformation Plan Decisions Are Compatible with Upper Scale Plan Decisions, Location Selection of Social and Technical Infrastructure Areas Suitable for Population Density and Accessibility, Development of Housing Typologies Compatible with Social-Cultural Life and Local Architectural Heritage, Density Gradation Compatible with Topography and Land Use Factors, Compliance of the Transportation Structure of the Settlement with the Existing Zoning

Plan and Transportation Master Plan, Designing The Settlement at A Density Compatible with The Human Scale.’

Ocakçı, Türk, and Terzi (2017) and Ministry of Environment and Urbanization (2019) listed ‘Ensuring a Balanced Distribution of Social and Technical Infrastructure Equipment Areas in the Near Environment of the Area at the Settlement Level.’

Ocakçı, Türk, and Terzi (2017) and Sajjad, Chan, and Chopra (2021) mentioned ‘Housing Areas are at a Walkable Distance to Public Transportation Systems.’

Peng et al. (2015) and Ocakçı, Türk, and Terzi (2017) mentioned ‘Access to Cultural Facilities - Average Journey Time by Foot, Access to Medical Facilities - Average Journey Time by Foot.’

Wang et al. (2017) identified ‘Land Use Intensity, Urban Renewal Development Potential.’

Yang (2010) mentioned ‘Public Transport and Car Ownership Per 1,000 Capita, Residential Floor Area Per Capita.’

Yang (2010), Sajjad, Chan, and Chopra (2021) and Peng et al. (2015) mentioned ‘Public Green Area Per Capita.’

Arkon (2006) identified ‘Vacant Parcel Rate, Number of Parcels Implemented According to Article 18 of the Zoning Law and Attrition Rates (%), Human Scale, Floor Area Ratio, Number of Floors of Existing Buildings, License Status and License Years of Existing Buildings, Current Occupancy-Vacancy Status, Number and Size Distribution of Existing Parcels, Building Construction Area Status of Existing Buildings.’

4.4 Selecting and Weighting of the Critical Indicators

The following section provides a detailed explanation of the methodology for selecting and weighting the critical indicators suitable for the targeted urban transformation projects from among the three hundred indicators identified in the dissertation research. The selection and weighting of critical indicators should include the examination of local characteristics and the opinions of stakeholders on this issue. Therefore, the process for the determination of critical indicators should be identified through methods that are specifically designed for local circumstances.

Table 22: List of Planning and Design Indicators

(Prepared by Author)

ID	Indicator	Category	Subcategory	Principle	Regulations	Citation
248	Public Transport and Car Ownership Per 1,000 Capita	6) Planning and Design, Technological Structure				(Yang 2010)
249	Planning by Considering Disaster Risks	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
250	Planning of Disaster Muster Areas and Evacuation Corridors	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
251	Participation of Actors in the Process	6) Planning and Design, Technological Structure				(CSB 2019)
252	Considering and Designing the Area with a Neighborhood Approach	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
253	Current Usage Functions of the Area	6) Planning and Design, Technological Structure				(CSB 2019)
254	Planning The Area in Harmony with The Land Use Pattern in Its Immediate Surroundings	6) Planning and Design, Technological Structure	Planning Decisions			(Ocakçı et al. 2017)
255	Ensuring a Balanced Distribution of Social and Technical Infrastructure Equipment Areas in the Near Environment of the Area at the Settlement Level	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017) (CSB 2019)
256	Land Use Intensity	6) Planning and Design, Technological Structure				(Wang et al. 2017)
257	Capacity of Information Systems (Database Management)	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
258	Buildings Constructability	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
259	Vacant Parcel Rate	6) Planning and Design, Technological Structure				
260	Protection of the Natural Water Cycle and Habitat Areas	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
261	Conservation of Natural Topography	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
262	Planning Affordable/Rentable Housing Types for Low and Middle-Income Groups	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
263	Number of Parcels Implemented According to Article 18 of the Zoning Law and Attrition Rates (%)	6) Planning and Design, Technological Structure				
264	Human Scale	6) Planning and Design, Technological Structure				
265	Floor Area Ratio	6) Planning and Design, Technological Structure				
266	Preservation and Enhancement of City Skyline	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
267	Preferring Regions with 5-15% Slope Priority for Settlement in Urban Transformation Areas	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
268	Urban Renewal Development Potential	6) Planning and Design, Technological Structure				(Wang et al. 2017)
269	Urban Transformation Plan Decisions Are Compatible with Upper Scale Plan Decisions	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
270	Creating Urban Center/Attraction Point	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
271	Public Green Area Per Capita	6) Planning and Design, Technological Structure	Resiliency, Environmental Development			(Yang 2010) (Sajjad et al. 2021) (Peng et al. 2015)
272	Residential Floor Area Per Capita	6) Planning and Design, Technological Structure				(Yang 2010)
273	Housing Areas are at a Walkable Distance to Public Transportation Systems	6) Planning and Design, Technological Structure	Resiliency			(Ocakçı et al. 2017) (Sajjad et al. 2021)
274	Housing Stock Conditions	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
275	Access to Cultural Facilities - Average Journey Time by Foot	6) Planning and Design, Technological Structure				(Peng et al. 2015) (Ocakçı et al. 2017)
276	Observing Spatial Harmony	6) Planning and Design, Technological Structure				(MoEaU 2014)
277	Existing Zoning Status (Construction Conditions etc.)	6) Planning and Design, Technological Structure				(CSB 2019)
278	Number of Floors of Existing Buildings	6) Planning and Design, Technological Structure				
279	License Status and License Years of Existing Buildings	6) Planning and Design, Technological Structure				
280	Current Occupancy-Vacancy Status	6) Planning and Design, Technological Structure				
281	Request for Increase in Existing Development Rights	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
282	Existing Implementation Plan Rights	6) Planning and Design, Technological Structure				(CSB 2019)
283	Number and Size Distribution of Existing Parcels	6) Planning and Design, Technological Structure				
284	Building Construction Area Status of Existing Buildings	6) Planning and Design, Technological Structure				
285	Property Structure - Cadastral Status	6) Planning and Design, Technological Structure				(CSB 2019)
286	Capacity and Distribution of Parking lots	6) Planning and Design, Technological Structure				(MoEaU 2014)
287	Proposed Implementation Plan Rights	6) Planning and Design, Technological Structure				(CSB 2019)
288	Number of Independent Units of the Buildings According to the Proposed Plan	6) Planning and Design, Technological Structure				(CSB 2019)
289	Distance to Proposed Reserve Building Areas	6) Planning and Design, Technological Structure				(CSB 2019)
290	Access to Medical Facilities - Average Journey Time by Foot	6) Planning and Design, Technological Structure	Social Development			(Peng et al. 2015) (Ocakçı et al. 2017)
291	Location Selection of Social and Technical Infrastructure Areas Suitable for Population Density and Accessibility	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
292	Development of Housing Typologies Compatible with Social-Cultural Life and Local Architectural Heritage	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
293	Technological Capability	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
294	Technological Resources (People, Equipment, Information, Money, etc.)	6) Planning and Design, Technological Structure				(Aladağ & Işık 2016)
295	Density Gradation Compatible with Topography and Land Use Factors	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
296	Increasing Life Quality and Urban Prosperity	6) Planning and Design, Technological Structure				(MoEaU 2014) (Aladağ & Işık 2016)
297	Horizontal Architecture	6) Planning and Design, Technological Structure				(CSB 2019)
298	Compliance of the Transportation Structure of the Settlement with the Existing Zoning Plan and Transportation Master Plan	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)
299	Designing The Settlement at A Density Compatible with The Human Scale	6) Planning and Design, Technological Structure				(Ocakçı et al. 2017)

CHAPTER 5

METHODOLOGY OF THE RESEARCH

In the fifth chapter, the methodological structure of the research and the methods used, as well as the tools for data collection, analysis and evaluation of the results are explained. Within the scope of the problems defined in the previous chapters, the necessity of developing a multi-criteria decision-making methodology to determine the urban transformation strategies necessary for the implementation of resilient cities against major earthquakes and similar natural disasters in Türkiye through an effective and efficient decision-making process has been attempted. For this purpose, urban transformation strategies have been grouped under five main headings through a literature review and it is aimed to rank these strategies in terms of importance by institutions in the identified urban transformation regions with a comprehensive decision-making method.

5.1 Research Design

Within the scope of this thesis, quantitative and qualitative methods including a combination of field research, survey, statistical validity analysis and case study are used to prepare an integrated multi-criteria decision-making method. Therefore, the methodological technique used is considered as 'Mixed-method Approaches.'

5.1.1 Research Design Approaches

In this research, a comprehensive literature review was conducted in a wide range of fields, including Resilience, Disaster Management, Hazard Mitigation, Sustainability, Sustainable Urbanization and Urban Transformation issues, as well as urban transformation and urban planning issues in legislation. In this context, the indicator weights of 300 indicators belonging to the criteria classified into 6 groups as physical structure, economic structure, social structure, environmental structure, legislation, and institutional structure, planning and design, and technological structure were determined using the multi-criteria decision-making method. Then, using these indicator weights, 5 alternative urban transformation strategies described in the urban design literature and selected by adding the parcel-based urban transformation activities intensively implemented within the framework of The Law of Transformation of Areas under the Disaster Risks (Law No. 6306) are ranked in order of priority by evaluating them by experts in the urban transformation areas selected as case studies.

For this purpose, in the first stage, it was determined that the number of 300 identified indicators should be reduced because it would take too much time to use them in the modeling phase. In addition, since the weights of the indicators that will emerge in the research are in percentage values, the possibility that the values will be very close to each other and give statistically significant results is considered negative for the research. In practice, it is not expected that such a number of indicators will be used together. Therefore, it has become a requirement to reduce the number of indicators from 300 to about 20% and to conduct a survey with 60 indicators.

The statistical evaluation that will emerge as a result of this survey will also provide useful results in terms of demonstrating how the selected criteria are distributed across Türkiye and, therefore, which indicators are considered more significant.

In this phase, an online survey of 300 indicators was implemented with 40 respondents, including academics, relevant staff of public institutions, relevant staff of Izmir Metropolitan Municipality, relevant staff of municipalities, and representatives of subsidiaries involved in urban transformation activities in Izmir.

A second survey was prepared in order to reduce the number of 60 indicators selected as a result of this first stage online survey. In the second stage, 60 indicators had to be evaluated according to the 7-point Likert scale and 20 indicators were selected according to the scores given by the survey participants and were planned to be used in determining the criteria weights in the Multi-Criteria Decision-Making Model. However, this second stage of the survey could not be realized due to the work intensity in the institutions. Therefore, 20 indicators were selected based on the first stage survey, which was answered by 40 expert participants.

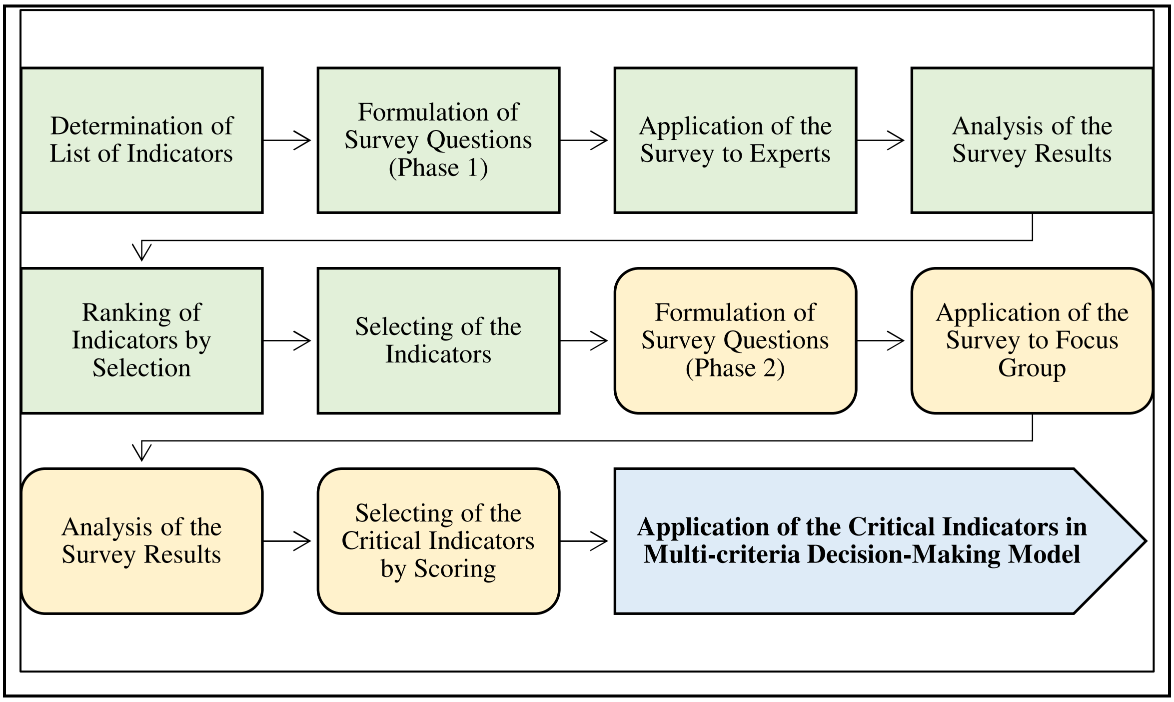


Figure 39: Stages of Determination of the Critical Indicators.
(Prepared by Author)

The purpose of the survey study was to demonstrate the application of the multi-criteria decision-making method developed in the context of the Doctoral Thesis for the determination of urban transformation strategies to be applied in seismically vulnerable areas, and it aimed to use sample applications by selecting the indicators with a certain scientific method.

This multi-criterion decision-making method is intended to be used by the Ministry of Environment, Urbanization and Climate Change and Provincial Organizations, Metropolitan Municipalities, Local Municipalities, Authorized Institutions and Organizations, and Companies operating in the field of urban renewal, in addition to academic studies. Therefore, it is expected that there will be differences in the indicators to be selected according to the location, physical, economic, social, environmental, legislative, and institutional, planning and design, and technological characteristics of the area where the urban transformation strategy will be determined. For example, while proximity to the sea is not an expected indicator in Ankara, it can be a very important and decisive indicator in cities such as Izmir and Istanbul. From this point of view, instead of determining the indicators to be selected correctly and effectively for each urban transformation area, it is expected that the users concerned will determine the relevant indicators from the multi-criteria decision-making method in accordance with the conditions of the study they are going to carry out.

Consequently, the case study aims to investigate whether the multi-criteria decision-making method produced within the scope of the dissertation works in a reasonable and effective way, and it targets to provide a manageable and statistically significant result of the number of indicators with a two-stage survey design in order to provide accurate and consistency of results.

5.1.2 Survey Method

The survey method of collecting information presents advantages due to its ability to be applied to larger groups and cost-effectiveness in comparison to other methods. The evaluation criteria utilized in studies are typically derived from the literature. Nonetheless, it is imperative for decision-makers to opt for appropriate criteria that align with their unique dynamics to obtain accurate and dependable results. It is thus necessary to conduct a thorough literature review, identify the frequently employed evaluation criteria, and formulate hypotheses based on such criteria.

Therefore, the online survey method was used to reduce the number of indicators and identify critical indicators. The online survey consists of 11 main sections, with the first three sections providing information about the research and collecting statistical data about the respondents. The fourth section includes ten indicators selected by the researcher due to the nature of the research and the opportunity to make a choice is provided here. In the fifth section 51 indicators related to physical structure, in the sixth section 69 indicators related to economic structure, in the seventh section 63 indicators related to social structure, in the eighth section 23 indicators related to environmental structure, in the ninth section 34 indicators related to legislation and institutional structure, in the tenth section 50 indicators related to planning and design and technological structure. In the eleventh section it was stated that the participants could define 1 indicator under the titles of Physical Structure Indicator, Economic Structure Indicator, Social Structure Indicator, Environmental Structure Indicator, Legislation and Institutional Structure Indicator, Planning and Design and Technological Structure Indicator (Appendix A).

5.1.2.1 Participants

In this study, the 40 experts who participated in the survey were asked to complete the online survey by considering their academic or professional studies on urban transformation and urban planning. Among the 40 respondents, 15 were employees of Izmir Metropolitan Municipality, 15 were employees of different district municipalities, 2 were employees of public institutions and organizations, 1 was a representative of a company working on urban transformation and 7 were university faculty members. The participants were asked some compulsory questions such as 'Institution, Department, Position in the Institution, Profession (Actual Job), Profession (Education Status - Expertise), Total Number of Years of Professional Experience, Do You Have Experience in Urban Transformation, Total Number of Years of Experience in Urban Transformation, How Would You Like to Describe Your Role in Participating in the Survey?' and as a result of these questions, the institution where the participants work, their duties in the institution and their current position are summarized in Table 23.

Table 23: Distribution of Participants (Their Professions and Their Institutions) (Prepared by Author)

Institution / Department / Title	Number of Participants	Participants (%)	Scale of Participants
Metropolitan Municipality	**15**	**37.50%**	
Assistant Secretary General	**1**	**2.50%**	
Assistant Secretary General	1	2.50%	
Department of Climate Change and Zero Waste	**1**	**2.50%**	
City Planner	1	2.50%	
Department of Earthquake Risk Management and Urban Improvement	**2**	**5.00%**	
Director	2	5.00%	
Department of Urban Planning and Urban Development	**1**	**2.50%**	
City Planner	1	2.50%	
Department of Urban Transformation	**10**	**25.00%**	
Architect	4	10.00%	
City Planner	3	7.50%	
Civil Engineer	1	2.50%	
Director	1	2.50%	
Geomatics Engineer	1	2.50%	
Metropolitan Sub-Provincial Municipality	**15**	**37.50%**	
Directorate of Plan and Project	**9**	**22.50%**	
City Planner	7	17.50%	
Director	1	2.50%	
Technician	1	2.50%	
Directorate of Survey and Project	**2**	**5.00%**	
Director	2	5.00%	
Directorate of Zoning and Urban Planning	**3**	**7.50%**	
City Planner	2	5.00%	
Director	1	2.50%	
Vice President	**1**	**2.50%**	
Vice President	1	2.50%	
Public Institution	**2**	**5.00%**	
General Directorate of Planning and Risk Mitigation	**1**	**2.50%**	
City Planner	1	2.50%	
Planning Unit	**1**	**2.50%**	
Expert	1	2.50%	
Subsidiary	**1**	**2.50%**	
Urban Transformation Unit	**1**	**2.50%**	
Project Coordinator	1	2.50%	
University	**7**	**17.50%**	
Department of City and Regional Planning	**3**	**7.50%**	
Faculty Member	3	7.50%	
Faculty of Architecture, Department of Architecture	**3**	**7.50%**	
Faculty Member	3	7.50%	
Planning Department	**1**	**2.50%**	
Faculty Member	1	2.50%	
General Total	**40**	**100.00%**	**100.00%**

In terms of the profession and graduation of the participants, 60% of the participants are urban planners, 25% of the participants are architects, 12.5% of the participants are engineers, 37.5% of the participants are urban planners, and 15% of the participants are urban planners (master's degree). More detailed information can be found in Table 23 and Table 24.

Table 24: Distribution of Participants in Terms of Their Profession (Education) (Prepared by Author)

Profession (Education)	Number of Participants	Participants (%)
Architect	4	10.00%
Architect (master's degree)	1	2.50%
Architect (PhD)	5	12.50%
City Planner	15	37.50%
City Planner (master's degree)	6	15.00%
City Planner (PhD)	3	7.50%
Civil Engineer	2	5.00%
Geology Engineer	1	2.50%
Geomatics Engineer	2	5.00%
Technician	1	2.50%
General Total	40	100.00%

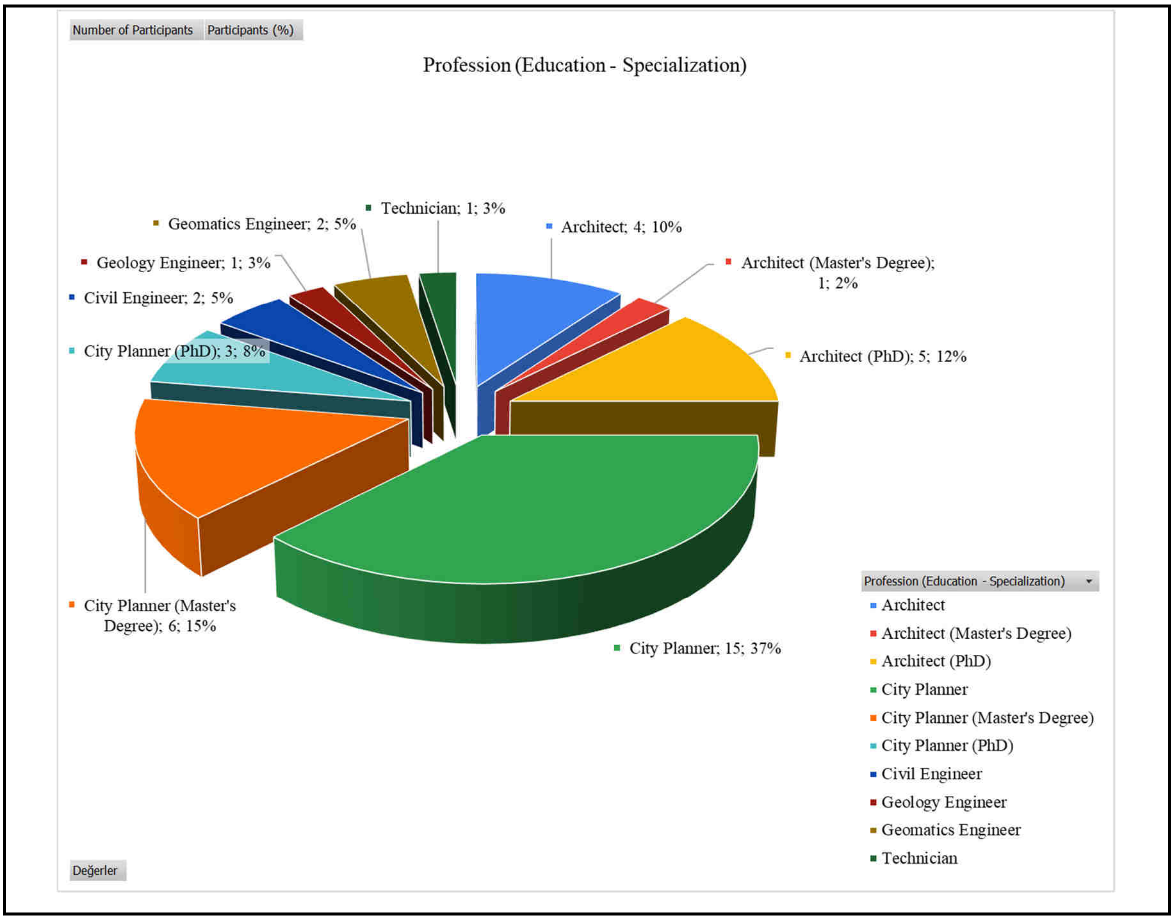
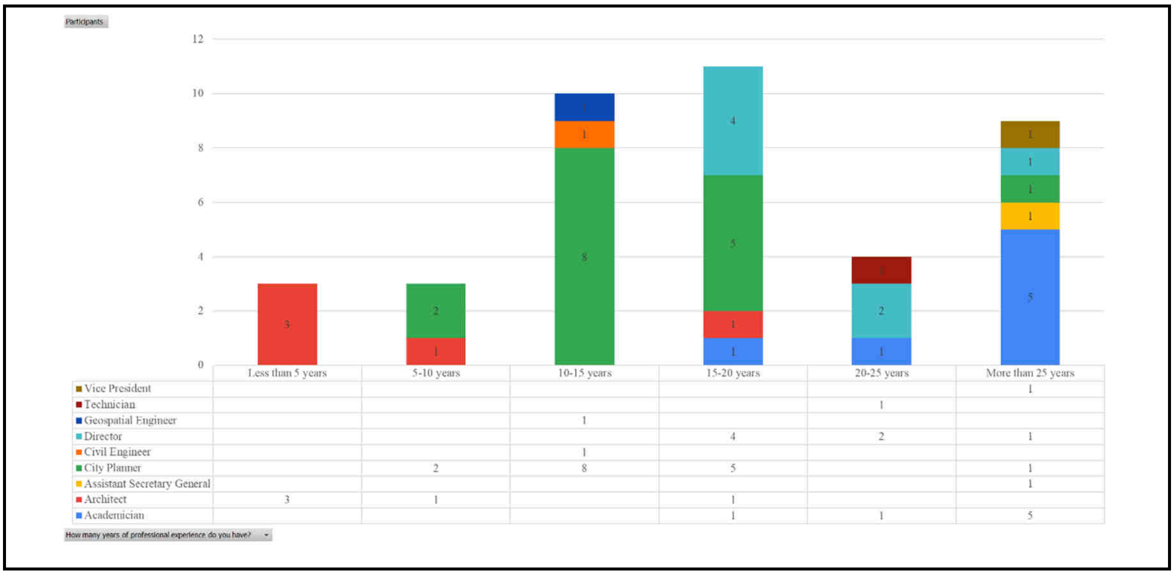


Figure 40: Distribution of Participants in Terms of Their Profession (Education) (Prepared by Author)

The answers to the question "How many years of work experience do you have? (Required Question)", which was asked to understand the professional experience of the respondents, demonstrates that 52.5% (21 participants) have between 10 and 20 years of professional experience and 22.5% (9 participants) have been working in their profession for more than 25 years. The detailed graph of their professional experience in terms of profession (actual job) is shown in Figure 41.



	Less than 5 years	5-10 years	10-15 years	15-20 years	20-25 years	More than 25 years
Vice President						1
Technician					1	
Geospatial Engineer			1			
Director				4	2	1
Civil Engineer			1			
City Planner		2	8	5		1
Assistant Secretary General						1
Architect	3	1		1		
Academician				1	1	5

Figure 41: Graph Showing the Professional Experience of the Participants (Prepared by Author)

Two questions measuring the experience of the participants in urban transformation indicate that 26 (65%) of the participants have experience in urban transformation and 15 (58%) of the participants have more than 5 years of experience. Figure 43 and Figure 45. Here, an analysis by professions highlights that the number of urban planners working in local municipalities is high, and they stated that they have no experience in urban transformation, because the practice of urban transformation in local municipalities is limited Figure 44.

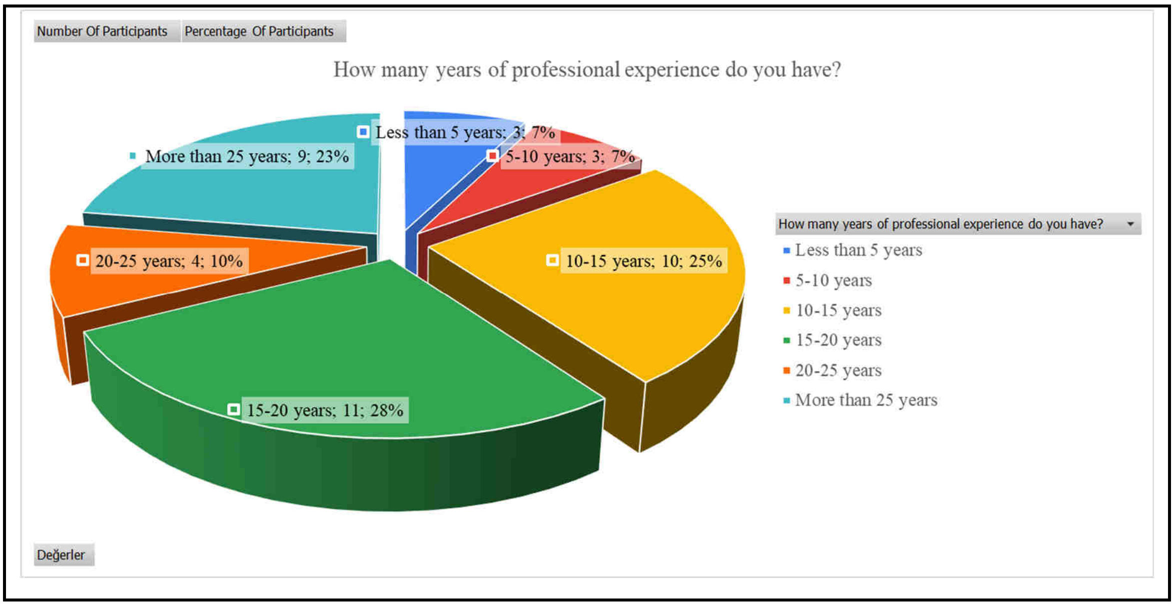


Figure 42: Professional Experience of the Partitions (Years)

(Prepared by Author)

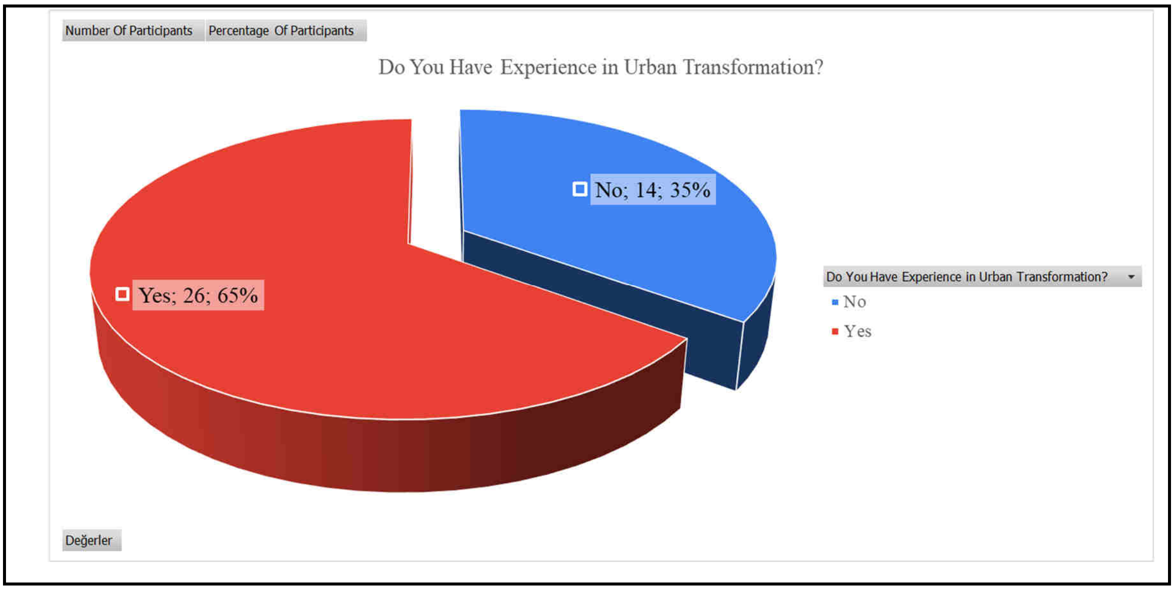


Figure 43: Urban Transformation Experience of the Partitions

(Prepared by Author)

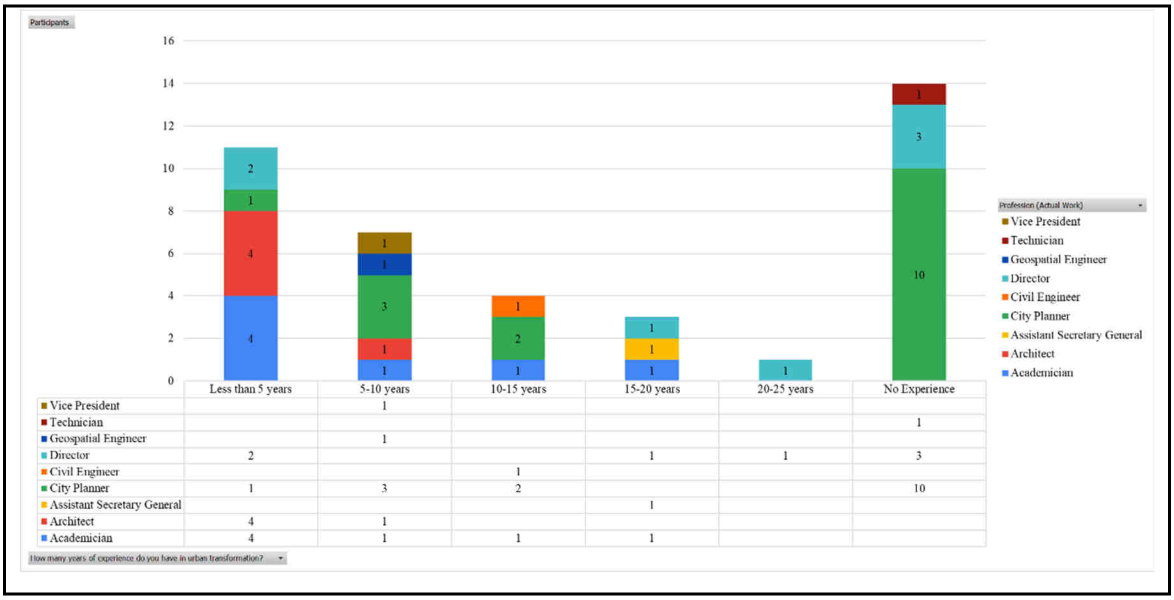


Figure 44: Graph Showing the Urban Transformation Experience of the Participants (Prepared by Author)

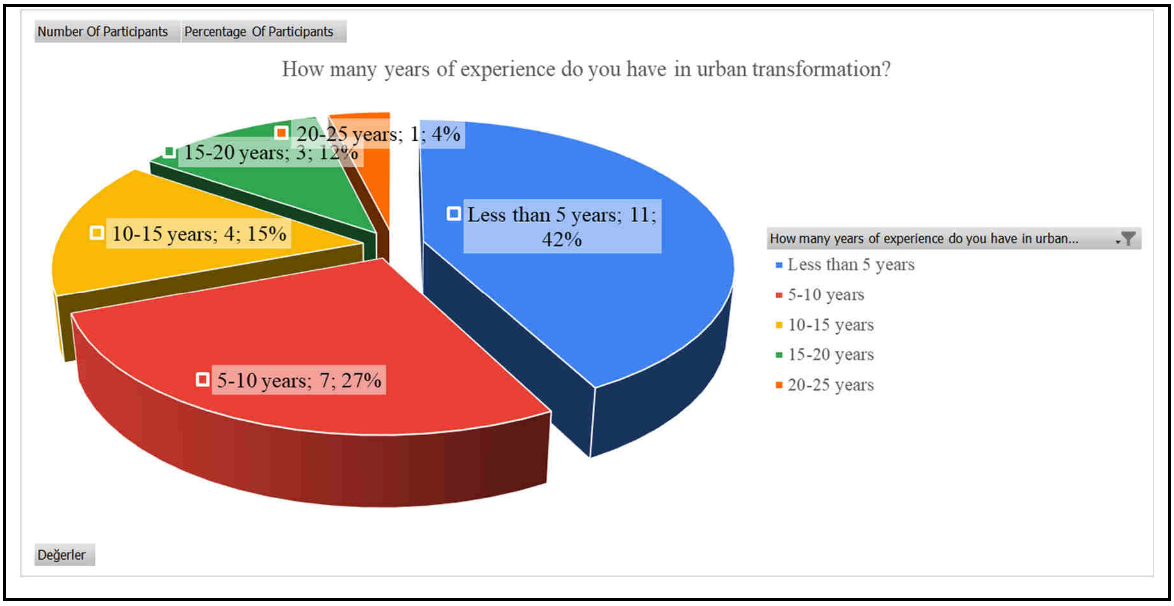


Figure 45: Urban Transformation Experience of the Partitions (Years) (Prepared by Author)

In terms of the participant role in which the participants identified themselves in the first stage survey, 15 (37.5%) identified themselves as managers or employees in Izmir Metropolitan Municipality and 7 (17.5%) identified themselves as academicians Figure 46.

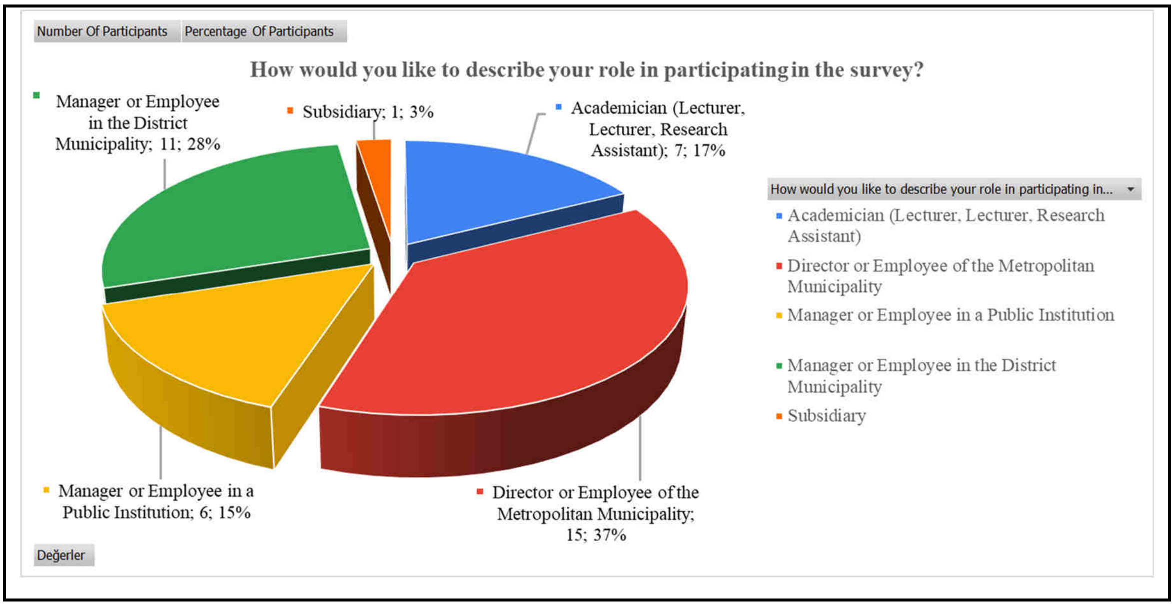


Figure 46: Describing Their Role in Survey of the Partitions
(Prepared by Author)

In the first phase of the survey, participants were asked to select 60 indicators out of 300 that they considered most important and mark them in the online survey. However, most participants selected far more than 60 indicators, so the average number of selected indicators should have been 60 but ended up being 122.20. 40 participants were asked to select 60 indicators, and while a total of 2400 selections were expected, the actual number was 4888 (Table 25). However, in the face-to-face interviews with the participants, it was assessed that the level of importance of all indicators was high, and some of the indicators were selected again due to their similar content. As a result, considering the number of participants and the diversity of the first stage of the survey, the indicators in the first 20 percentile were selected as an example for the selection of indicators and used to test the multi-criteria decision-making method to be used with these indicators in the case study phase.

Table 25: Distribution of The Selected Indicators by Category (Prepared by Author)

Name of the Category	Total Number of Selected Indicators	Selected Indicators (%)
1) Physical Structure	834	17.06%
2) Economic Structure	847	17.33%
3) Social Structure	951	19.46%
4) Environmental Structure	486	9.94%
5) Legislative and Institutional Structure	758	15.51%
6) Planning and Design, Technological Structure	1012	20.70%
General Total	**4888**	**100.00%**

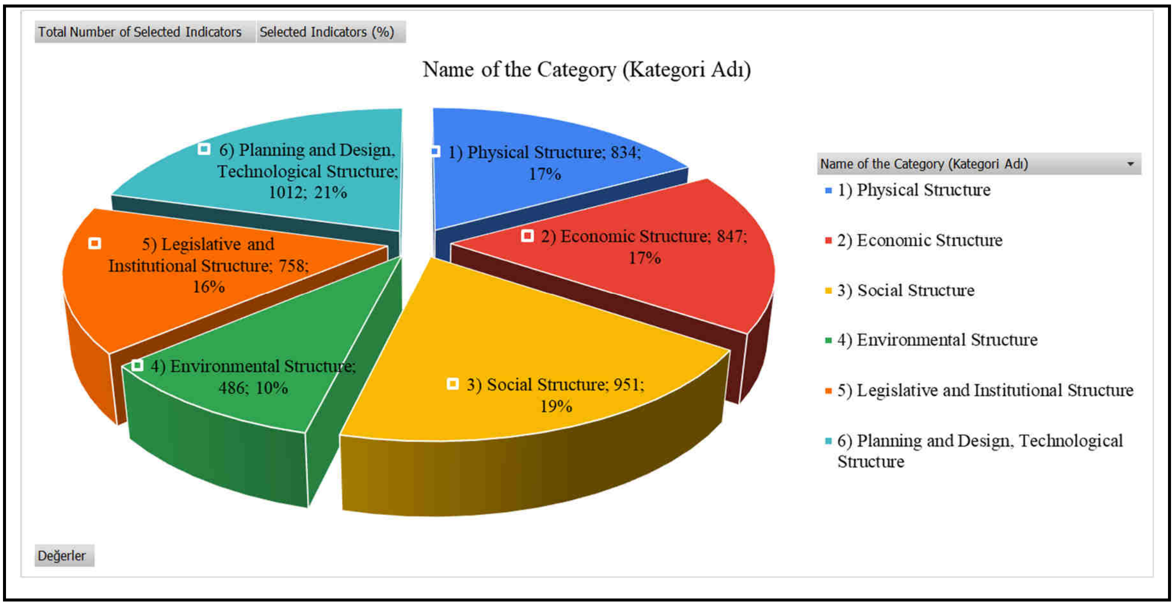


Figure 47: Graph of The Distribution of Total Selection of Indicators by Category (Prepared by Author)

Examination of the responses shows that 6 of the 20 indicators selected by the participants and ranked first were among the 10 indicators selected by the researcher before the survey, which represents 30% of the total selected criteria. It is understood that

4 indicators in the category of environmental structure (20%) and 3 indicators in the category of physical structure (15%) resulted in this ranking (Figure 47).

Considering these 20 indicators together with the ones previously selected by the researcher, it is understood that the indicators related to the physical structure are in the first place with 6 (30%) and the second category are the indicators in the environmental structure category with 4 (20%).

Table 26: Total Selected Indicators by Category
(Prepared by Author)

Category Name of the Selected Indicators	Total Number of Selected Indicators	Percentage of Selected Indicators in Category (%)
1) Physical Structure	6	30.00%
2) Economic Structure	2	10.00%
3) Social Structure	3	15.00%
4) Environmental Structure	4	20.00%
5) Legislative and Institutional Structure	3	15.00%
6) Planning and Design, Technological Structure	2	10.00%
Total Number of Selected Indicators	**20**	**100.00%**

Considering the results of the survey in general, if we look at the distribution of selected indicators out of 300 indicators, 6 (60%) of the 10 indicators selected by the researcher were also selected by the participants. Out of 23 indicators in the category of environmental structure, 4 (17.39%) were selected by the participants, and out of 69 indicators in the category of economic structure, only 1 (1.45%) was selected by the participants Figure 48.

Percentage of Selected Indicators in Total Selected Indicators (%)	Total Number of Indicators Selected	Name of the Category	Total Number of Indicators	Percentage of Selected Indicators in Category (%)
30.00%	6	V) Indicators Selected as Default	10	60.00%
15.00%	3	1) Physical Structure	51	5.88%
5.00%	1	2) Economic Structure	69	1.45%
15.00%	3	3) Social Structure	63	4.76%
20.00%	4	4) Environmental Structure	23	17.39%
10.00%	2	5) Legislative and Institutional Structure	34	5.88%
5.00%	1	6) Planning and Design, Technological Structure	50	2.00%
100.00%	**20**	**Total**	**300**	**6.67%**

Figure 48: Distribution of the Selected Indicators in Total Selection (Prepared by Author)

Statistical analysis of the selection of indicators in the survey shows that the most selected indicators are 'Geological Structure (Suitability for Settlement)' and 'Earthquake Risk Analysis Status', selected by 37 participants; the 5 indicators in the least selected group are 'Amount of Shopping District' / 'Informal Economy' / 'Reputation and Income of Business Improvement' / 'Net Jobs Created (Percentage of Employees from Local Area)' / 'Student-Teacher Ratio', selected by 3 participants. If the selection values of the indicators are considered, the mean is 16.29, the median is 16 and the variance is 54.41 (Table 27). The normal distribution of the selection of indicators in the survey is shown in Figure 49.

Table 27: Statistical Analysis of the Survey by Indicator
(Prepared by Author)

Type of Statistical Value	Value
Number of Variables	300.00
Variance (σ^2)	54.41
Upper Limit of Error (B)	2.00
Standard Deviation	7.38
Mean	16.29
Median	16.00
Mode	14.00

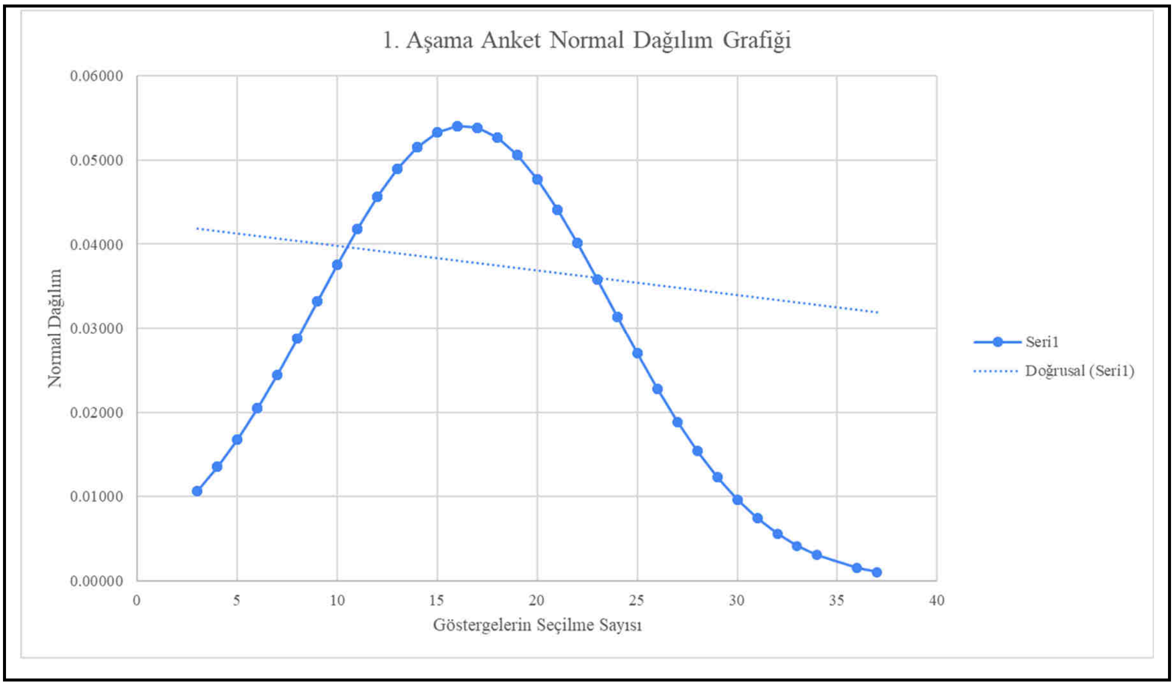


Figure 49: Normal Distribution of Selection of the Indicator
(Prepared by Author)

As a result of these analyses, 'Geological Structure (Suitability for Settlement)' and 'Earthquake Risk Analysis Status', which were the most selected indicators as a result of the survey, were preferred by 37 participants (92.50%). In this context, 20 selected indicators were re-examined as a result of the evaluations received (Table 28).

In this context, the indicator 'Disaster Risk Status' has been removed from the list because of similarity of the indicators 'Earthquake Risk Analysis Status' / 'Risk Status of Structures' / 'Disaster Risk Status'. As the indicators 'Cultural and Local Characteristics of the Region' / 'Historical and Cultural Value Data of the Area' are related, the indicator 'Historical and Cultural Value Data of the Area' has been removed from the indicators list. Instead of these two indicators, the indicators 'Planning of Disaster Muster Areas and Evacuation Corridors' and 'Beneficiary Identification and Real Estate Valuation Status' have been adopted in the list of selected indicators (Table 28).

Table 28: List of Selected Indicators by Participants
(Prepared by Author)

Name of the Selected Indicators	Number Of Selection of Indicators	Percentage Of Indicators Selected by Participants (%)	Sequence Number of The Selected Indicators	Selection Status
Geological Structure (Suitability for Settlement)	37	92.50%	1	Selected
Earthquake Risk Analysis Status	37	92.50%	2	Selected
Risk Status of Structures	36	90.00%	3	Selected
Whether the area is suitable for construction	36	90.00%	4	Selected
Building Stock Status of the Area	34	85.00%	5	Selected
Disaster Risk Status	34	85.00%	6	Not Selected
Socio Economic Status of the Area	33	82.50%	7	Selected
Environmental Quality Improvement	32	80.00%	8	Selected
Planning by Considering Disaster Risks	32	80.00%	9	Selected
Ground Condition (Soil Classification)	31	77.50%	10	Selected
Cultural and Local Characteristics of the Region	31	77.50%	11	Selected
Protection of Environmental Values	31	77.50%	12	Selected
Opportunity to Sort Hazardous Wastes Before and During Demolition	31	77.50%	13	Selected
Property Structure - Cadastral Status	30	75.00%	14	Selected
Building Density	30	75.00%	15	Selected
Land Value	30	75.00%	16	Selected
Historical and Cultural Value Data of the Area	30	75.00%	17	Not Selected
Cost of Urban Transformation	29	72.50%	18	Selected
Connecting Natural and Open Spaces	29	72.50%	19	Selected
Whether Urban Transformation Works Can Meet the Existing Building Density	29	72.50%	20	Selected
Planning of Disaster Muster Areas and Evacuation Corridors	29	72.50%	21	Selected
Beneficiary Identification and Real Estate Valuation Status	28	70.00%	22	Selected

As a result, out of the 300 indicators identified, 20 indicators selected through the first stage survey were selected as the core indicators to be evaluated during the case study with the employees of the Izmir Metropolitan Municipality Department of Urban Transformation.

5.2 MCDM Methods Selected for INTEMUS

In order to develop a comprehensive and integrated MCDM approach for the purpose of this thesis, a comprehensive selection of four MCDM methods has been developed, two of them for the determination of criteria weights and two of them for the ranking of alternatives, based on their simplicity of application and their frequency of use in the literature. In this section, the application and calculation steps described in the literature are explained in the following subsections to explain the steps of these four MCDM methods in the INTEMUS method.

5.2.1 Application Stages of DEMATEL

Application stages of DEcision MAking Trial and Evaluation Laboratory (DEMATEL) can be summarized by Tzeng and Huang (2011) and Ayçin (2020) as follows:

Step 1: Creation of the Direct Relationship Matrix

In the initial phase of DEMATEL Management, constructing the direct relationship matrix is a crucial step. It is important to understand the direct relationship matrix. Respondents are required to assess the degree of direct influence of each criterion $\boldsymbol{i}$ on criterion $\boldsymbol{j}$ using a Likert scale ranging from ***0*** (No Influence) to ***4*** (Very Highly Influential) as per the default scales (Table 29) (Tzeng and Huang 2011), (Ayçin 2020).

Table 29: A Comparison Scale of the DEMATEL Method
(Source: Modified from Ulu and Şahin 2021, 1699)

Numeric Value	**Definition**
4	Very High Influence
3	High Influence
2	Low Influence
1	Very Low Influence
0	No Influence

After creating their respective direct relationship matrices, respondents should calculate the average matrix ***A*** along with other matrices, if different respondents' direct relationship matrices are being used. The following equation represents the average matrix ***A*,** Equation *(2)* (Tzeng and Huang 2011), (Ayçin 2020).

$$\boldsymbol{A} = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix} \qquad (2)$$

Step 2: Calculate the Normalized Matrix

In this step, the largest value in the row and column sums is used to divide all values in the direct relationship matrix ***A*** created in the first step, followed by normalization using Equation (3):

$$X\left(X = \left[x_{ij}\right]_{nxn}\right) \qquad (3)$$

As all main diagonal values are equal in the created X matrix, it is assigned a value of zero. The normalized matrix is obtained by equations (4) and (5).

$$X = s\,.\,A \qquad (4)$$

$$s = min\left[{}^{1}/_{max_i}\sum_{j=1}^{n}|a_{ij}|, {}^{1}/_{max_j}\sum_{i=1}^{n}|a_{ij}|\right] \tag{5}$$

Step 3: Creation of The Total Influence Matrix

A continuous decrease of the indirect effects of problems along the powers of ***X***, e.g., ***X***^{2}, ***X***^{3},..., ***X***^{k} and $\lim_{k\to\infty} X^k = [0]_{nxn}$, when $X = [x_{ij}]_{nxn}$, $0 \leq x_{ij} \leq 1$, $0 \leq (\sum_i x_{ij}, \sum_j x_{ij}) < 1$ and only one column sum $\sum_j x_{ij}$ or one row sum $\sum_j x_{ij}$ equals 1. The total-influence matrix is listed as follows in Equation *(6)* and *(7)*.

$$T = X + X^2 + \cdots + X^k = X(1 - X)^{-1} \tag{6}$$

$$T = \begin{bmatrix} t_{11} & \dots & t_{1j} & \dots & t_{1n} \\ \vdots & & \vdots & & \vdots \\ t_{i1} & \dots & t_{ij} & \dots & t_{1n} \\ \vdots & & \vdots & & \vdots \\ t_{n1} & \dots & t_{nj} & \dots & t_{nn} \end{bmatrix} \tag{7}$$

The proof of the Equation *(6)* is below (Tzeng and Huang 2011):

$$T = X + X^2 + \cdots + X^k \tag{8}$$

$$= X(1 + X + X^2 + \cdots + X^{k-1}) \tag{9}$$

$$= X[(1 + X + X^2 + \cdots + X^{k-1})(1 - X)](1 - X)^{-1} \tag{10}$$

$$= X[(1 - X^k)](1 - X)^{-1} \tag{11}$$

$$= X(1 - X)^{-1}, \qquad when \lim_{k\to\infty} X^k = [0]_{n\times n} \tag{12}$$

Step 4: Determination of Variables That Affect and Are Affected

Where $T = [t_{ij}]_{n\times n}$ and $(1-X)(1-X)^{-1} = 1$. Additionally, the method represents each row sum and column sum of total matrix ***T***. in Equation (13) and (14)

$$r = (r_i)_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \tag{13}$$

$$c = (C_j)_{n\times 1} = (C_j)'_{1\times n} = \left[\sum_{j=1}^{n} t_{ij}\right]'_{n\times 1} \tag{14}$$

According to Tzeng and Huang (2011), where r_i is the row sum of the i_{th} row of the ***T matrix*** and represents the sum of the direct and indirect effects of criterion ***i*** on the other criteria. Similarly, c_j is the column sum of column ***j*** of the ***T matrix*** and represents the sum of the direct and indirect effects of criterion ***j*** on the other criteria. Furthermore, when $i = j$ (row and column sums), $(r_i + c_i)$ provides an index of the strength of the given and received influences, (r_i+c_i) indicates the degree of central role criterion ***i*** plays in the problem. If (r_i-c_i) is positive, criterion ***i*** influences other criteria and if (r_i-c_i) is negative, criterion ***i*** is influenced by other criteria.

Step 5: Drawing the Influence Diagram and Relationship Map

The concluding step in the methodology is to create an impact diagram using the (r_i+c_i) and (r_i-c_i) values computed from the overall influence matrix and the determined threshold value. The threshold value can be determined by the decision maker or experts. When plotting the influence diagram, (r_i+c_i) values are used on the horizontal axis and (r_i-c_i) values are used on the vertical axis of the coordinate plane (Ayçin 2020).

5.2.2 Application Stages of ENTROPY Method

According to Ayçin (2020), The Entropy Method basically consists of five stages. The variables used in this method can be described as follows:

- A_i: ***i.*** decision alternative (***i=1,2,...,m***)
- C_j: ***j.*** evaluation criteria (***j=1,2,...,n***)
- x_{ij}: the value that Alternative ***i*** evaluated for evaluation criterion ***j***
- p_{ij}: ***i*** according to the evaluation criterion. Normalized value of alternative
- ***k***: Entropy coefficient
- e_j: Entropy value
- d_j: degree of differentiation
- w_j: weight of the evaluation criterion (***j=1,2,...,n***)

Stage 1: Creating the Decision Matrix

In the initial step of the Entropy Method, the determination of the decision matrix is crucial, which comprises the x_{ij} values and is denoted as ***D***. This matrix is constructed as presented in Equation (15) (Ayçin 2020).

$$\boldsymbol{D} = \begin{matrix} A_1 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & & \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & & \vdots & & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \qquad (15)$$

Stage 2: Normalization of the Decision Matrix:

The criteria values in decision problems that have varying units should be standardized to a common range of (0,1) using the normalization process outlined in Equation *(16)* (Ayçin 2020).

$$P_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad \forall i, j \qquad (16)$$

Stage 3: Calculation of Entropy Values for The Criteria

At this stage, the entropy values e_j of each evaluation criterion are calculated as shown in Equation *(17)* (Ayçin 2020).

$$e_{ij} = -k \cdot \sum_{j=1}^{n} p_{ij} \cdot ln(p_{ij}) \;\; i = 1,2,\cdots,m \; and \; j = 1,2,\cdots,n \qquad (17)$$

The value of $\boldsymbol{k}$ as a constant value calculated as below in Equation *(18)*.

$$k = (ln(m))^{-1}, \qquad 0 \leq e_j \leq 1 \qquad (18)$$

The $\boldsymbol{e_j}$ value is the uncertainty measure or, in other words, the entropy value of the $\boldsymbol{j_{th}}$ criterion.

Stage 4: Calculating Degrees of Differentiation

The $\boldsymbol{d_j}$ values for each criterion are calculated using Equation 19 based on the previously calculated entropy values (Ayçin 2020).

Stage 4: Calculating Degrees of Differentiation

Using the previously calculated entropy values, $\boldsymbol{d_j}$ values (the degree of diversification) are calculated for each criterion as shown in Equation *(19)*. The calculated dj values indicate a significant differentiation between the alternative scores related to the criteria (Ayçin 2020).

$$d_j = 1 - e_j, \qquad j = 1,2,\ldots,n \qquad (19)$$

Stage 5: Calculation of Entropy Criteria Weights

In the final step of the method, the weight values ($\boldsymbol{w_j}$) for each criterion are determined by dividing the degree of differentiation of each criterion by the total degree of differentiation. Equation (20) is used to calculate the weight values for the criteria (Ayçin 2020).

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \qquad (20)$$

5.2.3 Application Stages of PROMETHEE

Preference Ranking Organization METhod for Enrichment Evaluations (PROMETHEE) method aims to rank the decision alternatives by considering the selected criteria. For this purpose, the seven basic phase of the PROMETHEE method can be summarized as follows.

- Phase 1: Determination of Decision Alternatives, Criteria and Criteria Weights
- Phase 2: Determination of Preference Functions for Criteria
- Phase 3: Identification of Common Preference Functions
- Phase 4: Determination of Preference Indices
- Phase 5: Calculation of Positive and Negative Advantages
- Phase 6: Calculating Partial Priorities with PROMETHEE I
- Phase 7: Calculation of Net Priorities with PROMETHEE II and Full Ranking

The stages of PROMETHEE method are given below in detail.

Phase 1: Determination of Decision Alternatives, Criteria and Criteria Weights

In the first phase of the method, the decision maker first determines the decision alternatives and evaluation criteria. Then, the importance weights of the evaluation criteria are determined, and the data are created. The data matrix resulting from these processes is as shown in Table 30.

$$\text{Decision Alternatives (A)} = \{a_1, a_2, \ldots, a_n\} \tag{21}$$

$$\text{Criteria (C)} = \{c_1, c_2, \ldots, c_k\} \tag{22}$$

$$\text{Relative Importance of Criteria (w)} = \{w_1, w_2, \ldots, w_k\} \tag{23}$$

The weight values (w_i) for the evaluation criteria are determined such that their sum is $\sum_{i=1}^{n} w_i = 1$. The greater the weight of a criterion, the more important it is for the decision maker. These weights can be determined through the methods used to determine the criteria weights.

Table 30: PROMETHEE Data Matrix
(Prepared by Author)

		Evaluation Criteria			
		c_1	c_2	…	c_k
Scale Orientation		max/min	max/min	…	max/min
Decision Alternatives (Actions)	a_1	c_1a_1	c_2a_1	…	c_ka_1
	a_2	c_1a_2	c_2a_2	…	c_ka_2
	…	…	…	…	…
	a_n	c_1a_n	c_2a_n	…	c_ka_n
Weights of Criteria (w_i)		w_1	w_2	…	w_k

Phase 2: Determination of Preference Functions for Criteria

In this phase, preference functions should be determined to show the structure of the evaluation criteria determined in the previous phase and the relationship between them. Preference functions are used to make pairwise comparisons of decision alternatives according to the criteria and to find the degree of preference of the best alternative.

By choosing a preference function denoted by P, two alternatives such as a and b are compared, and the result of this comparison can be explained by preference functions. A preference function can take a value between 0 and 1. It expresses the difference between the decision alternatives a and b when the evaluation is made considering the selected criterion.

The PROMETHEE method does not assign an absolute value to either the evaluation criteria or the decision alternatives. It generates a preference structure based on pairwise comparisons. This is determined by considering the difference between two decision alternatives for each evaluation criterion. The size of the difference between the values of the two decision alternatives indicates the preference value. If the difference is small, the preference value is small, and the larger the difference, the larger the preference value.

Six different preference functions are defined by Brans and Vincke for the convenience of decision makers.

1. First Type Preference Function (Usual Criterion): If the decision maker has no preference for the relevant evaluation criterion, the preference function to be selected for that evaluation criterion should be the first type (ordinary) preference function.

2. Second Type Preference Function (Quasi Criterion): If the decision maker prefers the decision alternatives with a value above a self-determined value for the relevant evaluation criterion, the preference function to be selected should be the second type (Type U) preference function.

3. The Third Type Preference Function (V-Shape Criterion): If the decision maker wants to select the decision alternatives with values above the mean for a particular evaluation criterion but does not want to neglect the values below the mean, the preference function to be selected should be the third type (Type V) preference function.

4. Fourth Type Preference Function (Level Criterion): In cases where the decision maker is required to select a certain range of values for an evaluation criterion, the preference function to be selected should be the Fourth Type (Level) preference function.

5. Fifth Type Preference Function (Linear Criterion): If the decision maker wants to select one of the decision alternatives with an above average value in terms of an evaluation criterion, the preference function to be selected should be the fifth type (linear) preference function.

6. Sixth Type Preference Function (Gaussian Criterion): If the decision maker makes his choice with respect to an evaluation criterion by considering the deviation values from the mean, the preference function to be selected should be the sixth type (Gaussian) preference function (Figure 51).

In each case 0, 1 or 2 parameters must be defined, their significance is clear:

- ***q*** is a threshold or indifference (The ***q*** indifference threshold is the largest deviation, which is considered as negligible by the decision maker)
- ***p*** is a threshold of strict preference (the ***p*** preference threshold is the smallest deviation which is considered as sufficient to generate a full preference.)
- ***s*** is an intermediate value between ***q*** and ***p***

Step 1. Determination of deviations based on pair-wise comparisons

$$d_j(a,b) = g_j(a) - g_j(b) \qquad (1)$$

Where $d_j(a,b)$ denotes the difference between the evaluations of a and b on each criterion.

Step 2: Application of the preference function

$$P_j(a,b) = F_j[d_j(a,b)] \qquad j=1,\ldots,k \qquad (2)$$

Where $P_j(a,b)$ denotes the preference of alternative a with regard to alternative b on each criterion, as a function of $d_j(a,b)$.

Step 3: Calculation of an overall or global preference index

$$\forall a,b \in A, \qquad \pi(a,b) = \sum_{j=1}^{k} P_j(a,b) w_j \qquad (3)$$

Where $\pi(a,b)$ of a over b (from 0 to 1) is defined as the weighted sum $p(a,b)$ of for each criterion, and w_j is the weight associated with jth criterion.

Step 4: Calculation of outranking flows/ The PROMETHEE I partial ranking

$$\phi^+(a) = \frac{1}{n-1} \sum_{x \in A} \pi(a,x) \qquad (4) \qquad \text{and} \qquad \phi^-(a) = \frac{1}{n-1} \sum_{x \in A} \pi(x,a) \qquad (5)$$

Where $\phi^+(a)$ and $\phi^-(a)$ denote the positive outranking flow and negative outranking flow for each alternative, respectively.

Step 5: Calculation of net outranking flow/ The PROMETHEE II complete ranking

$$\phi(a) = \phi^+(a) - \phi^-(a) \qquad (6)$$

Where $\phi(a)$ denotes the net outranking flow for each alternative.

Figure 50: Stepwise Procedure for PROMETHEE II

(Source: Behzadian et al. 2010, 199)

The effort to establish a comprehensive criterion is therefore limited to the careful selection of appropriate parameters. This is a relatively simple task Brans et al. (2005). The preference functions for each evaluation criterion are determined by the decision maker, considering the characteristics of the relevant criterion. For instance, if a linear preference function (type five) is selected by the decision maker for an evaluation criterion, the values of 'p' and 'q' in the function should be determined by the decision maker. The decision maker should repeat this process for all evaluation criteria separately.

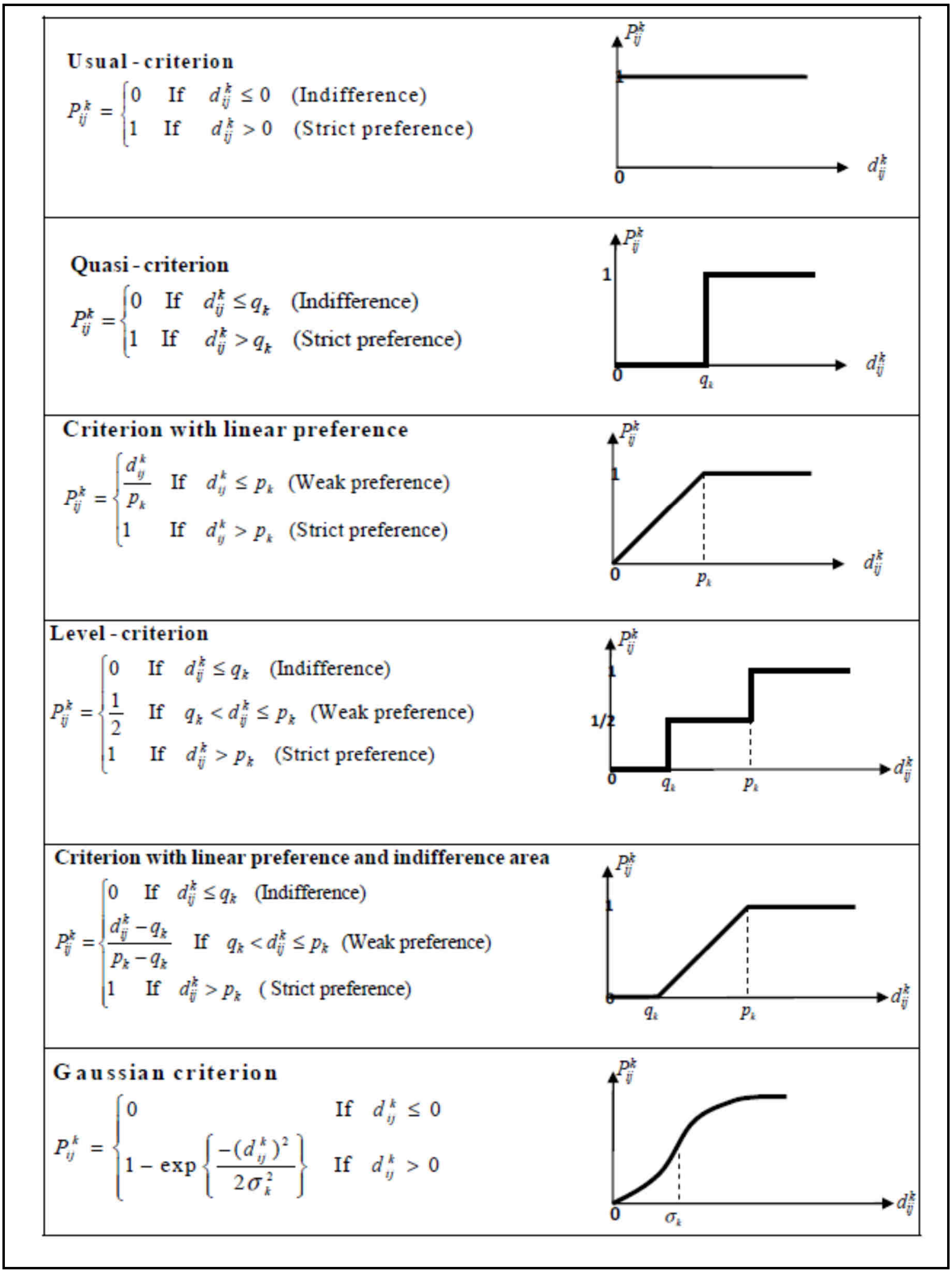


Figure 51: Preference Functions of PROMETHEE Method

(Source: Moalla, Chabchoub, and Martel 2017, 48)

Phase 3: Identification of Common Preference Functions

The preference functions determined in the previous stage should be referenced to the pairwise comparisons of the decision alternatives for each evaluation criterion. At the end of this procedure, common preference functions are determined. When making pairwise comparisons for decision alternatives, it is necessary to consider whether the evaluation criteria are maximization or minimization oriented. The preference function is constructed by using Equation (24) and equation (25) so that a and b represent two decision alternatives.

$$P_j(a,b) = F_j\left[d_j(a,b)\right] \qquad \forall a,b \in A \tag{24}$$

$$d_j(a,b) = c_j(a) - c_j(b) \tag{25}$$

$$0 \leq P_j(a,b) \leq 1 \tag{26}$$

Where $c_j(a)$ is the value of alternative ***a*** for any criterion ***j;*** $d_j(a,b)$ is the difference between the values of decision alternatives ***a*** and ***b*** for criterion ***j***.

Phase 4: Determination of Preference Indices

At this stage, once the joint preference functions have been determined, the preference index for each pair of decision alternatives should be determined. Equations (27) and (28) should be used to determine the preference index.

$$\pi(a,b) = \sum_{i=1}^{k} P_i(a,b)\,.\,w_i \tag{27}$$

$$\pi(b,a) = \sum_{i=1}^{k} P_i(b,a)\,.\,w_i \tag{28}$$

In Equation (27) and Equation (28);

- w_i: Importance weights of the criteria (i= 1, 2,..., k)
- k: Number of criteria

- π (a, b): The degree to which decision alternative a is preferred to decision alternative ***b*** for all criteria.
- π (b, a): Indicates the degree of preference of decision alternative b over decision alternative ***a*** for all criteria.

A value of π (a, b) approaching zero indicates a weak global preference for alternative ***a*** over ***b***, while ***a*** value approaching ***1*** indicates a strong global preference for alternative ***a*** over ***b***. Some properties of preference indices are shown in equation (29) and equation (32).

$$\pi(a,a) = 0 \tag{29}$$

$$0 \leq \pi(a,b) \leq 1 \tag{30}$$

$$0 \leq \pi(b,a) \leq 1 \tag{31}$$

$$0 \leq \pi(a,b) + \pi(b,a) \leq 1 \tag{32}$$

It is clear that:

$\pi(a,b)\sim 0$ implies a weak global preference of ***a*** over ***b***.

$\pi(a,b)\sim 1$ implies a strong global preference of ***a*** over ***b***.

After computing $\pi(a,b)$ and $\pi(b,a)$ for all pairs of alternatives in $\boldsymbol{A}$, a fully valued outranking graph is generated, consisting of two connections for each pair of nodes (Brans et al. 2005).

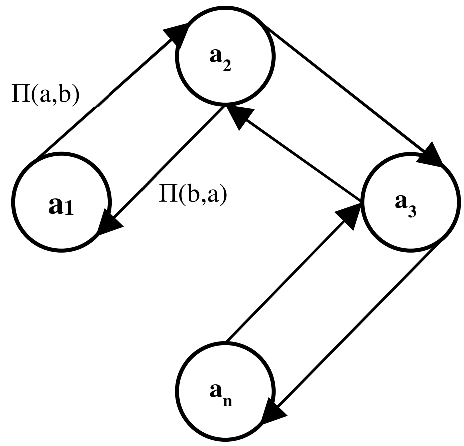


Figure 52: Valued Outranking Graph

(Source: Modified from Brans et al. 2005)

Phase 5: Calculation of Positive and Negative Advantages

At this stage, in order to rank the decision alternatives, positive and negative advantages should be determined for each decision alternative. Equation (33) and equation (34) should be used to calculate the values of positive advantage ϕ^{+} and negative advantage ϕ^{-}.

$$\Phi^{+}(a) = \frac{1}{n-1}\sum_{x \in A} \pi(a, x) \tag{33}$$

$$\Phi^{-}(a) = \frac{1}{n-1}\sum_{x \in A} \pi(x, a) \tag{34}$$

In Equation(33) and Equation(34)

- ***A***: Set of decision alternatives
- ***n***: Number of decision alternatives
- ***x***: denotes each decision alternative other than a.

The graphical representation of the positive and negative advantages for decision alternative 'a' is given in Figure 53.

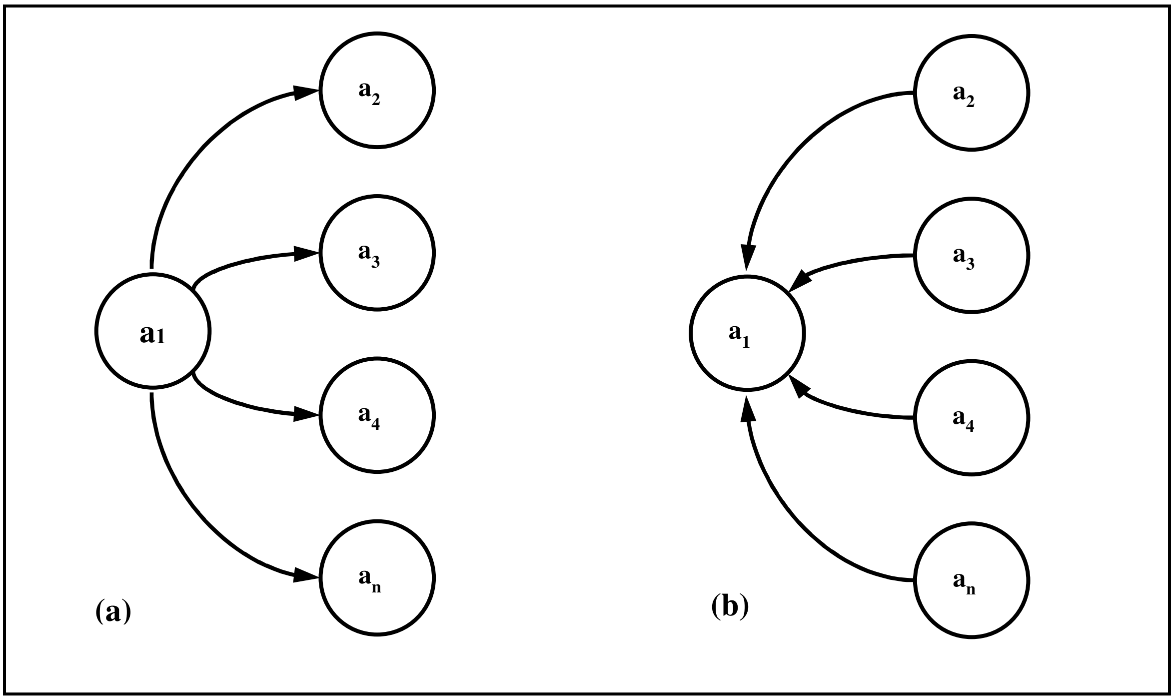


Figure 53: (a) The ϕ+ outranking flow (b) The ϕ- outranking flow

(Source: Modified from Brans et al. 2005)

Positive Outranking $\phi^{+}(a)$ indicates the advantages of decision alternative an over other available alternative. A high positive outranking value of a decision alternative means that it is the better option compared to other decision alternatives.

Negative outranking $\phi^{-}(a)$ indicates the weaknesses of decision alternative as compared to other available alternatives. A low negative outranking indicates that a decision alternative is the better option compared to other decision alternatives.

Phase 6: Calculating Partial Priorities with PROMETHEE I

In this phase, the partial ranking of the decision alternatives is determined by making pairwise comparisons of positive outranking and negative outranking values. Three different situations can be identified when determining the rankings. The PROMETHEE I partial ranking (P^{I}, I^{I}, R^{I}) is obtained from the positive and the negative outranking flows. Both flows do not usually induce the same rankings. PROMETHEE I is their intersection. These situations are:

- Advantages of decision alternatives over each other (Priority),
- Indifference between decision alternatives (Equality),

- Inability to compare decision alternatives with each other (incomparability).

Specifically, these situations for decision alternatives ***a*** and ***b*** can be summarized as follows (Brans et al. 2005).

- Decision alternative ***a*** is preferred over decision alternative ***b*** if it satisfies one of the following conditions ($aP^{I}b$) in Equations (35), (36), (37).

$$\Phi^{+}(a) > \Phi^{+}(b) \; ve \; \Phi^{-}(a) < \Phi^{-}(b) \tag{35}$$

$$\Phi^{-}(a) < \Phi^{-}(b) \; ve \; \Phi^{+}(a) = \Phi^{+}(b) \tag{36}$$

$$\Phi^{+}(a) > \Phi^{+}(b) \; ve \; \Phi^{-}(a) = \Phi^{-}(b) \tag{37}$$

- Decision alternative ***a*** and decision alternative ***b*** are equivalent if the following condition is satisfied ($aI^{I}b$) in Equation (38).

$$\Phi^{+}(a) = \Phi^{+}(b) \; ve \; \Phi^{-}(a) = \Phi^{-}(b) \tag{38}$$

- Decision alternative ***a*** cannot be compared with decision alternative ***b*** if any of the following conditions are met ($aR^{I}b$) in Equations (39), (40).

$$\Phi^{+}(a) > \Phi^{+}(b) \; ve \; \Phi^{-}(a) > \Phi^{-}(b) \tag{39}$$

$$\Phi^{+}(a) < \Phi^{+}(b) \; ve \; \Phi^{-}(a) < \Phi^{-}(b) \tag{40}$$

In such a case the information provided by both flows is not consistent. In this case it seems reasonable to be cautious and consider both alternatives as incomparable. Evaluation of PROMETHEE I is precautionary: it does not decide which action is best in such situations. It remains decision-maker's decision to take responsibility for it.

Phase 7: Calculation of Net Priorities with PROMETHEE II and Full Ranking

In the previous phase, PROMETHEE I was used to determine partial priorities. Since it provides a partial ranking and the decision alternatives cannot be fully ranked, PROMETHEE II, the next stage of the method, was developed.

PROMETHEE II consists of the (P^{II}, I^{II}) complete ranking. It is often the case that the decision-maker requests a complete ranking. The net outranking flow can then be considered (Brans et al. 2005). It is the balance between the positive and the negative outranking flows. The higher the net flow, the better the alternative, so that:

In this phase, net outranking flows are calculated for all decision alternatives. Net outranking flows are calculated by taking the difference between the positive outranking flows and the negative outranking flows of each decision alternative. With the calculated net outranking values, all decision alternatives can be evaluated in the same way and a consistent ranking can be made. Equation (41) should be used to calculate the net outranking flow.

$$\Phi^{net}(a) = \Phi^{+}(a) - \Phi^{-}(a) \tag{41}$$

Since net outranking flow is calculated with PROMETHEE II, a complete ranking can be made among the decision alternatives. The calculation of net outranking flow in PROMETHEE II eliminates the situation where decision alternatives are evaluated as indistinguishable from each other. It is possible to summarize the situations that may be encountered when making a complete ranking for decision alternatives $\boldsymbol{a}$ and $\boldsymbol{b}$ as follows.

If the following condition is provided, decision alternative $\boldsymbol{a}$ is preferable to decision alternative $\boldsymbol{b}$ in Equation (42).

$$\Phi^{net}(a) > \Phi^{net}(b) \tag{42}$$

If the following condition is satisfied, decision alternative a and decision alternative b are equivalent as Equation (43).

$$\Phi^{net}(a) = \Phi^{net}(b) \tag{43}$$

When PROMETHEE II is considered, all the alternatives are comparable. No incomparability remains, but the resulting information can be more disputable because more information gets lost by considering the difference (Brans et al. 2005). The properties of the net priority value are shown in Equation (44) and Equation (45).

$$-1 \leq \Phi^{net}(a) \leq 1 \tag{44}$$

$$\sum_{x \in A} \Phi^{net}(a) = 0 \tag{45}$$

When $\Phi^{net}(a) > 0$, a is more outranking all the alternatives on all the criteria. When $\Phi^{net}(a) < 0$ It is more outranked (Brans et al. 2005). According to the definition of the positive and the negative outranking flows and of the aggregated indices mentioned in Equations (46), (47).

$$\Phi(a) = \sum_{j=1}^{k} \Phi_j(a) w_j \tag{46}$$

$$\Phi_j(a) = \frac{1}{n-1} \sum_{x \in A} \left[P_j(a,x) - P_j(x,a)\right] \tag{47}$$

$\Phi_j(a)$is the single criterion net flow obtained when only criterion $\boldsymbol{C_j}$ is considered (100% of the total weight is allocated to that criterion). It expresses how an alternative ***a*** is outranking $\left(\Phi_j(a) > 0\right)$ or outranked $\left(\Phi_j(a) < 0\right)$ by all the other alternatives on criterion $\boldsymbol{C_j}$. The profile of an alternative consists of the set of all the single criterion net flows: $\Phi_j(a),\ j = 1, 2, \dots, k$ (Brans et al. 2005, 175).

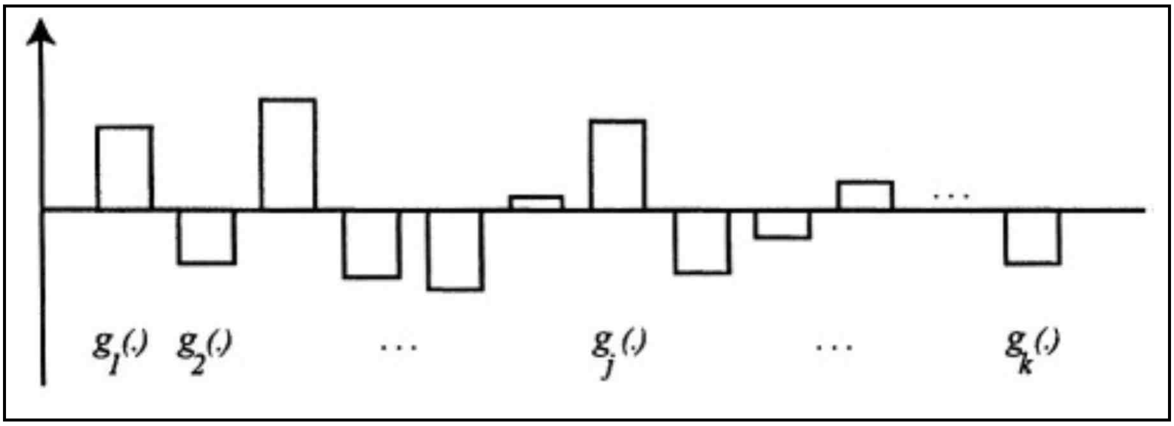


Figure 54: Profile of an Alternative.

(Source: Brans et al. 2005, 175)

The profiles of the alternatives are considered particularly valuable for understanding their quality across different criteria. Decision makers often use these profiles to finalize their evaluations. It is observed that the global net flow of an alternative is the scalar product between the vector of weights and the profile vector of the alternative, a property that is extensively used in the computation of the GAIA plane Brans et al. (2005).

Belonging to the family of outranking methods, PROMETHEE and GAIA methods are used to compare actions in pairs on each criterion based on the decision maker's preferences, resulting in local scores. PROMETHEE is a prescriptive (***P.y***) method that allows ranking of actions based on the decision maker's preferences. The local scores are then integrated to produce global scores, resulting in two rankings: a partial ranking based on uncontested preferences and a complete, potentially less robust ranking that depends on the decision maker's requirements. If only the first few actions from the ranking are selected, it solves a choice problem (***P.a***) (Mareschal, Nemery, and Ishizaka 2010).

Flow Sort is used for sorting (P.β) and elimination problems, where actions are compared to reference profiles and then sorted or eliminated. GAIA is a descriptive method (***P,δ***) that complements PROMETHEE by providing decision makers with a synthetic visual representation of the primary characteristics of the decision problem, such as the conflicts between criteria and the specific profiles of actions. GAIA is also used to prioritize decision makers by showing the weights of the criteria and their impact on the PROMETHEE rankings. Thus, GAIA can be used to identify or create new actions in a design problem formulation (Mareschal, Nemery, and Ishizaka 2010).

The GAIA (Geometrical Analysis for Interactive Aid) plane is a graphical representation that provides decision makers with a straightforward presentation of PROMETHEE results. The decision maker can easily make decisions by visualizing the conflicting criteria results on a plane. As Brans et al. (2005) explained the methodology of the PROMETHEE-GAIA in their writing it could be summarized the interpretation as below.

The geometric representation of alternatives and criteria in the GAIA plane can provide a significant enrichment in explaining problems to the decision maker. This technique is used in particular to evaluate the importance of each criterion in the decision process and to determine the preference ratios on the criteria. Understanding homogeneous sets of alternatives, specific criteria for selecting the best alternatives among those under consideration and determining the state of non-comparability between alternatives can also be achieved with this technique. The presentation of the PROMETHEE results on the GAIA level is essential to help the decision maker to make quick and well-founded decisions. A detailed explanation of the notation used is given below.

The length of the bar or axis representing the criteria on the GAIA plane indicates the discriminative power of the criterion and its influence on the decision. Thus, the length of the bar corresponds to its importance. Criteria bars pointing in the same direction have similar properties and belong to the same criteria, while those pointing in different directions are associated with conflicting criteria. Alternatives with similar values are positioned close to each other on the GAIA plane, and the ranking of alternatives is determined by their high value on a criterion. If an alternative has a high value on a criterion, then it is located close to that criterion bar on the GAIA plane.

If the discriminative power of a criterion is low, the corresponding bar on the GAIA plane will be short. This is because criteria with low discriminatory power are more perpendicular to the GAIA plane. The graphical representation of the criteria bars will reflect this by appearing short. Representing alternatives and criteria on the GAIA plane provides a clear understanding of the decision bar and its meaning and provides visual comfort to the decision maker. This is in contrast to determining the location of alternatives and criteria, where weights are used to represent the decision bar on the GAIA plane.

The decision bar on the GAIA plane is represented by the weights determined by the decision maker, which reflect the decision maker's preferences. Therefore, the direction and length of the decision bar may change if the decision maker changes his or her weights. However, it is important to note that the position of the alternatives and criteria on the GAIA plane remains constant and is determined without the use of weights. A long decision bar on the GAIA plane indicates a strong decision strength and guides the decision maker to the most appropriate alternative or alternatives. In this scenario, the decision maker can move toward the most appropriate alternative or alternatives because the criteria are not too conflicting in the direction indicated by the bar.

If the decision bar is relatively short, it indicates a lack of robust decision power. This, in turn, suggests that the criteria at hand are fundamentally at odds with each other in terms of the given weights, making it a challenging task to identify the most appropriate alternative or alternatives. It is evident that by assigning different weights to the criteria, the weights of the criteria in the direction indicated by the decision bar exceed the weights of the other criteria. The GAIA plane provides an interactive display of how the direction of the decision bar changes as the weight assigned to the criteria is adjusted. The comments on the GAIA layer also facilitate a more comprehensive understanding of the layer. With a better understanding of the criteria, alternatives, and decision bar positions, it becomes clear that the resulting GAIA planes offer more richness than simply presenting the PROMETHEE results on a two-dimensional plane. However, it is important to note that the GAIA plane should always be used in conjunction with the PROMETHEE net flow results. The graphical representation of the GAIA plane provides a visual demonstration of the results of the PROMETHEE method and offers decision makers and researchers a quick, easy to understand and straightforward perspective beyond a simple ranking system characteristic of other multi-criteria decision-making methods. This presentation brings a unique approach to Multi-Criteria Decision-Making methods and provides significant benefits to the decision-making process.

5.2.4 Application Stages of COPRAS

According to article of Podvezko (2011), the COmplex PRoportional ASsessment (COPRAS) is capable of evaluating decision problems involving both maximization and minimization of criterion values. It should be mentioned that the ranking of alternatives generated by the COPRAS method is sensitive to even small changes in the data, and therefore the results may differ from other methods used in the same decision context.

The application of COPRAS generally follows the stages as Bausys, Zavadskas, and Kaklauskas (2015) mentioned.

Step 1: Determination of the Decision Matrix.

An $\boldsymbol{mxn}$ dimensional decision matrix $\boldsymbol{X}$ is created, with rows representing decision alternatives ($\boldsymbol{m}$) and columns representing evaluation criteria ($\boldsymbol{n}$) Equation (48).

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad (48)$$

Step 2: Determination of the weight of the criteria w_j.

At this stage, MCDM methods used for weight determination can be preferred or declared by the decision maker to determine the criteria weights.

Step 3: Normalize the decision-making matrix.

The decision matrix $\boldsymbol{X}$ is transformed into the normalization matrix $\overline{\boldsymbol{X}}$. The elements of the normalization matrix $\overline{\boldsymbol{X}}$ is calculated using the following formula. The normalized weighted value ($\boldsymbol{x_{ij}}$) is calculated in Equation *(49)*,

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \; ; \quad i = 1,2,\dots,m \; ; \quad j = 1,2,\dots,n \quad (49)$$

Step 4: The weighted normalized decision-making matrix D is computed, with components calculated accordingly.

$$d_{ij} = \bar{x}_{ij} \cdot w_j \; ; \quad i = 1,2,\cdots,m \; ; \quad j = 1,2,\cdots,n \quad (50)$$

x_{ij} represents the value of the i_{th} criterion in relation to the j_{th} alternative; qi represents the weight of the i_{th} criterion, while m and n represents the number of criteria and alternatives respectively as Equation*(50)* (Atkinson 2018).

Step 5: Calculate the total criterion values according to the optimization direction for each alternative.

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \ ; \quad P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \tag{51}$$

Where $\boldsymbol{d_{+ij}}$ values represent the criteria to be maximized and $\boldsymbol{d_{-ij}}$ values represent the criteria to be minimized Equation *(51)*.

Step 6: Specifying the minimum component of P_{-i}.

$$P_{-min} = \min_i P_{-i} \ ; \quad i = 1,2, \dots, L_{min} \tag{52}$$

Step 7: Determine the score value of each alternative Q_i.

The relative significance of the alternative is evaluated based on the maximizing ***(P_{+j})*** and minimizing ***(P_{-j})*** criterion values in a given case. Q_i, the relative significance of the alternative, is calculated as per the following equation (53) (Atkinson 2018).

$$Q_i = P_{+i} + \frac{\left(P_{-min} \sum_{j=1}^{L_{min}} P_{-j}\right)}{\left(P_{-i} \sum_{j=1}^{L_{min}} \frac{P_{-min}}{P_{-j}}\right)} \ ; \quad j = 1, \dots, L_{min} \tag{53}$$

Step 8: Determine optimality criterion Q_{max} for the alternatives.

Determination of the degree of ranking of the alternatives. The alternative with a higher score value Q_i is considered to have the higher rank in Equation *(54)*.

$$Q_{max} = \max_{i} Q_i ; \quad i = 1,2, \dots, m \tag{54}$$

The higher the significance (***Q_i***), the better the ranking and quality of the alternative. Relative significance (***Q_i***) represents the degree to which the alternative satisfies the requirements of the decision maker. In the scenario with ***Q_{max}***, satisfaction is at an all-time high and the other solutions have lower relative significance; in other words, all other alternatives fulfill the requirements of the decision maker to a lower level than ***Q_{max}*** (Atkinson 2018).

Step 9: Computing the degree of utility of each alternative,

The degree of utility of each alternative is calculated by comparing the alternatives to ***Q_{max}***. The alternative of greatest significance, ***Q_{max}***, is assigned a utility degree (***N_j***) of 100%, while the utility degrees of all other alternatives fall between 0% and 100%, depending on their relative merit. The utility degree (***N_j***) for each alternative is computed using the following method. The top-ranked relative importance score is then determined as Equation *(55)* (Atkinson 2018).

$$N_j = \frac{Q_i}{Q_{max}} \times 100 \tag{55}$$

A decision point with a performance index of 100 is the best alternative. The preference ranking of decision points is the ranking of the performance index values in descending order. The preference ranking of the decision points is the ranking of the performance index values in descending order (Karagoz and Tecim 2018).

5.2.5 Selecting a Multi-Criteria Decision-Making Method

As a result of the literature review, it is determined that Multi-Criteria Decision-Making Methods do not have advantages or disadvantages over each other, and that the method should be selected according to the purpose of use and the expected results of the evaluation method. Therefore, four Multi-Criteria Decision-Making Methods, two

'Criteria Weighting Method' and two 'Ranking of Alternatives Method', were selected to be used within the scope of this dissertation by considering the evaluation criteria in Table 31 and Table 32.

Since the integrated Multi-Criteria Decision-Making Method to be developed within the scope of the thesis study is designed using the Microsoft Excel program for this stage, it is aimed that the Multi-Criteria Decision-Making Methods to be used in the model are compatible with the way the Microsoft Excel program works and is designed.

As a result of this review, Table 33 shows, the DEcision-Making Trial and Evaluation Laboratory (DEMATEL), Preference Ranking Organization METhod for Enrichment Evaluations (PROMETHEE), Analytic Network Process (ANP), Analytic Hierarchy Process (AHP), ELimination Et Choix Traduisant la Realite (ELECTRE) methods are considered important. The fact that PROMETHEE, ANP and AHP methods work with their own computer program is an important advantage. However, the main disadvantage of ANP and AHP methods in the context of this thesis is that if any criterion or alternative in both methods needs to be changed, all analyses have to be re-evaluated from the beginning and it is difficult to plan this on Microsoft Excel program. In addition, for different users working in different institutions, it is necessary to perform the analysis from the beginning for each changing condition. Although this is also the case in PROMETHEE, since the weights of the criteria must be determined by another multi-criteria decision-making method, it is not necessary to repeat these weights once they have been determined, and it is sufficient to compare only the alternatives and the criteria. Another advantage of the PROMETHEE method is that a table created with the Microsoft Excel program can be directly integrated into the Visual PROMETHEE-GAIA package program (WEB6 2022). Within the scope of the thesis, the results of the model developed on the Microsoft Excel software are used by providing an add-on to the Visual PROMETHEE-GAIA software.

Table 31: Evaluation Framework of the Multi-Criteria Decision-Making Method (Prepared by Author)

Name	Explanation of the Evaluation	Reference
MCDM METHODS	Name of the MCDM Method	
MCDM METHODS (abb.)	Abbreviation of Name of the MCDM Method	
Reference	Name of the Author	
Characteristics of the Method	Explanation of the Characteristics of the Method	
CHOICE PROBLEM	Exist/None	Ishizaka&Nemery 2013
SORTING PROBLEM	Exist/None	Ishizaka&Nemery 2013
RANKING PROBLEM	Exist/None	Ishizaka&Nemery 2013
DESCRIPTION PROBLEM	Exist/None	Ishizaka&Nemery 2013
ELIMINATION PROBLEM	Exist/None	Ishizaka&Nemery 2013
DESIGN PROBLEM	Exist/None	Ishizaka&Nemery 2013
Determining the Best Alternative	Exist/None	(Yaralıoğlu 2023)
Placing Alternatives in Importance Ranking	Exist/None	(Yaralıoğlu 2023)
Determining the Most Important Evaluation Criteria	Exist/None	(Yaralıoğlu 2023)
Determination of Weight Values of Evaluation Criteria	Exist/None	(Yaralıoğlu 2023)
Creation of Sub-Evaluation Criteria (Internal Dependence)	Exist/None	(Yaralıoğlu 2023)
Demonstrating the Causalities Between Evaluation Criteria and Alternatives	Exist/None	(Yaralıoğlu 2023)
Differentiation of Evaluation Criteria According to Their Characteristics	Exist/None	(Yaralıoğlu 2023)
Involvement of A Large Number of Decision Makers in the Decision Process	Exist/None	(Yaralıoğlu 2023)
Creation of Decision Scenarios	Exist/None	(Yaralıoğlu 2023)
The Incomparability of Alternatives or the Reason for Their Indifference	Exist/None	(Yaralıoğlu 2023)
Ability of the Decision Maker to Incorporate Preferences on the Evaluation Criteria into the Decision Process	Exist/None	(Yaralıoğlu 2023)
Creation of Alternative Portfolios (Similar Clusters)	Exist/None	(Yaralıoğlu 2023)
Computational Time	Less/Moderate/High/Very high/Very less	(Brauers 2012)
Simplicity	Simple/Very critical/Moderately critical/Very simple	(Brauers 2012)

(cont. on next page)

Table 31 (cont.)

Name	Explanation of the Evaluation	Reference
Mathematical Calculations	Minimum/Moderate/Maximum	(Brauers 2012)
Stability	Good/Medium/Poor	(Brauers 2012)
Information Type	Mixed/Quantitative	(Brauers 2012)
Inputs	ideal and anti-ideal option/ideal option and constraints/indifference and preference thresholds/indifference, preference, and veto thresholds/no subjective inputs required/pairwise comparisons on a ratio scale/pairwise comparisons on a ratio scale and interdependencies/pairwise comparisons on an interval scale/utility function	Ishizaka&Nemery 2013
Effort Input	1/2/3/4/5/6/7/8/9	(Ishizaka & Nemery 2013)
Output	Classification with scoring/Complete ranking with closeness score/Complete ranking with scores/Feasible solution with deviation score/Partial and complete ranking (pairwise outranking degrees)/Partial and complete ranking (pairwise preference degrees and scores)/Partial ranking with effectiveness score	(Ishizaka & Nemery 2013)

The DEMATEL method is a well-known method for determining criteria weights in multi-criteria decision-making methods. Within the scope of the thesis, an evaluation was made of the selection method in terms of the intended end users, and it was evaluated that it would be both easy for different technical staff and administrators in the institutions to use the DEMATEL method to determine the criteria weights, and that it allows group decisions to be produced, since it is possible to provide collaborative action.

In addition to these two methods, in order to develop an integrated Multi-Criteria Decision-Making Model that can be operated dynamically, an arrangement has been designed within the Microsoft Excel program that will allow the weighting of the criteria using the Entropy Method. The purpose here is to integrate an alternative method into the model that provides for the determination of criteria weights by comparing criteria and weights. The entropy method is a reliable method that can be easily used to determine criteria weights, especially in decision alternatives where criteria can be measured quantitatively.

In the Microsoft Excel software, where the Entropy criteria weighting method is used, a multi-criteria decision-making method that can operate compatibly with Entropy has been studied as calculation steps, and in this context the COPRAS method has been integrated into the model to be used for ranking alternatives.

As a result, the criteria weights can be calculated by selecting one of the DEMATEL or Entropy methods and, if desired, using these criteria weights, the ranking of alternatives according to their importance can be calculated by selecting one of the PROMETHEE or COPRAS methods.

The Entropy-COPRAS hybrid model provides a powerful and dynamically modifiable calculation, especially in research with a large number of quantitative criteria, while the DEMATEL-PROMETHEE hybrid model provides a research environment where decision makers have the opportunity to make subjective evaluations in criteria weights and personal evaluations in criterion types with more qualitative characteristics. The PROMETHEE method is integrated into the model as a useful multi-criteria decision-making method because it provides the possibility to define preference functions in the criterion types and to define lower and upper limits within the request. In addition, the Visual PROMETHEE software offers the possibility to operate on different scenarios and supports them with two-dimensional and three-dimensional graphics, and the availability of ready-made tables and statistics are also considered as strengths of the method.

Table 32: Evaluation of the Multi-Criteria Decision-Making (MCDM) Methods

(Prepared by Author)

MCDM METHODS (definition)	MCDM METHODS (abb.)	Reference	Characteristics of the Method	CHOICE PROBLEM (Ishizaka & Nemery, 2013)	SORTING PROBLEM (Ishizaka & Nemery, 2013)	RANKING PROBLEM (Ishizaka & Nemery, 2013)	DESCRIPTION PROBLEM (Ishizaka & Nemery, 2013)	ELIMINATION PROBLEM (Ishizaka & Nemery, 2013)	DESIGN PROBLEM (Ishizaka & Nemery, 2013)	Determining the Best Alternative (Yaralıoğlu, 2023)	Placing Alternatives in Importance Ranking (Yaralıoğlu, 2023)	Determining the Most Important Evaluation Criteria (Yaralıoğlu, 2023)	Determination of Weight Values of Evaluation Criteria (Yaralıoğlu, 2023)	Creation of Sub-Evaluation Criteria (Internal Dependence) (Yaralıoğlu, 2023)	Demonstrating the Causalities Between Evaluation Criteria and Alternatives (Yaralıoğlu, 2023)	Differentiation of Evaluation Criteria According to Their Characteristics (Yaralıoğlu, 2023)	Involvement of A Large Number of Decision Makers in the Decision Process (Yaralıoğlu, 2023)	Creation of Decision Scenarios (Yaralıoğlu, 2023)	The Incomparability of Alternatives or the Reason for Their Indifference (Yaralıoğlu, 2023)	Ability of the Decision Maker to Incorporate Preferences on the Evaluation Criteria into the Decision Process (Yaralıoğlu, 2023)	Creation of Alternative Portfolios (Similar Clusters) (Yaralıoğlu, 2023)	Computational Time (Brauers & Zavadskas, 2012)	Simplicity (Brauers & Zavadskas, 2012)	Mathematical Calculations (Brauers & Zavadskas, 2012)	Stability (Brauers & Zavadskas, 2012)	Information Type (Brauers & Zavadskas, 2012)	Inputs (Ishizaka & Nemery, 2013)	Effort Input (Ishizaka & Nemery, 2013)	Output (Ishizaka & Nemery, 2013)
Analytic Hierarchy Process	AHP	(Yaralıoğlu, 2023)	AHP can be explained as a decision-making and forecasting method that gives percentage distributions of decision points (alternatives) in terms of the factors affecting the decision (evaluation criteria) used when the decision hierarchy can be defined.	EXIST	EXIST	EXIST				NONE	EXIST	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	Very high	Very critical	Maximum	Poor	Mixed	pairwise comparisons on a ratio scale	6	Complete ranking with scores
Analytic Network Process	ANP	(Yaralıoğlu, 2023)		EXIST		EXIST				EXIST	EXIST	NONE	NONE	EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE						pairwise comparisons on a ratio scale and interdependencies	8	Complete ranking with scores
Additive Ratio ASsesment Process	ARAS	(Yaralıoğlu, 2023)	According to the ARAS method, the utility function used to determine the relative effectiveness of an alternative in a decision problem is directly proportional to the relative effects of the weights and values of the evaluation criteria. The ARAS method helps determine the performance of an alternative and reveals the proportional similarity of each alternative to the ideal alternative.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
COmbined COmpromise Solution	COCOSO	(Yaralıoğlu, 2023)	The method presents three different relative evaluation strategies to the decision maker, taking into account the multiplication and total functions, and in the final stage, it combines these three strategies to determine the importance ranking of the alternatives according to their performance.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
COmbinative Distance-based Assessment	CODAS	(Yaralıoğlu, 2023)	It is a method based on calculations that takes into account the distances of the alternatives to the negative ideal solution.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
COPELAND		(Yaralıoğlu, 2023)	The COPELAND Method is used in the literature to combine the individual decisions (importance rankings) of multiple decision-makers equipped with decision-making authority and to create a single decision model.							EXIST	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
COmplex PRoportional Assesment	COPRAS	(Yaralıoğlu, 2023)	The COPRAS (Complex Relative Evaluation) method works by sequencing and evaluating decision points (alternatives) in terms of their importance and degree of benefit.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	Very less	Simple	Minimum	Good	Mixed			
CRiteria Importance Through Intercriteria Correlation	CRITIC	(Yaralıoğlu, 2023)	The method differs from other MCDM methods in that it provides a coherent solution to the problem of determining the weights of the evaluation criteria, which is an important element for the definition and solution of a decision problem. With this method, determining the weights of the evaluation criteria also solves the intuitive dimension of the problem.							NONE	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Data Envelopment Analysis	DEA	(Ayçin, 2020)	DEA is a non-parametric approach that attempts to measure the relative effectiveness of similar decision-making units with the help of linear programming.	EXIST		EXIST																					no subjective inputs required	1	Partial ranking with effectiveness score
DEcision MAking Trial and Evaluation Laboratory	DEMATEL	(Yaralıoğlu, 2023)	The method is generally used in practice to determine the importance levels of the evaluation criteria and to create decision scenarios by determining the causality relationships between the evaluation criteria. The method allows a large number of decision makers to create a common solution to the decision problem.							EXIST	EXIST	EXIST	EXIST	NONE	EXIST	NONE	EXIST	EXIST	NONE	NONE	NONE								
Disaggregation – Aggregation Approaches	UTA*, UTAII, UTADIS	(Ishizaka & Nemery, 2013)			EXIST																						utilityfunction	9	Classificationwith scoring
ELimination Et Choix Traduisant la Realite	ELECTRE	(Yaralıoğlu, 2023)	The method is based on comparisons of binary superiority between alternative decision points for each evaluation criterion.	EXIST	EXIST	EXIST				EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	High	Moderately critical	Moderate	Medium	Mixed	indifference, preference and veto thresholds	5	Partial and complete ranking (pairwise outranking degrees)
ENTROPY		(Yaralıoğlu, 2023)	The ENTROPY method is used to determine the weights of the evaluation criteria in the process of solving the decision problem. It is defined as a good co-resolver as it reduces the uncertainty of decision problems and/or the factor of subjectivity arising from the decision maker to an acceptable level.							NONE	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Evaluation based on Distance from Average Solution	EDAS	(Yaralıoğlu, 2023)	It is based on the average (compromise) solution to determine the best alternative.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
EVAluation of MIXed data	EVAMIX	(Yaralıoğlu, 2023)	The obvious difference of the method from other MCDM methods is that in addition to differentiating the evaluation criteria with the aim aspects, it can also evaluate their quantitative and qualitative characteristics in the solution process.							EXIST	EXIST	NONE	NONE	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE								
Goal Programming	GP	(Ishizaka & Nemery, 2013)		EXIST																							ideal option and constraints	3	Feasible solution with deviation score
Grey Relational Analysis	GRA	(Ayçin, 2020)	Gray System theory can be used to solve uncertainty problems in cases with discrete data and incomplete information.																										
Iterative Multi Criteria Decision Making	TODIM	(Yaralıoğlu, 2023)	In addition to showing the adequacy of considering the quantitative and/or qualitative characteristics of the evaluation criteria in the ranking process, the TODIM method also takes into account the benefit or cost purpose aspects of the evaluation criteria as in other MCDM methods.							EXIST	EXIST	NONE	EXIST	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE								
KEmeny Median Indicator Rank Accordance-modified	KEMIRA-M	(Yaralıoğlu, 2023)	The KEMIRA – M method is used to determine the importance order and weight of the evaluation criteria. It also defines the internal and external criteria characteristics of the evaluation criteria, as distinct from the benefit-cost and quantitative-qualitative characteristics of the evaluation criteria.							NONE	NONE	NONE	EXIST	NONE	NONE	EXIST	EXIST	NONE	NONE	NONE	NONE								
Measuring Attractiveness by a categorical Based Evaluation Technique	MACBETH	(Ishizaka & Nemery, 2013)		EXIST		EXIST																					pairwise comparisons on an interval scale	7	Complete ranking with scores
Measurement Alternatives and Ranking according to COmpromise Solution	MARCOS	(Yaralıoğlu, 2023)	The MARCOS method is basically used to explain the relationship between existing alternatives and determined reference values. On the basis of the defined relationship, the utility functions of the alternatives are determined and the order of compromise according to ideal and non-ideal solutions is revealed. The utility functions indicate the position of alternatives relative to the ideal and non-ideal solution.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
MEthod based on the Removal Effects of Criteria	MEREC	(Yaralıoğlu, 2023)	The MEREC method is a weighting method used to calculate the weights of criteria to determine the effect of each evaluation criterion on the total performance of the alternatives.							NONE	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Multi – Attributive Border Appproximation area Comparision	MABAC	(Yaralıoğlu, 2023)	The MABAC method is based on determining the distance of the evaluation criterion function of each alternative from the boundary approach area.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Multi Attributive Ideal-Real Comparative Analysis	MAIRCA	(Yaralıoğlu, 2023)	The MAIRCA method is based on identifying the gaps between ideal and empirical (experimental) ratings. By summing the gaps for each evaluation criterion, a total gap for the alternatives is obtained. At the end of the decision process, it is determined as the alternative with the closest value to the ideal rating that can represent the evaluation criteria. In other words, the alternative with the least total void value is determined as the best alternative.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Multi-Attribute Utility Theory	MAUT	(Yaralıoğlu, 2023)	the MAUT method, qualitative and quantitative evaluation criteria are considered together and simultaneously to determine the most useful alternative. In the method, subjective data are also made computable in order to find the most useful alternative.	EXIST		EXIST				EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE						no subjective inputs required	9	Complete ranking with scores
Multi-Objective Optimization by Ratio Analysis	MOORA	(Yaralıoğlu, 2023)	MOORA method is the process of simultaneously optimizing a large number of decision points (alternatives) under certain evaluation criteria.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	Very less	Very simple	Minimum	Good	Quantitative			
Multi-Objective Optimization on the basis of Simple Ratio Analysis	MOOSRA	(Yaralıoğlu, 2023)	The advantages of the method include the short calculation time, very little mathematical operations, high reliability and simple applicability.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Operational Competitiveness Ratings Analysis	OCRA	(Yaralıoğlu, 2023)	The OCRA method evaluates the evaluation criteria according to the performance values separately according to the objectives and converts these values into total preference values.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Organisation, Rangement Et Synthèse de données relaTionnElles	ORESTE	(Yaralıoğlu, 2023)	The ORESTE method is basically based on the principle that alternatives are analyzed according to a reference vector of base (best measurement values) in terms of evaluation criteria and placed in importance ranking.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Preference Ranking Organization METhod for Enrichment Evaluations	PROMETHEE	(Yaralıoğlu, 2023)	The main difference from the mcdm methods is that the evaluation criteria take into account the importance weights that indicate the level of relationship between each other, as well as the internal relationship of each evaluation factor.	EXIST		EXIST	EXIST			EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	EXIST	EXIST	NONE	High	Moderately critical	Moderate	Medium	Mixed	indifference and preference thresholds	4	Partial and complete ranking (pairwise preference degrees and scores)
Preference Selection Index	PSI	(Yaralıoğlu, 2023)	The biggest advantage of the PSI Method is that it compares the evaluation criteria using measurement performances and assigns importance relative to the evaluation criteria. In other words, the PSI method can both determine the weights of the evaluation criteria and put the alternatives in the order of importance.							EXIST	EXIST	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
QUALItative FLEXible	QUALIFLEX	(Yaralıoğlu, 2023)	In the QUALIFLEX method, all possible permutations (rankings) of the alternatives are taken into account and the alternatives are compared bilaterally according to each evaluation criterion. Then, under each permutation, the fit/non-conformance indices for the alternative pairs are calculated.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Simple Additive Weighting	SAW	(Yaralıoğlu, 2023)	The method is also known as the weighted total method in the literature and is a simple and easy to use method.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Step-wise Weight Assessment Ratio Analysis	SWARA	(Yaralıoğlu, 2023)	Beyond the importance ranking of alternatives, it is only a method for determining the weight of the evaluation criteria. It is generally based on the dual comparisons of the evaluation criteria after they have been placed in a position of importance by the decision maker.							NONE	NONE	NONE	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Technique for Order Preference by Similarity to Ideal Solution	TOPSIS	(Yaralıoğlu, 2023)	The proximity of the decision points (alternatives) to the ideal solution is based on the main principle and the solution process is shorter than the ELECTRE method.	EXIST		EXIST				EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	Moderate	Moderately critical	Moderate	Medium	Quantitative	ideal and anti-ideal option	2	Complete ranking with closeness score
VIse Kriterijumska Optimizacija i kompromisno Resenje	VIKOR	(Yaralıoğlu, 2023)	The VIKOR method was developed not as a matter ranking but for the purpose of determining the best ones and forming a group. In this sense, it is mostly used in the creation of portfolio baskets in the financing sector.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	EXIST	Less	Simple	Moderate	Medium	Quantitative			
Weighted Aggregated Sum Product Assessment	WASPAS	(Yaralıoğlu, 2023)	The WASPAS method is a method that places alternatives in order of importance by calculating both the relative sum and relative product values.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Weighted Euclidean Distance Based Approach	WEDBA	(Yaralıoğlu, 2023)	Using the Euclidean Distance approach, it generates alternative sequencing with a certain deviation from the best solution.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Weighted Product Method	WPM	(Yaralıoğlu, 2023)	It is based on converting normalized measurement values to weighted product values and prioritizing alternatives.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
Weighted Sum Method	WSM	(Yaralıoğlu, 2023)	It is one of the first generation multi-criteria decision making methods. The WSM method finds the significance values (performance value) of the alternatives by summing the normalized measurement values of the respective alternative multiplied by the weight values of the corresponding evaluation criteria.							EXIST	EXIST	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								

Table 33: Summary Table of The Evaluation of Multi-Criteria Decision-Making (MCDM) Methods

(Prepared by Author)

MCDM METHODS	MCDM METHODS	Selection Criteria (%)	Computational Time	Simplicity	Mathematical Calculations	Stability	Information Type	Inputs	Effort Input	Output
DEcision MAking Trial and Evaluation Laboratory	DEMATEL	38.89								
Preference Ranking Organization METhod for Enrichment Evaluations	PROMETHEE	38.89	High	Moderately critical	Moderate	Medium	Mixed	indifference and preference thresholds	4	Partial and complete ranking (pairwise preference degrees and scores)
Analytic Network Process	ANP	33.33						pairwise comparisons on a ratio scale and interdependencies	8	Complete ranking with scores
Analytic Hierarchy Process	AHP	27.78	Very high	Very critical	Maximum	Poor	Mixed	pairwise comparisons on a ratio scale	6	Complete ranking with scores
ELimination Et Choix Traduisant la Realite	ELECTRE	27.78	High	Moderately critical	Moderate	Medium	Mixed	indifference, preference, and veto thresholds	5	Partial and complete ranking (pairwise outranking degrees)
Iterative Multi Criteria Decision-Making	TODIM	22.22								
Multi-Attribute Utility Theory	MAUT	22.22						no subjective inputs required	9	Complete ranking with scores
Technique for Order Preference by Similarity to Ideal Solution	TOPSIS	22.22	Moderate	Moderately critical	Moderate	Medium	Quantitative	ideal and anti-ideal option	2	Complete ranking with closeness score
EVAluation of MIXed data	EVAMIX	16.67								
KEmeny Median Indicator Rank Accordance-modified	KEMIRA-M	16.67								
Preference Selection Index	PSI	16.67								
VIse Kriterijumska Optimizacija i kompromisno Resenje	VIKOR	16.67	Less	Simple	Moderate	Medium	Quantitative			
Additive Ratio ASsesment Process	ARAS	11.11								
COmbined COmpromise Solution	COCOSO	11.11								
COmbinative Distance-based Assessment	CODAS	11.11								
COPELAND	COPELAND	11.11								
COmplex PRoportional Assessment	COPRAS	11.11	Very less	Simple	Minimum	Good	Mixed			
Data Envelopment Analysis	DEA	11.11						no subjective inputs required	1	Partial ranking with effectiveness score
Evaluation based on Distance from Average Solution	EDAS	11.11								
Measuring Attractiveness by a categorical Based Evaluation Technique	MACBETH	11.11						pairwise comparisons on an interval scale	7	Complete ranking with scores

5.3 Methodology for Determining Indicators

For the purpose of this thesis, different methods can be adopted to determine the indicators to be utilized. In order to evaluate the local characteristics within the scope of this thesis, the method of evaluating the indicators and ranking the alternatives using these indicators and their weights are tested on a case study with a group of experts including representatives from the Metropolitan Municipality, District Municipalities and the responsible public institutions in Izmir.

5.4 Case Study Design

A case study is an in-depth examination of a specific research problem rather than a comprehensive statistical survey. It is often used to reduce a very broad area of research to one or a few easily researchable examples. The case study research design is also useful for testing whether a particular theory or model applies to real-world phenomena. It is a useful design when not much is known about a phenomenon.

These studies provide us with a number of insights. First, the approach used in these studies is remarkable in that it allows us to gain a comprehensive understanding of a complex issue. This is achieved through a careful contextual analysis of a limited number of events or circumstances and their relationships. Second, researchers using the case study design have the opportunity to use a variety of methodologies and consult a variety of sources to investigate a research problem. This flexibility is a notable strength of the approach. Third, this design has the potential to extend experience or to reinforce what is already known from previous research. This is particularly valuable in the social sciences, where empirical evidence is highly valued. Fourth, social scientists make extensive use of this research design to study contemporary real-life situations. In addition, this approach provides a basis for applying concepts and theories and extending methods. Finally, this design can provide detailed descriptions of special and rare situations. This is not really helpful when studying events that are rarely observed or require a comprehensive understanding of intricate details.

The studies reviewed appear to have some limitations that need to be addressed. First, it is important to note that single or small numbers of cases are not sufficient to establish credibility or to generalize findings to a larger population of people, places, or things. This is because such cases may not be representative or typical of the larger problem being studied. Second, intensive case study may bias the researcher's interpretation of the findings. This may be due to the researcher's preconceptions or subjective biases. Third, the design of the study does not facilitate the assessment of cause-and-effect relationships. This may make it difficult to establish a causal relationship between the variables studied. Fourth, important information may be missing, making it difficult to interpret the case. This may be due to the unavailability of certain data or the inability to collect certain information. Finally, if the criterion for selecting a case is that it represents a very unusual or unique phenomenon or problem to be studied, your interpretation of the findings may be unique to that case. Therefore, it is important to consider these limitations when interpreting the results of such studies (Library of Sacred Heart University 2023) (accessed date: 27.06.2023).

CHAPTER 6

THE CASE STUDY

The aim of this section is to evaluate the results by applying the indicator weights obtained by using the multi-criteria decision-making method designed by determining the critical indicators related to urban transformation described in the methodology section to the areas where urban transformation works are being carried out or planned to be carried out within the central borders of Izmir Metropolitan Municipality, as determined by the Ministry of Environment, Urbanization and Climate Change, Izmir Metropolitan Municipality Presidency and District Municipalities.

6.1 Selection of The Case Study Areas

The chosen case study area aimed to implement alternative urban transformation strategies in a specific region. Three nearby areas located within the Gaziemir and Karabağlar districts were selected to fulfill this goal, as these districts present disaster risk within the confines of Izmir Province and possess potential for urban transformation in the central area. The Ministry of Environment, Urbanization, and Climate Change has declared a 540-hectare Risky Area in the western part of Karabağlar Municipality, encompassing the Abdi İpekçi, Devrim, İhsan Alyanak, Salih Omurtak, Bahriye Üçok, Limontepe, Umut, Ali Fuat Erden, Gazi, Özgür, Yüzbaşı Şerafettin, Peker, Yurdoğlu, Cennetçeşme, Uzundere, and Kibar Quarters. Currently, the planning process and various housing typologies within this area are under study (Table 34). The Ministry of Environment, Urbanization, and Climate Change has declared a 540-hectare Risky Area in the western part of Karabağlar Municipality, encompassing the Abdi İpekçi, Devrim, İhsan Alyanak, Salih Omurtak, Bahriye Üçok, Limontepe, Umut, Ali Fuat Erden, Gazi, Özgür, Yüzbaşı Şerafettin, Peker, Yurdoğlu, Cennetçeşme, Uzundere, and Kibar Quarters. In this context, the Ministry has officially approved the Master Plan and Implementation Plan for 101.4 hectares of land.

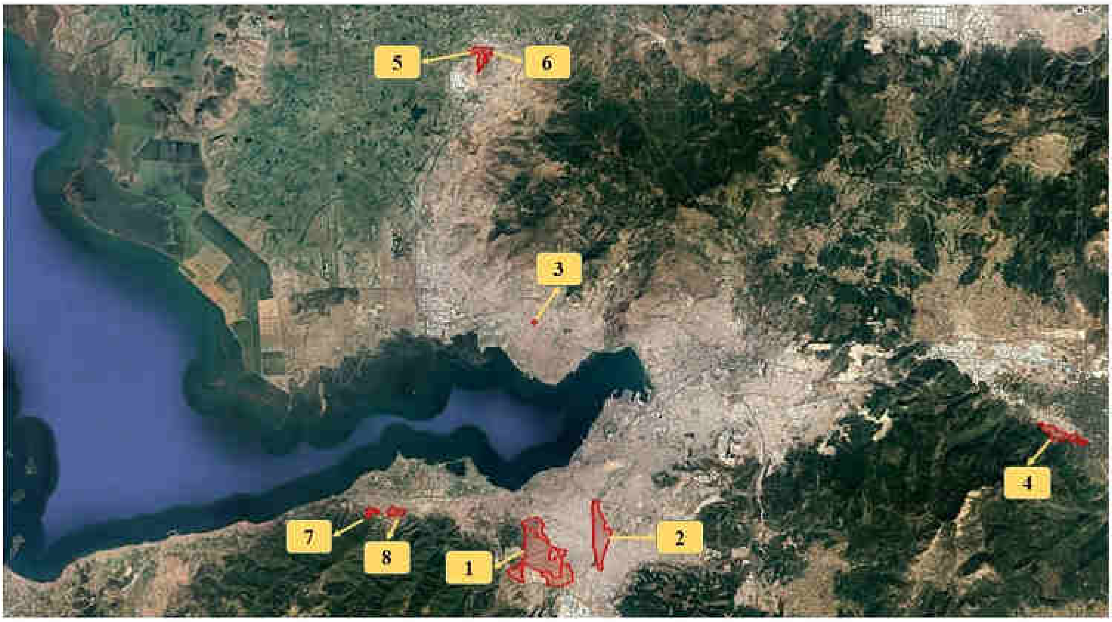


Figure 55: Risk Areas Declared by Law No. 6306

(Source: Provincial Directorate of Ministry of Environment Urbanization and Climate Change in Izmir 2021) (accessed date: 21.06.2023)

The Provincial Directorate of the Ministry of Environment, Urbanization, and Climate Change in Izmir (2016) provides information on the approved urban transformation plan. The plan includes the creation of 4,000 housing units and social reinforcement areas, as well as the transformation of a 350,000 m² area into a regional park. The social enhancement areas will comprise educational, healthcare, and sports facilities, as well as parking areas, footpaths, religious centers, play areas for children, cultural venues, and green spaces, all constructed by İLBANK A.Ş. It has been reported that the project's total construction cost will be approximately 1 billion Turkish Liras. Upon completion of the project, it is expected to expedite the urban transformation efforts in Izmir while also serving as a center of attraction to promote the region's rejuvenation.

Table 34: Risk Areas Declared by Law No. 6306

(Source: Provincial Directorate of Ministry of Environment Urbanization and Climate Change in Izmir 2021) (accessed date: 21.06.2023)

Area No.	Name of The Risky Area	Area (hectare)
1	Karabağlar Municipality - Abdi İpekçi, Devrim, İhsan Alyanak, Salih Omurtak, Bahriye Üçok, Limontepe, Umut, Ali Fuat Erden, Gazi, Özgür, Yüzbaşı Şerafettin, Peker, Yurdoğlu, Cennetçeşme, Uzundere and Kibar Districts	540.00
2	Karabağlar and Buca Municipality - Aşık Veysel, Aydın, Bozyaka, Osman Aksüner, Seyhan Districts	191.00
3	Karşıyaka Municipality - Cumhuriyet District	2.59
4	Kemalpaşa Municipality - Atatürk and Soğukpınar Districts	79.57
5	Menemen Municipality - Ahıhıdır, Gaybi, Kazımpaşa, Seydinnasrullah Districts	44.00
6	Menemen Municipality - Esatpaşa, Kazımpaşa, Tülbentli, Zafer Districts	18.00
7	Narlıdere Municipality - Çatalkaya and Narlı Districts	13.00
8	Narlıdere Municipality - Atatürk and İnönü Districts	30.00
Total Area (hectare)		**918.16**

6.1.1 Case Study Areas in Gaziemir - Karabağlar District

On the other hand, the Izmir Metropolitan Municipality is undertaking a comprehensive and consensus-based urban transformation process in the Aktepe-Emrez neighborhoods of the Gaziemir district, in addition to projects in many other parts of Izmir. Further information regarding these projects can be found in the subsequent sections (Figure 56).

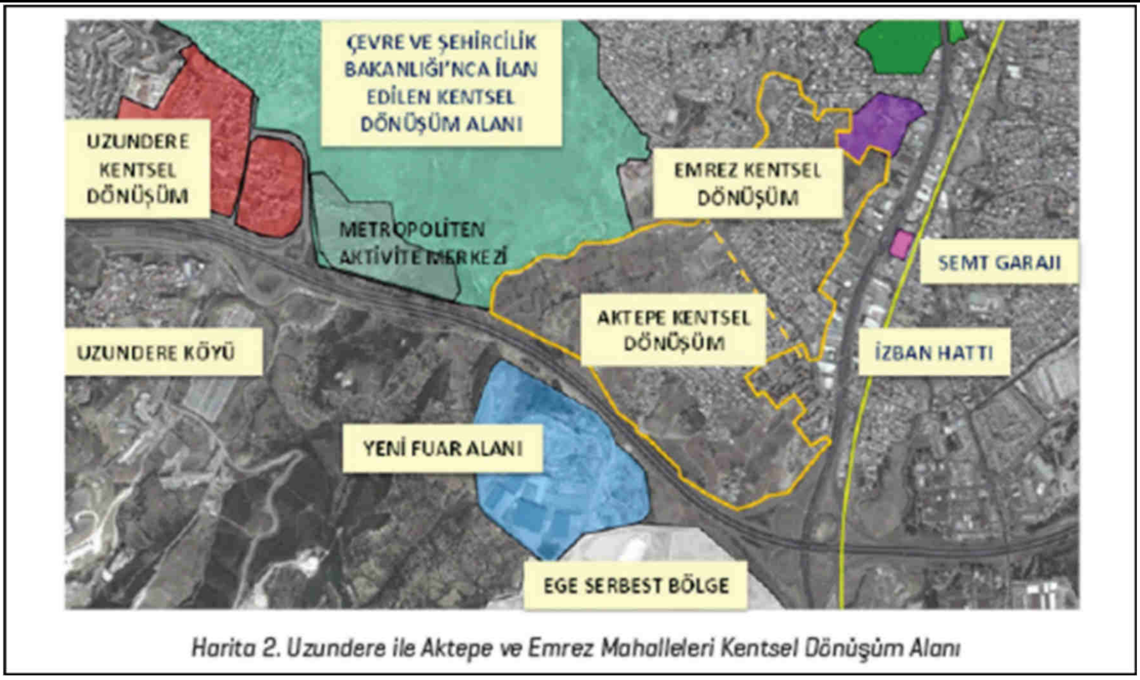


Figure 56: Study of Izmir Model
(Source: IMMDoUT 2013)

The Karabağlar Municipality has undertaken a study on urban transformation, specifically the implementation of zoning plans. Currently, ongoing zoning plan studies target various neighborhoods, covering different planning and time periods.

According to Karabağlar Municipality (2022), there are ongoing urban transformation projects in three different regions within Karabağlar. The area of 540 hectares, which was declared as risky in 2012, is currently under the jurisdiction and responsibility of the Ministry of Environment, Urbanization, and Climate Change, in accordance with Law No. 6306. The second transformation area comprises an urban transformation project for 32 hectares, being executed by the Izmir Metropolitan Municipality in Uzundere. The Municipality has revised the zoning plan in a 106-hectare area including Osman Aksüner, Aşık Veysel and Aydın quarters and submitted it to the Ministry for approval.

Due to the different urban transformation strategies implemented by various institutions in despite of similar physical and social conditions, it was considered that these areas within the jurisdiction of Karabağlar and Gaziemir districts would be suitable examples for the research scope of this thesis (Figure 57).

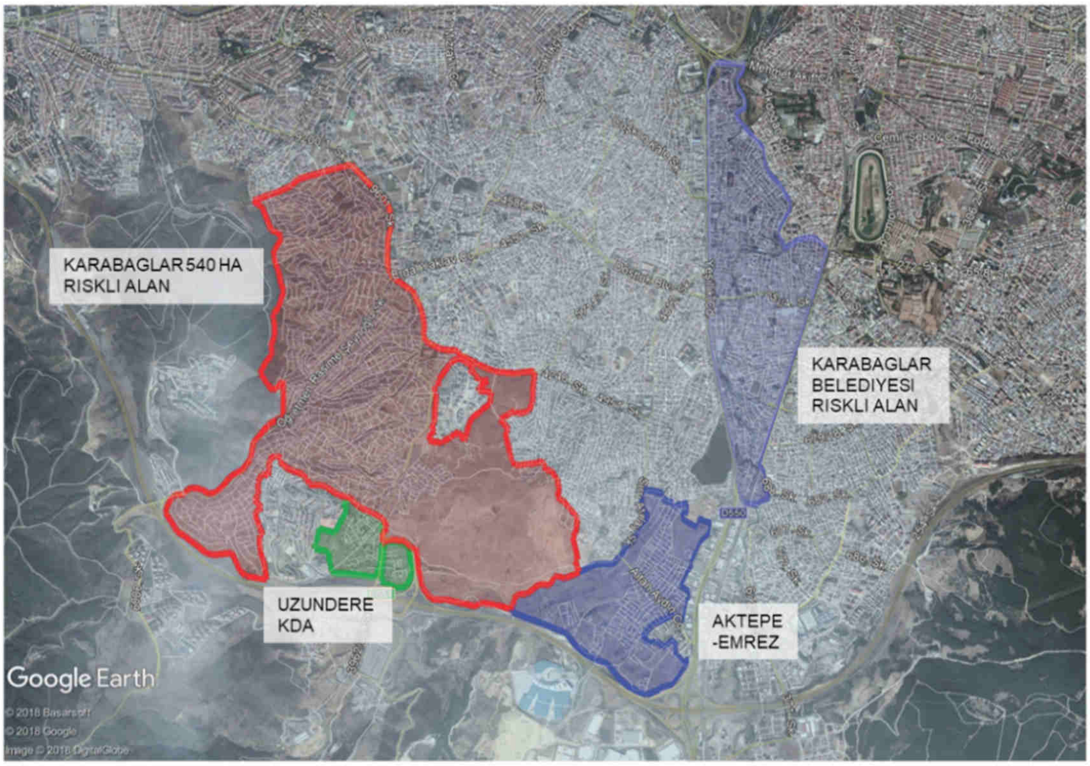


Figure 57: Urban Transformation Areas in Karabağlar Municipality
(Prepared by Author)

6.1.2 Urban Transformation Projects Executed by IMMDoUT

In the implementation processes of the urban transformation projects organized by Izmir Metropolitan Municipality throughout Izmir, the first step is to make the necessary assessments, collecting data, organizing interviews with stakeholders and neighborhood residents, planning and preliminary project presentation according to the feedback, conducting the necessary interviews and feedback again, project revisions, and public presentation of the project, According to the feedbacks, reconciliation negotiations after plan revisions, transfer of property rights, allocation of flats, construction activities and supervision services, infrastructure related manufacturing, property rights and ready-to-use delivery, management activities and support activities for the adaptation of the right holders to the area are carried out and all processes are carried out by Izmir Metropolitan Municipality (IMMDoUT 2013).

The urban transformation effort of the Metropolitan Municipality is aimed at creating a financing model that will ensure the sustainability of urban transformation, based on the principle of ‘float-for-construction’, where projects will be self-financed without the use of public resources. The analysis and synthesis will be carried out through the preparation of the database, the preparation of urban and architectural projects, the determination of the cost of the projects and the determination of the rights of the citizens to the construction of the new project. The distribution model of the projects, prepared by evaluating the project costs and market conditions for investors to undertake construction in the urban transformation area, is determined by the Municipality. Construction procurement is regulated by the Law on Public Procurement No. 2886. In the absence of participation in the selection process, the construction process will be carried out by IZBETON, Izmir Metropolitan Municipality, which will take the necessary administrative decision to award contracts for the rapid implementation of the projects presented to the public (IMMDoUT 2013).

The demand for new residential buildings and infrastructure in the project areas will be developed according to master plans. The buildings are constructed according to the existing regulations, rules of science and art. The purpose is to ensure economic continuity by offering jobs produced by the project to those who have jobs in the community. Izmir Metropolitan Municipality is also responsible for the design and construction of projects such as day care centers and community engagement facilities. (IMMDoUT 2013).

The most important feature of Izmir Metropolitan Municipality's urban transformation projects is that they set an example for 11,000 hectares of urban areas with similar characteristics and deficiencies in infrastructure and superstructure that need significant transformation for the city. For all areas in need of urban transformation in the central districts, these projects are an opportunity for the future prosperity of the city and its citizens, and for every citizen to benefit from the modern opportunities offered by the metropolis. The implementation of the projects in line with all the above-mentioned strategies and action plans will help the city adapt to climate change and ensure that all city residents, regardless of economic level, have the right to the city. (Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

Izmir Metropolitan Municipality's urban transformation projects are being implemented in many stages and in parallel, which facilitates the transfer of experience from one area to another. The fact that the proposed solutions create spaces that can be shared at the neighborhood level and create a system that should be carried out together will facilitate the realization of the principle of participation not only in the project implementation phase, but also in its use (Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

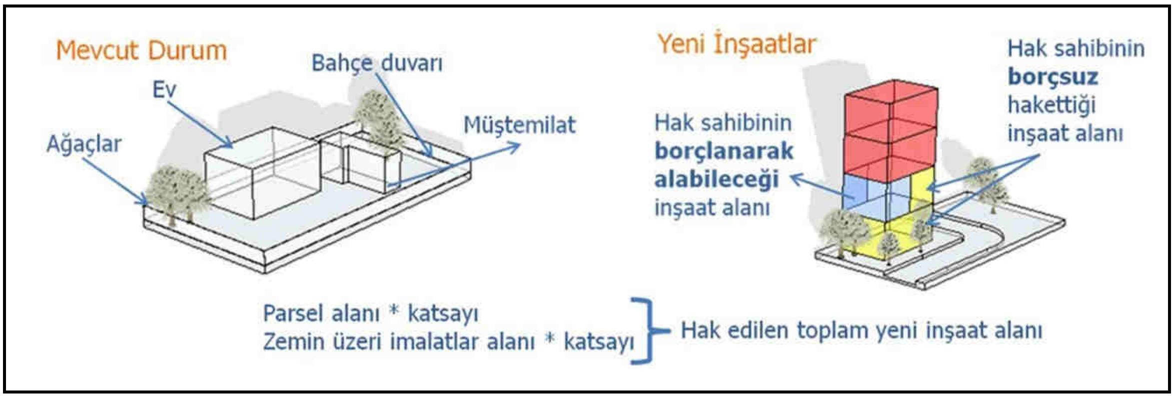


Figure 58: Diagram of The Beneficiary's Right to A Loan
(Source: IMMDoUT 2013)

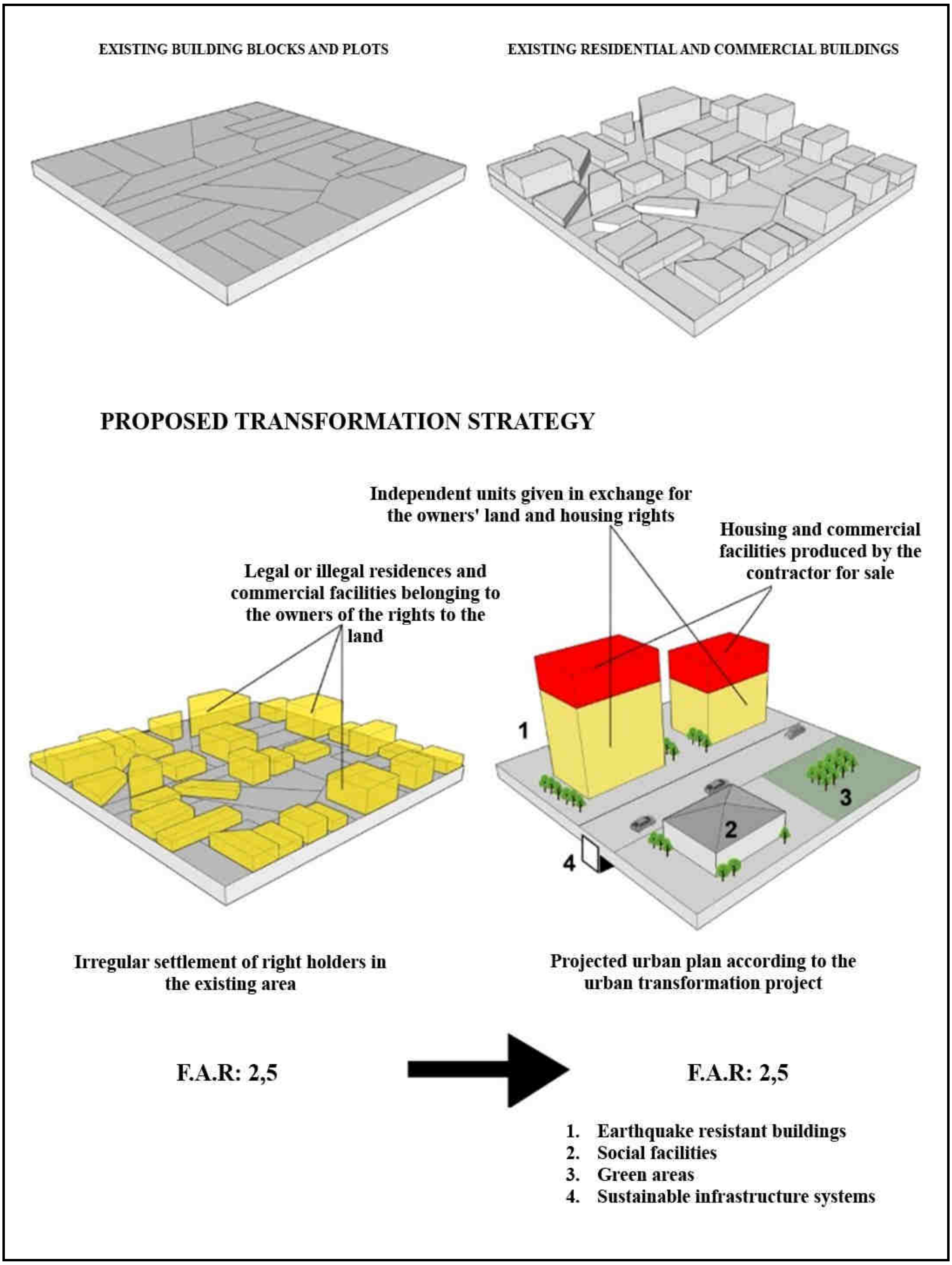


Figure 59: Defining the Distribution Model

(Source: IMMDoUT 2013)

6.1.2.1 Gaziemir Municipality, Aktepe-Emrez Districts Urban Transformation Project

Aktepe-Emrez Neighborhoods within the borders of Gaziemir District, located on the southern axis of the city of Izmir, was determined as the study area (Figure 60) because the area consists of reclamation parcels, illegal construction is dense, it supports the macro form of the city in the north-south development direction, and it has strong transportation connections, It is located near the airport on the entrance axis of the city, it is a continuation of the 'Uzundere Valley Belt' which includes Uzundere Mass Housing Area, New Fairgrounds, Uzundere Recreational Areas, and therefore, as a result of the realization of the urban transformation project, it is complementary to the applications on the said axis (IMMDoUT 2013).

In this context, the area surrounded by Uzundere, which is also the district boundary, on the west, Emrez and Aydın neighborhood boundary on the north, Aydın-Çeşme highway on the south, Police Lodgings and Emrez stream on the east, on the southern axis of Izmir city, was determined as 'Urban Transformation and Development Area' with the decision of Izmir Metropolitan Municipality Council dated 14.03.2011 and numbered 05.229. On 25.04.2011, the boundary of the area, which was submitted to the Governor's Office for approval by the Council of Ministers in accordance with Article 73 of the Municipality Law No. 5393 as amended by Law No. 5998, was approved by the Council of Ministers Decision No. 2012/3434 of 16.07.2012 and published in the Official Gazette No. 28375 of 05.08.2012 (IMMDoUT 2013).

Figure 60: Location of Aktepe-Emrez Urban Transformation-Development Area (Source: IMMDoUT 2013)

6.1.2.1.1 Aktepe-Emrez Districts Urban Transformation Project Current Situation

In the Environmental Plan of Izmir Metropolitan Municipality at the scale of 1:25,000, a large part of it is designated as 'Built-up (Residential) Areas'. In Article 7.1.4.1. of the Implementing Provisions of the aforementioned plan, it is decided in relation to 'Built-up (Residential) Areas'; 'In these areas, plans and projects for protection/renewal, rehabilitation or liquidation may be made according to the condition, texture and functional characteristics of the building stock, the geological structure of the area, the nature of the facilities, the social and economic structure of the population living in the area'. A part of the area is planned as ‘2nd and 3rd degree center’ and is in dense relationship with the central business area (Figure 61) (IMMDoUT 2013).

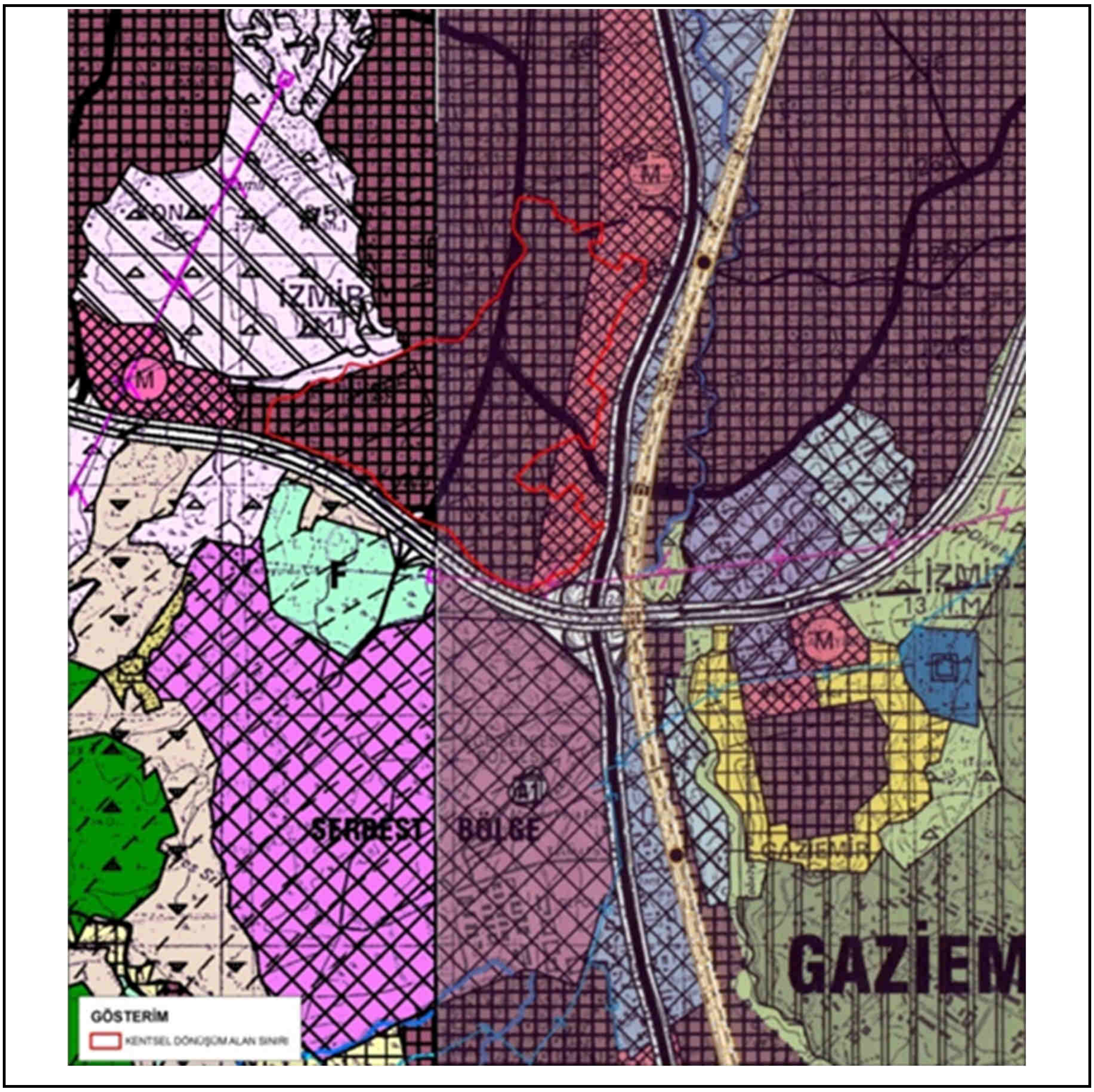


Figure 61: 1/25.000 Master Plan of Aktepe-Emrez
(Source: IMMDoUT 2013)

Examining the 1/5000 scale master plans for the area, it can be seen that the plans were approved on 29.08.1994 and 13.02.1995, and plan revisions were made on 15.03.1996 and 23.09.1998 (Figure 62) (IMMDoUT 2013).

Upon examination of the master plan, it is observed that the region is planned as existing and development housing areas, social reinforcement areas and green areas are concentrated within the plan, especially in the area where development housing areas are located.

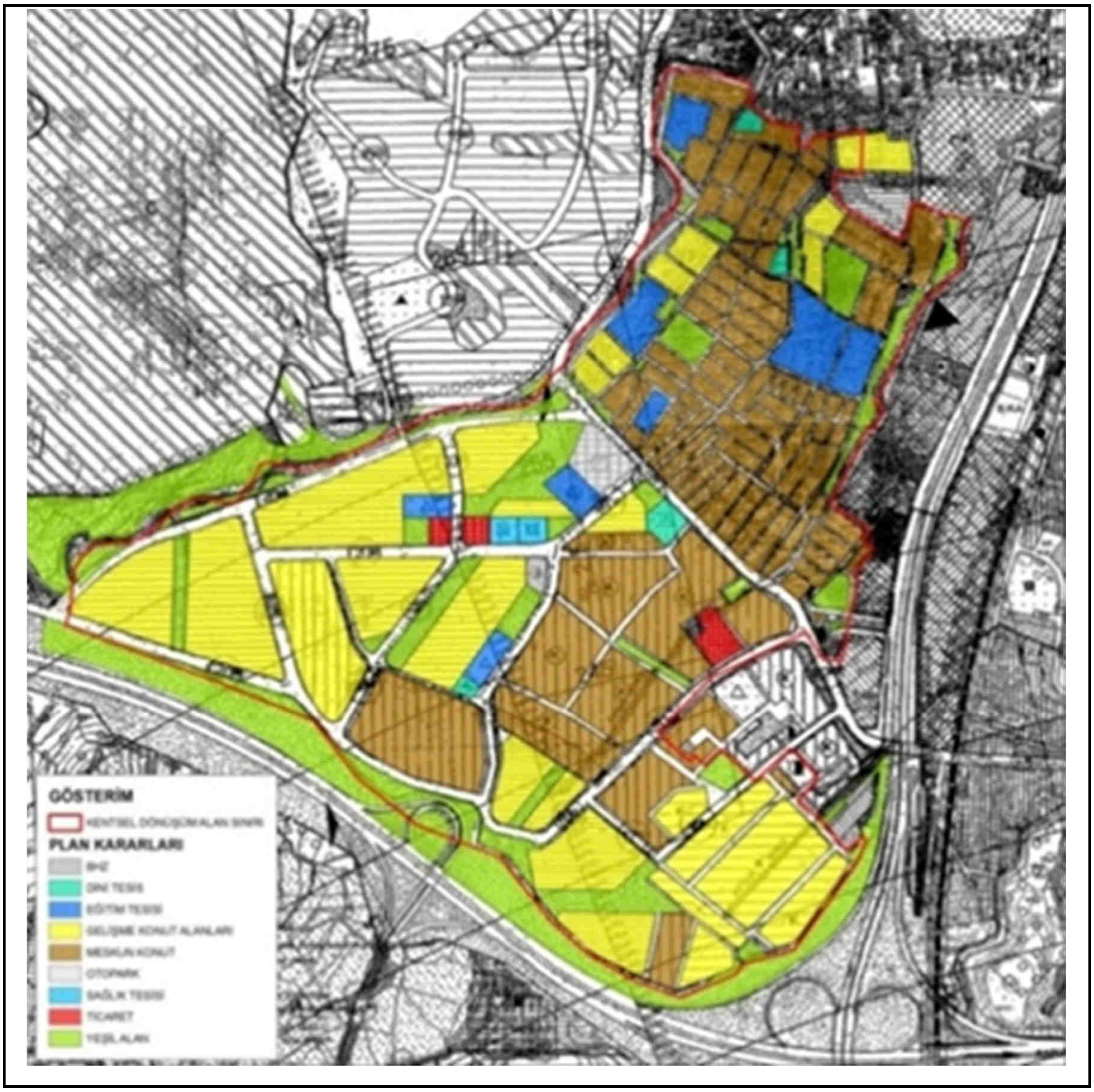


Figure 62: 1/5000 Master Plan of Aktepe-Emrez
(Source: IMMDoUT 2013)

According to implementation plan, on a scale of 1/1000, it can be seen that the plan was approved by the Ministry of Housing and Settlement on 30.07.1981 and the plan was approved by the Izmir Metropolitan Municipality on 17.01.1997 (IMMDoUT 2013).

Upon examination of the implementation plan, it is observed that the region is planned as existing and development housing areas, social reinforcement areas and green areas are concentrated within the plan, especially in the area where development housing areas are located.

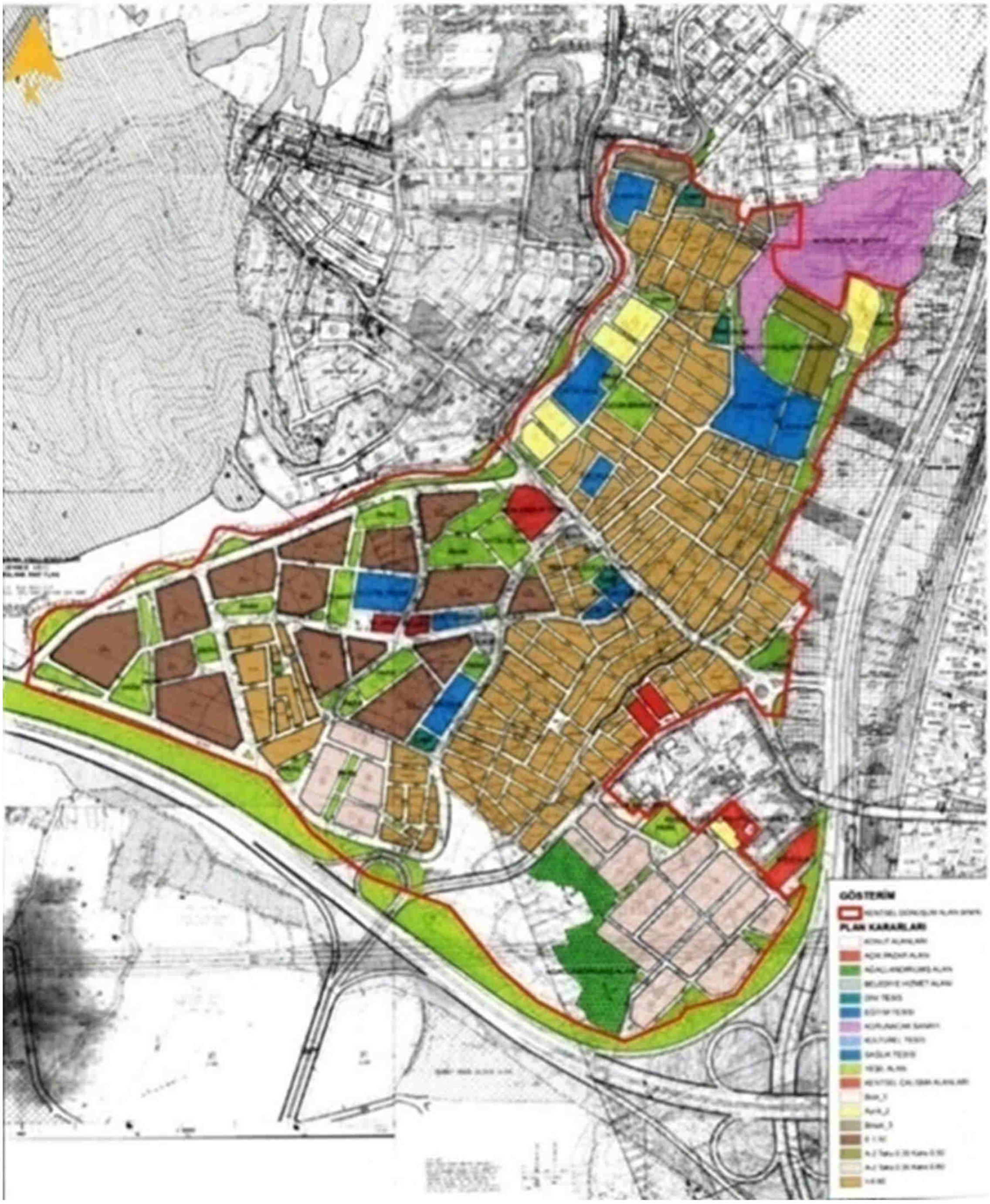


Figure 63: Existing 1/1000 Implementation Plan of Aktepe-Emrez
(Source: IMMDoUT 2013)

The analysis of the existing land use of the site indicated that currently there are dense residential areas, while the commercial and minor industrial businesses are located close to the main roads (Figure 64).

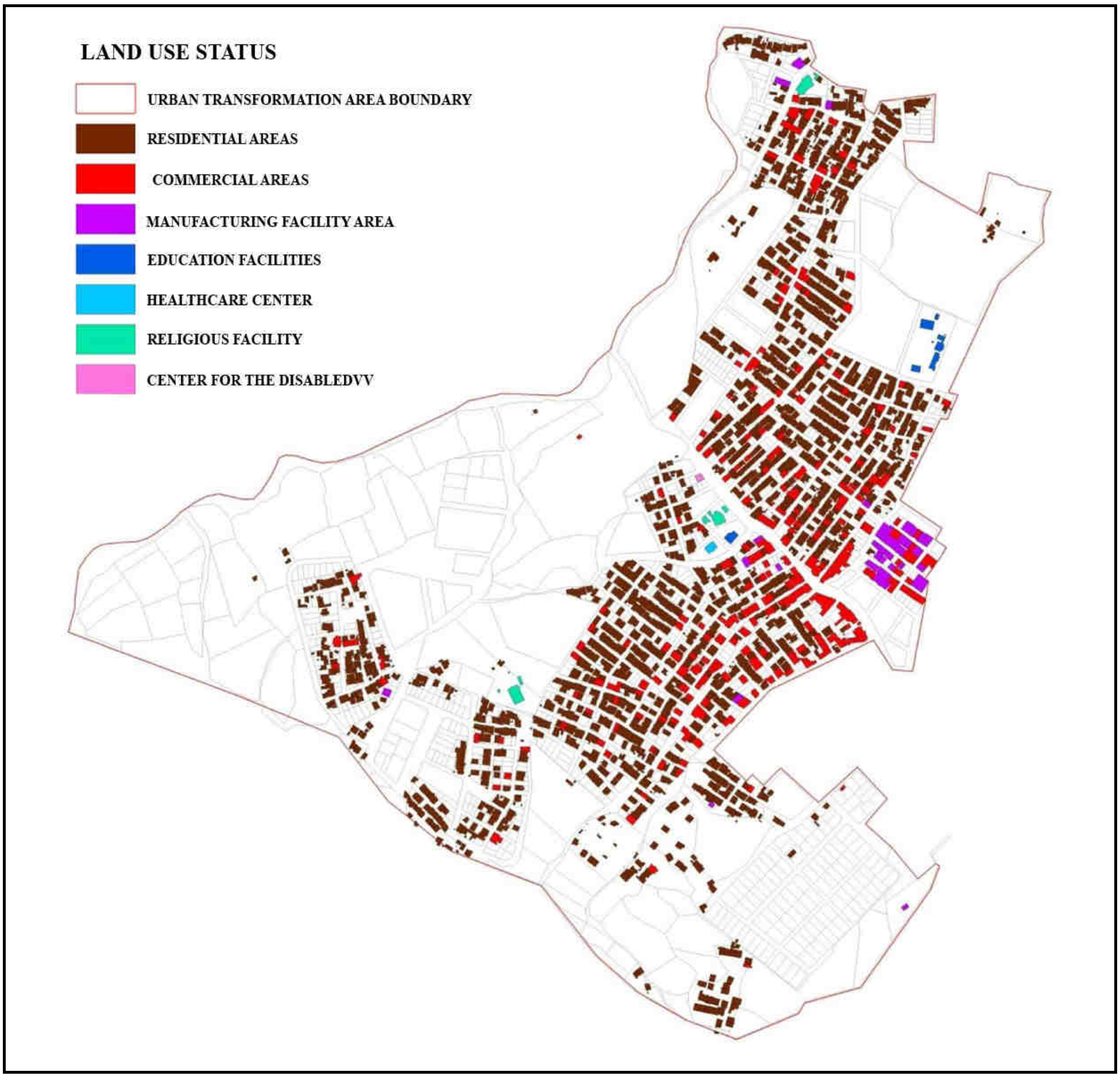


Figure 64: Land Use Status in The Aktepe-Emrez Transformation Area
(Source: IMMDoUT 2013)

When the ownership and building analysis of Aktepe and Emrez neighborhoods are examined, it is seen that vacant plots are generally located in Aktepe neighborhood. There are 571 2-storey, 527 3-storey, 434 1-storey, 249 4-storey, 52 5-storey and 2 6-storey buildings in the area (Figure 64) (IMMDoUT 2013).

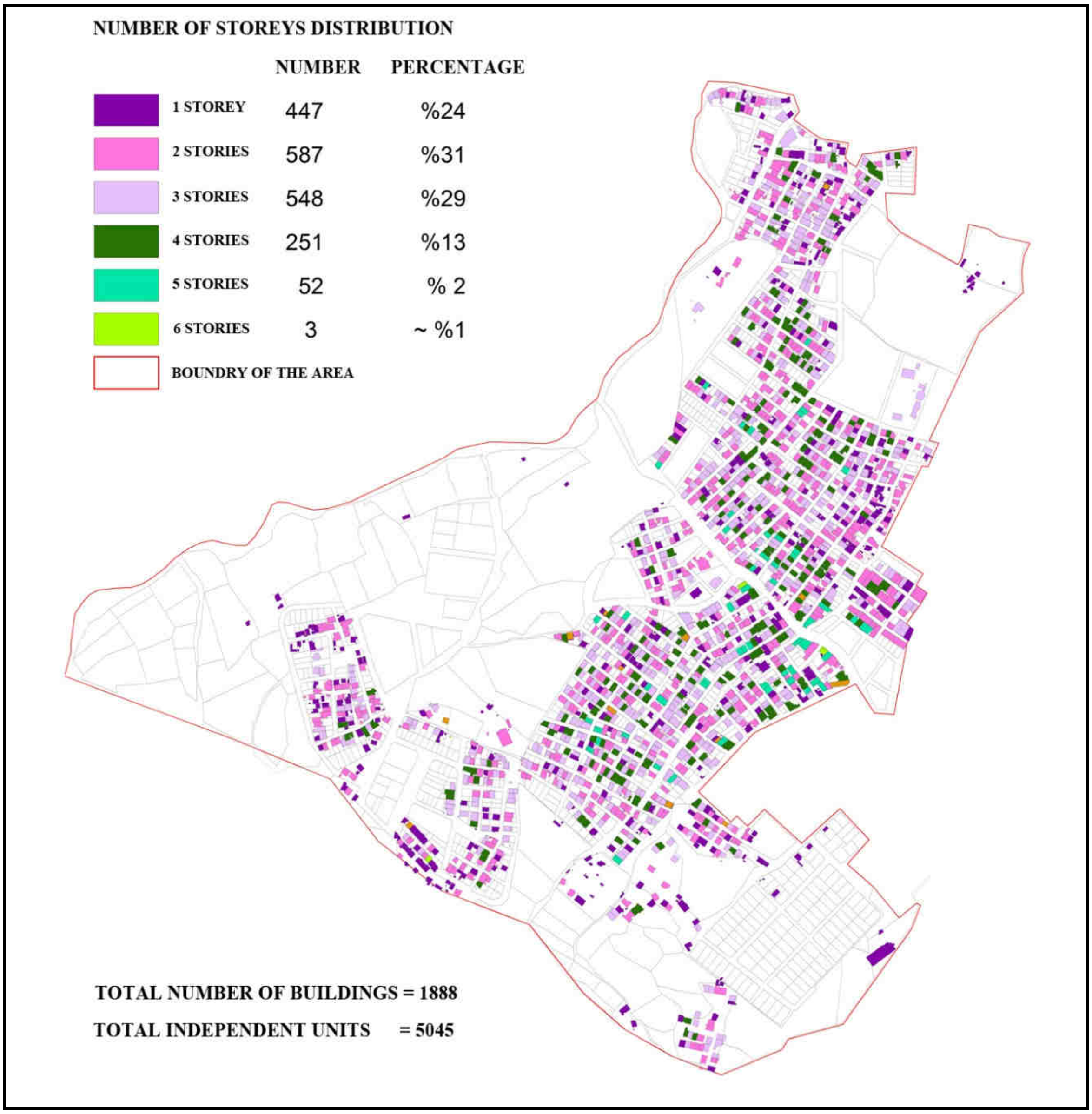


Figure 65: Number of Building Stories in The Aktepe-Emrez Transformation Area (Source: IMMDoUT 2013)

There are 1836 buildings in the whole area. The total number of independent units is 4966. The total number of beneficiaries (as of 2019, when the implementation principles were approved by the Metropolitan Municipality Council) is 2820 (IMMDoUT 2013).

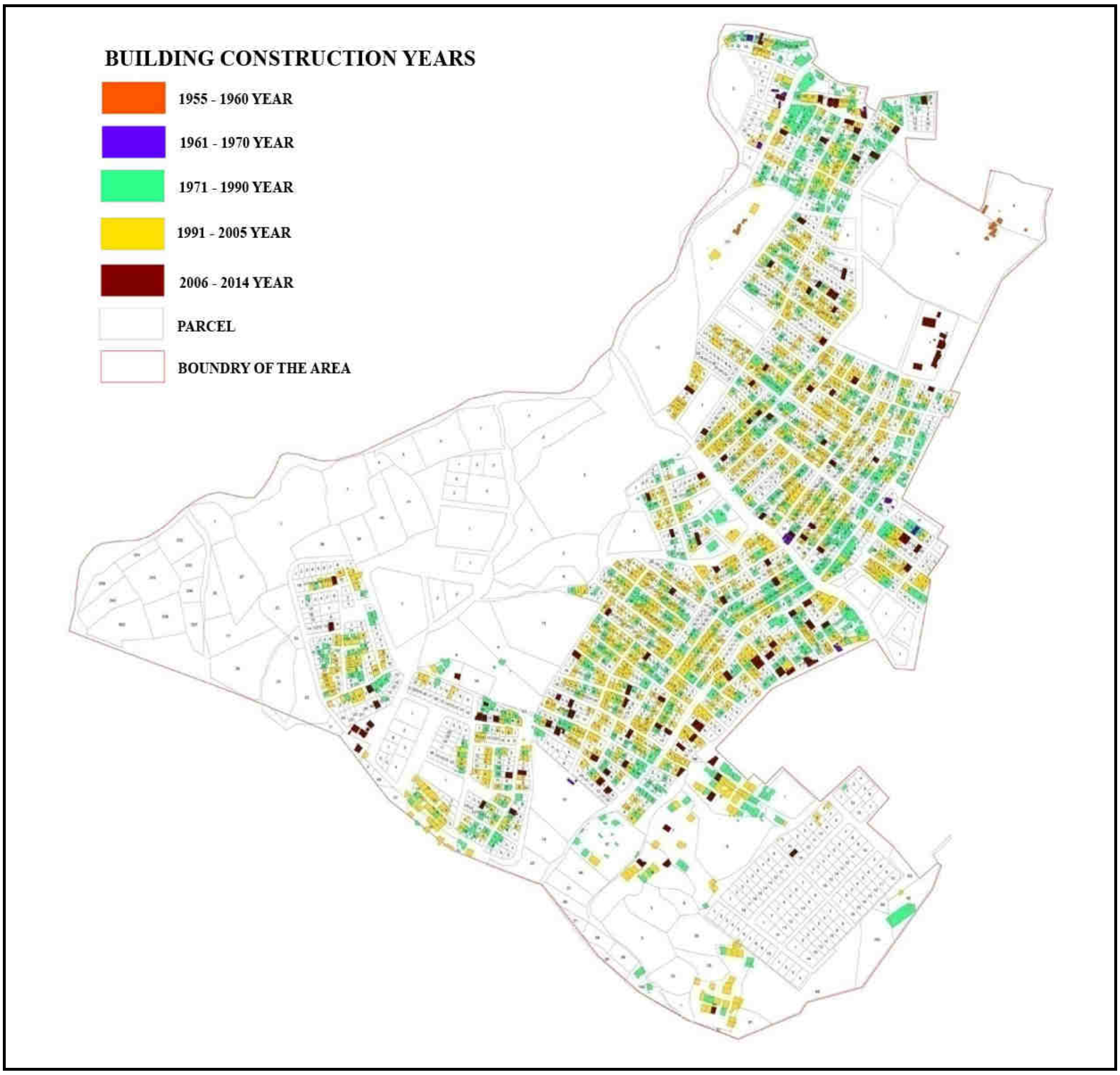


Figure 66: Year of Building Construction in The Aktepe-Emrez Transformation Area (Source: IMMDoUT 2013)

The data displayed in Figure 66 indicates that most of the buildings in the project area were constructed between 1971 and 1990, as well as between 1991 and 2005. Therefore, it can be assessed that a majority of the structures are situated in high-risk properties in terms of compliance with earthquake legislation. This condition is a precondition for renewal projects, especially for Izmir Metropolitan Municipality.

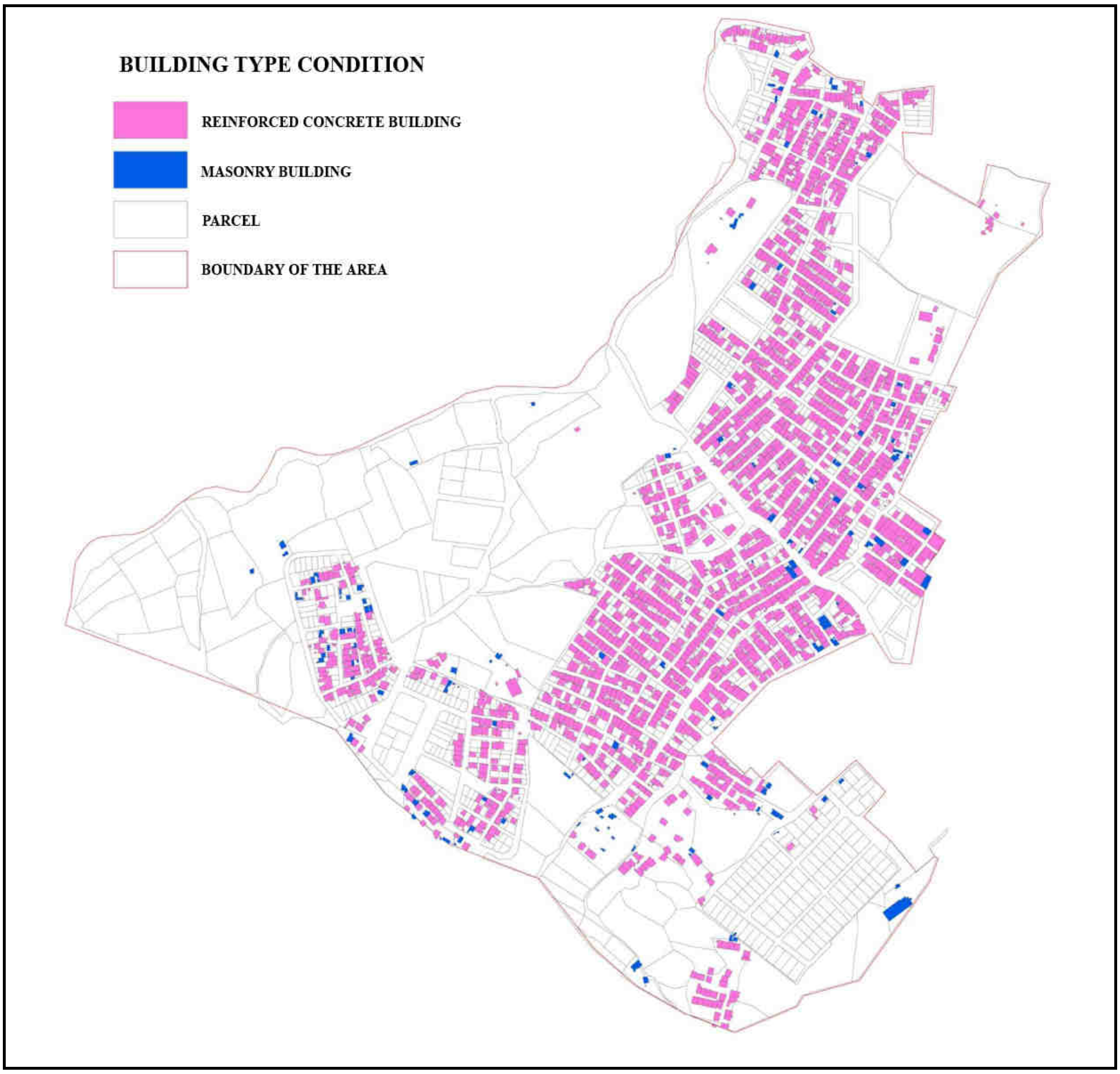


Figure 67: Construction Types of Buildings in The Aktepe-Emrez Transformation Area (Source: IMMDoUT 2013)

Figure 67 displays that the majority of the buildings in the region are reinforced concrete buildings and there are very few masonry buildings in the region.

As can be seen in Figure 68, when the floor areas of the buildings are analyzed, it is understood that 1158 buildings with a rate of 61% have a floor area between 90 m² and 130 m². The number of buildings with a floor area larger than 200 m² is 75 and has a ratio of 4%.

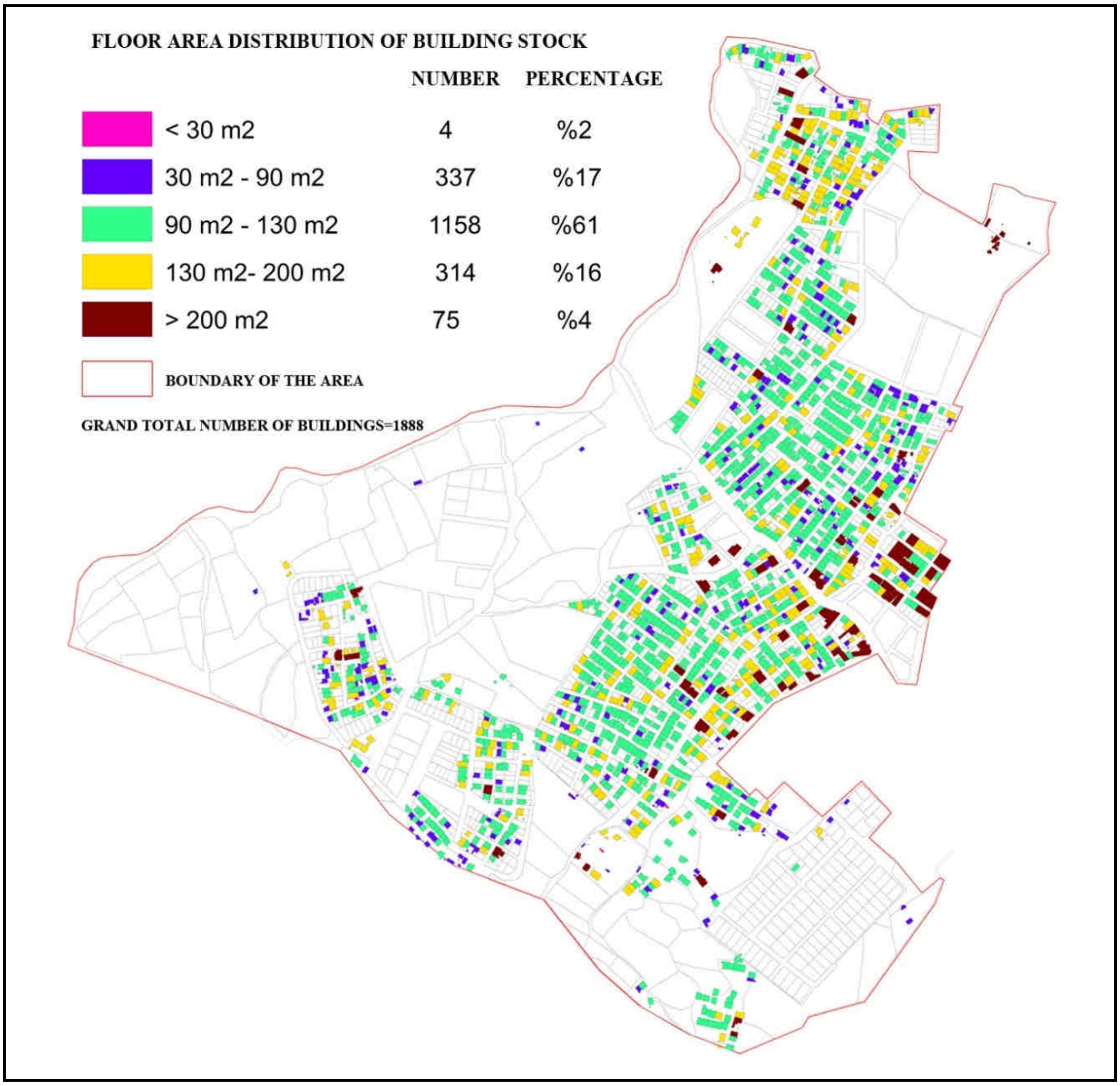


Figure 68: Flor Area Distribution in The Aktepe-Emrez Transformation Area
(Source: IMMDoUT 2013)

The Aktepe-Emrez project area has a total of 2453 parcels (984133.04 m²), of which 2345 are private parcels (805724.72 m²), 53 are public and private parcels (30961.66 m²) and 55 are public parcels (147446.66 m²). Although a considerable section of the area comprises private-owned lands, a substantial proportion of parcels remain under public ownership shown in Figure 69.

Among the public properties, the transfer of 24 parcels (3,481 m²) registered in the name of Gaziemir Metropolitan Municipality was made against a fee. There are 66 parcels registered in the name of the Ministry of Finance, 6 of which cannot be taken over because they are used for education and health. Of the remaining 60 plots, 52 have been transferred for a fee and 8 are still in process (IMMDoUT 2013).

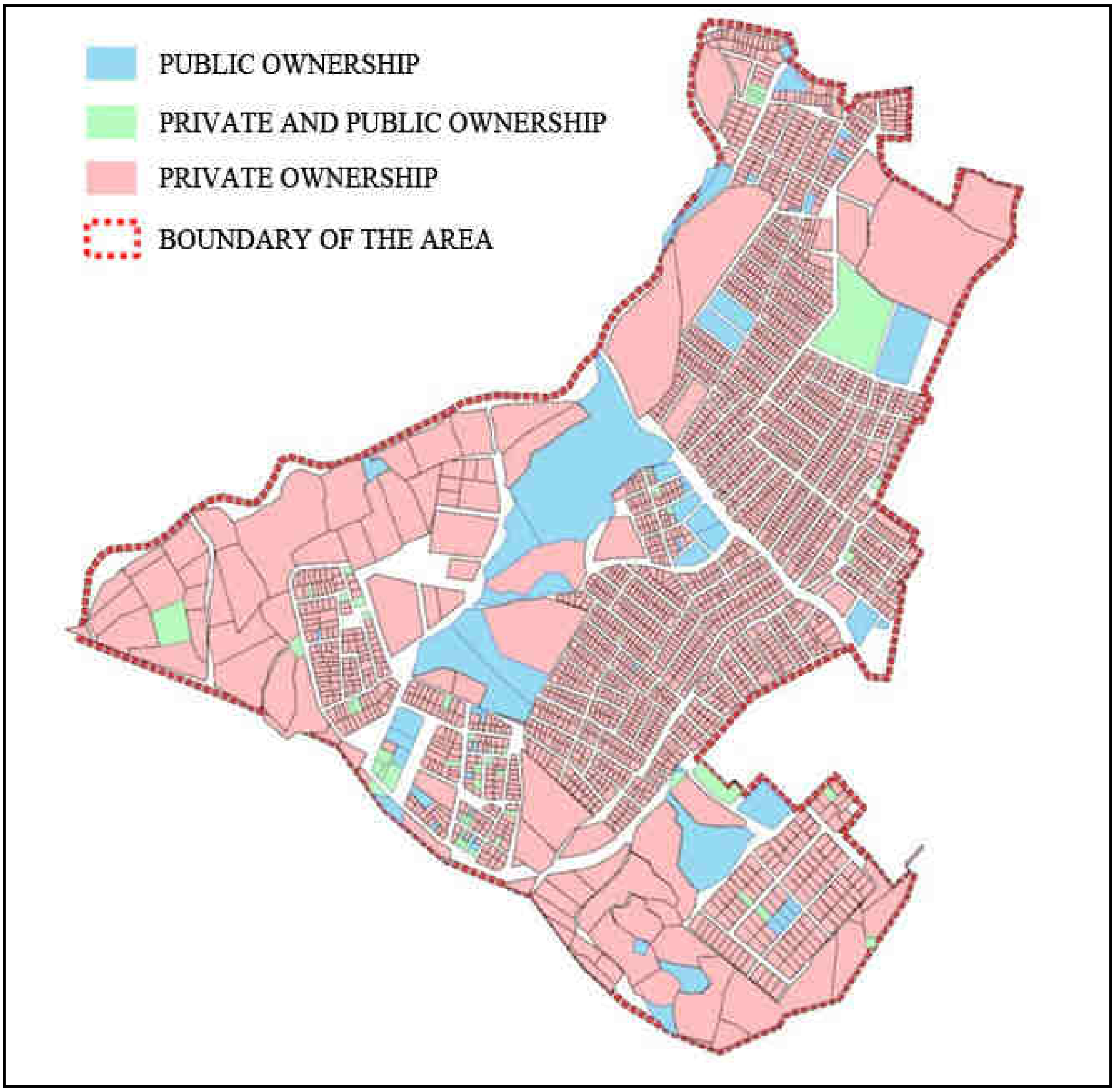


Figure 69: Property Status of The Aktepe-Emrez Transformation Area (Source: IMMDoUT 2013)

Reclamation parcels and cadastral parcels are in the majority throughout the area. As can be seen in the building analysis, the construction is located on reclamation parcels. According to the current zoning plan, it can be seen that there is construction contrary to the plan in the reclamation parcels, which have a zoning right of Hmax: 6.80, and illegal floors are concentrated in this area. Although there is no construction on the cadastral parcels, they are shared parcels with several owners. The zoning parcels formed by Article 18 of Law No. 3194, which have been subjected to development readjustment share (DOP) deduction and zoning application, are in the minority (IMMDoUT 2013).

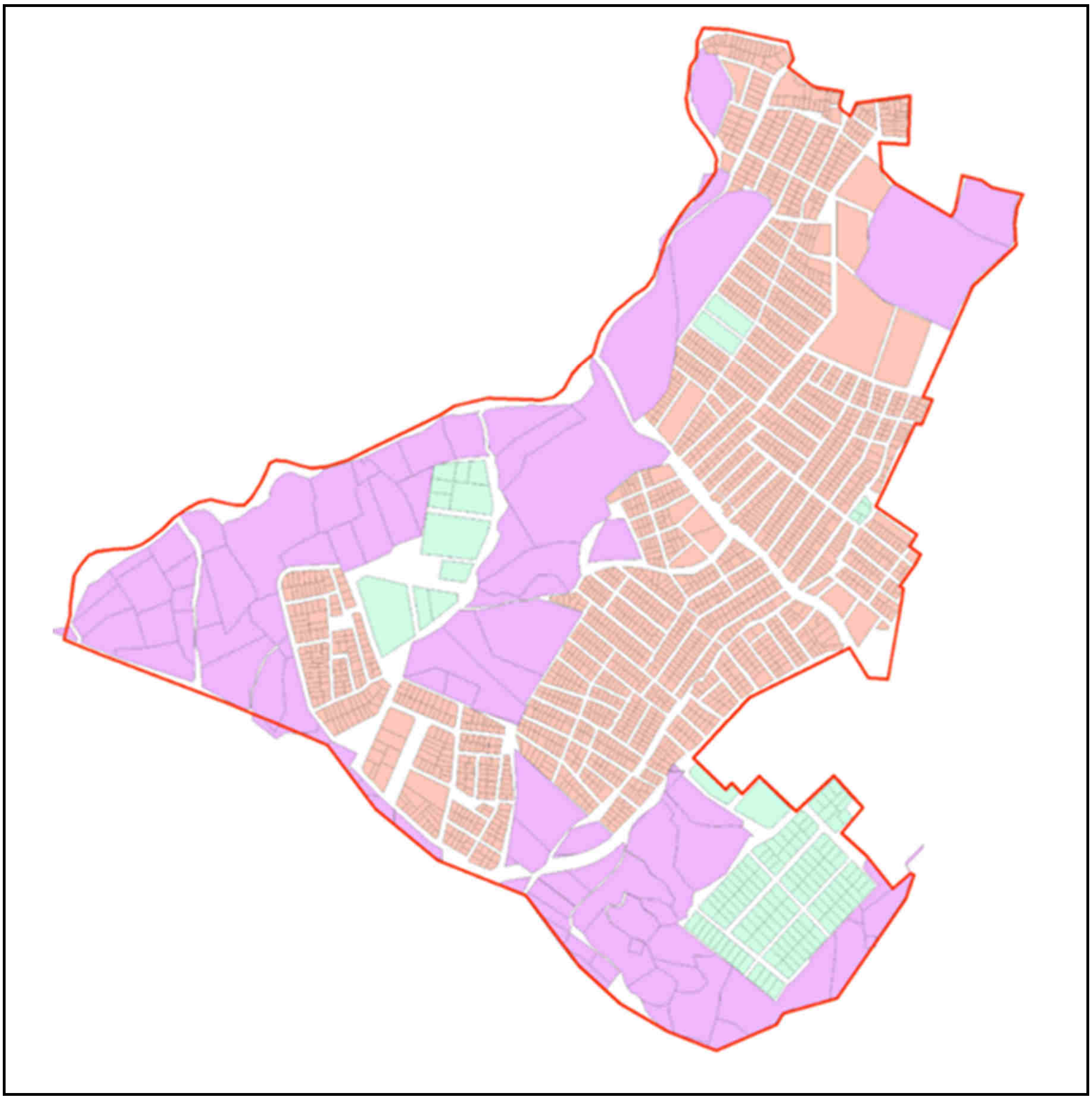


Figure 70: Aktepe-Emrez Urban Transformation Area Types of Parcels
(Source: IMMDoUT 2013)

In individual title deeds, there is an annotation stating that *"...more than...square meters belong to the Treasury"*. These annotations, which do not appear on the title deeds, can be found in the cadastral registers. This is a situation that has arisen as a result of cadastral applications (IMMDoUT 2013).

The surplus annotation of the treasury is mostly located in Aktepe neighborhood. A total of 904 plots has this annotation. Within an area of 122 hectares, an area of 172,113 m² is annotated as treasury surplus. Removal of the annotations is the responsibility of the parcel owners and can be accomplished by making a payment to the Treasury. Treasury surplus, which is one of the biggest problems of the area, makes reconciliation negotiations difficult for citizens in urban transformation works (IMMDoUT 2013).

Table 35: Aktepe-Emrez Urban Transformation Area Distribution of Types of Plots. (Source: IMMDoUT 2013)

Type of Plots	Number of Plot	Number of Plot (%)	Total Plot Area (m²)	Total Plot Area (%)
Plot (İmar Parseli)	135	5.48%	89.1	9.31%
Cadastral Parcel (Kadastral Parsel)	101	4.10%	481.3	50.28%
Improved Parcels (Islah Parseli)	2228	90.42%	386.8	40.41%
TOTAL	**2464**	**100.00%**	**957.148**	**100.00%**

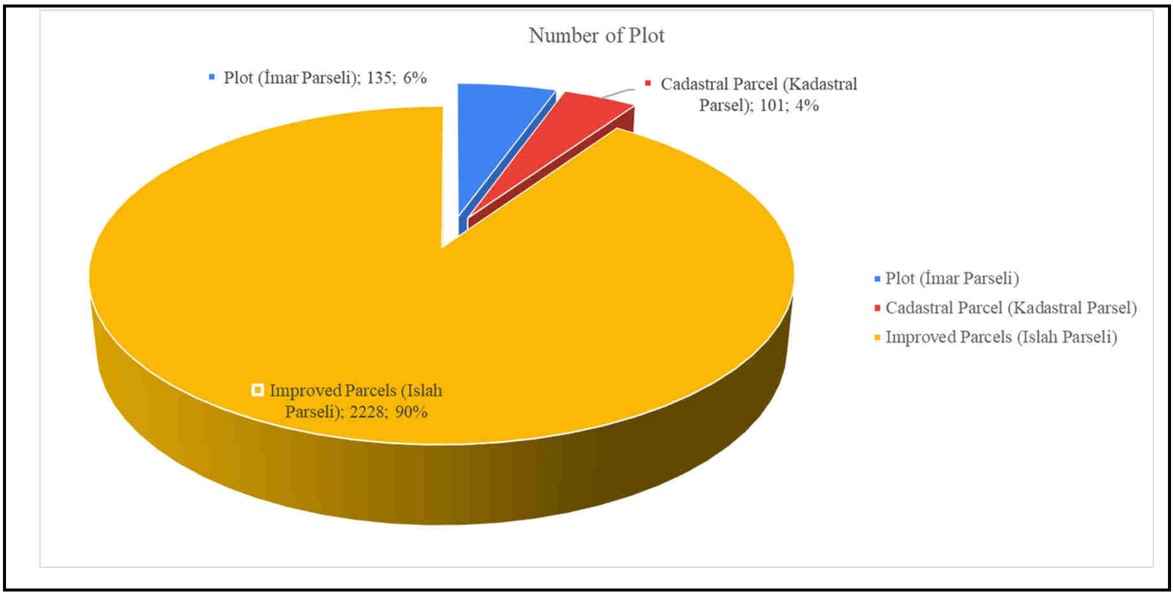


Figure 71: Aktepe-Emrez Urban Transformation Area Types of Plots.

(Source: IMMDoUT 2013)

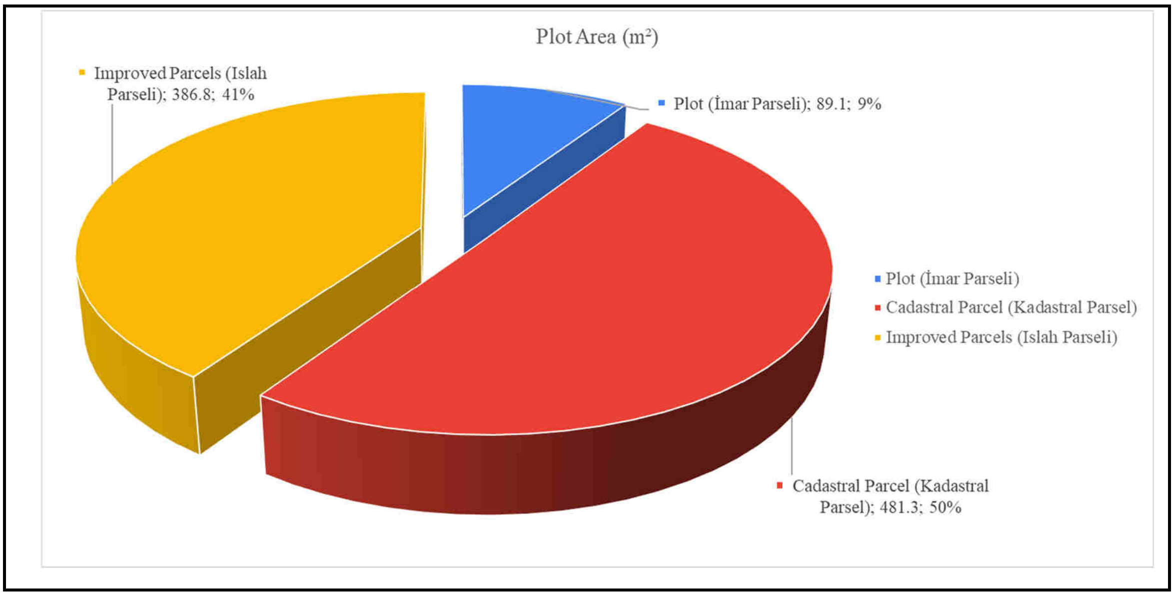


Figure 72: Aktepe-Emrez Urban Transformation Area Types of Plots (m²).

(Source: IMMDoUT 2013)

6.1.2.1.2 Aktepe-Emrez Urban Transformation Project Procedure

There are 4968 independent units in the 122 ha project area located in Aktepe-Emrez neighborhoods of Gaziemir district, Gaziemir district, Izmir province, whose works are being carried out by Izmir Metropolitan Municipality within the scope of Article 73 of Municipality Law No. 5393 (Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

Detailed land surveys of each building were carried out one by one, the data collected were transferred to the database and the right holders were identified. A distribution model was created based on the ground and above-ground inventory owned by the right holders, calculating the new construction areas they will be entitled to from the new residences after the project (Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

In the light of all these data, an Urban Transformation Project Competition was organized to obtain urban design and preliminary architectural projects for the whole area, with the aim of redesigning the existing usage decisions and creating living spaces in urban space standards, and urban design and architectural preliminary projects of the area were prepared(Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

With the project, it is planned to produce mixed-use areas with approximately 10,000 independent units, housing, sub-residential workplaces, and tourism-commercial functions in the area. These residences, ranging from 1+1 to 4+1, are planned to be built at different heights, ranging from 7 to 15 stories, depending on the open spaces, street widths and facades of use (Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

In the urban transformation area, a decision was made by the Assembly to hold a construction tender on a floor-by-floor basis within the framework of Law No. 2886. In Phase I, a protocol was signed with İZBETON A.Ş. with the decision of Izmir Metropolitan Municipality Assembly and the land was delivered. Building permits for 290 independent units have been obtained and work is underway. In Phase II, a construction contract has been signed for approximately 300 independent units on a floor-by-floor basis within the scope of Law No. 2886 and the ground delivery has been made. In both phases, geotechnical surveys, superstructure implementation projects and in-island infrastructure implementation projects have been prepared. Izmir Metropolitan Municipality's staff is responsible for the construction supervision activities within the scope of Article 26 of the Zoning Law(Izmir Metropolitan Municipality Department of Urban Transformation 2023) (accessed date: 02.07.2023).

Figure 73: Aktepe Emrez District in Gaziemir
(Source: IMMDoUT 2013)

Figure 74: Ariel Photo from South Direction
(Source: Öner 2022, 58)

According to Öner (2022), the case area is, geographically, located at an elevation of one hundred meters above sea level. It is situated in a valley-like formation, nestled between two towering mountains that direct the prevailing winds from the sea to penetrate inland. The area itself is extensive, spanning a total of approximately 120 hectares, and it significantly influences the behavior of the wind due to the presence of uninhabited areas behind small residential buildings. There is a limited number of parks and urban open areas nearby. Existing buildings are concentrated near the primary arterial road linking the airport and the city center. The density of buildings in this area is low compared to other regions of the city due to limited public transportation options. The majority of residents are low-income and employed in industrial or service sectors within the city. Additionally, it is important to note that the current building layout deviates from regional plans. Instead, the buildings are arranged along narrow streets, and the local municipality has failed to improve the infrastructure due to future development plans (Öner 2022, 58).

Figure 75: Ariel Photo from East Direction
(Source: Öner 2022, 59)

Öner (2022) observed that the area is clustered and has only grown organically to solve local problems such as distance to basic services and public transportation. Unfortunately, new regulations for efficient infrastructure distribution were not put in place, and residents were not penalized for illegal construction. In fact, zoning amnesties granted residents permission to continue with such construction. From the 1970s to the 1990s, the number of squatter areas increased rapidly, and most of these squatter areas were quickly legalized by changing political views for the sake of votes. Municipalities were forced to accept existing settlements without making any progress in planning until the reorganization of the areas as ‘Urban Transformation Areas’ to low-density areas.

Figure 76: Ariel Photo from Southwest Direction
(Source: Öner 2022, 59)

Figure 77: Photograph of Sample of Tight-Clustered Neighborhood
(Source: Öner 2022, 60)

According to Izmir Metropolitan Municipality Department of Urban Transformation (IMMDoUT 2013), the project area is defined by two northeast-southwest oriented stream beds and valley formation. These creeks and their surroundings have been planned as open green areas, and with the rehabilitation of the creek beds and the arrangement of the valley landscape, recreational activities such as promenades, bicycle trails, outdoor sports areas, etc. will be organized in accordance with the recreational activities. Areas of public use have been planned to connect these two green areas, thus increasing the use of cultural facilities, health facilities, municipal services, etc., which are lacking in the neighborhoods, and at the same time making them accessible. In the middle of these areas, at the highest level, an artery has been identified where pedestrian use and commercial activities will be intense, and this pedestrian axis, which provides connections to squares, parks and reinforcing areas, terminates with the area where the existing tree clusters in Aktepe Neighborhood are located. At the same time, Altan Aydın Street, where commercial activities are currently taking place, has been planned as the main commercial axis where the same suburban commercial units will take place. In between these areas, residential areas will be designed with improved access to infrastructure and transportation. These residential units, ranging from 1+1 to 3+1, will be built at different heights, from 6 to 16 stories, depending on the open spaces, street widths and facades of use. In addition to the residential areas, mixed-use areas have been created on the facade of the fairgrounds, and tourism, commercial, office and accommodation functions are planned.

The winning masterplan office of the competition, organized by Izmir Metropolitan Municipality Department of Urban Transformation, proposed the new conceptual project. The project comprises over 2,500,000 square meters of residential and commercial building space, new recreational areas and parks, and fully redesigned transportation infrastructure. The project proposal for the urban design concept satisfyingly meets the municipal guidelines for residential unit requirements. Apartment blocks vary from six to fifteen stores high. To accommodate heavier traffic loads, the streets are wider. The taller buildings are aligned parallel to one another and concentrated on the central axis of the project. This axis is projected to transform into a commercial district, with storefronts occupying the first floors of the buildings (Öner 2022).

Figure 78: Urban Design and Architectural Project Competition - Equivalent Prize (Source: 1/X Tasarım 2018f) (accessed date: 10.07.2023)

The conceptual design approach for the site was to create courtyards with four to six building blocks around them, connected by intersecting streets; these public spaces would serve as recreational green spaces and enhance the overall value of the neighborhood. The conceptual approach is deemed suitable to meet the future population's requirements. (Öner 2022).

In this regard, it is stated that the master plan for the 120-hectare urban transformation area and the first stage architectural preliminary project for the 10-hectare project area, which were updated by the contractor company and Izmir Metropolitan Municipality staff, were completed in 2018 (IMMDoUT 2013).

Figure 79: Revised Urban Design Project of The Urban Transformation Area
(Source: 1/X Tasarım 2018e) (accessed date: 10.07.2023)

The area designated as the 1st Stage Implementation Area includes the land south of the intersection of Altan Aydın Street and Uzundere and in the immediate vicinity of the existing market area. The fact that the majority of the land is owned by the Municipality, that there are no buildings to be converted and the advantages of the location were decisive for the selection of the site. The building stock within the project defines modular contents that can be produced economically and quickly. Variable block types, which can be derived from each other with modern and contemporary styles, are proposed for the building stock to be produced. The project mainly adopts a linear block typology with balconies and double orientation (courtyard-street) in accordance with the sloping structure of the land, living culture and climatic characteristics. The core solution in these blocks allows two-way access from the courtyard or street at different levels (1/X Tasarım 2018c) (accessed date: 10.07.2023).

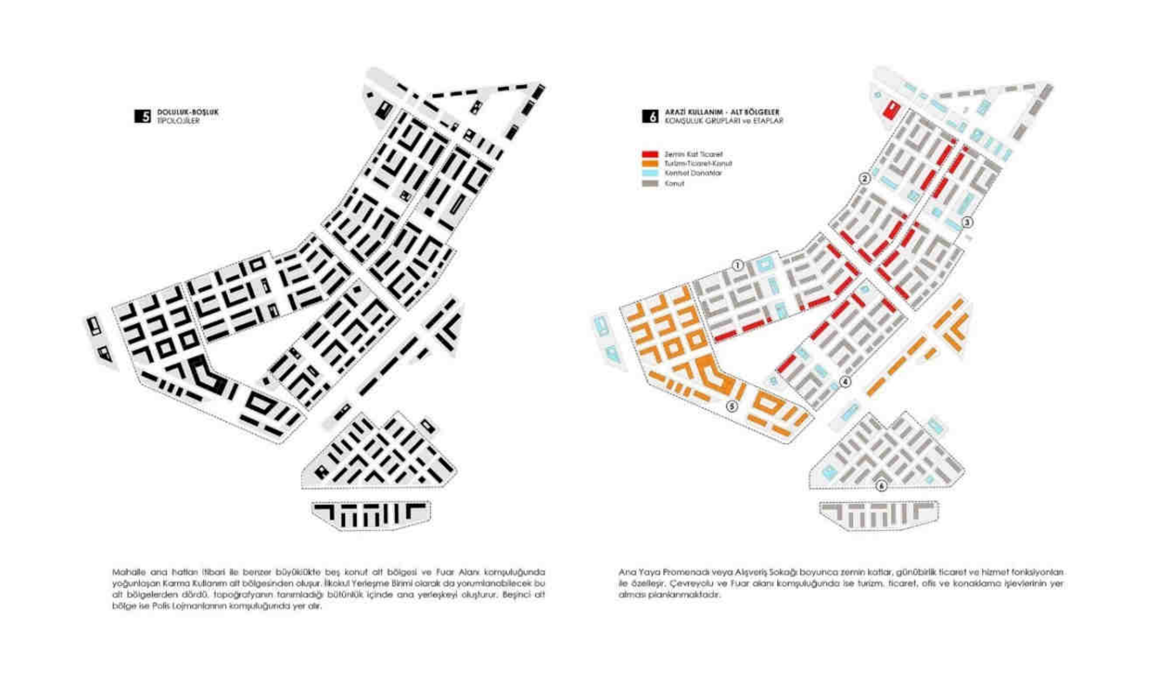


Figure 80: Figure-Ground Diagram and Land Use Distribution of the Project (Source: 1/X Tasarım 2018a) (accessed date: 10.07.2023)

1/X Tasarım (2018c) (accessed date: 10.07.2023) states that the project concept includes courtyard or street-oriented blocks with deep viewpoints at the corner locations of the zoning island and two high blocks with podium at the periphery of the shopping street. These blocks are treated as a corridor system (courtyard or street oriented) due to the comfortable relationship they establish with the land and other zoning islands. The low-rise block types, which can establish a direct relationship with the courtyards, include diversifiable apartment types located on both sides of the fixed core module. Blocks A, B and C are standardized with 1.5 and 2 floors of the core axis module, allowing a certain level of variation in the total arithmetic of independent units. A hierarchy of public, semi-public, and private spaces is considered throughout the project. The relationships between urban open and green spaces, pedestrian passages, courtyards, ground floor garden uses are handled within this hierarchy. The single fronted spaces under the embankments, exposed in the courtyards due to the slope, are reserved for social functions. The number of indoor and outdoor parking spaces is based on current regulations. The entrances and exits of the parking garages, which operate on an island basis, are located at the level of the underground road. The garages, which can be accessed from the vertical circulation elements of the blocks or from the courtyards, establish a relationship with the basements of the blocks, while gradually ‘sitting’ on the land.

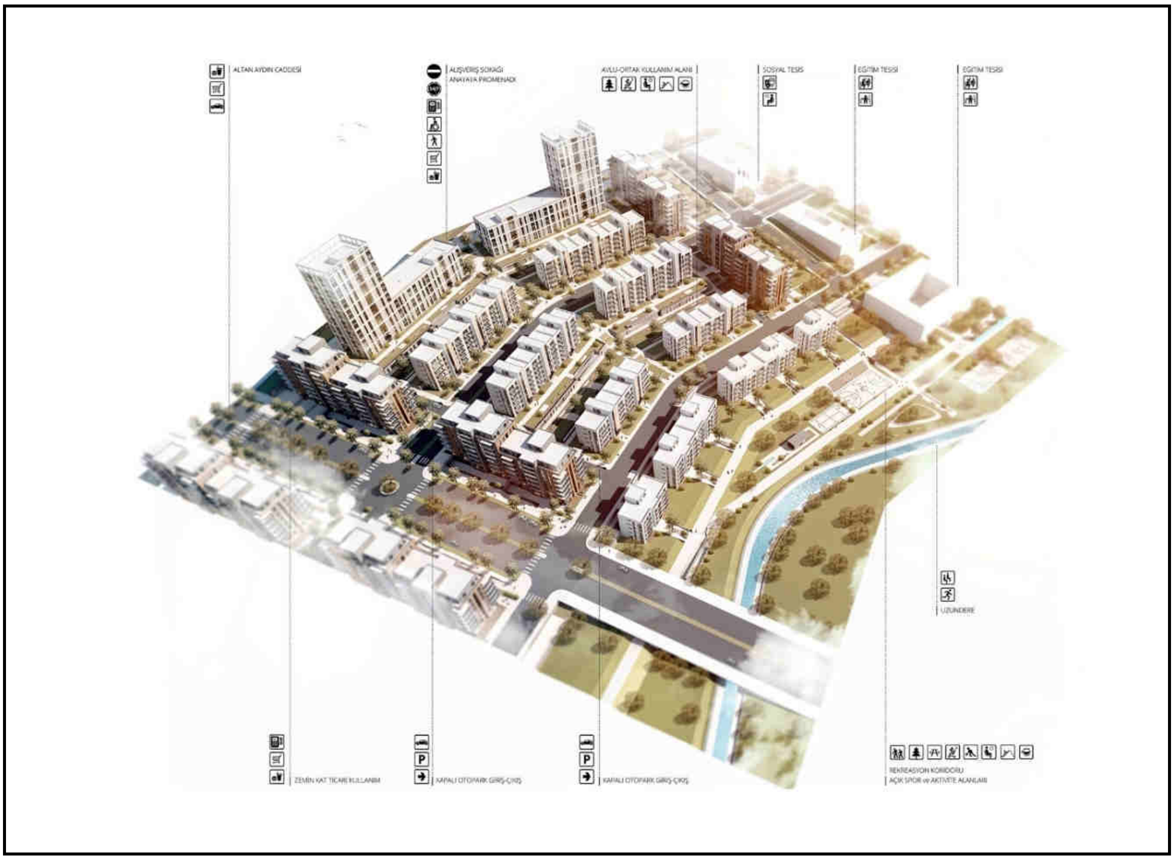


Figure 81: Phase 1 Project Area in Urban Transformation Area
(Source: 1/X Tasarım 2018d) (accessed date: 10.07.2023)

Since February 2019, the promotional activities for the project have been completed and the negotiations with the rights holders have begun in stages. The sharing model has been determined in a way that does not increase the precedent in the entire area, and coefficients have been created based on the building area that can be produced, the floor supply rates in the current market, and the legal obligations established in Article 73. The rights from the existing plan have been preserved in the area and a separate coefficient has been determined for each parcel, considering the plan rights of the right holders and the types of parcels. Negotiations are being conducted considering the structures and facilities on the plots. Currently, in Gaziemir Communication Office, Izmir Metropolitan Municipality Department of Urban Transformation continue to negotiate step by step the new construction area and units they deserve in the project produced by our municipality in return for all the existing rights of the right holders and to sign reconciliation agreements with the right holders who want (IMMDoUT 2013).

Figure 82: Image from the Project Area
(Source: 1/X Tasarım 2018b) (accessed date: 10.07.2023)

The construction in the area will also be done in stages. The area registered in the name of Izmir Metropolitan Municipality has been identified as the first phase of construction, and the work of plan revision and zoning application for the area has been completed. With the plan revision accepted by the Municipal Assembly and suspended between 21.12.2018 and 21.01.2019, a total of 44,000 m² of imputed building area and approximately 600 houses can be built on two zoning islands. An environmental impact analysis is not required for the area where the plan revision was made. This area will be considered as a reserve area offered to the project beneficiaries. The construction activities in this area are planned in two phases (IMMDoUT 2013).

A protocol has been signed with İZBETON A.Ş. for 300 independent units in Phase I and the land has been delivered. In Phase II, the tender process for 300 independent units in exchange for flats has been completed, the contract has been signed with the contractor and the ground delivery has been made. Izmir Metropolitan Municipality Department of Urban Transformation is supervising the construction of all the buildings within the framework of Article 26 of the Zoning Law (IMMDoUT 2013).

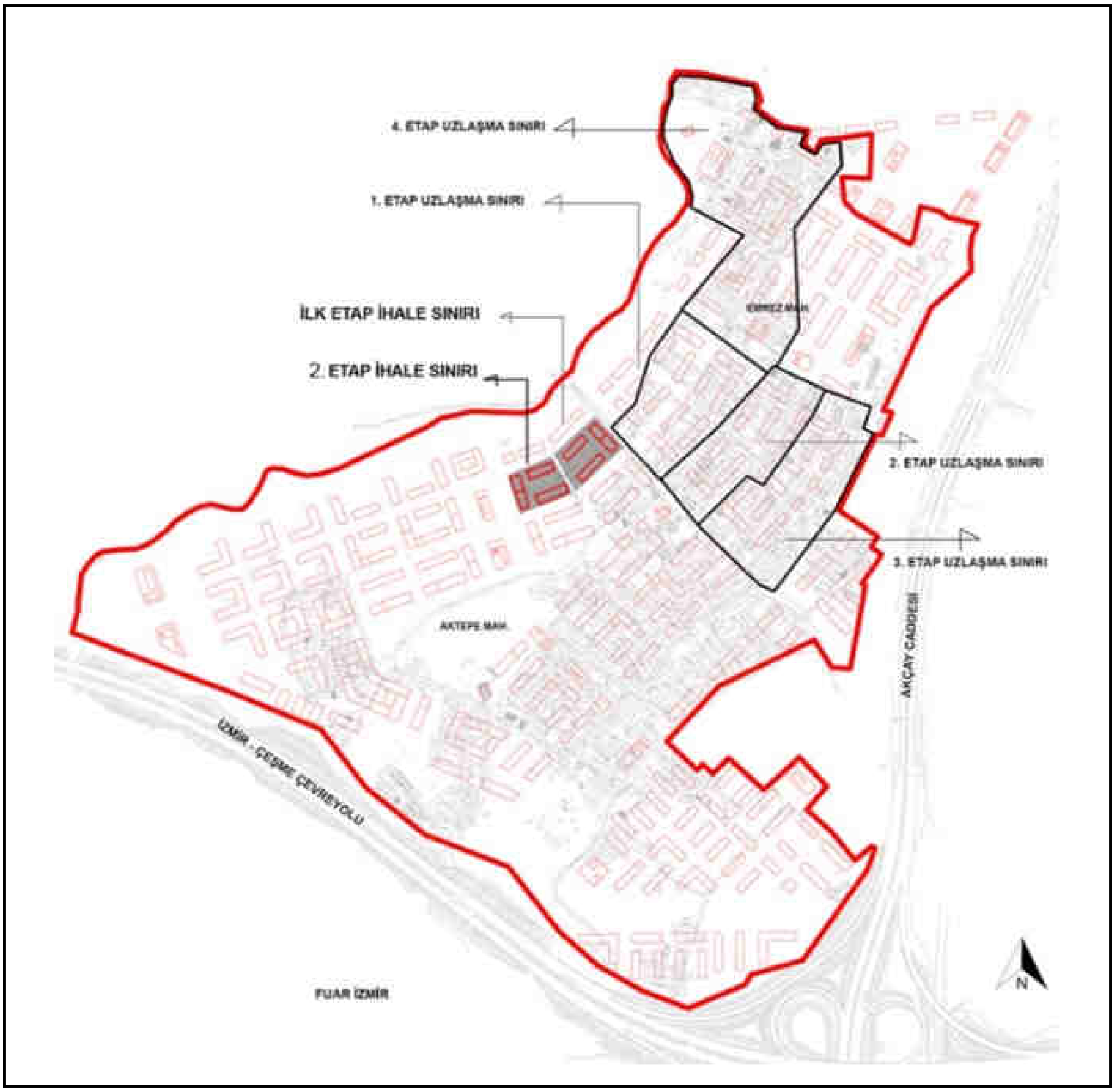


Figure 83: Stages of Urban Transformation Project
(Source: IMMDoUT 2013)

6.2 Integration of MCDM Method in Case Study Area

The competition area for urban transformation organized by Izmir Metropolitan Municipality Urban Transformation Department is evaluated within the framework of the Multi-Criteria Decision-Making (MCDM), which is prepared within the scope of the thesis and evaluated specifically for this case area.

In this context, the methodological approach presented in Chapter 5 is examined for its implementation. The process initially applied two selected criteria weighting programs, DEMATEL and the Entropy method. Afterwards, five different urban transformation strategies identified in the thesis were ranked as decision alternatives using the COPRAS and PROMETHEE methods.

For this purpose, the decision-making process was evaluated using the integrated and comprehensive model prepared within the scope of the thesis and named as INTEgrated Model of Urban transformation Strategy (INTEMUS).

INTEMUS was developed as a comprehensive MCDM methodology. The program is based on the Microsoft Excel software, where it is possible to work on different screens. Model screens are illustrated in Figure 84, Figure 85, and Figure 86 which can be selected when the indicators and their weights are to be determined through a survey method or similar group study of indicator weights and decision alternatives.

If users are planning to make a decision on their own, they can complete the entire process on the main model screen shown in Figure 87. Here, it is sufficient to compare the indicators and decision alternatives after selecting the indicator weights and other parameters that are entered or expected to be calculated when selecting the method for determining the criteria weights and the method for ranking the decision alternatives. If the DEMATEL method is to be used, the indicators should be compared by assigning a score from 0 to 4 on a Likert scale in the Indicator Comparison screen in Figure 85. If indicator weights are to be calculated using the ENTROPI Method, it is sufficient to compare the indicators with the decision alternatives on the screen shown in Figure 87.

If the COPRAS method is selected after the indicator weights have been calculated using one of the two methods, the calculation of the indicators and alternatives is performed automatically, as shown in Figure 87.

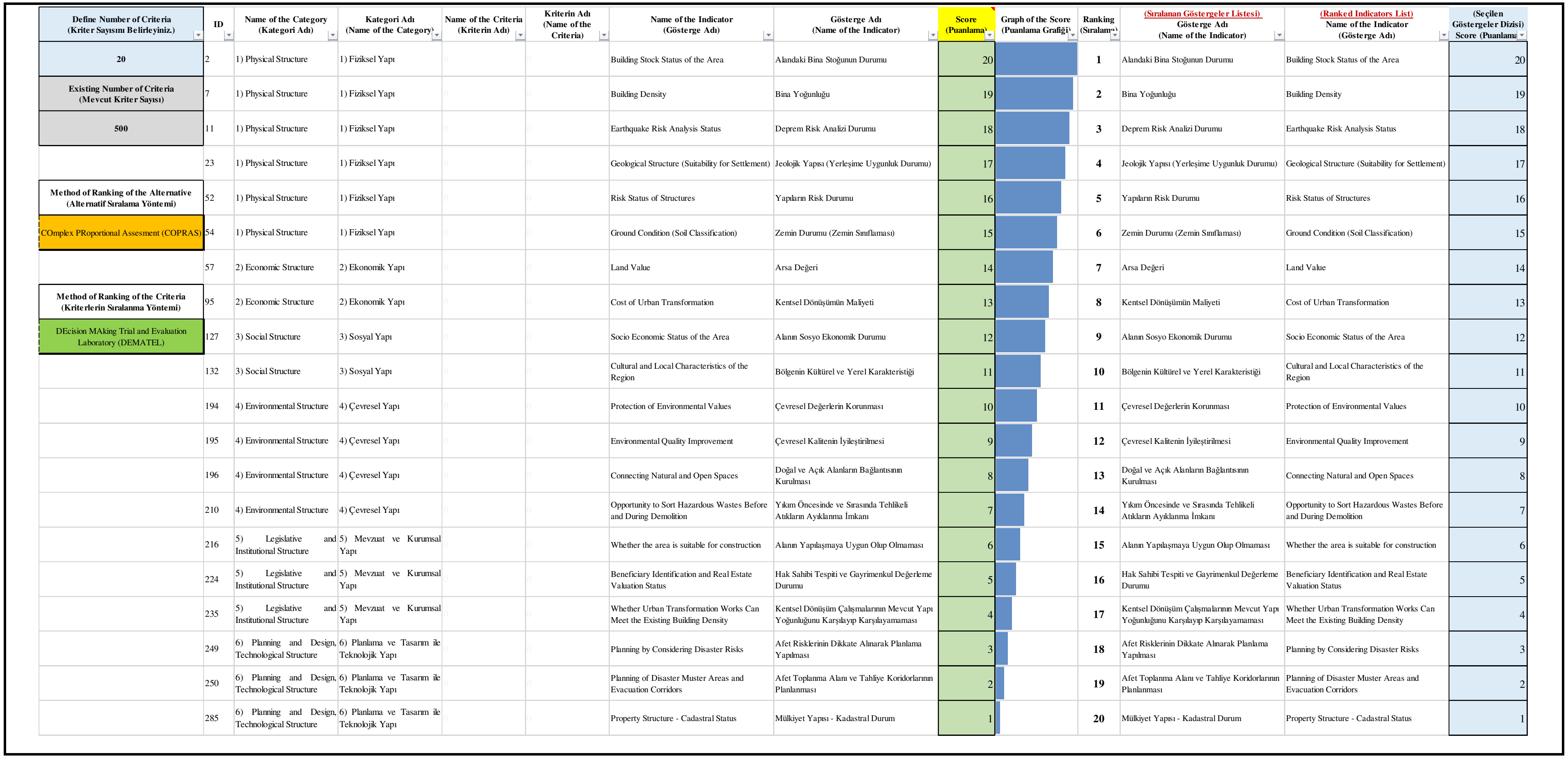
If it is preferred to use the PROMETHEE method for decision alternatives, the results of the multicriteria decision method can be analyzed by saving the screen in Figure

88 in .csv format and transferring the data to the PROMETHEE program by rotating (.) with (,) in .csv format.

Table 36: Selected Critical Indicators from Survey Analysis
(Prepared by Author)

No of Indicator	Name of the Critical Indicator
C1	Building Stock Status of the Area
C2	Building Density
C3	Earthquake Risk Analysis Status
C4	Geological Structure (Suitability for Settlement)
C5	Risk Status of Structures
C6	Ground Condition (Soil Classification)
C7	Land Value
C8	Cost of Urban Transformation
C9	Socio Economic Status of the Area
C10	Cultural and Local Characteristics of the Region
C11	Protection of Environmental Values
C12	Environmental Quality Improvement
C13	Connecting Natural and Open Spaces
C14	Opportunity to Sort Hazardous Wastes Before and During Demolition
C15	Whether the area is suitable for construction
C16	Beneficiary Identification and Real Estate Valuation Status
C17	Whether Urban Transformation Works Can Meet the Existing Building Density
C18	Planning by Considering Disaster Risks
C19	Planning of Disaster Muster Areas and Evacuation Corridors
C20	Property Structure - Cadastral Status

The case study prepared within the scope of the thesis, in the expert study conducted with the officials of the Urban Transformation Department of Izmir Metropolitan Municipality, the expert group was asked to evaluate the twenty critical indicators determined by the previous survey results and listed in Table 36, in order to compare them with the five urban transformation strategies determined within the scope of the thesis, and to analyze them in the INTEMUS program.



Define Number of Criteria (Kriter Sayısını Belirleyiniz.)	ID	Name of the Category (Kategori Adı)	Kategori Adı (Name of the Category)	Name of the Criteria (Kriterin Adı)	Kriterin Adı (Name of the Criteria)	Name of the Indicator (Gösterge Adı)	Gösterge Adı (Name of the Indicator)	Score (Puanlama)	Graph of the Score (Puanlama Grafiği)	Ranking (Sıralama)	(Sıralanan Göstergeler Listesi) Gösterge Adı (Name of the Indicator)	(Ranked Indicators List) Name of the Indicator (Gösterge Adı)	(Seçilen Göstergeler Dizisi) Score (Puanlama)
20	2	1) Physical Structure	1) Fiziksel Yapı	0	0	Building Stock Status of the Area	Alandaki Bina Stoğunun Durumu	20		1	Alandaki Bina Stoğunun Durumu	Building Stock Status of the Area	20
Existing Number of Criteria (Mevcut Kriter Sayısı)	7	1) Physical Structure	1) Fiziksel Yapı	0	0	Building Density	Bina Yoğunluğu	19		2	Bina Yoğunluğu	Building Density	19
500	11	1) Physical Structure	1) Fiziksel Yapı	0	0	Earthquake Risk Analysis Status	Deprem Risk Analizi Durumu	18		3	Deprem Risk Analizi Durumu	Earthquake Risk Analysis Status	18
	23	1) Physical Structure	1) Fiziksel Yapı	0	0	Geological Structure (Suitability for Settlement)	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	17		4	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	Geological Structure (Suitability for Settlement)	17
Method of Ranking of the Alternative (Alternatif Sıralama Yöntemi)	52	1) Physical Structure	1) Fiziksel Yapı	0	0	Risk Status of Structures	Yapıların Risk Durumu	16		5	Yapıların Risk Durumu	Risk Status of Structures	16
COmplex PRoportional Assesment (COPRAS)	54	1) Physical Structure	1) Fiziksel Yapı	0	0	Ground Condition (Soil Classification)	Zemin Durumu (Zemin Sınıflaması)	15		6	Zemin Durumu (Zemin Sınıflaması)	Ground Condition (Soil Classification)	15
	57	2) Economic Structure	2) Ekonomik Yapı	0	0	Land Value	Arsa Değeri	14		7	Arsa Değeri	Land Value	14
Method of Ranking of the Criteria (Kriterlerin Sıralanma Yöntemi)	95	2) Economic Structure	2) Ekonomik Yapı	0	0	Cost of Urban Transformation	Kentsel Dönüşümün Maliyeti	13		8	Kentsel Dönüşümün Maliyeti	Cost of Urban Transformation	13
DEcision MAking Trial and Evaluation Laboratory (DEMATEL)	127	3) Social Structure	3) Sosyal Yapı	0	0	Socio Economic Status of the Area	Alanın Sosyo Ekonomik Durumu	12		9	Alanın Sosyo Ekonomik Durumu	Socio Economic Status of the Area	12
	132	3) Social Structure	3) Sosyal Yapı	0	0	Cultural and Local Characteristics of the Region	Bölgenin Kültürel ve Yerel Karakteristiği	11		10	Bölgenin Kültürel ve Yerel Karakteristiği	Cultural and Local Characteristics of the Region	11
	194	4) Environmental Structure	4) Çevresel Yapı	0	0	Protection of Environmental Values	Çevresel Değerlerin Korunması	10		11	Çevresel Değerlerin Korunması	Protection of Environmental Values	10
	195	4) Environmental Structure	4) Çevresel Yapı	0	0	Environmental Quality Improvement	Çevresel Kalitenin İyileştirilmesi	9		12	Çevresel Kalitenin İyileştirilmesi	Environmental Quality Improvement	9
	196	4) Environmental Structure	4) Çevresel Yapı	0	0	Connecting Natural and Open Spaces	Doğal ve Açık Alanların Bağlantısının Kurulması	8		13	Doğal ve Açık Alanların Bağlantısının Kurulması	Connecting Natural and Open Spaces	8
	210	4) Environmental Structure	4) Çevresel Yapı	0	0	Opportunity to Sort Hazardous Wastes Before and During Demolition	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	7		14	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	Opportunity to Sort Hazardous Wastes Before and During Demolition	7
	216	5) Legislative and Institutional Structure	5) Mevzuat ve Kurumsal Yapı	0	0	Whether the area is suitable for construction	Alanın Yapılaşmaya Uygun Olup Olmaması	6		15	Alanın Yapılaşmaya Uygun Olup Olmaması	Whether the area is suitable for construction	6
	224	5) Legislative and Institutional Structure	5) Mevzuat ve Kurumsal Yapı	0	0	Beneficiary Identification and Real Estate Valuation Status	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	5		16	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	Beneficiary Identification and Real Estate Valuation Status	5
	235	5) Legislative and Institutional Structure	5) Mevzuat ve Kurumsal Yapı	0	0	Whether Urban Transformation Works Can Meet the Existing Building Density	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	4		17	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	Whether Urban Transformation Works Can Meet the Existing Building Density	4
	249	6) Planning and Design, Technological Structure	6) Planlama ve Tasarım ile Teknolojik Yapı	0	0	Planning by Considering Disaster Risks	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	3		18	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	Planning by Considering Disaster Risks	3
	250	6) Planning and Design, Technological Structure	6) Planlama ve Tasarım ile Teknolojik Yapı	0	0	Planning of Disaster Muster Areas and Evacuation Corridors	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	2		19	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	Planning of Disaster Muster Areas and Evacuation Corridors	2
	285	6) Planning and Design, Technological Structure	6) Planlama ve Tasarım ile Teknolojik Yapı	0	0	Property Structure - Cadastral Status	Mülkiyet Yapısı - Kadastral Durum	1		20	Mülkiyet Yapısı - Kadastral Durum	Property Structure - Cadastral Status	1

Figure 84: INTEMUS Indicator Scoring Screen

(Prepared by Author)

		Name of Criteria	Building Stock Status of the Area	Building Density	Earthquake Risk Analysis Status	Geological Structure (Suitability for Settlement)	Risk Status of Structures	Ground Condition (Soil Classification)	Land Value	Cost of Urban Transformation	Socio Economic Status of the Area	Cultural and Local Characteristics of the Region	Protection of Environmental Values	Environmental Quality Improvement	Connecting Natural and Open Spaces	Opportunity to Sort Hazardous Wastes Before and During Demolition	Whether the area is suitable for construction	Beneficiary Identification and Real Estate Valuation Status	Whether Urban Transformation Works Can Meet the Existing Building Density	Planning by Considering Disaster Risks	Planning of Disaster Muster Areas and Evacuation Corridors	Property Structure - Cadastral Status
formula (formül)	formula (formül)	Kriter Adı	Alandaki Bina Stoğunun Durumu	Bina Yoğunluğu	Deprem Risk Analizi Durumu	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	Yapıların Risk Durumu	Zemin Durumu (Zemin Sınıflaması)	Arsa Değeri	Kentsel Dönüşümün Maliyeti	Alanın Sosyo Ekonomik Durumu	Bölgenin Kültürel ve Yerel Karakteristiği	Çevresel Değerlerin Korunması	Çevresel Kalitenin İyileştirilmesi	Doğal ve Açık Alanların Bağlantısının Kurulması	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	Alanın Yapılaşmaya Uygun Olup Olmaması	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	Mülkiyet Yapısı - Kadastral Durum
Name of the Criteria (Kriterin Adı)	Kriterin Adı (Name of the Criteria)	Number of Criteria (Kriter Numarası)	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
Building Stock Status of the Area	Alandaki Bina Stoğunun Durumu	C1	0.00	0.00	3.67	0.00	4.00	0.00	0.00	0.00	2.33	1.33	0.00	0.00	0.33	3.33	0.00	3.67	0.00	0.00	0.00	0.00
Building Density	Bina Yoğunluğu	C2	0.00	0.00	0.33	0.33	0.00	0.00	0.00	3.33	0.00	0.00	0.00	2.67	3.00	4.00	0.00	0.00	4.00	0.00	2.00	2.00
Earthquake Risk Analysis Status	Deprem Risk Analizi Durumu	C3	3.00	2.00	0.00	4.00	4.00	4.00	2.67	3.33	0.67	0.00	0.00	0.00	0.33	0.33	3.67	2.00	3.33	4.00	4.00	0.00
Geological Structure (Suitability for Settlement)	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	C4	4.00	2.50	4.00	0.00	4.00	3.67	4.00	4.00	1.00	0.00	2.00	2.00	3.00	0.33	4.00	3.67	3.67	4.00	3.00	0.33
Risk Status of Structures	Yapıların Risk Durumu	C5	3.50	1.00	4.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00	2.00	0.00	0.33	0.00	2.00	0.00	4.00	0.00	0.00
Ground Condition (Soil Classification)	Zemin Durumu (Zemin Sınıflaması)	C6	0.00	2.00	4.00	4.00	3.33	0.00	4.00	4.00	1.00	0.00	0.00	0.00	0.00	0.00	4.00	3.67	3.67	4.00	3.00	0.00
Land Value	Arsa Değeri	C7	1.00	2.00	0.00	0.00	0.00	0.00	0.00	4.00	3.00	1.00	0.00	0.00	2.00	0.00	0.00	4.00	3.00	0.00	2.00	2.00
Cost of Urban Transformation	Kentsel Dönüşümün Maliyeti	C8	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	4.00	2.00	2.00	3.00	0.00	3.00	0.00	4.00	4.00	0.00	0.00	0.00
Socio Economic Status of the Area	Alanın Sosyo Ekonomik Durumu	C9	3.00	0.00	0.00	0.00	3.00	0.00	3.00	2.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	2.00	2.00	0.00	0.00	0.00
Cultural and Local Characteristics of the Region	Bölgenin Kültürel ve Yerel Karakteristiği	C10	3.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	3.00
Protection of Environmental Values	Çevresel Değerlerin Korunması	C11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	4.00	0.00	4.00	0.00	3.00	0.00	0.00	0.00	0.00	2.00	0.00
Environmental Quality Improvement	Çevresel Kalitenin İyileştirilmesi	C12	1.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	4.00	0.00	0.00	3.00	1.00	0.00	4.00	0.00
Connecting Natural and Open Spaces	Doğal ve Açık Alanların Bağlantısının Kurulması	C13	0.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	2.00
Opportunity to Sort Hazardous Wastes Before and During Demolition	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	C14	0.00	4.00	0.00	0.00	0.00	0.00	3.00	4.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
Whether the area is suitable for construction	Alanın Yapılaşmaya Uygun Olup Olmaması	C15	1.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	4.00	4.00	4.00	4.00	2.00
Beneficiary Identification and Real Estate Valuation Status	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	C16	0.00	0.00	0.00	0.00	0.00	0.00	4.00	3.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00
Whether Urban Transformation Works Can Meet the Existing Building Density	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	C17	0.00	4.00	2.00	3.00	2.00	0.00	2.00	3.00	0.00	0.00	2.00	3.00	2.00	1.00	0.00	3.00	0.00	2.00	2.00	0.00
Planning by Considering Disaster Risks	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	C18	0.00	3.00	4.00	0.00	4.00	0.00	4.00	3.00	1.00	0.00	3.00	3.00	1.00	1.00	0.00	4.00	4.00	0.00	4.00	0.00
Planning of Disaster Muster Areas and Evacuation Corridors	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	C19	0.00	3.00	3.00	0.00	3.00	0.00	3.00	4.00	2.00	1.00	1.00	2.00	2.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00
Property Structure - Cadastral Status	Mülkiyet Yapısı - Kadastral Durum	C20	2.00	3.00	2.00	0.00	2.00	0.00	3.00	3.00	2.00	0.00	2.00	4.00	3.00	0.00	0.00	4.00	4.00	3.00	3.00	0.00

Figure 85: INTEMUS DEMATEL Comparison Criteria Screen

(Prepared by Author)

formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula (formül)	formula / fill handle	Name of Alternatives -->		Bütüncül Kentsel Dönüşüm ve Uygulama Modeli	Bütüncül Kentsel Dönüşüm ve Parçalar Halinde Uygulama Modeli	Parçacıl Kentsel Dönüşüm ve Uygulama Modeli	Önemli Yatırımların Mevcut Yapıya Eklenmesi Modeli	Parsel Bazlı Kentsel Dönüşüm Modeli
Name of the Criteria (Kriterin Adı)	Kriterin Adı (Name of the Criteria)	Number of Criteria (Kriter Numarası)	Unit (Birim)	min/max	Weight of Criteria (Kriterin Ağırlığı)	code_preference function (Tercih Fonksiyonu)	thresholds (Eşikler)	q (min value)	p (max value)	s (standard deviation)	Name_Constant_Values	Constant_Values	A1	A2	A3	A4	A5
Building Stock Status of the Area	Alandaki Bina Stoğunun Durumu	C1	LikertScale	max	0.03196889	1: Usual	abs	0.0	0.0	0.8	Number of Decision Alternatives	5	4.333	4.333	4.000	5.000	6.000
Building Density	Bina Yoğunluğu	C2	KAKS	min	0.05046265	1: Usual	abs	0.0	0.0	1.2	Constant k (k=1/ln(m))	0.6213	6.667	6.000	5.667	4.333	3.667
Earthquake Risk Analysis Status	Deprem Risk Analizi Durumu	C3	LikertScale	min	0.06625400	1: Usual	abs	0.0	0.0	0.3	Number of Decision Criteria	20	6.667	6.667	6.000	6.000	6.333
Geological Structure (Suitability for Settlement)	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	C4	LikertScale	max	0.06896037	1: Usual	abs	0.0	0.0	0.0			6.333	6.333	6.333	6.333	6.333
Risk Status of Structures	Yapıların Risk Durumu	C5	LikertScale	min	0.04459849	1: Usual	abs	0.0	0.0	0.6			5.000	5.000	4.333	5.667	5.667
Ground Condition (Soil Classification)	Zemin Durumu (Zemin Sınıflaması)	C6	LikertScale	max	0.05649473	1: Usual	abs	0.0	0.0	0.1			6.000	6.000	6.000	6.000	5.667
Land Value	Arsa Değeri	C7	TL/m²	min	0.05623843	1: Usual	abs	0.0	0.0	1.7			2.667	4.000	6.000	5.333	7.000
Cost of Urban Transformation	Kentsel Dönüşümün Maliyeti	C8	TL	min	0.06292477	1: Usual	abs	0.0	0.0	1.4			7.000	4.000	3.333	5.333	5.333
Socio Economic Status of the Area	Alanın Sosyo Ekonomik Durumu	C9	LikertScale	max	0.03640882	1: Usual	abs	0.0	0.0	1.9			6.333	5.667	4.000	2.333	7.000
Cultural and Local Characteristics of the Region	Bölgenin Kültürel ve Yerel Karakteristiği	C10	LikertScale	max	0.02535302	1: Usual	abs	0.0	0.0	0.6			4.000	4.000	3.667	3.333	2.667
Protection of Environmental Values	Çevresel Değerlerin Korunması	C11	LikertScale	max	0.03980254	1: Usual	abs	0.0	0.0	0.3			4.000	4.000	4.000	3.667	3.333
Environmental Quality Improvement	Çevresel Kalitenin İyileştirilmesi	C12	LikertScale	max	0.04505652	1: Usual	abs	0.0	0.0	1.1			6.000	5.000	4.667	4.667	3.000
Connecting Natural and Open Spaces	Doğal ve Açık Alanların Bağlantısının Kurulması	C13	LikertScale	max	0.03204606	1: Usual	abs	0.0	0.0	1.5			6.000	6.000	5.667	5.000	2.333
Opportunity to Sort Hazardous Wastes Before and During Demolition	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	C14	LikertScale	min	0.03291967	1: Usual	abs	0.0	0.0	0.2			6.000	6.000	5.667	5.667	5.667
Whether the area is suitable for construction	Alanın Yapılaşmaya Uygun Olup Olmaması	C15	LikertScale	max	0.06634037	1: Usual	abs	0.0	0.0	0.2			6.333	6.333	6.333	6.000	6.667
Beneficiary Identification and Real Estate Valuation Status	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	C16	LikertScale	max	0.05435911	1: Usual	abs	0.0	0.0	1.1			7.000	6.667	6.000	4.333	7.000
Whether Urban Transformation Works Can Meet the Existing Building Density	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	C17	LikertScale	max	0.06857381	1: Usual	abs	0.0	0.0	0.6			7.000	7.000	6.667	5.667	7.000
Planning by Considering Disaster Risks	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	C18	LikertScale	max	0.05575833	1: Usual	abs	0.0	0.0	0.2			7.000	7.000	6.667	7.000	6.667
Planning of Disaster Muster Areas and Evacuation Corridors	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	C19	LikertScale	max	0.05710492	1: Usual	abs	0.0	0.0	0.3			6.667	6.667	6.667	6.667	6.000
Property Structure - Cadastral Status	Mülkiyet Yapısı - Kadastral Durum	C20	LikertScale	max	0.04837449	1: Usual	abs	0.0	0.0	1.0			7.000	7.000	5.000	5.000	6.333

Figure 86: INTEMUS Decision Variables Screen

(Prepared by Author)

								1.0000	Total Weight of Criteria (must be 1)						Ranking Weight of Alternative (%)		98.90	100.00	95.63	90.05	92.60
								0.0000	Complementary Weight of Criteria						Ranking of the Alternative		2	1	3	5	4
	formula / fill handle	formula / fill handle	formula / fill handle	formula / fill handle	formula	fill handle	select min/max type	formula / fill handle	formula	select from list (Preference Function)	select from list (Absolute Value / Percentage Value)	fill handle	fill handle	formula / fill handle	Name of Alternatives -->		Bütüncül Kentsel Dönüşüm ve Uygulama Modeli	Bütüncül Kentsel Dönüşüm ve Parçalar Halinde Uygulama Modeli	Parçacıl Kentsel Dönüşüm ve Uygulama Modeli	Önemli Yatırımların Mevcut Yapıya Eklenmesi Modeli	Parsel Bazlı Kentsel Dönüşüm Modeli
BUTTONS (Tuşlar)	**Ranking Weight of Criteria (Kriterlerin Sıralama Ağırlığı)**	**Ranking of the Criteria (Kriterlerin Sıralanışı)**	**Kriterin Adı (Name of the Criteria)**	**Name of the Criteria (Kriterin Adı)**	**Number of Criteria (Kriterlerin Numarası)**	**unit**	**min/max**	**Weight of Criteria**	**preference function**	**code_preference function**	**thresholds**	**q (min value)**	**p (max value)**	**s (standard deviation)**	**Name_Constant_Values**	**Constant_Values**	**A1**	**A2**	**A3**	**A4**	**A5**
Method of Ranking of the Alternative (Alternatif Sıralama Yöntemi)	3.20%	19	Alandaki Bina Stoğunun Durumu	Building Stock Status of the Area	**C1**	**LikertScale**	max	0.03196889	1	1: Usual	abs	0.0	0.0	0.8	**Number of Decision Alternatives**	5	4.333	4.333	4.000	5.000	6.000
COmplex PRoportional Assesment (COPRAS)	5.05%	11	Bina Yoğunluğu	Building Density	**C2**	**KAKS**	min	0.05046265	1	1: Usual	abs	0.0	0.0	1.2	**Constant k (k=1/ln(m))**	0.6213	6.667	6.000	5.667	4.333	3.667
	6.63%	4	Deprem Risk Analizi Durumu	Earthquake Risk Analysis Status	**C3**	**LikertScale**	min	0.06625400	1	1: Usual	abs	0.0	0.0	0.3	**Number of Decision Criteria**	20	6.667	6.667	6.000	6.000	6.333
Method of Ranking of the Criteria (Kriterlerin Sıralanma Yöntemi)	6.90%	1	Jeolojik Yapısı (Yerleşime Uygunluk Durumu)	Geological Structure (Suitability for Settlement)	**C4**	**LikertScale**	max	0.06896037	1	1: Usual	abs	0.0	0.0	0.0			6.333	6.333	6.333	6.333	6.333
DEcision MAking Trial and Evaluation Laboratory (DEMATEL)	4.46%	14	Yapıların Risk Durumu	Risk Status of Structures	**C5**	**LikertScale**	min	0.04459849	1	1: Usual	abs	0.0	0.0	0.6			5.000	5.000	4.333	5.667	5.667
	5.65%	7	Zemin Durumu (Zemin Sınıflaması)	Ground Condition (Soil Classification)	**C6**	**LikertScale**	max	0.05649473	1	1: Usual	abs	0.0	0.0	0.1			6.000	6.000	6.000	6.000	5.667
	5.62%	8	Arsa Değeri	Land Value	**C7**	**TL/m²**	min	0.05623843	1	1: Usual	abs	0.0	0.0	1.7			2.667	4.000	6.000	5.333	7.000
	6.29%	5	Kentsel Dönüşümün Maliyeti	Cost of Urban Transformation	**C8**	**TL**	min	0.06292477	1	1: Usual	abs	0.0	0.0	1.4			7.000	4.000	3.333	5.333	5.333
	3.64%	16	Alanın Sosyo Ekonomik Durumu	Socio Economic Status of the Area	**C9**	**LikertScale**	max	0.03640882	1	1: Usual	abs	0.0	0.0	1.9			6.333	5.667	4.000	2.333	7.000
	2.54%	20	Bölgenin Kültürel ve Yerel Karakteristiği	Cultural and Local Characteristics of the Region	**C10**	**LikertScale**	max	0.02535302	1	1: Usual	abs	0.0	0.0	0.6			4.000	4.000	3.667	3.333	2.667
	3.98%	15	Çevresel Değerlerin Korunması	Protection of Environmental Values	**C11**	**LikertScale**	max	0.03980254	1	1: Usual	abs	0.0	0.0	0.3			4.000	4.000	4.000	3.667	3.333
	4.51%	13	Çevresel Kalitenin İyileştirilmesi	Environmental Quality Improvement	**C12**	**LikertScale**	max	0.04505652	1	1: Usual	abs	0.0	0.0	1.1			6.000	5.000	4.667	4.667	3.000
	3.20%	18	Doğal ve Açık Alanların Bağlantısının Kurulması	Connecting Natural and Open Spaces	**C13**	**LikertScale**	max	0.03204606	1	1: Usual	abs	0.0	0.0	1.5			6.000	6.000	5.667	5.000	2.333
	3.29%	17	Yıkım Öncesinde ve Sırasında Tehlikeli Atıkların Ayıklanma İmkanı	Opportunity to Sort Hazardous Wastes Before and During Demolition	**C14**	**LikertScale**	min	0.03291967	1	1: Usual	abs	0.0	0.0	0.2			6.000	6.000	5.667	5.667	5.667
	6.63%	3	Alanın Yapılaşmaya Uygun Olup Olmaması	Whether the area is suitable for construction	**C15**	**LikertScale**	max	0.06634037	1	1: Usual	abs	0.0	0.0	0.2			6.333	6.333	6.333	6.000	6.667
	5.44%	10	Hak Sahibi Tespiti ve Gayrimenkul Değerleme Durumu	Beneficiary Identification and Real Estate Valuation Status	**C16**	**LikertScale**	max	0.05435911	1	1: Usual	abs	0.0	0.0	1.1			7.000	6.667	6.000	4.333	7.000
	6.86%	2	Kentsel Dönüşüm Çalışmalarının Mevcut Yapı Yoğunluğunu Karşılayıp Karşılayamaması	Whether Urban Transformation Works Can Meet the Existing Building Density	**C17**	**LikertScale**	max	0.06857381	1	1: Usual	abs	0.0	0.0	0.6			7.000	7.000	6.667	5.667	7.000
	5.58%	9	Afet Risklerinin Dikkate Alınarak Planlama Yapılması	Planning by Considering Disaster Risks	**C18**	**LikertScale**	max	0.05575833	1	1: Usual	abs	0.0	0.0	0.2			7.000	7.000	6.667	7.000	6.667
	5.71%	6	Afet Toplanma Alanı ve Tahliye Koridorlarının Planlanması	Planning of Disaster Muster Areas and Evacuation Corridors	**C19**	**LikertScale**	max	0.05710492	1	1: Usual	abs	0.0	0.0	0.3			6.667	6.667	6.667	6.667	6.000
	4.84%	12	Mülkiyet Yapısı - Kadastral Durum	Property Structure - Cadastral Status	**C20**	**LikertScale**	max	0.04837449	1	1: Usual	abs	0.0	0.0	1.0			7.000	7.000	5.000	5.000	6.333

Figure 87: INTEMUS Model Screen

(Prepared by Author)

dimensions	5.00	20.00																		
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
unit	LikertScale	KAKS	LikertScale	LikertScale	LikertScale	LikertScale	TL/m²	TL	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale
Min/Max	max	min	min	max	min	max	min	min	max	max	max	max	max	min	max	max	max	max	max	max
weight	0.03	0.05	0.07	0.07	0.04	0.06	0.06	0.06	0.04	0.03	0.04	0.05	0.03	0.03	0.07	0.05	0.07	0.06	0.06	0.05
preference function	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
thresholds	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs	abs
q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
s	0.80	1.23	0.33	0.00	0.56	0.15	1.70	1.41	1.89	0.56	0.30	1.08	1.55	0.18	0.24	1.12	0.58	0.18	0.30	1.01
Bütüncül Kentsel Dönüşüm ve Uygulama Modeli	4.33	6.67	6.67	6.33	5.00	6.00	2.67	7.00	6.33	4.00	4.00	6.00	6.00	6.00	6.33	7.00	7.00	7.00	6.67	7.00
Bütüncül Kentsel Dönüşüm ve Parçalar Halinde Uygulama Modeli	4.33	6.00	6.67	6.33	5.00	6.00	4.00	4.00	5.67	4.00	4.00	5.00	6.00	6.00	6.33	6.67	7.00	7.00	6.67	7.00
Parçacıl Kentsel Dönüşüm ve Uygulama Modeli	4.00	5.67	6.00	6.33	4.33	6.00	6.00	3.33	4.00	3.67	4.00	4.67	5.67	5.67	6.33	6.00	6.67	6.67	6.67	5.00
Önemli Yatırımların Mevcut Yapıya Eklenmesi Modeli	5.00	4.33	6.00	6.33	5.67	6.00	5.33	5.33	2.33	3.33	3.67	4.67	5.00	5.67	6.00	4.33	5.67	7.00	6.67	5.00
Parsel Bazlı Kentsel Dönüşüm Modeli	6.00	3.67	6.33	6.33	5.67	5.67	7.00	5.33	7.00	2.67	3.33	3.00	2.33	5.67	6.67	7.00	7.00	6.67	6.00	6.33

Figure 88: INTEMUS - PROMETHEE Screen

(Prepared by Author)

6.2.1 Implementation of PROMETHEE Model in Case Study Area

As a result of importing the Microsoft Excel spreadsheet created with INTEgrated Model of Urban transformation Strategy (INTEMUS) and Multi-Criteria Decision-Making (MCDM) into the Visual PROMETHEE program, it is displayed on the screen shown in Figure 81. It is possible to make any modifications that the users may wish to make in relation to the decision-making process in this program, and it becomes possible to generate the final PROMETHEE reports. In this study, as a result of the Multi-Criteria Decision-Making Method study conducted with the staff of Izmir Metropolitan Municipality Urban Transformation Department and the Aktepe-Emrez Neighborhoods Urban Transformation Project as an example, an evaluation was made with 20 indicators for 5 alternative urban transformation strategies and this comparison can be automatically transferred from the file in the Microsoft Excel program by adding the (.csv) extension in the Visual PROMETHEE program.

Scenario1	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Unit	LikertScale	KAKS	LikertScale	LikertScale	LikertScale	LikertScale	TL/m²	TL	LikertScale	LikertScale
Cluster/Group										
Preferences										
Min/Max	max	min	min	max	min	max	min	min	max	max
Weight	0,03	0,05	0,07	0,07	0,04	0,06	0,06	0,06	0,04	0,03
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics										
Minimum	4,00	3,67	6,00	6,33	4,33	5,67	2,67	3,33	2,33	2,67
Maximum	6,00	6,67	6,67	6,33	5,67	6,00	7,00	7,00	7,00	4,00
Average	4,73	5,27	6,33	6,33	5,13	5,93	5,00	5,00	5,07	3,53
Standard Dev.	0,71	1,10	0,30	0,00	0,50	0,13	1,52	1,26	1,69	0,50
Evaluations										
Total Design Model	4,33	6,67	6,67	6,33	5,00	6,00	2,67	7,00	6,33	4,00
All of Piece Model	4,33	6,00	6,67	6,33	5,00	6,00	4,00	4,00	5,67	4,00
Piece by Piece M...	4,00	5,67	6,00	6,33	4,33	6,00	6,00	3,33	4,00	3,67
Plug-In Model	5,00	4,33	6,00	6,33	5,67	6,00	5,33	5,33	2,33	3,33
Plot-by-Plot Urba...	6,00	3,67	6,33	6,33	5,67	5,67	7,00	5,33	7,00	2,67

Scenario1	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
Unit	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale	LikertScale
Cluster/Group										
Preferences										
Min/Max	max	max	max	min	max	max	max	max	max	max
Weight	0,04	0,05	0,03	0,03	0,07	0,05	0,07	0,06	0,06	0,05
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics										
Minimum	3,33	3,00	2,33	5,67	6,00	4,33	5,67	6,67	6,00	5,00
Maximum	4,00	6,00	6,00	6,00	6,67	7,00	7,00	7,00	6,67	7,00
Average	3,80	4,67	5,00	5,80	6,33	6,20	6,67	6,87	6,53	6,07
Standard Dev.	0,27	0,97	1,38	0,16	0,21	1,00	0,52	0,16	0,27	0,90
Evaluations										
Total Design Model	4,00	6,00	6,00	6,00	6,33	7,00	7,00	7,00	6,67	7,00
All of Piece Model	4,00	5,00	6,00	6,00	6,33	6,67	7,00	7,00	6,67	7,00
Piece by Piece M...	4,00	4,67	5,67	5,67	6,33	6,00	6,67	6,67	6,67	5,00
Plug-In Model	3,67	4,67	5,00	5,67	6,00	4,33	5,67	7,00	6,67	5,00
Plot-by-Plot Urba...	3,33	3,00	2,33	5,67	6,67	7,00	7,00	6,67	6,00	6,33

Figure 89: PROMETHEE Main Window

(Prepared by Author)

6.2.1.1 PROMETHEE Problem Definition

After importing data from INTEgrated Model of Urban Transformation Strategy (INTEMUS), Visual PROMETHEE can export a detailed report of the analyses completed by the program. It is also possible to use menu commands to access specific evaluations, which can be used for appropriate conditions. Table 37, Table 38, Table 39 shows the details of the alternatives and criteria of the model.

Table 37: PROMETHEE Table of Problem Definition
(Prepared by Author)

Problem definition	Total	Active
Number of actions:	5	5
Number of criteria:	20	20
Number of scenarios:	1	1

Table 38: PROMETHEE Table of Actions (Alternatives)
(Prepared by Author)

Name	Short name	Active	Category	Location
Total Design Model	A1	yes	none	Visual PROMETHEE HQ
All-of-a-Piece Model	A2	yes	none	Visual PROMETHEE HQ
Piece-by-Piece Model	A3	yes	none	Visual PROMETHEE HQ
Plug-In Model	A4	yes	none	Visual PROMETHEE HQ
Plot-by-Plot Urban Transformation	A5	yes	none	Visual PROMETHEE HQ

Table 39: PROMETHEE Table of Criteria
(Prepared by Author)

Name	Short name	Active	Scale	Unit	Cluster	Group
C1	C1	yes	numerical	Likert Scale	none	none
C2	C2	yes	numerical	KAKS	none	none
C3	C3	yes	numerical	Likert Scale	none	none
C4	C4	yes	numerical	Likert Scale	none	none
C5	C5	yes	numerical	Likert Scale	none	none
C6	C6	yes	numerical	Likert Scale	none	none
C7	C7	yes	numerical	TL/m²	none	none
C8	C8	yes	numerical	TL	none	none
C9	C9	yes	numerical	Likert Scale	none	none
C10	C10	yes	numerical	Likert Scale	none	none
C11	C11	yes	numerical	Likert Scale	none	none
C12	C12	yes	numerical	Likert Scale	none	none
C13	C13	yes	numerical	Likert Scale	none	none
C14	C14	yes	numerical	Likert Scale	none	none
C15	C15	yes	numerical	Likert Scale	none	none
C16	C16	yes	numerical	Likert Scale	none	none
C17	C17	yes	numerical	Likert Scale	none	none
C18	C18	yes	numerical	Likert Scale	none	none
C19	C19	yes	numerical	Likert Scale	none	none
C20	C20	yes	numerical	Likert Scale	none	none

6.2.1.2 PROMETHEE Evaluation Table

The results of the analysis show that the All-of-a-Piece Model is the best option, followed by the Total Design Model, the Piece-by-Piece Model, Plot-by-Plot Urban Transformation and the Plug-In Model according to flow Table 43 and Figure 90. There is a relation between alternatives and criteria below:

1. The All-of-a-Piece Model is the best option because it is better than the other models on the criteria of C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C15, C16, C17, C18, C19, C20.
2. The Total Design Model is the second-best option because it is better than the other models on the criteria of C4, C5, C6, C7, C9, C10, C11, C12, C13, C15, C16, C17, C18, C19, C20.
3. The Piece-by-Piece Model is the third best option because it is better than the other models on the criteria of C2, C3, C4, C5, C6, C8, C10, C11, C13, C14, C15, C19.

4. Plot-by-Plot Urban Transformation is the fourth preferred option because it is better on the criteria C1, C2, C3, C4, C9, C14, C15, C16, C17, C20.
5. The Plug-In Model is the least preferred option because it is worse than the other models on the criteria of C1, C2, C3, C4, C6, C7, C14, C18, C19.

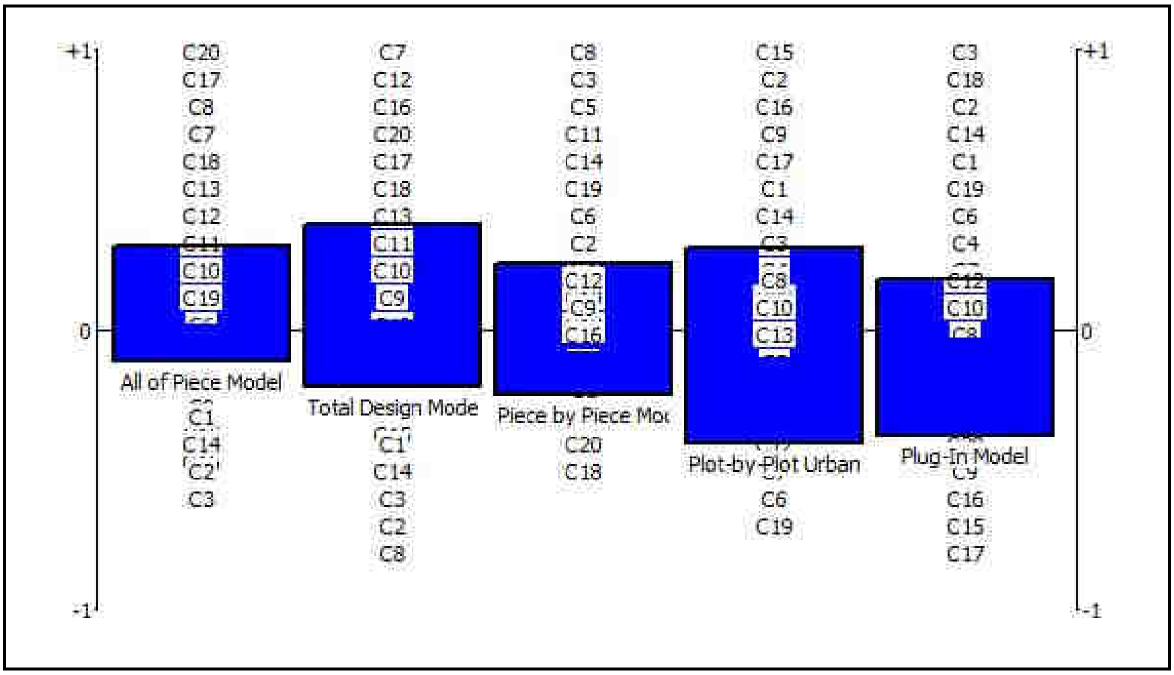


Figure 90: PROMETHEE Rainbow
(Prepared by Author)

Table 40: PROMETHEE Table of Evaluations (Scenario 1)

(Prepared by Author)

Evaluations	**Active**	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Active	**Scenario 1**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
yes	**Total Design Model**	4.33	6.67	6.67	6.33	5.00	6.00	2.67	7.00	6.33	4.00	4.00	6.00	6.00	6.00	6.33	7.00	7.00	7.00	6.67	7.00
yes	**All-of-a-Piece Model**	4.33	6.00	6.67	6.33	5.00	6.00	4.00	4.00	5.67	4.00	4.00	5.00	6.00	6.00	6.33	6.67	7.00	7.00	6.67	7.00
yes	**Piece-by-Piece Model**	4.00	5.67	6.00	6.33	4.33	6.00	6.00	3.33	4.00	3.67	4.00	4.67	5.67	5.67	6.33	6.00	6.67	6.67	6.67	5.00
yes	**Plug-In Model**	5.00	4.33	6.00	6.33	5.67	6.00	5.33	5.33	2.33	3.33	3.67	4.67	5.00	5.67	6.00	4.33	5.67	7.00	6.67	5.00
yes	**Plot-by-Plot Urban Transformation**	6.00	3.67	6.33	6.33	5.67	5.67	7.00	5.33	7.00	2.67	3.33	3.00	2.33	5.67	6.67	7.00	7.00	6.67	6.00	6.33

Table 41: PROMETHEE Table of Statistics (Scenario 1)

(Prepared by Author)

Active	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
Minimum	4.00	3.67	6.00	6.33	4.33	5.67	2.67	3.33	2.33	2.67	3.33	3.00	2.33	5.67	6.00	4.33	5.67	6.67	6.00	5.00
Maximum	6.00	6.67	6.67	6.33	5.67	6.00	7.00	7.00	7.00	4.00	4.00	6.00	6.00	6.00	6.67	7.00	7.00	7.00	6.67	7.00
Average	4.73	5.27	6.33	6.33	5.13	5.93	5.00	5.00	5.07	3.53	3.80	4.67	5.00	5.80	6.33	6.20	6.67	6.87	6.53	6.07
Standard Dev.	0.71	1.10	0.30	0.00	0.50	0.13	1.52	1.26	1.69	0.50	0.27	0.97	1.38	0.16	0.21	1.00	0.52	0.16	0.27	0.90

Table 42: PROMETHEE Table of Preference Parameters (Scenario 1)

(Prepared by Author)

Active	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
Min/Max	max	min	min	max	min	max	min	min	max	max	max	max	max	min	max	max	max	max	max	max
Weight	0.03	0.05	0.07	0.07	0.04	0.06	0.06	0.06	0.04	0.03	0.04	0.05	0.03	0.03	0.07	0.05	0.07	0.06	0.06	0.05
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 43: PROMETHEE Flow Table (Scenario 1)

(Prepared by Author)

Actions	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
All-of-a-Piece Model	**-0.25**	**-0.50**	**-0.75**	**0.00**	**0.25**	**0.25**	**0.50**	**0.50**	**0.00**	**0.75**	**0.50**	**0.50**	**0.75**	**-0.75**	**0.00**	**0.00**	**0.50**	**0.50**	**0.25**	**0.75**
Total Design Model	**-0.25**	**-1.00**	**-0.75**	**0.00**	**0.25**	**0.25**	**1.00**	**-1.00**	**0.50**	**0.75**	**0.50**	**1.00**	**0.75**	**-0.75**	**0.00**	**0.75**	**0.50**	**0.50**	**0.25**	**0.75**
Piece-by-Piece Model	**-1.00**	**0.00**	**0.75**	**0.00**	**1.00**	**0.25**	**-0.50**	**1.00**	**-0.50**	**0.00**	**0.50**	**-0.25**	**0.00**	**0.50**	**0.00**	**-0.50**	**-0.50**	**-0.75**	**0.25**	**-0.75**
Plot-by-Plot Urban Transformation	**1.00**	**1.00**	**0.00**	**0.00**	**-0.75**	**-1.00**	**-1.00**	**-0.25**	**1.00**	**-1.00**	**-1.00**	**-1.00**	**-1.00**	**0.50**	**1.00**	**0.75**	**0.50**	**-0.75**	**-1.00**	**0.00**
Plug-In Model	**0.50**	**0.50**	**0.75**	**0.00**	**-0.75**	**0.25**	**0.00**	**-0.25**	**-1.00**	**-0.50**	**-0.50**	**-0.25**	**-0.50**	**0.50**	**-1.00**	**-1.00**	**-1.00**	**0.50**	**0.25**	**-0.75**

6.2.1.3 Preference Ranking Organization METhod for Enrichment Evaluations (PROMETHEE)

The PROMETHEE I partial ranking has the potential to be presented in a number of ways, each offering a unique perspective. A common way of presenting it is through a network diagram, as shown in Figure 91. The directional arrows within the diagram serve to indicate preferences. However, such a representation does not provide clear visual information about the differences between the flow values. As a result, it is difficult to understand exactly how the ranking would be affected by even small variations in the weighting of the criteria.

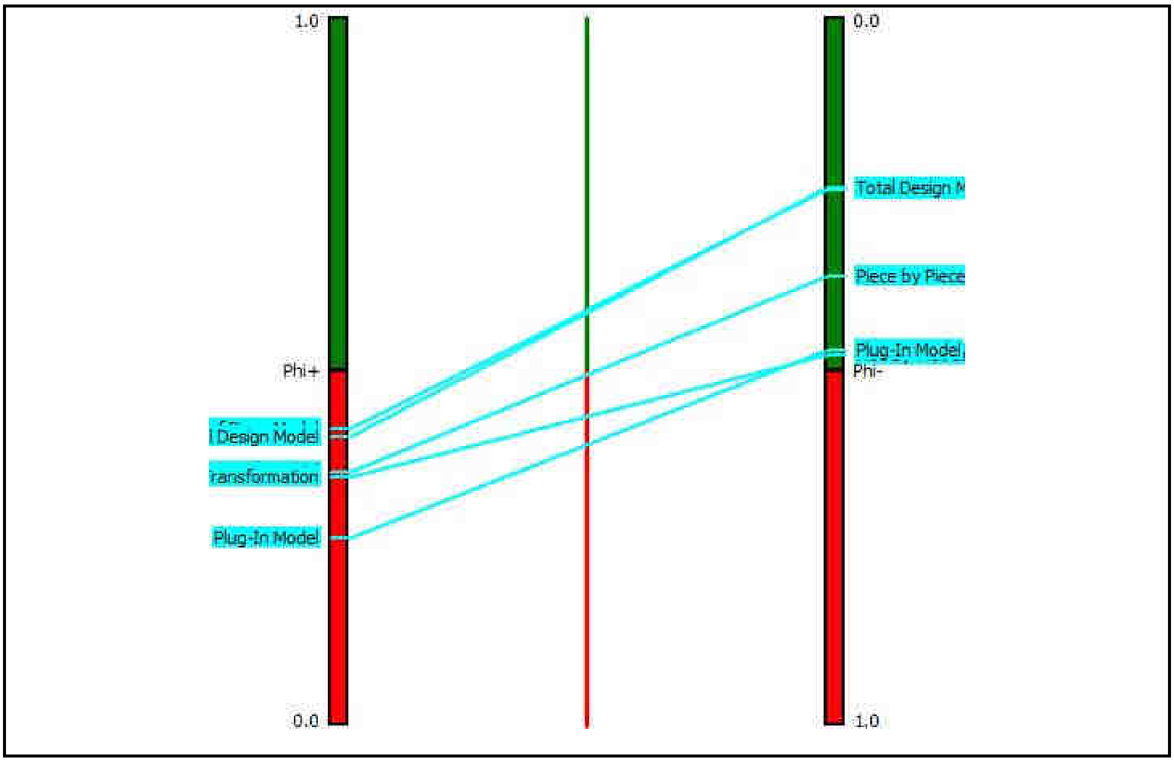


Figure 91: PROMETHEE I
(Prepared by Author)

In order to provide a more comprehensive and thorough overview of the PROMETHEE I analysis Figure 91, the PROMETHEE Diamond diagram Figure 93 is explicitly presented. Within this representation, both the outgoing and incoming flows are meticulously depicted. The axis is intentionally angled so that the vertical axis corresponds exactly to the net flow. Furthermore, each individual action is meticulously represented by a point and an accompanying cone. Thus, it can be deduced that higher points correlatively correspond to higher actions in the PROMETHEE II complete ranking Figure 92. Furthermore, wherever a cone is contained within another cone, it effectively denotes a preference in the PROMETHEE I partial ranking. Finally, the existence of overlapping cones indicates the presence of situations where both streams result in diametrically opposed rankings, further emphasizing the subtleties and complexities of the PROMETHEE I analysis.

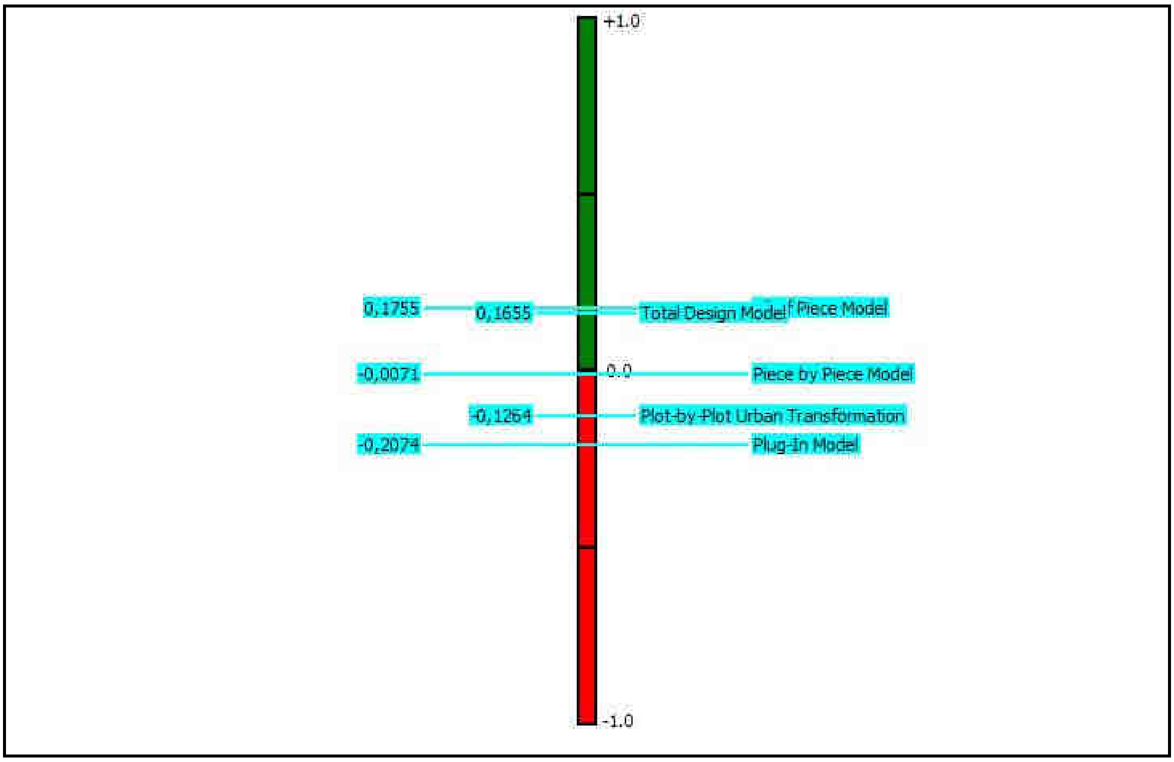


Figure 92: PROMETHEE II
(Prepared by Author)

The Diamond view gives a joint view of both rankings and an indication of the robustness of both with respect to changes in the preference parameters. It is also interesting to note that all action cones are located on the left side of Figure 93. This is because it can be directly proved that the sum of the leaving and entering flows of a given action is always less than 1.

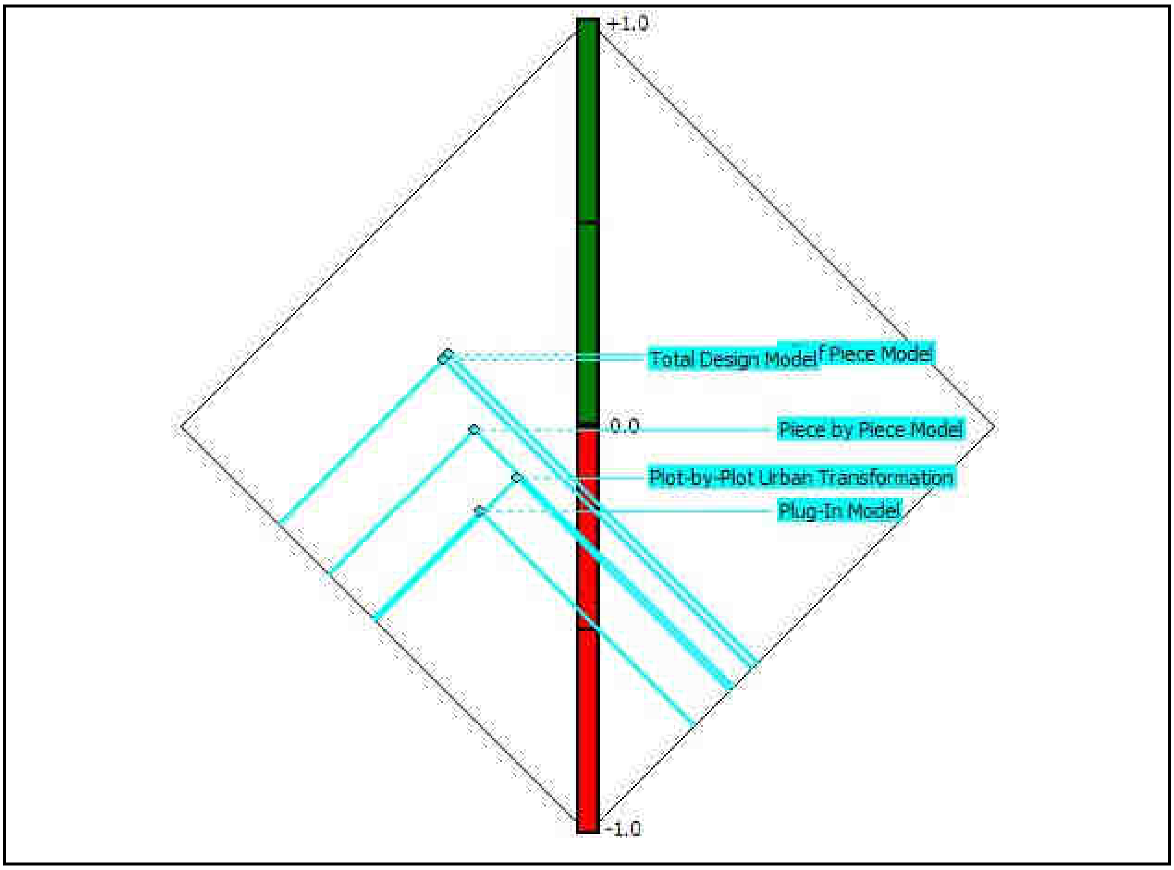


Figure 93: PROMETHEE Diamond
(Prepared by Author)

The PROMETHEE analysis is prescriptive. It relies on the preference parameters determined by the decision-maker. Changes in these parameters, especially the weights of the criteria, can have an important impact on the PROMETHEE rankings. The GAIA analysis is based on the noncriterion net flows (6). Each action is then represented by a point in the k-dimensional space defined by these flows. A principal components analysis is applied to these points to obtain a two-dimensional representation of the decision problem. Unit axes for the criteria are also projected on the GAIA plane. The resulting display is given in Figure 95. Among others, it shows the conflicts between criteria such as C1 and C19 (opposite axes) or the agreement between C3 and C14.

Both Piece-by-Piece Model and Plug-In Model are close to each other indicating similar profiles while Plot-by-Plot Urban Transformation, Total Design Model and All-of-a-Piece Model appear quite different from each other.

6.2.1.4 PROMETHEE GAIA

On the GAIA plane, alternatives are shown as blue square boxes and indicators are shown as dark blue square boxes. The ‘decision stick’ appears on the plane with a red π sign. Among the alternatives to be ranked, All-of-a-Piece Model and Total Design Model alternatives are determined to be the best urban transformation strategies because they are in the direction indicated by the decision stick. Plug-In Model and Piece-by-Piece Model, on the other hand, are in the opposite direction of the decision bar and therefore are not preferred alternatives for the decision maker during the selection process. It can be said that the indicators on similar vector axes are compatible with each other. On the other hand, indicators located in opposite directions in the factors appear as opposite or conflicting criteria.

The longer the bar (axis) indicating a criterion, the more discriminating that criterion is and the more important it is in influencing the decision bar. Criteria bars pointing in the same direction belong to criteria with similar characteristics. Criteria bars pointing in different directions belong to criteria that contradict each other.

In this case, it can be observed that criteria C9, C16, C17, C20 are close to each other and to the decision bar in different directions and have a high influence on All-of-a-Piece Model and Total Design Model. On the other hand, criteria C3 and C14, which are in the opposite axis, have a high value in influencing the Piece-by-Piece Model and Plug-In Model (Figure 94).

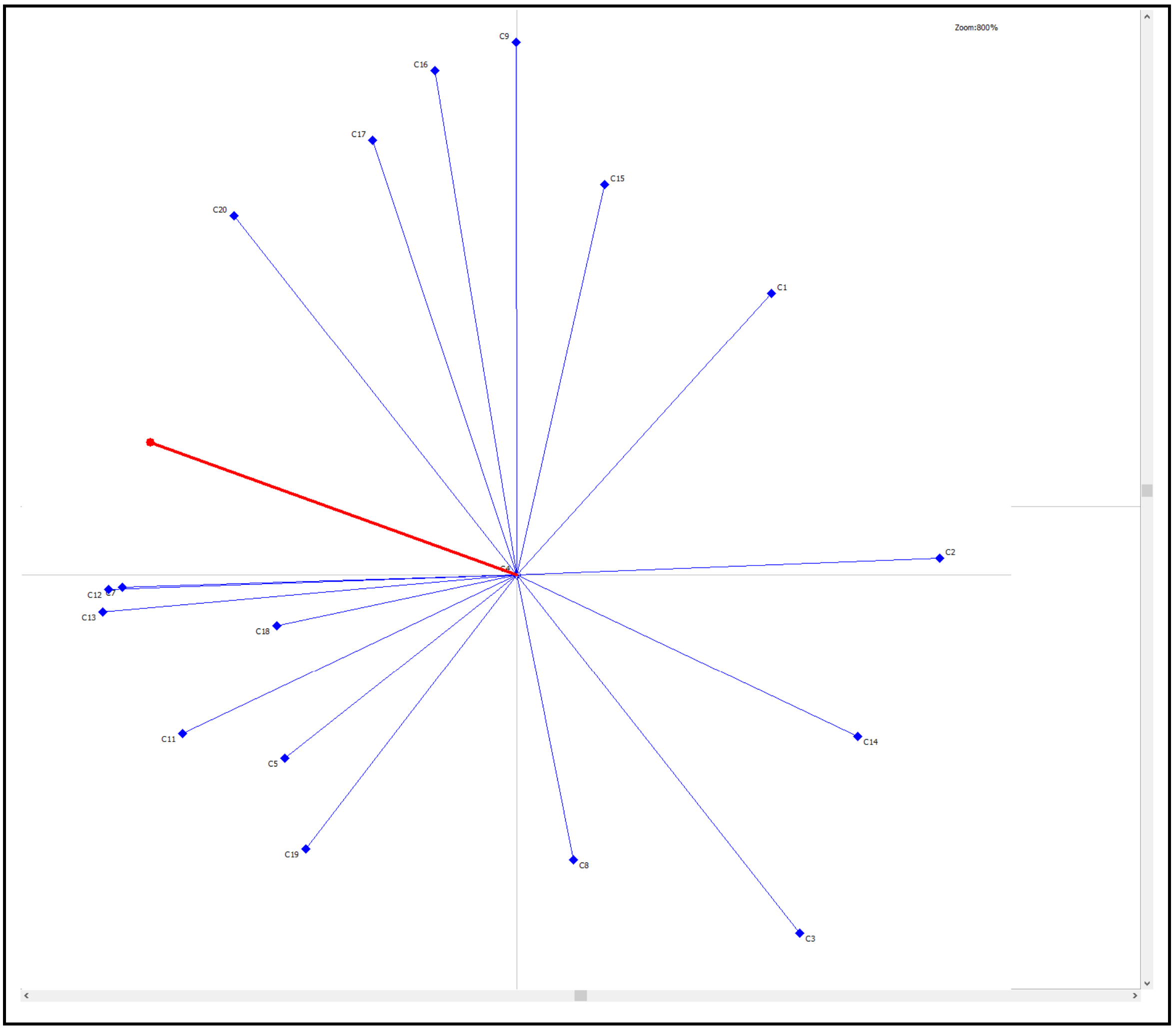


Figure 94: Detail of the GAIA Plane

(Prepared by Author)

The graphical representation of the GAIA plane visually presents the results of the PROMETHEE method and provides decision makers and researchers with a quick, simple, and understandable perspective beyond a simple ranking like other Multi-Criteria Decision-Making methods. This presentation brings a different approach to Multi-Criteria Decision-Making methods and benefits the decision-making process.

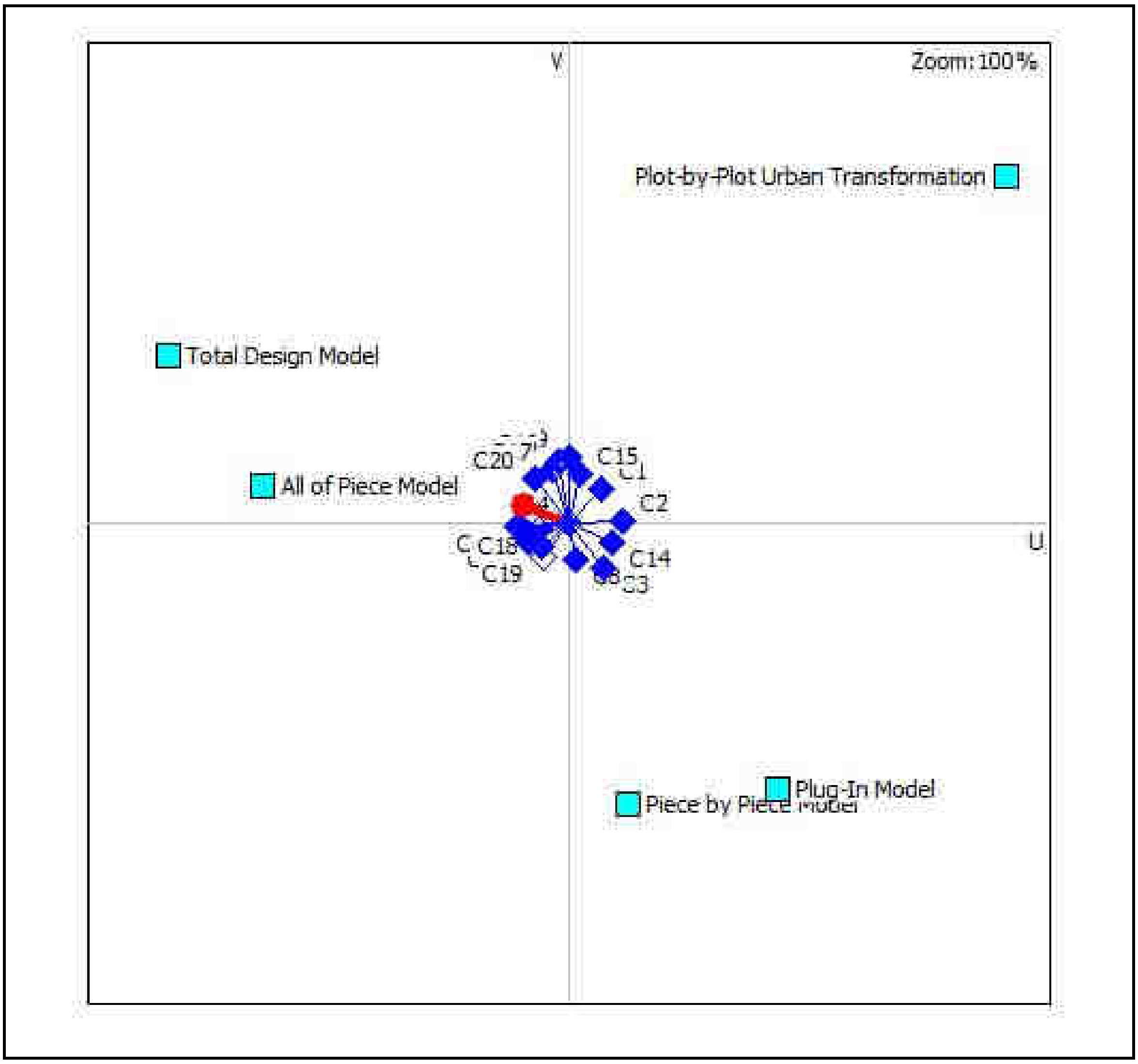


Figure 95: PROMETHEE GAIA Plane
(Prepared by Author)

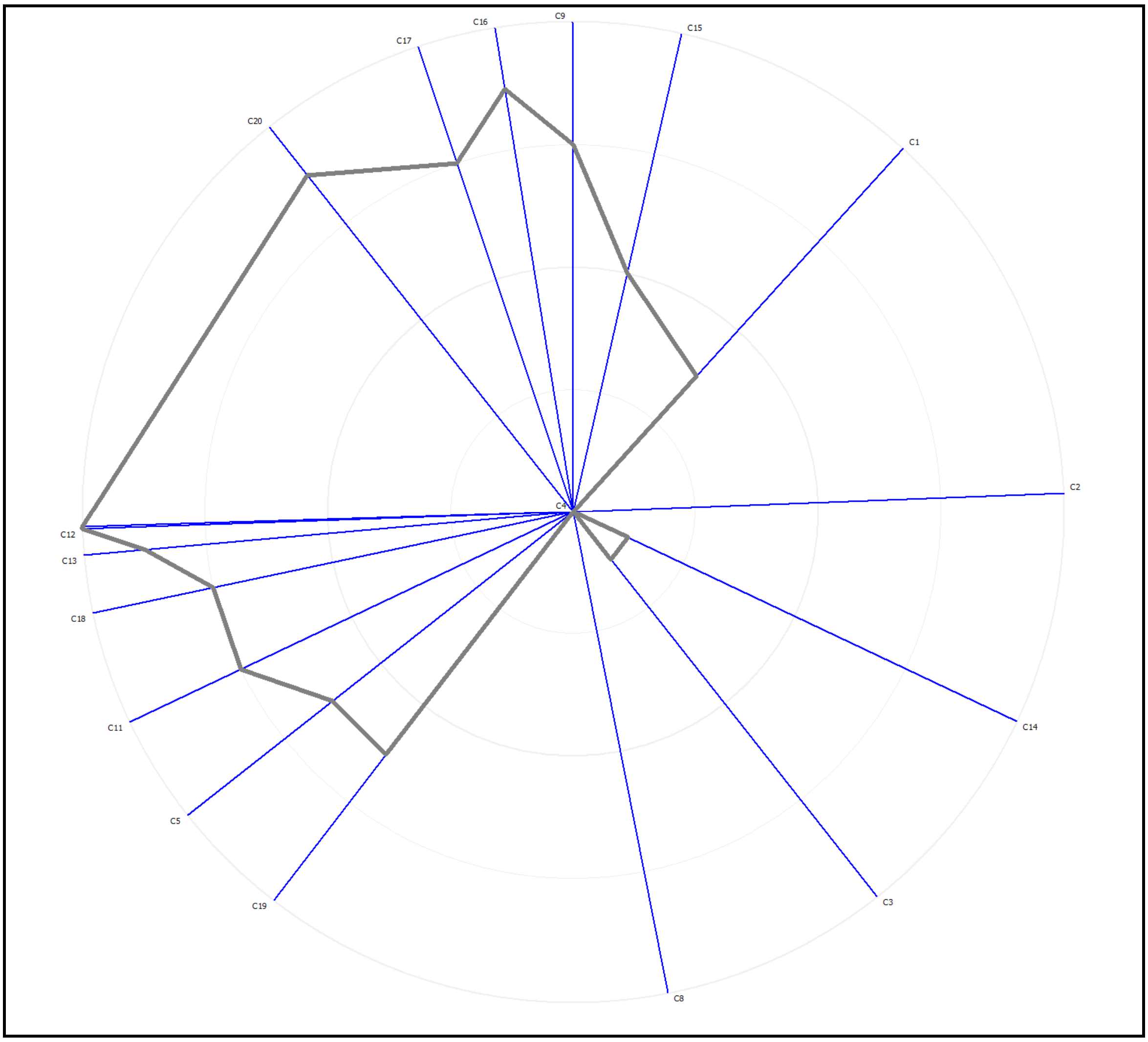


Figure 96: PROMETHEE GAIA Plane (All-of-a-Piece Model)

(Prepared by Author)

6.2.1.5 PROMETHEE Sensitivity Analysis

The PROMETHEE Sensitivity Analysis is a method that can be used to assess the robustness of a PROMETHEE decision model to changes in the weights of the criteria. The method works by calculating the net flows for each alternative for a variety of different weight vectors, where the weights of the criteria range from 0 to 1 in 0.1 increments. The result of the analysis is shown in the graph, which shows that the All-of-a-Piece Model is the optimal option for most of the weight vectors. However, the Total Design Model is the superior choice for weight vectors that assign a high weight to C1.

On the other hand, the Piece-by-Piece model is the most advantageous alternative for weight vectors that place a high weight on C2. Furthermore, the graph shows that the ranking of the alternatives is relatively insensitive to changes in the weights of the criteria, indicating that the PROMETHEE model is relatively resilient to changes in the decision maker's preferences.

In particular, the PROMETHEE Walking Weights technique is a mechanism for incorporating uncertainty into the PROMETHEE decision method that shown in Figure 97. The method works by assigning weights to the criteria and then iteratively adjusting the weights until the best alternative is identified. PROMETHEE Walking Weights is a powerful tool that can be used to make complex decisions under uncertainty. The approach is straightforward to understand and implement and can be used to rank a significant number of alternatives. The method is also relatively insensitive to the weights of the criteria, making it a robust decision-making tool.

Additional points that can be made in explaining the graph include the fact that the All-of-a-Piece Model is the best option for most of the weight vectors because it is the best overall performer. The Total Design Model is the optimal alternative for weight vectors that assign a high weight to C1 because it is the most cost-effective option. The Piece-by-Piece model is the superior choice for weight vectors that place a high weight on C2 because it is the fastest alternative. Furthermore, the ranking of alternatives is relatively insensitive to changes in the weights of the criteria because the PROMETHEE model is relatively robust to changes in the decision maker's preferences.

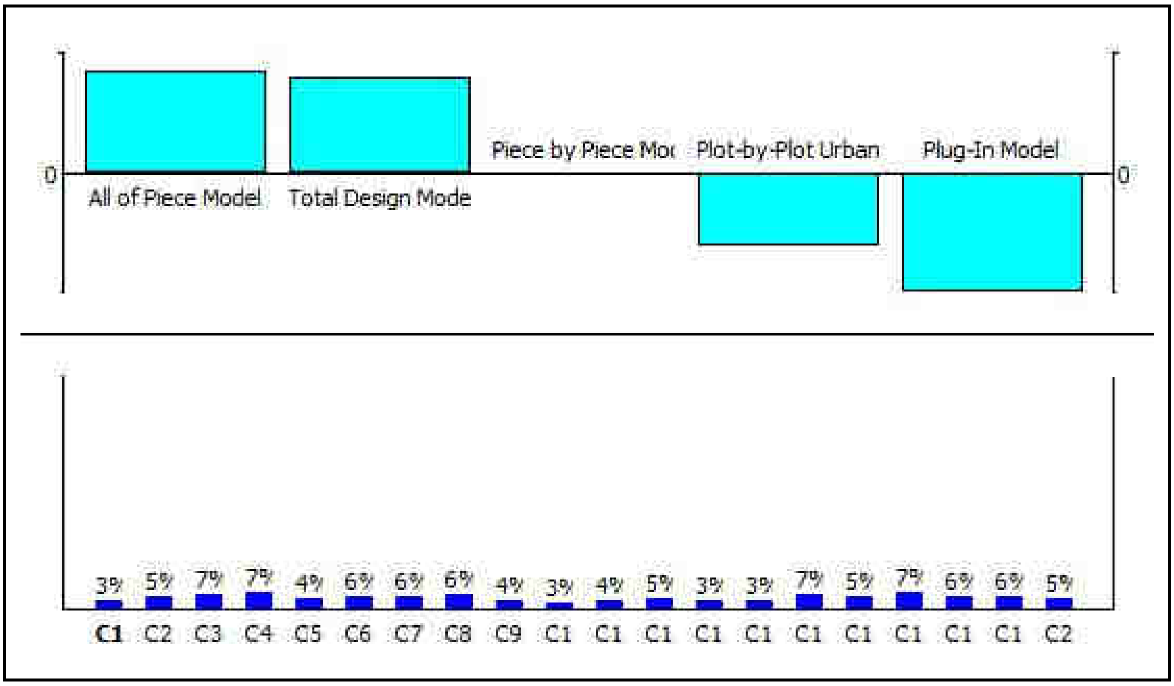


Figure 97: PROMETHEE Walking Weights
(Prepared by Author)

6.2.1.6 PROMETHEE V

PROMETHEE I and II are appropriate to select one alternative. However, in some applications a subset of alternatives must be identified, given a set of constraints. PROMETHEE V is extending the PROMETHEE methods to that particular case. Let be $\{a_i, I=1, 2, \ldots; n\}$ the set of possible alternatives and let us associate the following Boolean variables to them:

Table 44: PROMETHEE V Optimal Selection
(Prepared by Author)

Actions	Phi	Selected	Compared
All-of-a-Piece Model	0.1755	no	no
Total Design Model	0.1655	no	no
Piece-by-Piece Model	-0.0071	no	no
Plot-by-Plot Urban Transformation	-0.1264	no	no
Plug-In Model	-0.2074	no	no

Table 45: PROMETHEE V Constraint Slacks
(Prepared by Author)

Constraint	Opt. LHS	Comp. LHS	Type	RHS
Minimum	0	0	>=	1
Maximum	0	0	<=	5

6.2.1.7 Results of the PROMETHEE Analysis

The Phi value is a measure of the overall performance of an alternative. The Phi+ value is a measure of the extent to which an alternative outranks other alternatives. The Phi- value is a measure of the extent to which an alternative is outranked by other alternatives.

Table 46: PROMETHEE Scenario Table (Scenario 1)
(Prepared by Author)

Actions	Phi	Phi+	Phi-
All-of-a-Piece Model	0.1755	0.4178	0.2424
Total Design Model	0.1655	0.4060	0.2406
Piece-by-Piece Model	-0.0071	0.3576	0.3648
Plot-by-Plot Urban Transformation	-0.1264	0.3497	0.4761
Plug-In Model	-0.2074	0.2637	0.4710

The Visual PROMETHEE program, a multi-criteria decision-making method that uses outranking relationships to rank alternatives, was demonstrated using the data you provided to show the results for five different urban transformation models. The ‘Phi’, ‘Phi^{+}’, and "‘Phi^{-}’" columns, which represent the outranking flows for each model, were also presented. A positive Phi value indicates that the model is preferred over the others, while a negative Phi value indicates that the model is not preferred. The strength of the preference is indicated by the higher Phi value. The results of the Visual PROMETHEE program have shown that the All-of-a-Piece Model is the most preferred urban transformation model, followed by the Total Design Model, while the Piece-by-Piece

Model, the Plug-In Model, and the Plot-by-Plot Urban Transformation are all less preferred. The Visual PROMETHEE program is a valuable tool for decision-making in various settings, as it can be used to rank alternatives based on multiple criteria and facilitate the identification of the best alternative for a given situation.

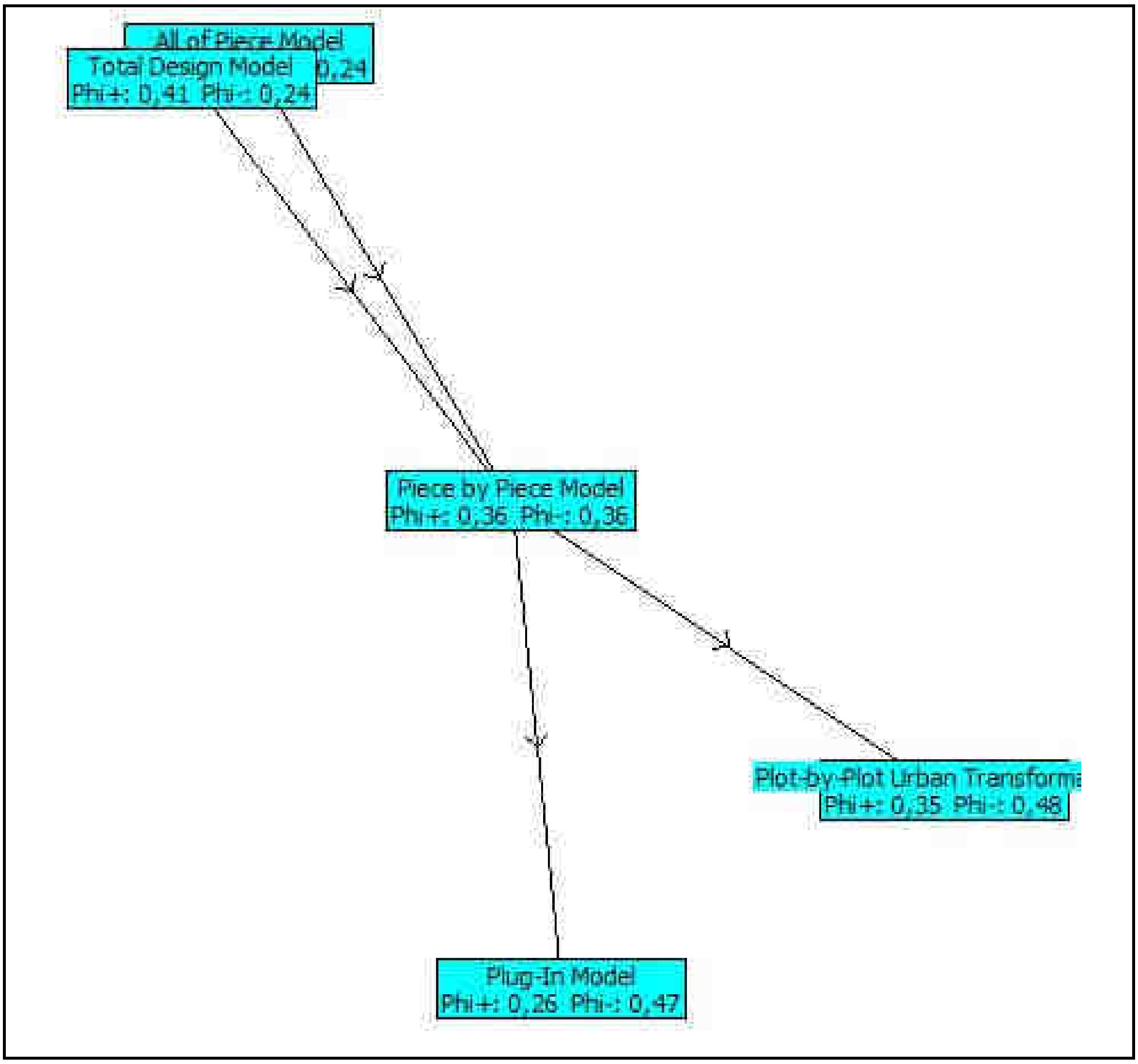


Figure 98: PROMETHEE Network

(Prepared by Author)

In addition, the results have been subjected to additional analysis. The All-of-a-Piece Model has the highest 'Phi+' value, indicating that it is preferred over the other models in more criteria. The Total Design Model, on the other hand, has the second highest 'Phi+' value, indicating that it is preferred over the other models on a few criteria.

The Piece-by-Piece Model has the lowest ‘Phi^+’ value, indicating that it is preferred over the other models in the fewest criteria. The ‘Phi^-’ values for all models are relatively close, indicating that they are not strongly dominated by any of the other models. Overall, the results of the Visual PROMETHEE program suggest that the All-of-a-Piece Model and the Total Design Model are the most preferred urban transformation models, while the Piece-by-Piece Model, the Plug-In Model, and the Plot-by-Plot Urban Transformation are less preferred but may be more appropriate for certain situations.

CHAPTER 7

CONCLUSIONS

The dissertation concludes with a summary of the main conclusions of the research, a discussion of limitations and recommendations for future studies in the field of urban transformation and hazard mitigation in disaster-prone areas. Applications of the methodology to case studies will be demonstrated and recommendations for future research identified.

Although urban transformation in disaster-prone urban areas is necessary in Türkiye, as in many developing countries, effective and comprehensive strategies have not been developed. The most important problems in this regard can be considered as rapid population growth, uncontrolled migration to cities, poverty as a result of inefficient use of economic resources, and high rents or similar problems that arise as a result of the demand of the real estate sector to structure the urban areas.

Although many academic studies, legislative reforms and new institutional structures were carried out after the Great Marmara Earthquake of 1999, it can be argued that the preparations made were mostly for the post-disaster phase, the hazard mitigation activities that should have been implemented before the earthquake were limited to public buildings and infrastructure, and the necessary reconstruction requirements for residential and non-residential urban areas were delegated to the private sector and citizens. The shortages in this process were most clearly observed in 2023 with two major earthquakes affecting Kahramanmaraş, which caused major devastation in eleven provinces.

It is recognized that the public institutions that are responsible for disaster preparedness and prevention have some deficiencies in theory, technology, and data. The influence of the political process on the institutions has a negative impact on many implementations and, most importantly, there are serious economic and structural problems in the financing of these preparations.

However, within the context of this dissertation, although it is known that the deficiencies experienced in every field in Türkiye deepen the problems experienced in the disaster mitigation process, it has been determined that one of the most important deficiencies, especially in disaster mitigation and urban transformation initiatives, is the incapability of the responsible authorities to manage the decision-making process effectively and the lack of knowledge in this regard. It has been found that the deficiency in the decision-making process regarding urban transformation actions in disaster-prone areas causes many failures, delays, and the loss of resources in the decision-making and implementation processes.

In order to address decision-making challenges in urban transformation for disaster-prone cities, conceptual and methodological research was conducted. This research aimed to develop a program grounded in multi-criteria decision-making methods tailored for officials and specialists in relevant government institutions. Additionally, a preliminary application of the designed program is presented within the scope of this thesis.

7.1 Development of the Research Method and Results of the Method

In the scope of the thesis study, firstly, the concepts of resilience, disaster management, hazard mitigation, sustainability, sustainable urbanization, and urban transformation were introduced along with the research conducted on the topics and based on these concepts, the five types of principal urban transformation strategies were identified. Then, based on the literature, legislation and practice of implementation, indicators to be used in the evaluation of urban transformation strategies were determined. Finally, the alternative urban transformation strategies and the selected indicators were applied in a software, using the methods of determining the weight of criteria and ranking the alternatives selected from multi-criteria decision-making methods.

In this context, five urban transformation strategies are described: four from urban design literature and one from planning practice. They are categorized as '(1) Total Design Model', '(2) All-of-a-Piece Model', '(3) Piece-by-Piece Model', '(4) Plug-In Model', '(5) Plot-by-Plot Urban Transformation'.

Further, three hundred indicators from literature review, legislation review, technical reports and the practice of implementation have been classified into six categories: Physical Structure, Economic Structure, Social Structure, Environmental Structure, Legislation and Institutional Structure, Planning and Design and Technological Structure. They have been added to the INTEgrated Model of Urban Transformation

Strategy (INTEMUS) program. The purpose is to provide the indicators to be evaluated by the employees of institutions and organizations.

As a result of these specifications, a survey was conducted with forty experts for selecting the most preferred indicators and as a result of this survey, the most preferred indicators were ranked and the indicators in the top twenty were selected and analyzed within the context of Aktepe-Emrez Neighborhoods Urban Transformation Project as a case study with the officials of Izmir Metropolitan Municipality Urban Transformation Department using the INTEgrated Model of Urban transformation Strategy (INTEMUS) program in order to make an application.

Twenty indicators selected as a result of the first stage survey were used in this analysis. These include; ‘Building Stock Status of the Area’, ‘Building Density’, ‘Earthquake Risk Analysis Status’, ‘Geological Structure (Suitability for Settlement)’, ‘Risk Status of Structures’, ‘Ground Condition (Soil Classification)’, ‘Land Value’, ‘Cost of Urban Transformation’, ‘Socio Economic Status of the Area’, ‘Cultural and Local Characteristics of the Region’, ‘Protection of Environmental Values’, ‘Environmental Quality Improvement’, ‘Connecting Natural and Open Spaces’, ‘Opportunity to Sort Hazardous Wastes Before and During Demolition’, ‘Whether the area is suitable for construction’, ‘Beneficiary Identification and Real Estate Valuation Status’, ‘Whether Urban Transformation Works Can Meet the Existing Building Density’, ‘Planning by Considering Disaster Risks’, ‘Planning of Disaster Muster Areas and Evacuation Corridors’, ‘Property Structure - Cadastral Status’.

In the case study, the purpose was to determine the weights of the indicators with the ‘DEMATEL’ method, which is based on the comparison of twenty indicators with each other for the officers of the Urban Transformation Department of Izmir Metropolitan Municipality. Then, the final indicator weight was determined by averaging these weights at each comparison in the matrix. Finally, twenty indicators and five alternative urban transformation strategies (decision alternatives) were evaluated on a matrix by scoring according to Likert scale and the calculation was finalized by averaging the values given by the participants.

The result of the case study ranking as the "All-of-a-Piece Model" placed first, the "Total Design Model", "Piece-by-Piece Model", "Plot-by-Plot Urban Transformation", "Plug-In Model" urban transformation strategies were found to be important,

Nevertheless, this case study was prepared to determine the functioning of the INTEgrated Model of Urban Transformation Strategy (INTEMUS) program and to identify its deficiencies and issues that need to be corrected. The aim of this study is not to identify decision alternatives and criteria that can be used throughout Türkiye. It is necessary to analyze the indicators/criteria required by each province, municipality, or specific project area and to plan alternative urban transformation strategies or projects specific to the conditions in which they are located. The main objective of the INTEgrated Model of Urban Transformation Strategy (INTEMUS) program is to make multi-criteria decision-making methods, widely used in the field of management and engineering, available to institutions and organizations responsible for determining urban transformation strategies through an integrated computer program. Here, it is aimed to ensure that the decision-making process of the employees working in the institutions is made easily within a specified method and that the decisions made are presented within the framework of a specified scientific method when presented to the decision-making administrative authority.

7.2 Limitations of the Study

Within the scope of this study, the potential of Multi-Actor Multi-Criteria Analysis (MAMCA) methods, which have been widely discussed in the literature in recent years, has been reviewed together with Multi-Criteria Decision-Making methods. Especially in disaster-prone areas where urban regeneration is proposed, it is imperative that these stakeholders are involved in the process, considering the scale of the problem, the large number of stakeholders, the existence of actors who manage urban rent, and large-scale financing problems. Therefore, the involvement of these stakeholders in the "negotiation" is important for the well-functioning of the procedure. However, negotiation is not practiced much in Türkiye due to the capacity of the institutions and the problems of the conflict actors to reach an agreement. Within the scope of this thesis, due to the limited time and the lack of such 'negotiation' environments, the approaches of these interest groups in the INTEgrated Model of Urban transformation Strategy (INTEMUS) program could not be studied as part of the research methods of the dissertation.

One of the objectives of the thesis is to integrate the INTEgrated Model of Urban transformation Strategy (INTEMUS) model into Geographical Information Systems or to develop it as a web application, however, since this requires a high level of software knowledge, it has been left as a research project for the post-doctoral period. The use of a method that can work both on the Web and in the urban information systems of the institutions, especially in the management of these decision-making processes within the institutions and with the stakeholders connected to the institutions, will be of significant benefit and will ensure that urban transformation processes can be carried out on a participatory basis in a reasonable time.

It is expected that the participation of the actors involved in the urban transformation process in the targeted areas will prevent legitimacy debates and that the procedure will be easier to explain, since it will be decided by a scientific method considering certain indicators. It is expected that this determination could not be made because it exceeded the thesis preparation period and should be examined within the framework of further study.

7.3 Suggestions for Further Research

Within the scope of this doctoral thesis, the completion of the research parts that had to be limited because of lack of time, financial and human resources, will contribute to the ease of use of INTEgrated Model of Urban transformation Strategy (INTEMUS) by generating computer software, finding a program interface that works by saving over the web, or producing modules that can be integrated into the urban information systems of institutions. In this way, the institutions will be able to use multi-criteria decision-making methods in their decision-making processes through this application, without the need for additional scientific research.

In this doctoral thesis, the gaps in research due to constraints in time, finances, and human resources are addressed to enhance the usability of the INTEgrated Model of Urban transformation Strategy (INTEMUS). This is achieved by developing computer software, introducing a web-based program interface, or creating modules compatible with institutional urban information systems. Consequently, institutions can employ multi-criteria decision-making methods in their processes through this application without requiring further scientific research.

Another research focus is to expand the 'Criterion Weighting Methods' and 'Comparison of Alternatives Methods' in the INTEgrated Model of Urban transformation Strategy (INTEMUS) program. This enhancement aims to accommodate various Multi-Criteria Decision-Making methods for diverse decision processes. Consequently, users seeking different multi-criteria decision-making methods will find the appropriate techniques within the INTEMUS program.

The system INTEMUS includes three hundred indicators identified as a result of the research. Therefore, decision makers are able to select these selected indicators from the research and literature. However, within the INTEMUS program, it is possible for both indicators and decision alternatives to be completely determined by the organization. It is therefore possible for the multi-criteria decision-making model to operate dynamically according to the local characteristics of institutions and disaster-prone areas.

Within the scope of this thesis study, some of the multi-criteria decision-making methods that are widely used in decision-making processes in the fields of management and engineering can be used by institutions in urban transformation in their applications. In the management of urban areas, there are many criteria that affect any decision-making process and numerous indicators that can be used to evaluate the criteria. These criteria, which should be evaluated within the framework of ‘Urban Studies’, are carried out in many institutions in Türkiye based on experience, education, expertise, and intuition. In these decision-making processes, criteria and alternatives are already being compared, probably without being aware of scientific methods. In contemporary context, there is a universal demand across institutions for evidence-based information. Intuitive decision-making will be replaced by decisions derived from scientific methodologies, all without the need for additional training, thanks to specialized systems.

Consequently, the INTEgrated Model of Urban Transformation Strategy (INTEMUS) method, which enables the urban transformation processes of disaster-prone areas to be carried out with a specific scientific methodology, has been developed within the framework of the thesis, and a case study application has been carried out by the officials of the Urban Transformation Department of Izmir Metropolitan Municipality and the results have been reported. At this stage, by eliminating the problems and deficiencies experienced during the research process, this decision-making method has been completed as a program and provided to the relevant authorities.

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APPENDIX A

SURVEY (QUESTIONNAIRE) ABOUT THE DETERMINATION OF CRITICAL INDICATORS FOR EXPERTS

KENTSEL DÖNÜŞÜM STRATEJİLERİNİN DEĞERLENDİRİLMESİNDE KULLANILACAK GÖSTERGELERİN BELİRLENMESİ

Bu anket çalışması, İzmir Yüksek Teknoloji Enstitüsü, Şehir ve Bölge Planlama Bölümü, Şehir Planlama Doktora Programı kapsamında yürütülen **"Deprem Riski Olan Alanlarda Etkinlik Göstergeleri Yoluyla Farklı Kentsel Dönüşüm Stratejilerinin Değerlendirilmesi"** konulu doktora tezinin bir parçası olarak yapılmaktadır.

Çalışma kapsamında, Türkiye'de özellikle deprem afet riski altındaki bölgelerin kentsel dönüşüm yoluyla afetlere dirençli hale gelebilmesi için uygulanacak kentsel dönüşüm stratejilerinde kullanılabilecek karar alternatiflerinin önem ağırlıklarına göre sıralanması amaçlanmaktadır. Bu amaçla, literatür taraması, ilgili mevzuat ve planlama ilke ve esaslarından derlenen kriterler, Çok Kriterli Karar Verme Yöntemi için hazırlanan programda kullanılacak olup burada belirleyici olacak kriterlerin etkinliğine ilişkin kullanılacak göstergelerin ağırlıklarının tespitinin yapılması gerekmektedir.

Bu anket çalışması kapsamında, ilk aşama olarak belirlenen **300** adet göstergeden **60** adedinin seçilebilmesi için (1) Fiziksel Yapı, (2) Ekonomik Yapı, (3) Sosyal Yapı, (4) Çevresel Yapı, (5) Mevzuat ve Kurumsal Yapı, (6) Planlama ve Tasarım ile Teknolojik Yapı ana grupları altında toplanan göstergelerden **her grubun altında en az 2 adet olmak üzere toplam 60 adedinin seçilerek anket formunda işaretlenmesi beklenmektedir.**

Bu anketle elde edilen sonuçlar ile oluşturulan 60 adet göstergeye ilişkin liste daha sonra belirlenen odak grup tarafından puanlama usulü ile 20 adede indirilecek ve bu göstergelerin birbirleri ile karşılaştırmasına dayalı Çok Kriterli Karar Verme Yöntemi ile 20 adet kriterin ağırlıkları belirlenmiş olacaktır.

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Paylaşılmıyor

Düzenleme erişimi iste

IZMIR INSTITUTE OF TECHNOLOGY
SOCIAL SCIENCES AND HUMANITIES
SCIENTIFIC RESEARCH AND PUBLICATION ETHICS COMMITTEE

DETERMINATION OF INDICATORS TO BE USED IN THE EVALUATION OF URBAN TRANSFORMATION STRATEGIES

This survey study is carried out as part of the doctoral thesis on **"Evaluation of Different Urban Transformation Strategies through Effectiveness Indicators in Earthquake-Prone Areas"** conducted within the scope of Izmir Institute of Technology, Department of City and Regional Planning, City Planning Doctoral Program.

Within the scope of the study, it is aimed to rank the decision alternatives that can be used in the urban transformation strategies to be implemented in order to make the regions under the risk of earthquake disasters in Turkey resistant to disasters through urban transformation according to their importance weights. For this purpose, the criteria compiled from the literature review, relevant legislation and planning principles and guidelines will be used in the program prepared for the Multi-Criteria Decision Making Method and it is necessary to determine the weights of the indicators to be used regarding the effectiveness of the criteria that will be decisive here.

Within the scope of this survey study, in order to select **60** indicators out of the **300** indicators determined as the first stage, **it is expected that 60 indicators in total, at least 2 under each group, will be selected from the indicators gathered under the main groups** of (1) Physical Structure, (2) Economic Structure, (3) Social Structure, (4) Environmental Structure, (5) Legislation and Institutional Structure, (6) Planning and Design and Technological Structure.

The list of 60 indicators created with the results obtained from this survey will then be reduced to 20 by the designated focus group by scoring method and the weights of 20 criteria will be determined by the Multi-Criteria Decision Making Method based on the comparison of these indicators with each other.

INFORMATION ON SURVEY PARTICIPANTS

Within the scope of this survey, it is not mandatory to provide the Name, Surname, E-mail address, telephone number information of the participants of the survey and it will be used to contact the participants who want to participate in the further stages of the study. This information will not be shared with third parties within the scope of the Law on the Protection of Personal Data No. 6698 or will not be included in any publication and is for information purposes only. **The information about the institution where the respondents work, the unit they work in and the institution where they work, their professional status, their education status will be used to determine the qualitative distribution of the respondents and will be used only for the purpose of creating statistical data.**

Do you agree to the use of the information you provide in accordance with the above explanation and to participate in the survey? (Required Question)

- I agree.
- I do not agree.

IZMIR INSTITUTE OF TECHNOLOGY
SOCIAL SCIENCES AND HUMANITIES
SCIENTIFIC RESEARCH AND PUBLICATION ETHICS COMMITTEE

INFORMATION ON SURVEY PARTICIPANTS

It is sufficient to fill in only the mandatory fields and it is necessary to write the contact information for those who want to participate in the further studies.

- Employed Institution
- Unit of Employment (Required Question)
- Position in the Institution (Required Question)
- Profession (Actual Job) (e.g., Academician, Urban Planner, Architect, Manager, Self-Employed etc.) (Required Question)
- Profession (Education Status - Specialization) (e.g., Urban Planner, Architect, Civil Engineer, etc.) (Required Question)
- How many years of professional experience do you have? (Required Question)
  1. Less than 5 years
  2. 5-10 years
  3. 10-15 years
  4. 15-20 years
  5. 20-25 years
  6. More than 25 years
- Do You Have Experience in Urban Transformation? (Required Question)
  - Yes / No
- (If applicable) How many years of experience do you have in urban transformation?
  1. Less than 5 years
  2. 5-10 years
  3. 10-15 years
  4. 15-20 years
  5. 20-25 years
  6. More than 25 years
- Name Surname
- E-mail Address
- Phone Number (5XX...)
- How would you like your role in survey participation to be defined? (Required Question)
  - Academician (Lecturer, Lecturer, Research Assistant)
  - NGO Representative or Member
  - Administrator or Employee in a Public Institution
  - Manager or Employee in Metropolitan Municipality
  - Manager or Employee in the District Municipality
  - Contracting Company Owner or Employee
  - Special City Planning, Architecture, Engineering, etc. Project Office Owner or Employee
  - Self-Employed
  - Politician (Mayor, Municipal Council Member, Mukhtar, etc.)
  - Other

INDICATORS SELECTED BY THE RESEARCHER CONSIDERING THAT THEY ARE USED IN THE DETERMINATION OF URBAN TRANSFORMATION STRATEGIES WITHIN THE SCOPE OF THE RESEARCH

In this section, in order to inform the survey participants, the list of indicators selected by the researcher is given considering that they are used in the determination of urban transformation strategies within the scope of the research. These criteria are included as indicators that are considered to be used by default in the model created by Multi-Criteria Decision-Making Methods and the respondents can also choose from these indicators.

Which indicators do you think should be used in urban transformation strategies as you see fit among the indicators selected by the researcher?

1) Indicators selected by default

Mark the Indicators You Selected.

Building Stock Status of the Area	
Geological Structure (Suitability for Settlement)	
Risk Status of Structures	
Cost of Urban Transformation	
Disaster Risk Status	
Area Size to be at least 5 ha and at most 500 hectares	
Whether at least 65% of the total number of buildings in the area consists of buildings that have obtained a building and occupancy license	
Beneficiary Identification and Real Estate Valuation Status	
Existing Zoning Status (Construction Conditions etc.)	
Property Structure - Cadastral Status	

CRITERIA FOR PHYSICAL STRUCTURE

Which indicators do you think should be used in urban transformation strategies for criteria related to physical structure? (Please mark at least 2 criteria under this group)

2) Select physical structure indicators.

Mark the Indicators You Selected.

Ratio of Open Space	
Amount of Shopping District	
Land Use Pattern	
Land Use Rate	

Residential Density Levels in Relation to Plot Size	
Building Density	
Bicycle Road Network Status	
Gross Density	
Landfill Site	
Earthquake Risk Analysis Status	
Circulation Pattern	
Access to Nearest Parks	
Accessibility to Nearest Health Services	
Accessibility to Nearest Sports Facility	
Existence of Slum Settlement	
Amount of General Parking Lot	
Existence of Light Rail System	
Ratio of Dilapidated Housing	
Area Size or Proportion of Immovables Belonging to the Treasury	
Amount of Undeveloped Land	
Commuter Distance	
Cadastral Parcel Ratio	
Existence and Condition of Public Buildings	
Public Good	
Existence and Condition of Public Open Spaces	
Ratio of Public Space	
Existence and Status of Sewerage System	
Mixed-Use Ratio	
Amount of Residential Area	
Central Business Height Index (CBHI)	

Accessibility Of Subway	
Existing Number of Independent Units and Structures	
Building Quality Status of Existing Buildings	
Existing Residential Differentiation	
Existing Housing Conditions, Business Activities	
Existing Retail Floor Space	
Net Residential Area	
Average Noise Pollution Level	
Status of Strategic Structures and Infrastructures (Military Facility, Airport, Port, etc.)	
Water Supply System	
Proximity to Water Coasts (Sea, Lake, River, etc.)	
Sustainability	
Land Coverage	
Status of Technical Infrastructure	
Traffic Improvement Status (Traffic Volume)	
Transportation Distances and Mixed Use Ratio	
Selection of Appropriate Building Typology and Settlement Layout	
Energy Efficiency of Building Materials / Construction Methods	
Reclamation of Building Materials	
The Coordination Degree of New and Old Buildings	
Ground Condition (Soil Classification)	

CRITERIA FOR ECONOMIC STRUCTURE

Which indicators for the criteria related to economic structure do you think should be used in urban transformation strategies? (Please mark at least 2 criteria under this group)

3) Select Economic Structure Indicators.

Mark the Indicators You Selected.

Land Compensation	
Land Speculation	
Land Value	
Land Revenue Condition	
Allowing municipalities to fund urban transformation projects with long-term bond issuance	
Gross Development Value	
Growth (Rate of Profitability, the Shareholder Gain, Increase in the Rate of Sales, Cash Flow)	
Dynamic Investment Payback Period	
Economic Efficiency	
Real Estate Fair Values	
Amount of Property Tax	
Energy Consumption	
Inflation Rate	
Opportunity Cost	
Financial Internal Rate of Return (FIRR)	
Financial Net Present Value (FNPV)	
Financial Sustainability	
Financing Requirement	
Gross National Product	
Development of Financial Instruments such as Transfer of Development Rights, Transformation Certificates, etc that can be converted into Real Estate Certificates	
Deepening of Real Estate Certificate (REIC) markets and public REIT institutions becoming stakeholders in transformation projects	
Income Level	
Income and Expense Analysis	

Repayment Period	
Existence of Shadow Prices	
Household Expenditure Rate	
Number of Jobs Created Per 1000 Square Meters	
Return of the Construction and Operating Costs	
Employment Structure	
Labor Opportunities	
Operation Cost	
Unemployment Rate	
Female Employment Rate	
Public Finance	
Profitability (Increase in Market Share and Return on Resources)	
Amount of Value Added Tax	
Redevelopment and Revitalization of the Lost Economic Activity	
Informal Economy	
Economic Values to be Provided to the City	
Urban Renewal Cycle	
Rent	
The Level of Rental Income	
Personal Disposable Income	
Housing Finance	
Mortgage Loan	
Housing Affordability Rate	
Housing Subsidies	
Access to Housing, Affordability and Choice	
Loan Payment Period	

Credit and Financing Support	
Reputation and Income of Corporate Improvement	
Budget and Staff Structure of the Institution	
Net Employment Density	
Net Population Density	
Correct Calculation of Final Estimates	
Number of New Enterprises Created	
Median Family Income	
Retail Impact Assessment	
Funding Opportunities to Balance between High Return and Low Return Regions in Project Finance	
Interim Payments Received During the Project Implementation	
Construction Cost of the Projects	
Amount of Rent Subsidy in Risky Buildings (TL)	
Correct Calculation of Requested Cost	
The Level of Compensation and Resettlement Cost	
Number of Jobs and Enterprises Created	
Net Jobs Created (Percentage of Employees from Local Area)	
Rate of Return on Investment (ROR)	
Investment Cost	
Time Management	

CRITICAL FOR SOCIAL STRUCTURE

Which indicators for social structure criteria do you think should be used in urban transformation strategies? (Please mark at least 2 criteria under this group)

4) Select Social Structure Indicators.

Mark the Indicators You Selected.

Access to Open Space - Average Journey Time By Foot	

Ratio of Active Population	
Socio Economic Status of the Area	
Historical and Cultural Value Data of the Area	
Segregation	
Dependency Ratio	
The Existence of Interdependent Communities	
Cultural and Local Characteristics of the Region	
Growth Rate	
Birth Rate	
Life Expectancy at Birth (In Years)	
Occupancy Rate	
Access to Educational Needs - Average Journey Time by Foot	
Access to Leisure Facilities - Average Journey Time by Foot	
Accessibility to Nearest Child Care Centre	
Life Without Disabilities	
Integration and Social Inclusion	
Owner Occupation	
Activity Rate	
Extended Family	
Hidden Household	
Immigration Status	
Demographic, Socio-Economic Structure of the People	
Public Needs and Expectations	
The Degree of Public Participation	
Public Concerns and Anxieties	
Mobility (Ability to Change Location)	

Enhancing Employment Opportunities	
Ratio of Tenants	
Average No. of Rooms Per Person	
The Degree of Improvement in Culture and Education	
Planning Common Areas in Neighborhoods and Building Groups	
Current Population Density and Distribution	
The Perfect Degree of Base and Public Facilities	
Population (Economically Active Population)	
Population (Economically Inactive Population)	
Population (Night Population)	
Population (Youth Population)	
Population (Day Population)	
Population (Total Population)	
Population Decrease	
Population Risk Status (day and night)	
Post-Secondary Education Rate	
Student-Teacher Ratio	
Access to Retail Facilities - Average Journey Time By Foot to CBD	
Social Values that the Projects will Provide to the City	
Social Permeability Condition	
Social Cost	
The Degree of Social Welfare Improvement	
Social Harmony and Stability	
Proximity to Crime Scenes (Hotspots)	
Historical and Cultural Values and Inheritor of Urban Style	
Public Transport Links - Walking Distance to Nearest Facilities	

Community Group Involvement	
Community Satisfaction	
Cleanliness, Safety and Belonging of the Community	
Consensus Building	
Access to Free Education	
Citizens' Expectations and Approaches from Urban Transformation	
The Degree of Living Conditions Improvement	
The Degree of Living and Entertaining Improvement	
Sense of Place	
Development of Social Programs for Poverty Reduction	

CRITERIA FOR ENVIRONMENTAL STRUCTURE

Which indicators for environmental structure criteria do you think should be used in urban transformation strategies? (Please mark at least 2 criteria under this group)

5) Select Environmental Structure Indicators.

Mark the Indicators You Selected.

Number of Trees in the Area and Tree Fee Amount (TL)	
Separation of Waste at Source and Possibility of Recycling	
Building Energy Efficiency	
Building Efficiency Accelerator (BEA)	
Energy Efficiency of Building Layout and Design	
Biological Diversity	
Protection of Environmental Values	
Environmental Quality Improvement	
Connecting Natural and Open Spaces	
Ecological Footprint	
The Degree of Ecological Environment Impact	

Ensuring land use integrity to protect the ecological balance and ecosystem	
Energy Storage and Energy Efficiency	
Water Consumption Per Capita Per Day	
Presence of Air Pollutants	
The Degree of Improvement in Urban Landscape Features	
Electricity Consumption Per Capita	
Possibility to Reuse and Recycle Materials	
Making the Right Design for Minimum Waste	
Prevention of Soil Pollution	
Choice of Local/Regional Materials	
Green Energy Applications	
Opportunity to Sort Hazardous Wastes Before and During Demolition	

CRITERIA FOR LEGISLATION AND INSTITUTIONAL STRUCTURE

Which indicators do you think should be used in urban transformation strategies for legislative and institutional structure criteria? (Please mark at least 2 criteria under this group)

5) Select Legislation and Institutional Structure Indicators.

Mark the Indicators You Selected.

Rate of Inclusion in the Scope of Law No. 2981	
Legal Status of the Area	
Whether the area is suitable for construction	
Damage to Infrastructure or Superstructure	
Municipality Council Decision Making	
Existence and Status of Building Regulations	
Whether there is a Construction with Risk of Loss of Life and Property	
Whether there is a Ground Structure with Risk of Loss of Life and Property	
Existence and Status of Environmental Impact Assessment	

Existing Of Nature Reserve	
Ensuring Public Participation	
Shared Ownership Asset	
Whether there is an Improvement Plan	
Evaluation of Spatial Regional Plan, Strategy Plan, Sectoral Investment Decisions of Relevant Public Institutions	
Political Preference of the Head of the Relevant Institution	
Ratio of By-Low Housing	
Easement	
Development Plan	
Public-Private Partnership	
Protection of the Public Interest (Effective, Efficient and Transparent Use of Resources)	
Compulsory Purchase	
Whether Urban Transformation Works Can Meet the Existing Building Density	
Existence and Status of Protected Areas	
Neighborhood Organization Status	
Whether it is one of the areas subject to special laws	
Whether it is a Special Status Area	
Status of Groups to Participate in the Planning Process	
Inadequate Planning or Infrastructure Services	
Risk Status (Loss of Life, Economic Loss, Environmental Impacts, etc.)	
Necessity of Zoning Right Transfers for Right Holders in the Risky Area	
Presence of Social Infrastructure and Technical Infrastructure Area	
Defining and Establishing the Participation Model in the Process	
Existence and Status of Implementation Plan	
Ensuring Effective Use of Green Settlement and Green Building Certificates	

CRITERIA FOR PLANNING AND DESIGN AND TECHNOLOGICAL STRUCTURE

Which indicators do you think should be used in urban transformation strategies for planning and design and technological structure?

(Please mark at least 2 criteria under this group)

5) Choose Planning and Design and Technological Structure Indicators.

Mark the Indicators You Selected.

Public Transport and Car Ownership Per 1,000 Capita	
Planning by Considering Disaster Risks	
Planning of Disaster Muster Areas and Evacuation Corridors	
Participation of Actors in the Process	
Considering and Designing the Area with a Neighborhood Approach	
Current Usage Functions of the Area	
Planning The Area in Harmony with The Land Use Pattern in Its Immediate Surroundings	
Ensuring a Balanced Distribution of Social and Technical Infrastructure Equipment Areas in the Near Environment of the Area at the Settlement Level	
Land Use Intensity	
Capacity of Information Systems (Database Management)	
Buildings Constructability	
Vacant Parcel Rate	
Protection of the Natural Water Cycle and Habitat Areas	
Conservation of Natural Topography	
Planning Affordable/Rentable Housing Types for Low and Middle-Income Groups	
Number of Parcels Implemented According to Article 18 of the Zoning Law and Attrition Rates (%)	
Human Scale	
Floor Area Ratio	
Preservation and Enhancement of City Skyline	
Preferring Regions with 5-15% Slope Priority for Settlement in Urban Transformation Areas	

Urban Renewal Development Potential	
Urban Transformation Plan Decisions Are Compatible with Upper Scale Plan Decisions	
Creating Urban Center/Attraction Point	
Public Green Area Per Capita	
Residential Floor Area Per Capita	
Housing Areas are at a Walkable Distance to Public Transportation Systems	
Housing Stock Conditions	
Access to Cultural Facilities - Average Journey Time By Foot	
Observing Spatial Harmony	
Number of Floors of Existing Buildings	
License Status and License Years of Existing Buildings	
Current Occupancy-Vacancy Status	
Request for Increase in Existing Development Rights	
Existing Implemantation Plan Rights	
Number and Size Distribution of Existing Parcels	
Building Construction Area Status of Existing Buildings	
Capacity and Distribution of Parking lots	
Proposed Implemantation Plan Rights	
Number of Independent Units of the Buildings According to the Proposed Plan	
Distance to Proposed Reserve Building Areas	
Access to Medical Facilities - Average Journey Time By Foot	
Location Selection of Social and Technical Infrastructure Areas Suitable for Population Density and Accessibility	
Development of Housing Typologies Compatible with Social-Cultural Life and Local Architectural Heritage	
Technological Capability	
Technological Resources (People, Equipment, Information, Money, etc.)	

Density Gradation Compatible with Topography and Land Use Factors	
Increasing Life Quality and Urban Prosperity	
Horizontal Architecture	
Compliance of the Transportation Structure of the Settlement with the Existing Zoning Plan and Transportation Master Plan	
Designing The Settlement at A Density Compatible with The Human Scale	

CRITERIA THAT MAY BE RECOMMENDED BY RESPONDENTS

In this section, which is reserved for criteria that can be suggested by the respondents, you can add which indicators you think should be used in urban transformation strategies in the groups below.

This section is not mandatory and is left to the preference of the respondents.

Physical Structure Indicator

(Must be entered as a descriptive indicative name.)

Economic Structure Indicator

(Must be entered as a descriptive indicative name.)

Social Structure Indicator

(Must be entered as a descriptive indicative name.)

Environmental Structure Indicator

(Must be entered as a descriptive indicative name.)

Legislation and Institutional Structure Indicator

(Must be entered as a descriptive indicative name.)

Planning and Design and Technological Structure Indicator

(Must be entered as a descriptive indicative name.)

Confirmation message

Thank you for taking the survey and for your answers.

VITA

PERSONEL INFORMATION

Name Surname **:** Uğur BOZKURT

EDUCATION

Ph.D. : Doctor of Philosophy in City Planning, Izmir Institute of Technology, The Graduate School, Department of City and Regional Planning (2023).

M.Sc. : Master of Urban Design, Izmir Institute of Technology, Graduate School of Engineering and Sciences, Department of City and Regional Planning (2004).

B.S. : City Planning, Dokuz Eylül University, Faculty of Architecture, Department of City and Regional Planning (1999).

PROFESSIONAL AND ACADEMIC POSITIONS HELD

Urban Planner : Bornova Municipality, Directorate of Planning and Project (February 2012–Present)

Research Assistant : Izmir Institute of Technology, Faculty of Architecture, Department of City and Regional Planning (December 2001 – February 2012).

Visiting Student Researcher (The Fulbright PhD Dissertation Research Scholarship Program): Texas A&M University, College of Architecture, The Department of Landscape Architecture and Urban Planning, Hazard Reduction and Recovery Center. Academic Advisors: Prof. Dr. Michael K. Lindell, Dr. Carla Prater (August 18, 2009 – June 17, 2010).

PUBLICATIONS

National Journal Paper

Bozkurt, U. 2011. “A Research Method for Comparing Cost-Benefit Ratio of Sustainable Hazard Mitigation Strategies and Current Situation of Pre-Disaster Risk for Seismic Prone Urban Areas”, Dosya 26 Disaster and Architecture, Chamber of Architects Ankara Branch Publication, Ankara.

National Conference Proceedings

Özdemir, S., İ. Özkeresteci, K. Kutluca, U. Bozkurt, R. Bolposta, and İ. Elvan. 2006. "Yerel Potansiyellerin Değerlendirilmesinde Stratejik Planlama Yaklaşımı: Karaburun Yarımadası İçin Turizm Alternatifleri", in the Proceedings of Tourism and Architecture Symposium, Turizmde Sosyal, Kültürel Fiziksel Gelişmeler, Sorunlar ve Öneriler, The Chamber of Architects of Turkey, Antalya (April 28–29, 2006).

Unpublished Conference Proceedings (International)

Bozkurt, U., K. Velibeyoğlu. 2019. The Effectiveness Indicators of Different Urban Transformation Strategies in Earthquake-Prone Areas Uluslararası Afet ve Dirençlilik Kongresi, 26-28 June 2019, Eskişehir Teknik Üniversitesi, Eskişehir.

National Seminar Presentations

Yılmaz, E., S. Kutucu, U. Bozkurt. 2006. Presentation of Bursa Santral Garaj Urban Square Project, Yıldız Meeting 2006, in Uludağ University, Faculty of Architecture, Bursa (December 15, 2006).

ACADEMIC AND PROFESSIONAL AWARDS

1st Prize in "İzmir Karabağlar Municipality Public Open Space and City Square Urban Design Project Competition", İzmir (2017).

Equivalent 1st Prize "Gaziemir Aktepe and Emrez Districts Urban Transformation Area, Urban Design and Architectural Concept Project Competition", İzmir (2015).

1st Prize in "National Design Project Competition on the Urla-Çeşme-Karaburun Peninsula, Izmir, Türkiye" (2008).

1st Prize in "Architectural and Urban Design Project Competition in the Santral Garaj District, Bursa, Türkiye" (2005).