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PERFORMANCE EVALUATION OF COMPANIES WORKING ON CONSTRUCTION AND URBAN TRANSFORMATION WASTES: THE CASE OF THE CITY OF IZMIR

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ABSTRACT

PERFORMANCE EVALUATION OF COMPANIES WORKING ON CONSTRUCTION AND URBAN TRANSFORMATION WASTES. THE CASE OF THE CITY OF IZMIR

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Due to the increasing population and migration from rural areas to cities, the city population is increasing, and cities that cannot expand horizontally due to natural or human reasons have had to expand vertically. For this reason, the number of constructions and the amount of waste load increased significantly. On the other hand, due to the decrease in the world's resources and pollution, resources are gradually decreasing, so it is important to use and recycle resources more efficiently. With this research, studies on the recycling of construction wastes will be examined and the performances of companies will be evaluated. To achieve this aim, first of all, a set of criteria will be determined in order to compare the companies, and the weights of these criteria will be calculated with the help of the Analytical Hierarchy Process (AHP) and expert opinions. Then, using this calculated GRA model, evaluation and ranking will be made among these companies.

Key Words: Urban regeneration, Recycling, Land management, Recycling of resources, Waste management, Gray Relational Analysis (GRA), Analytical hierarchy process (AHP)

ÖZ

İNŞAAT VE KENTSEL DÖNÜŞÜM ATIKLARI ÜZERINDE ÇALIŞAN FIRMALARIN PERFORMANS DEĞERLENDIRMESI. İZMIR İLİ ÖRNEĞİ

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Artan nüfus ve kırsal alanlardan kentlere göç nedeniyle kent nüfusu artmakta, doğal ya da beşeri nedenlerle yatay olarak genişleyemeyen kentler dikey olarak genişlemek zorunda kalmıştır. Bu nedenle inşaat sayısı ve hafriyat yükü miktarı önemli ölçüde artmıştır. Öte yandan dünya kaynaklarının azalması ve kirlilik nedeniyle kaynaklar giderek azalmakta, bu nedenle kaynakların daha verimli kullanılması ve geri dönüştürülmesi önem arz etmektedir. Bu araştırma ile inşaat atıklarının geri dönüşümüne yönelik çalışmalar incelenecek ve hafriyat firmalarının performansları değerlendirilecektir. Bu amaca ulaşmak için öncelikle firmaların karşılaştırılması için bir dizi kriter belirlenecek ve Analitik Hiyerarşi Süreci (AHP) ve uzman görüşleri yardımıyla bu kriterlerin ağırlıkları hesaplanacaktır. Daha sonra hesaplanan bu GRA modeli kullanılarak bu şirketler arasında değerlendirme ve sıralama yapılacaktır.

Anahtar Kelimeler: Kentsel dönüşüm, Geri dönüşüm, Arazi yönetimi, Kaynakların geri dönüşüm kullanımı, Atık yönetimi, Gri İlişkisel Analiz (GRA), Analitik hiyerarşi süreci (AHP)

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I would like to express my enduring love to my parents, who are always supportive, loving and caring to me in every possible way in my life.

İzmir, 2021

TEXT OF OATH

I declare and honestly confirm that my study, titled “Performance Evaluation of Companies Working On Construction and Urban Transformation Wastes. The Case of the City of Izmir.” and presented as a Master’s Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

September 7, 2021

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SYMBOLS AND ABBREVIATIONS

CDW: Construction and Demolition Waste

AHP: Analytical Hierarchy Process

GRA: Gray Relational Analysis

VAT: Value Added Tax

TOKI: Toplu Konut İdaresi Başkanlığı

CHAPTER 1
INTRODUCTION

Waste management is a method developed to optimize dwindling world resources. In this regard, studies were conducted primarily to measure the recyclability of materials (Villalba et al., 2002). With the concept of circular economy developed later, these studies started to gain momentum (Huysman et al., 2017). Within this developing process, waste types were also divided into areas such as domestic waste, industrial waste, agricultural waste, construction and demolition waste, hazardous waste, medical waste, and special waste (Gündüzalp and Güven, 2016). In this study, a study will be conducted on the recycling of construction and demolition wastes and the performance of companies engaged in this business.

Urban transformation/renewal is one of the main causes of construction and demolition waste. In order to build the houses needed by the increasing population, the old buildings must be transformed and the new buildings must be sustainable in order not to repeat this situation. (Yıldız et al., 2020) studies explain what needs to be done for sustainable urban transformation. Urban transformation in Turkey first started to prevent squatting (Tekeli, 2011). Later, with the construction sector being the backbone of the Turkish economy in the following stages, it was taken under control by the institutions established by the state and the laws enacted (Yenice,2014).

In this research, firstly, information about this urban transformation will be given, then information will be given about wastes and their content, calculation, separation and reuse processes will be mentioned. After all these explanations, the three research questions of this thesis can be summarized as follows;

- Which criteria should be used in the performance evaluations of companies related to construction waste and recycling?
- What is the current performance status of these companies?
- Do private or public companies work more efficiently in recycling construction waste?

To answer all these questions, the following way will be followed; First, all the data that can be obtained by applying to state and private companies will be obtained, then criteria set will be created by making a literature search and determining the ones that can be useful from these data. After this part, the evaluation phase, which is the most important part of the research, will be applied. In the evaluation part, the analytical hierarchy process (AHP) and gray relations analysis (GRA) will be implemented. The reason for choosing AHP in this research is that there is a hierarchical link between criteria and companies. Experts will be consulted regarding the criteria for AHP to give proper results. In order to evaluate the results from here, the gray system evaluation system GRA will be used. After that, as a final step, the results about the companies will be evaluated and compared.

Thesis study is organized as follows. After the introduction, information about urban transformation will be given, the importance of urban transformation, its causes, methods, application differences according to countries, the current situation in Turkey will be explained. In the next part, after first mentioning waste management, recycling and R activities carried out within this scope will be mentioned and construction and demolition wastes and separation, calculation, and recycling activities related to these wastes will be mentioned. In the third part, the methods to be used will be introduced and a literature study will be made about the studies related to these methods. In the next part, the criteria will be determined, then the application of the study will be done and the result will be obtained. Finally, discussions and applications will be written and a conclusion will be given to the study.

CHAPTER 2

URBAN RENEWAL/TRANSFORMATION

Urban renewal is an environmental management technique. This technique is due to insufficient transportation, unplanned urbanization, sanitation, urban decay, population growth, natural disasters, and changes in the social and demographic environment (Olabisi, 2013). Many researchers define this process as a 'living entity', (Broudehoux, 1994). There is not a single concept of urban transformation in the world, and it is different in approaches to urban transformation. Studies about urban transformation generally focused on two types. The first of these are technical studies dealing with issues such as the Utilization of land and sources, the renovation of the city, and the use of abandoned places. Studies in this field deal with urban design such as Infrastructure, Housing, Land, Heritage, (Zheng et al., 2014). The second type of research examines the socio-economic and cultural effects of urban transformation. In these types of researches, social justice, demography, social impact, property rights, institutional economic, economy, and legal processes of urban transformation are these studies that focus more on society and people, (Lai et al., 2017).

1.1 Urban Renewal/Transformation Concept and History

Urban transformation is a natural process that has occurred since the first urbanization. Despite this, there was no organized effort by the administrations for urban transformation until the nineteenth century. Baron Georges-Eugéne Haussmann made the first major breakthrough in the field of urban transformation, (Broudehoux, 1994). This work is known today as 'Haussmann's renovation of Paris', (Yücel, 2016). The most important development in Europe, known as the mass urban transformation movement, occurred after the Second World War. Some of the approximately 700,000 buildings were destroyed and some became unusable, (Maçin, 2018). In the US, the urban transformation took place under the leadership of the state collectively with the Housing Act of 1949.

Since urban transformation is affected by many factors such as time, place, location, population, building type, legal structure, so urban transformation does not have a definite format. Urban transformation takes place in nine different formats. Renewal, Conservation, Improvement, Rehabilitation, Clearance, Redevelopment, Infill development, Refurbishment, Revitalization, (Eğercioğlu, 2016; Şişman and Kibaroğlu, 2009)

In a global world, cities are ahead of countries with their assets and functions they undertake; cities stand out in many areas. In fact, some cities are more known than the names of the countries they belong to, and they compete with each other. Everyone in cities has the right to live in a healthy and balanced environment. Simultaneously, the right to housing is the most crucial dimension of the freedom of establishment, which is a personal right. Like countries, cities have their own histories too. If urban transformation is handled with this vision and approach, the place of cities in history can be sustained more effectively and meaningfully (Kaymak and Gürün, 2018).

When the urban transformation is mentioned in Turkey, people usually think more about constructing new apartment buildings instead of unqualified and intact structures due to reconstruction and earthquake risk in slum areas, resulting from illegal and unauthorized construction in the past. However, the meaning of the concept of urban transformation is much broader. It includes the processes of renewing the collapsed areas and historical regions in city centers and reviving them by gaining new functions (Tekeli, 2011).

In different cities of the world and Istanbul, urban transformation and gentrification processes were experienced in different periods and historical areas depending on various reasons and conditions. The state experienced the processes such as the first wave, 1950-1979 classical gentrification, the second wave 1979-1993 capital-based gentrification, the 3rd wave 1993 economic stagnation, and the state's role and the influence of large companies increased recently. Gentrification became globalized after 1980. In Istanbul, the gentrification processes were classical gentrification between 1980 and 2001, capital-based gentrification between 2001 and 2005. State-based gentrification processes gained speed with the Law Numbered in 2005 and the Law Numbered in 2012. However, when it comes to urban transformation in our country, it is understood to improve the slum areas and build safer houses against earthquakes.

1.2. Reasons and Necessity of Urban Transformation

In some regions, it is caused by humanitarian reasons such as economy, demography, social and cultural reasons; while in some regions it is caused by natural causes such as geography and natural disasters. The purpose and reason for urban transformation may differ according to human and natural causes.

1.2.1 Human Reasons

Urban transformation has many different reasons around the world. Demographic changes, migrations, population growth, and the need for new areas are some of the reasons. Physical changes; Aging structures, straining, and deterioration problems are yet another critical factor as well. Especially macroeconomic changes; Factors such as political, economic developments, standardization, the domination of automobile and electronic equipment companies, and the evacuation of urban centers worldwide after the first world war are also a significant cause of urban transformation (Roberts and Sykes, 2000).

Technological changes; the rapid spread of transportation systems and all kinds of transportation systems, the regions' economic specialization, the separation of industrial zones and agricultural areas are other essential factors in urban transformation. Political changes like 19th-century westernization and 20th-century modernization movements, globalization, capital decisions, and so on cause urban transformation. The problem of shanty settlements and natural disasters such as earthquakes has been experienced in our country, especially in developing countries, which have become other important causes of urban transformation (Görün and Kara, 2010).

In the world, urban populations are increasing rapidly with high-speed population growth and migration from rural areas to cities. Every month, five million people migrate from rural areas to cities around the world. If this migration does not stop, the urban population will increase by 1.4 billion within two decades (Yıldız et al., 2020).

According to the World Bank data, the urban and rural population growth from 1960 to 2019 is as follows; According to the report, while 1.019 million people lived in the city in 1960, this number increased to 4.274 million in 2019. According to the same data, while 2.012 million people lived in rural areas in 1960, this number increased to 3.397 million in 2019. While the urban population increased by 4.19 times in 49 years, the rural population increased by 1.69 times. While the rate of urban population was 50.65% compared to rural population in 1960, this rate increased to 125.92% in 2019.

The population explosion has brought many infrastructure and social problems. The main ones are; inclusion of arable land called 'wetland' into cities. Inadequate water treatment facilities, insufficiency of infrastructure, and sewage facilities. Lack of green areas in cities, more people are affected by the harmful gas emissions that are made by combining industrial areas with cities. Inadequate public transport due to traffic density and population resulting from the increase in the number of vehicles. With the increase in the population, the decrease in workers' wages, and the formation of commercial problems. The emergence of homeless people with housing shortages. Insufficiency of public facilities; Insufficiency of health services due to hospital shortage. Increase in crime rate due to insufficient security institutions, (Liu et al., 2019). Apart from these, it takes an important place in urban transformation due to economic reasons. With the formation of megacities, the population density has increased significantly. There has been a large increase in rent and land value, as the city population and the size of the city did not increase equally. Studies show that land rent and value in cities increase much more than in rural areas (Hardie et al., 2000), this difference creates an economic rent and disrupts the social balance. The main reason for this difference is the fact that there are few houses and very human beings because of the imbalance between supply and demand. This situation creates an economic rent and disrupts the social balance. Considering all these factors, it helps to eliminate social, economic, and environmental problems that may be an urban transformation.

Urban transformation continues to be experienced depending on this age's requirements, especially in today's cities where production and consumption are very high, and urbanization is much faster. Depending on these urban transformation processes, cities continue to change physically and socially. While managing these processes, our cities' history is well read, and the stronger our future imagination, the better the urban transformation practices will be. Accordingly, urban transformation studies will be successful as they are carried out following our beliefs, culture, and values rather than being rent-based.

1.2.2 Natural Causes

Many natural disasters such as hurricanes, tsunamis, volcanic eruptions, earthquakes, hurricanes, storms, floods occur every year in the world. Because of these disasters, life and property records are experienced. Natural disaster risk was mentioned in 'The World's Cities in 2018' data booklet published by the united nations. According to this study by the United Nations on six types of disasters (drought, flood, landslide, earthquake, cyclones, and volcanic eruptions), 679 of 1149 cities (59%) with a population of more than half a million are at high risk of experiencing at least one natural disaster. In addition, 189 cities most of which are located by the sea, are under the risk of two types of natural disasters. Twenty-six cities, most of which are on the Pacific coast, are at risk of three or more natural disasters. This shows that 1.4 billion people live against the risk of disaster. (Un the worlds cities in 2018 data booklet) Figure 1 shows the population and risk numbers of cities.

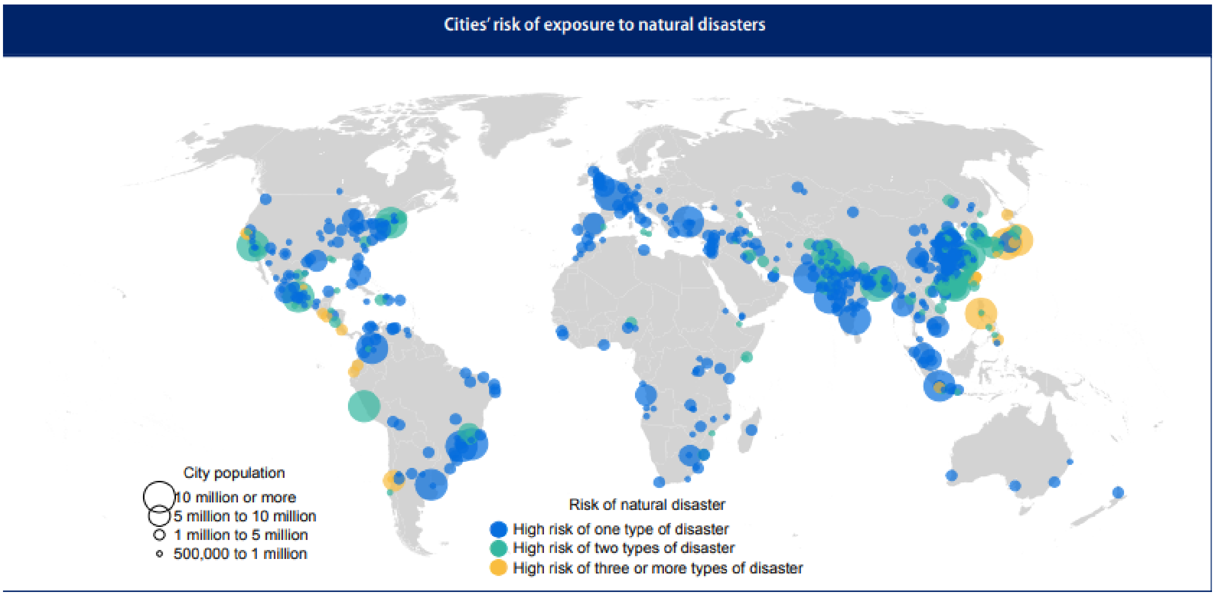

Fig. 1 Cities' risk of exposure to natural disasters

Source: The World's Cities in 2018 United Nations Data Booklet

Countries have set up many emergency response centers to deal with disasters. Some of the most well known, for example, in the United States Federal Emergency Management Agency (FEMA), the India National Disaster Management Authority (NDMA), Australia at The Australian Institute for Disaster Resilience, Disaster and Emergency Management Presidency of Turkey (AFAD) institutions are established. Natural disasters are unpredictable, but some types of disasters are annual or seasonal and these can be predicted as time. (Ladds et al., 2017) research shows; spent an average of $ 1.75 billion a year on natural disasters between 1967 and 1999 in Australia, Property loss from natural disasters in Australia; It consists of 28.9% floods, 26.2% storms, and 24.5% cyclones. Since these disasters are seasonal, it is easier to take precautions and protect than sudden disasters. In natural disasters, earthquakes occur regardless of time, but since they will occur where the fault lines pass, it can be predicted in which regions earthquakes will occur. However, some earthquakes can result in serious financial losses and risks. 2011 Great East Japan Earthquake approximately 1,150 It cost billion yen ($ 9.5 billion) and posed a major risk of nuclear danger from the Fukushima Daiichi nuclear power plant, (Sasao 2016). Thanks to urban transformation, it is aimed to build buildings that are far from or more resistant to these natural disasters.

The urban transformation takes place in our country for many reasons. However, since our country's cities are primarily located in an earthquake zone, and the buildings were not built as earthquake-resistant in the past, the first thing that comes to mind is earthquakes when the urban transformation is mentioned. There have been intense migrations from rural areas to cities after 1950, primarily due to economic and technological reasons, and after 1980 due to political reasons and terrorism. Due to these intense migrations, slums have emerged in the cities. Later, these slums turned into apartment buildings. These apartments were, as in the slums, unlicensed and unauthorized floors were built. Therefore, in general, buildings, without being bound by the earthquake and building regulations, without scientific engineering service, have created much building stock in cities in this way (Ergün, 2005) Today, during the urban transformation process, these buildings are demolished and replaced by earthquake-resistant structures. However, since such non-earthquake-resistant structures were built in many cities, especially in Istanbul, the urban transformation has become a state policy in our country. All relevant institutions of the state and all municipalities have been involved, and the scale of urban transformation has increased very much in this context. Due to all these, when an earthquake is mentioned, urban transformation comes to mind in our country, and urban transformation studies are carried out for this reason (Kılıç, 2006).

Urban transformation is done for specific reasons. It is anticipated to eliminate the physical, social and economic differences between the neighborhoods. Elimination of problems such as urban poverty and social exclusion is also seen as a requirement of urban transformation. Besides, in addition to reconsidering the urban life quality standards, lowering the building density and minimizing possible earthquake damages are seen as fundamental reasons for urban transformation (Mehanna and Mehanna, 2019). The cities we live in have reached today by carrying their histories with them. The cities' historical background and historical structures are identified with the city, and it is vital to protect them well. Being aware that the textures that have survived to the present day constitute the identity of cities and bear traces older than buildings, what should always be done in urban transformation studies, we should preserve all this historical past, preserve all the elements that make up the texture such as buildings, topography, and altitude (Yılmaz, 2016).

Urban transformation in Turkey has a larger scale; Its structure, content, meaning, and scope have expanded enormously. It continues as a process in every area in cities depending on many factors and has continuously changed. Urban transformation is about structuring and includes many social, cultural, political, psychological, economic, and social aspects. The urban transformation studies in Turkey should be made considering all these factors and specified reasons.

Urban transformation in Turkey's cities is dependent on the risk of earthquakes, but population growth and rapid urbanization are also the factors that press this process. Renovation of the old stock is gaining significant importance in metropolitan cities with increasing housing demand. Urban Transformation and Turkey Report prepared in 2014 estimated that approximately 6.7 million housing units will be destroyed and rebuilt throughout the country over the next 20 years. This corresponds to approximately 334,000 units per year. Approximately 44 billion TL of funding is required annually for the cost of demolition and reconstruction alone (Pakdemir, 2014).

The statement made by the Ministry of Environment and Urbanization supports the information above. It is stated that 6.7 million houses will be transformed in 20 years, there will be 300 thousand housing transformations every year, and 75 billion TL has been allocated for five years for this purpose. Again, in the statement made, it is more clearly understood how much effort we need to make for the transformation of 6.7 million houses, considering that a total of 550 thousand houses have been renovated within the scope of urban transformation since 2012, that is, the day the Law numbered 6306 was published.

1.3 Application Methods Regarding Urban Transformation

Urban transformation is the general name of the applications carried out to renew the existing urban structure. However, in urban transformation, there are different forms of implementation depending on the current conditions. In the implementation of these forms of application, different approaches have emerged. The main reason for this is that different disciplines are related to the subject and each project region has its own conditions and characteristics in different countries (Zheng et al., 2014)

These different forms of application are included in the concept of urban transformation; Spatial cleaning, revitalization, gentrification, quality improvement, renewal, redevelopment, and rehabilitation. All of these concepts whose functions, subjects, purposes, and methods differ from each other to a certain extent are used in bringing the outdated or about to be outdated areas of the cities to both society and economy (Polat, 2015). The application methods of urban transformation are summarized below.

Urban Clearance: In urban clearance, the collapsed area is completely cleared and replaced with new structures. A collapsed area is also part of the city. The texture is completely lost, and a new texture is formed in its place. The land is generally expropriated—the unhealthy qualities of the areas consisting of ruined buildings and where the low-income people reside (Lai et al., 2018).

Revitalization: It is the revitalization of the collapsed area with some changes. It is aimed to revitalize the urban areas that have lost their vitality in the past, especially the historical city centers, with various social practices. With this concept, it is expressed that urban areas, which have entered the period of physical collapse and abandoned, are brought back to life by eliminating the factors that cause the collapse (Taherkhani et al., 2021).

Gentrification: It is the region's renewal by changing the social tissue to save the collapse area. The gentrification method occurs in the city centers by the renewal of the built environment, the separation of the former inhabitants of the region, and the settlement of middle and upper class people in these areas. With this policy, with the settlement of middle and upper class people in urban centers with historical identity, the spaces physically recover, and the region gains a new identity (Es, 2012).

Gentrification involves the displacement of middle- and high-income housing users with low-income housing users, and the result is physical, social, and cultural changes. With globalization policies' effect every day, urban space stands out among the places where capital accumulation is used the most. This situation causes the cities to take new forms in line with the capital's expectations and rules in planning and to implement the city. In the historical buildings of the coastal part of Istanbul; After the 1980s, the transformation process that took place in districts such as Ortaköy, Cihangir, Kuzguncuk, Arnavutköy, Beyoğlu, Fener, Balat, and Galata, which have both historical and original characteristics and which have collapsed over time, has been such a transformation (Islam, 2009).

Improving the Quality: It is an intervention in which people improve the physical environment. Old houses are demolished and rebuilt following the rules determined, depending on the owners' initiative, legal regulations, and state support. Here, in particular, the owners of houses agree and contract with construction companies. The municipalities' legal regulations should be made very carefully as there is often the case of building extra floors.

Renewal: Urban renewal means the reconstruction of all or part of the buildings in areas where it is impossible to improve the living and health conditions in terms of the state of existing buildings (Hui et al., 2018). A need for renewal arises in the aging areas of cities that are born, grow and change just like living beings. Urban renewal, which is realized to meet this need, should be renewed in a way to meet the needs of the users and the needs of the users of the urban areas that have been physically, economically, and socially collapsed in time, lost their function, value, and quality. For the city to have a healthy structure, urban renewal, in the sense of correcting, repairing, or completely rebuilding the buildings, streets, and infrastructure systems in the urban area are needed in the outdated parts of the city.

Redevelopment: Redevelopment is the demolition of houses whose economic and structural features have deteriorated. It does not allow improvement, and the construction of the city parts formed by them with a new architectural design. The work to be done here involves long processes. Mainly, this transformation can take place with the leadership of the public. New structures replace existing structures in a completely different architectural style (Lai et al., 2017).

Rehabilitation: With the rehabilitation work, partial renewal is made in the collapse area, and the structures that damage the original quality are removed. Environmental conditions inside and outside the residences are improved. Urban improvement refers to the use of old urban texture and rift areas by subjecting to partial renovation. In the studies, to save the buildings that cannot fulfill their functions properly in a settlement from this situation, especially the uninhabitable and old residential areas, are made more qualified and habitable. Elimination of all contradictory construction that damages urban areas' original qualities is carried out to ensure urban improvement. Urban improvement, which aims to improve the buildings both physically and functionally, makes the region healthier (Hui et al., 2018).

In Turkey, municipalities, central government, private sector, and citizens carry out urban renewal projects of various types. Considering the scope and implementation of these projects, Urban transformation projects are carried out due to transformation, gentrification, the transformation of central business areas, transformation with prestigious projects, preservation of protected sites and transformation for tourism purposes, transformation initiated by the public and primarily appealing to the middle-income group, natural disasters in rift areas and slum areas (Ertaş and Bayındır, 2020).

In this globalizing world, cities are reshaped by transforming physically, socially, and culturally. There is fierce competition between cities in many ways. In this race, cities see the urban transformation process as an opportunity and aim at transformation and innovation in physical space. With the urban transformation, abandoned rift areas in the city are revitalized, the city is developed healthily and effectively, the city's economy is strengthened, and its quality of life is increased. Depending on all these, it aims to develop the city in a planned way, has multi-participation and secure investment opportunities, and become an important center of attraction with the urban transformation studies.

1.3.1 Urban Renewal/Transformation purpose

Urban transformation is carried out in line with specific goals. Based on this, there is always the goal of better and healthier housing, more livable and sustainable cities. Goals must be set out first in urban transformation. The historical texture's sustainability should be ensured by stopping the city's physical collapse regarding the historical and old residential areas. Besides, another goal should be dynamism and vitality to economic life. Again, it is an important goal to increase the quality of urban life. In addition to all these, activating the dynamics based on culture and ensuring social participation at all scales are stated as the goal of urban transformation (Huang et. al, 2020).

In urban transformation projects, rightful owners living there should not be victimized or displaced. In urban transformation projects, studies should be carried out, taking into account the people's solvency. In urban transformation projects, tenants should not be ignored, and they can be allowed to take advantage of certain rights to be homeowners. An environment should be created for the beneficiaries to participate in the projects to contribute to the urban transformation project, follow the processes closely, and express their opinions easily. While preparing urban transformation plans and projects, the area to be studied should be considered. Still, critical importance should be given to the point of its place in the city as a whole, and planning should be aimed not to isolate that area from the city. Urban transformation projects should be carried out not for economic benefit, without displacing the people residing there, setting targets in a way that covers the economic, social and cultural situation of the people, and which is suitable for the beliefs, values, and lifestyles of the people (Adams and Hastings 2001).

The urban transformation has sustainable goals with its economic, social, and environmental dimensions. Efforts can be made to efficiently use the land, increase job opportunities, attract new investments, and transform traditional trade and industry. It includes protecting local characteristics in social aspects, creating social environments, improving living conditions, building residences and public buildings according to needs and culture, and increasing job opportunities. Environmental objectives reveal approaches such as physical improvement of the built environment, the establishment of environmental infrastructure, and the protection of natural structure and resources (Almedia et al., 2018).

Our country's urban transformation goal is to eliminate the unqualified and non-earthquake-resistant building stock in cities. In addition, it is to create a more livable environment and environment. These conditions are provided to a certain extent. Still, urban transformation's main goal should be to build low-rise houses and reinforcement areas that will make people happy and peaceful, suitable for our neighborhood culture. However, since this is not done, urban transformation studies' main goal cannot be reached.

1.3.2 Urban Renewal Examples in the Word

There is no stereotype for urban transformation. Since the reasons, purposes, and methods of urban transformation are unclear, urban transformation is carried out for different purposes in every country and even in different regions. However, since the demographics of developed and developing countries in the world are similar to each other, they can form a certain group for urban transformation.

1.3.2.1 Developed Countries

Although the definition of the developed country differs slightly for organizations such as the UN and World Bank, it can generally be used for sovereign countries with a high gross national product, high gross domestic product, not having infrastructure problems, and leading in education and industrialization. Human Development Report (2019), World Economic Outlook Word Bank (2016). According to the Human Development Index (HDI), the 20 most developed countries in the world are Norway, Switzerland, Ireland, Germany, Hong Kong, Australia, Iceland, Sweden, Singapore, Netherlands, Denmark, Finland, Canada, New Zealand, United Kingdom, United States, Belgium, Liechtenstein, Japan, Austria. Thirteen of these countries are in the European continent, three in the Asian continent, two in the North American continent, and two in the Oceania continent.

U.S. America: Urban transformation in America marked its beginning after World War II. Urban regeneration turned into a federal policy with the 1949 Housing Act. The original aim of urban regeneration in the United States was to build modern homes within the framework of a master city plan suitable for all income groups. Within the scope of urban transformation, private properties for the upper and middle-income groups, public housing for the lower-income group, parks, playgrounds, recreational facilities, and commercial projects were financed in the post-war period. During this period, many commissions such as the New York City Planning Commission (CPC) were established to control these changes, (Zipp 2012). Despite all these investments, commission, and planning efforts, the problem of the slum has occurred. 53 billion dollars in support of 2,100 urban transformation projects to prevent slums, (Collins and Shester 2013). Despite all this, researches show that slums continue in America. (Kahler and Harrison 2020), examined a study led by the University of South Carolina between 1960 and 1985 aimed at eliminating slum settlement in the state of Columbia. (Fairbanks 2002) studied urban transformation and slum settlement in San Antonio, Texas, between 1949-1965.

Hong Kong: It is a Chinese metropolitan area and a special administrative region located in the Pearl River Delta on the coast of the South China Sea. Handed over to P.R. China by the UK on 1 July 1997. Population is 7,392,000 according to 2017 data. Fourth rank in the Human Development Index.

Urban regeneration projects in Hong Kong are carried out first by the Land Development Corporation (LDC) and later by the government agency named Urban Renewal Authority (URA). (Lai et al., 2018) and (Yung and Sun 2020)

In Hong Kong, the state can expropriate the regions it wants by showing reasons such as "public purpose" and "public uses" when it deems appropriate. To give an example of urban transformation in Hong Kong, The Sham Shui Po district in Hong Kong's district famous for the highest population density and lowest rents. In 2016, the average income of a shop here was 20,000$ per month. This amount was the lowest among 18 districts in Hong Kong. That's why URA has created an urban transformation project with three zones and 402 shops in these districts. this project garnered reaction from the public as the projects tend to serve special interest groups rather than the public, despite the expropriation of the lands by the state. As can be seen from this example, although urban transformation in Hong Kong is carried out by the state to increase the value of lands and increase utilization, there are still problems in issues such as Social justice, Property rights. (Lai et al., 2018) and (Yung and Sun 2020).

Germany: Looking at recent history, Germany has a lot of experience in urban transformation and reconstruction. The main reasons for this are the second world war and the division of Germany into two afterward. To the rebuilding of cities after the Second World War. The fall of the Berlin Wall, on the other hand, caused an urban transformation in cities such as Berlin and Dresden. Since all these works were carried out quickly at an early turn and Germany is a developed state, many problems such as infrastructure problems were solved. The urban transformation work carried out by Germany is more focused on areas such as energy planning and sustainability in urban transformation. For example, (Petersen and Heurkens 2018) examined the role of the authorities in energy policies for sustainable urban development and with supports helped young people to submit projects related to urban planning like a Leipzig Charter on Sustainable European Cities (2007).

1.3.2.1 Developing countries

Developing countries are in a good position in most of the issues such as gross national product, gross domestic product, infrastructure problems, education, and industrialization, and have problems in one or more of them. Urban transformation in developing countries is carried out by taking into account the changing and developing country's economy, urban migration, and increases in land values.

China: Since the late 1970s, China's rapid economic growth and urbanization have triggered large-scale urban regeneration. To tackle complex urban problems, urban regeneration, integrated, coordinated, and multi-faceted strategies have been developed involving a wide range of stakeholders. Targeted urban transformation projects are carried out considering the interests of stakeholders (Zhuang et. al. 2019) In past periods of rapid urbanization, the government-led urban transformation was widely used in China for infrastructure and residential construction. Here, urban transformation projects were managed to take into account the interests of property owners and the state, which are the main stakeholders. In the following periods, problems arose regarding rights with the increase of income and capital. (Liu et al., 2020) study, efficiency, and justice in urban transformation evaluate within the scope of game theory. (Yu et al., 2020) study examines the recycling of waste from urban regeneration in Shenzhen, China, and focuses on both waste management and recycling processes.

Brazil: Brazil is one of the countries with the most serious problem of slums. These problems are encountered especially in the city of Rio de Janeiro. Rio de Janeiro has a population of about 7 million. The city is divided into a favela (the name given to slum areas in Rio) and other parts. Those living in the planned developed part of the city are called "people of the asphalt part", and those in the area where the favelas are located "people of the hill". Favelas (shantytowns) are illegal areas established without any permission from the local government. There are two main reasons for their formation. The first is the understanding of slavery existing in the region. When slavery left the country, people who used to be slaves continued to stay in the region and started to establish their own lives. The second important factor is the migration of the city. The country aims to solve problems such as water, electricity, garbage collection, and security, which are basic needs, by restructuring the favela area.

1.4 The Current Situation of Turkey in Urban Transformation

The purpose of urban renewal projects in Turkey, the reasons behind these are closely related to the urbanization characteristics and problems peculiar to Turkey. The city in Turkey, excessive population concentrations, disaster hazards, and risks is faced with problems caused by various reasons such as wrong-site selection decisions. Each of these problems is a factor that causes the need for urban transformation/renewal for our country. Otherwise, the reasons for urban renewal are disasters and disaster risks, especially earthquakes. It is seen as the first urban transformation in Turkey; While the developments that started to take place in the socio-economic structure of the country in the 1950s and the following years caused the increase of the urbanization speed and the urban population, the cities have also entered a rapid transformation process that they have never seen since these years. In this process, new centers emerged, the development direction of the cities changed, most of the buildings were demolished before completing their economic life with the increase of urban rents in the central business area, and multi-story structures were built in their places, areas such as green areas and agricultural lands were started to be covered with residences, urban centers were more crowded and it has become valuable. The 1999 Marmara earthquake showed greatness the earthquakes may losses of life and property that may occur in Turkey. This earthquake has increased awareness of building disaster-resistant buildings. (Tekeli 1982; Genç 2008)

1.4.1 Financing Methods in Urban Transformation in Turkey

The financing method of urban transformation is one of the critical issues. Today, there are many different financing methods determined for urban transformation. The role of the state in providing financing support is crucial in urban transformation in Turkey. It also produces a lot of housing in urban transformation in the private sector, especially by making money and building/sale agreements with the righteous owners. Here, the beneficiaries renew their structures in agreement with the private sector. In addition to these, financing is provided for urban transformation studies with projects based on public and private partnerships.

Finance is also created for urban transformation works through public and legal regulations. The right holders are given exact new buildings in areas where public demolition is made by bringing zoning increase, structure, and population density. Here the main actor in public. Applications are carried out through the central government or municipalities. Again, financing is created by establishing several payment facilities in cooperation with the public and beneficiaries. This method is based on the public's approach to renewing structures with long-term, interest-free payment terms. Thus, the public makes the necessary arrangements and leaves the implementation to themselves by facilitating the right holders' financing needs. In addition to these, urban transformation is supported for beneficiaries, and those who destroy their old structure are encouraged to renew their buildings by increasing development. The rights holders choose to renew their structure as this gives an advantage to the rights holders (Aydın, 2013). The central government provides financial support to urban transformation works with many different loan support methods for various purposes such as rent aid, interest support, determination, construction, demolition, tax advantages, Value Added Tax (VAT) reduction, fees, and license purchasing facilities.

Building owners within the scope of urban transformation can renew old buildings that have completed their economic life, are not resistant to disasters, and are deemed risky by taking an urban transformation loan. If the owners of buildings that have undergone urban transformation are okay with the flat for land method, they can still buy houses using urban transformation loans. Tenants in risky buildings can also buy houses by taking advantage of the urban transformation loan. The banks that have agreed on interest rate cuts with the Ministry of Environment and Urbanization are given the urban transformation loan. Assistance is provided to the buildings' owners in the urban transformation application area evacuated with the agreement and the risky buildings, although outside the application area. Temporary housing or workplace allocation is offered to those whose conditions are appropriate from the date of evacuation to the houses and workplaces' delivery date or until the date determined by the relevant institution. If it is not possible, a monthly rent allowance determined by the ministry is provided.

Urban transformation applications consist of sub-processes and phases that follow each other. Some transformation methods and related strategies have been developed according to the changes in the cities' social and economic structures from the past to the present. The diversity of urban transformation application criteria has caused the approaches that can be developed to differ according to time and place and benefit from various disciplines. The changing conditions and advances in technology have revealed many approaches to urban transformation practices.

Today, urban transformation applications have revealed that especially real estate, construction, and finance sectors need to work together. International organizations such as the EU, the World Bank, and the Japanese International Cooperation Agency provide financial support for urban transformation projects. Central management in Turkey provides support as regulatory, resource building, and supportive to urban transformation. Moreover, Turkey is the main actor in local governments working with the urban transformation projects they did together with their own projects and different central government institutions (Özkul, 2017).

Methods to create an urban transformation financing model; Consolidation of development rights, transfer of development rights, flat for land and build-sell models, public and private sector partnerships, real estate investment trusts, real estate investment funds, lease certificate issuance, and real estate certificate method. Each of these methods, which will create a financing model for financing urban transformation, has advantages, disadvantages, and risks. It is essential to study these risks, advantages, and disadvantages separately for all parties.

In the most basic sense, the method of consolidating development rights is the evaluation and combination of the development rights, which are arranged differently based on the parcel, within the scope of a specific project, and the use of these rights by collecting them together. Assistance is provided to the owners of the buildings in the urban transformation application area evacuated with the agreement and the buildings that are found to be risky, although outside the application area. The aim here is to integrate existing development rights with projects based on parcels. The applications are based on an agreement with the landowners within the framework of public and private sector cooperation based on appropriation. This method can be used in risky areas, reconstruction studies of slums, etc. (Aydın, 2013).

The transfer of development rights is a method established to exchange development rights on lands through purchase and sale. The landowner sells development rights to investors under favorable market conditions or through the transfer of development rights through banks by local governments. The landowner does not use the development right that should exist on the property at their own request and demands that this right be converted into a value to be used in another project under free-market conditions in cooperation with local governments. This method is predominantly used in the evacuation of earthquake risk areas, the transfer of existing development rights to other areas or projects, and the transformation of slums and collapsed urban areas.

The flat for land and build & sell model is a widely used model. Urban transformation studies are carried out between this kind of construction companies and beneficiaries with the state and local administrations' support. This model is also widely used today. The state supports this model in specific ways. Although the government and municipalities determine the general legal infrastructure and principles, urban transformation studies are carried out by agreement between the construction companies and the right holders themselves.

Public and private partnerships are used to finance urban transformation works. This method was established to benefit from private companies' capacity to act faster than the public. Liberal policies have been influential in the development of this method. Here, the public is a model operated by including the private sector in the construction process and the operating processes.

Real estate investment partnerships are formed under the legal regulations made in this regard. The aim here is to pave the way for those who want to invest in real estate under free-market conditions and provide financing for urban transformation studies. It is established for specific projects and to invest in specific real estate. The income obtained in this method is exempted from corporate tax.

The real estate certification method is the transformation of development rights in the urban intervention area in urban transformation projects into papers called certificates. This certificate can be used to obtain real estate from another urban transformation project and liquidate it under appropriate market conditions. These certificates, which are traded on the stock exchange, can be purchased for investment purposes or to own real estate. Real estate certificates allow investors to own a real estate area from the relevant project if they have sufficient certificates. Investors who do not have adequate certificates or prefer to buy real estate can earn by selling the relevant certificates. These certificates are both an alternative source of financing for projects and using individual investors' capital markets with low purchasing power. It is aimed to collaborate with real estate projects

The real estate exchange model was established to invest in the real estate sector from abroad to provide finance, especially for urban transformation projects is the model. With this method, the real estate market is securitized. In this model, it is established and operated under the relevant laws and regulations. The real estate stock market has a significant contribution to the economy to attract international investments. Simultaneously, it is used to finance urban transformation works because it is an alternative financing method.

In Turkey, Toplu Konut İdaresi Başkanlığı (TOKI) has a massive impact on housing production and urban transformation projects. Especially TOKI has the authority to issue bonds and all kinds of securities while building houses, getting loans from international banks, giving loans, lending to transformation projects, providing interest subsidies to these projects, and doing profit-oriented projects. In its current state, TOKI can act as a financial institution besides being a construction company. Since TOKI is a state institution, it has the opportunity to determine the most suitable financing model and payment terms to provide financing for both the housing sales and the projects it implements. In this respect, TOKI can play a more influential role in financing urban transformation, especially by protecting the citizens from interest, providing suitable payment conditions for the poor, and regulating the competitive environment in the housing market (Koç, 2019).

1.4.2 Urban Renewal Laws ın Turkey

With the "Law on Transformation of Areas Under Disaster Risk" numbered 6306, which entered into force in 2012, the concept of Urban Transformation has emerged. In 1984, the first example of urban transformation in Turkey, the Law No. 2981 on "Some Procedures to be Applied to Buildings in Contrary to the Zoning and Slum Legislation and the Amendment of an Article of the Zoning Law No. 6785" played an important role in the process of slum transformation. With the said law, the opportunity to make improvement plans for slum areas was provided. Dikmen Valley Urban Transformation Project was the first example of an urban transformation project prepared for slum areas. Considering the earthquake of 1999, the importance of standardization in urban structuring has come into consideration, building regulations and control mechanisms have been rearranged. (Tekeli, 1982; Genç, 2008; Şişman and Kibaroglu, 2009; Aktaş-Polat, 2015)

The laws that will create a legal draft for urban transformation projects or projects for urban transformation under different names are as follows (Yenice, 2014):

- Zoning Law No. 3194
- Zoning Amnesty Law No. 2981
- Law No. 5104, "North Ankara Entrance Urban Transformation Project"
- Law No. 5366, "The Renewal, Preservation, and Use of Worn-Out Historical and Cultural Immovable Assets"
- 2005 No. 5393, Article 73 of the "Municipal Law"

1.4.2.1 Subsidies and supports in urban transformation

Subsidies and supports for urban transformation by the Turkish government are divided into two, groups for owners and tenants.

Urban transformation supports for those who own property in the building are as follows:

- If there are not many floors in the risky building, it can be made by a new building undertaking to the desired construction company using an urban transformation loan.
- Loan per independent section: 100.000 TL
- Maturity from 24 months to 120 months
- Interest rates are 0.35 -0.45 per month. If there are more floors to the building due to zoning and construction is made with a contractor in return for floors and there is no need for an urban transformation loan, rent assistance can be used. Rental Allowance is 650 TL per month for 18 months; non-refundable. Urban transformation loan and rent allowance cannot be used at the same time. If credit and rent assistance is not used as a property owner in the risky building, the urban transformation loan, which is entitled to buy an apartment from another place, can be used when buying this apartment, and thus serious financing is provided.

Supports for tenants are as follows:

- When tenants who have documented that they have been tenants for at least 1 year in a risky building, want to buy an apartment from another building after evacuating their houses, they can use an urban transformation loan with an interest rate of 0.35 -0.45 per month with a term of 24 months to 120 months of 100.000 TL, or they can receive 1300 TL non-refundable move aid while evacuating the building.

Urban transformation loan is received from banks contracted with the ministry, and rent & moving assistance is received from provincial infrastructure and urban transformation directorates by the application (Kalem, 2015).

In this section, natural and human factors that cause urban transformation are introduced in general. The demographic effects of urban transformation have been tried to be explained. In addition, urban transformation activities in developed and developing countries and in Turkey were mentioned. Financial and legal studies for urban transformation are mentioned. In the next section, we will examine the studies on the evaluation of the wastes arising from these urban transformation activities.

CHAPTER 3

WASTE RECYCLING AND WASTE IN URBAN TRANSFORMATION

2.1 WASTE MANAGEMENT

Waste is all of the materials produced after all kinds of daily life activities of people out of need and wanted to be thrown away. It is the whole of the processes of prevention, classification, collection, storage, separation and reprocessing, transfer, disposal, and post-disposal control of wastes.

Waste is directly related to industrial and social changes in human activities. Depending on the development and modifications of the waste management concept, wastes, and their occurrence have also varied. When examining the waste collected in a particular area, it is possible to comment on many issues such as the region's people's economic activities, consumption characteristics product. The variety and proportion of waste occurring in urban settlements are more significant than in rural areas.

The definition of recycling is generally the transformation of a product into its pre-use form after it has been used for a certain purpose. According to this definition, many materials are not capable of recycling because mixing a product with other materials while lying down causes it to lose its purity, the new shape taken by the material is not suitable for recycling or the material is not suitable for recycling (Villalba et al. 2002).

Recycling decreases the increasing amount of waste in our world and provides environmental and economic benefits. Major recycling materials, Building Materials, Electrical Equipment, Furniture, Metal, Glass, Mobiles, Paint/Oil, Textiles, Plastic, Batteries, Printer Cartridges, Clinical Waste, Composting, Computers, Asbestos, Paper, Recycling Banks, Vehicles, Wood.

Country	Year	Source	Population (000s)	Waste Generated	Landfill	Incineration	Other Recovery	Material Recycling	Composting and Digestion	Recycling Rate
1. Germany	2015	Eurostat	81,202	628.6	59.3	196.7		300.7	114.6	66.1%
2. Singapore	2015	Singapore Government	5,399	1421.3	560.1			861.2		60.6%
3. Wales	2015/16	Welsh Government	3,1	513.6	93.4	97.4	1.3	212.6	96.5	60.2%
4. South Korea	2014	OECD	50,424	361.3	60.9	91.5		209.9	3.6	59.0%
5. Austria	2015	Eurostat	8,538	566.4	16.8	214.6		145.3	177.0	55.9%
6. Taiwan	2015	Taiwan EPA	23492.0	307.7	3.9	133.8	0.1	144.0	26.0	55.2%
7. Slovenia	2015	Eurostat	2,067	448.1	101.7	76.5	14.3	208.1	34.3	53.9%
8. Belgium	2015	Eurostat	11,369	414.1	78.4	179.7		142.1	79.2	53.5%
9. Switzerland	2015	Eurostat	8,129	741.8		350.6		236.7	154.5	52.7%
10. Netherlands	2015	Eurostat	16,981	521.5	13.01	244.5		128.3	141.3	51.8%
11. Luxembourg	2015	Eurostat	563	632.7	111.5	215.7		180.4	125.1	48.3%
12. Sweden	2015	Eurostat	9,799	446.6	3.6	228.7		144.6	69.8	48.1%
13. Denmark	2015	Eurostat	5,611	799.3	9.1	420.4		217.9	151.8	46.3%
14. Scotland	2015	SEPA	5,4	457.2	213.1	41.9		202.1		44.2%
15. Italy	2015	Eurostat	61,637	479.0	176.7	90.6		124.1	84.4	43.6%
16. United Kingdom	2015	Defra	64,532	489.2	115.0	153.5		133.3	79.4	43.5%
17. Norway	2015	Eurostat	4,904	446.0	15.Oca	233.5	6.3	116.5	74.4	42.8%
18. England	2015/16	Defra	54300	481.1	98.1	166.8	12.3	126.9	77.0	42.4%
19. Poland	2015	Eurostat	38,016	285.7	129.7	37.9		75.4	46.0	42.3%
20. Northern Ireland	2015/16	Daera	1,9	510.1	205.4	90.0	1.4	122.3	91.1	41.8%
21. Australia	2015	Eurostat	23,941	557.2	260.6	64.9		231.7		41.6%
22. Finland	2015	Eurostat	5,493	498.5	57.3	238.9		140.2	62.1	40.6%
23. France	2015	Eurostat	66,498	502.3	134.8	174.4		111.8	86.7	39.6%
24. Hong Kong	2014	ong Gover	7,24	776.2	492.7			283.6		36.5%
25. United States	2014	OECD	318,857	735.3	386.7	94.3		188.9	65.5	34.6%

Table 1. Waste Generation and Treatment (Kg per Capita) source: World Recycling League - Full Report

When we examine the World Recycling League information shown in Table 1, we see the 25 countries with the highest recycling rates. The recycling rate of 10 of these countries is over 50%. In addition, the fact that 20 of the 25 countries on the list are located in the European continent reveals the leadership of this region in recycling. Turkey is not among the 25 countries in the world in recycling rates. Germany, which ranks first on the list, is one of the leading countries in recycling, so it is not surprising that it is at the top of the list. Wales and Singapore, which ranked second and third, have increased their recycling rates thanks to their low population and high development. The United States, which is at the bottom of the list, has the highest population among the states in Table 1 and is the only state on the list with a population of more than one hundred million.

City	Waste (kg/person-day)
Aksaray	1,01
Istanbul	1,28
Antalya	1,25
Konya	1,04
Batman	0,82
Samsun	0,91
Bursa	1,03
Trabzon	0,63
Eskişehir	1,04
Duzce	1,17
Mugla	1,85
Çanakkale	1,70
Ardahan	1,69
Kars	1,52
Van	0,42
Şanlıurfa	0,75
Bartın	2,01
Kırklareli	1,19

Table 2. Waste Production Table of Some Selected Provinces of Different Geographical Regions in Turkey

Source: TUIK , Municipal Waste Amount Per Person Per Day (2014).

According to the data in Table 2, the daily waste rate per capita of a few selected provinces from seven regions of Turkey is given. Bartın province has the highest rate of waste per capita with a waste rate of over 2 kg per day.

Waste varieties can be collected in seven main groups: Domestic waste; Industrial waste; Agricultural waste; Construction and demolition waste; Hazardous waste; Medical waste; Special waste (radioactive waste, tire waste, etc.)

2.1.1. Types of Waste

In daily life; Thousands of tons of waste are released every day from homes, hospitals, schools, all workplaces, all social and cultural sharing areas, and every field of industry. "Waste" Producer or real or legal person who actually owns it refers to any substance or material that is thrown or released into the environment or that has to be disposed of. Waste, which we used to compress under the concept of "garbage" in the past, has now become a social concept with its own institutions, which must be managed in a planned and programmed manner. Waste management, minimization of household, medical, hazardous, and non-hazardous wastes, separate collection at source, intermediate storage, the establishment of transfer stations for wastes when necessary, transportation, recovery, disposal of waste, operation of recovery and disposal facilities, closure, post-closure maintenance, it is a form of management that includes monitoring and control processes. Wastes are divided into eight categories as domestic, industrial, agricultural, construction and demolition, hazardous, medical, and special wastes.

Domestic Wastes: Waste produced in residential and office environments, collected by municipalities, transported, controlled by storage methods, generally organic content, and degradable by natural ways like separation, compost, incineration. These are kitchen wastes, packaging wastes, office wastes, etc., that can be converted into economic inputs (Gündüzalp ve Güven, 2016).

Industrial Wastes: These are wastes generated from industrial activities (Sayar, 2012). They are solid wastes that do not contain hazardous and harmful substances, which are formed during industrial and production processes. Such solid wastes are generally production residues or end-of-life machinery and scrap materials.

Agricultural Wastes: These are the residues generated from agriculture and livestock activities (Gündüzalp and Güven, 2016). It is the waste and residues that arise as a result of obtaining and processing plant and animal products. The amount and content characteristics of the solid wastes produced are affected by different conditions such as socioeconomic characteristics of communities or societies, dietary habits, traditions, geography, occupations, and climate.

Construction and Demolition Wastes: These are the types of wastes generated during the construction, repair, modification, or demolition of any construction (Gündüzal and Güven, 2016). Scrap steel, Wood, Copper scrap, Porcelain and tile, Galvanized steel plate, Stainless steel, PVC, Aluminum scrap, Zinc scrap, Galvanized steel, PE/PP, Asphalt, Chipboard, Plaster, Plywood, Concrete, Gravel or stone, Sand gravel Materials such as, garden wastes, gypsum glass wool, rock wool are classified as Construction and Demolition Wastes.

Hazardous Wastes: Wastes that directly negatively impact the environment and the environment it touches are called hazardous wastes. It generally occurs as a result of industrial activities. It is classified according to the hazardous features specified in the legislation (Waste

Management General Principles Regulation, 2008).

Hazardous wastes can also be grouped by considering their composition, physical properties, and the waste's reactions in the environment due to contact. These can be exemplified as: Varnish and paint waste; Organic solvents; Fluorescent lamps; Asbestos substances; Cyanide hardening salts; Oil-filled cables; X-ray and film emulsions; Cartridge and printing toners.

Medical Wastes: They are infectious, pathological, sharp object wastes or wastes that come into contact with these from health institutions such as hospitals, clinics, laboratories, health centers, which may pose a danger to a person's health and cause various diseases. Everything that comes into contact with blood and human tissue is considered medical waste (Medical Waste Control Regulation, 2005).

Special Wastes: It is the type of waste with the most dangerous potential among the wastes and therefore needs special precautions. Wastes containing radioactive content, hazardous and harmful industrial wastes, paint, thinners, cleaning agents, batteries, rubber wheels, wastewater sludge, construction and demolition wastes, and hospital wastes are included in this group.

2.1.2. Hierarchy In Waste Management

The Waste Management Hierarchy aims to evaluate all waste management steps as a whole and to ensure sustainability in both environmental and economic terms. An effective waste management is only possible by combining all methods. According to the Integrated Waste Management Hierarchy, prevention and reduction of waste at its source is the first step. In cases where waste generation cannot be prevented, reuse and recycling stages are applied. For waste types that cannot be recycled, regular landfilling is also carried out. The waste management hierarchy consists of six stages. These stages are respectively Prevention, Reduction, Reuse, Recycling, Recovery, Disposal.

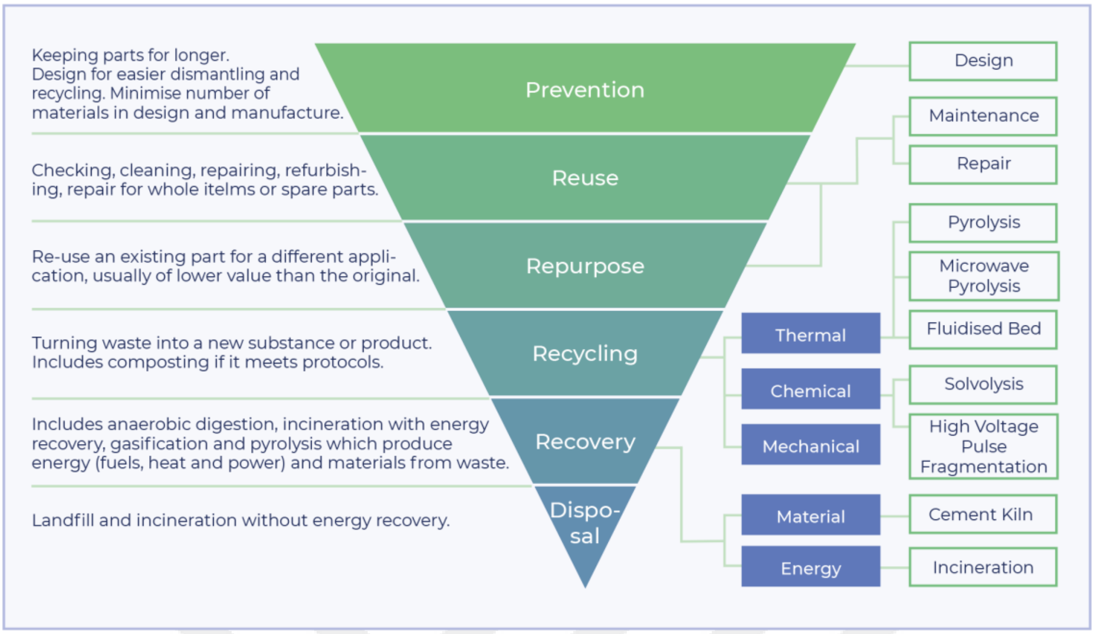

Fig 2. Domestic Solid Waste Management Hierarchy
Source: (https://baxcompany.com/).

As shown in Figure 2, the solid waste management hierarchy operates in an inverted pyramid. This is because the waste recovered at each stage decreases as they exit the system. In other words, the wastes established in the prevention stage do not reach the reuse stage, so it is aimed to reduce the amount of waste used at each stage and be finished. The activities in the upper steps of the pyramid are easier to implement and more useful, and the process becomes less desirable at each stage. Prevention is the easiest and most desirable method, while disposal is the least desirable and most inefficient.

*Prevention***:** It refers to the measures to be taken before any substance or material turns into waste in terms of reuse of products or prolonging their useful life, reducing the amount of waste, reducing harmful substances in product production, and minimizing the negative effects of the produced waste on the environment. environment and human health.

The first precaution is to prevent waste generation, which is an important step as it will also minimize the hazards that may arise from waste. To avoid waste, to use our natural resources as little as possible, and to prefer renewable energy sources if possible.

Reduction: Waste reduction; is expressed as preventing waste production, increasing the quality of the waste produced, reducing its damages, promoting recycling, reuse, and recycling.

If waste generation cannot be avoided, the next step must be to reduce waste.

*Reuse***:** It is defined as any process in which products or non-waste components are used for the same purpose as designed. In this step, the product should be reused as much as possible without becoming waste. (Şenaydın, 2018).

Recycling: Except for the recovery of energy, incineration of wastes for heat purposes, or reprocessing for use in filling, the utilization of organic wastes, economically and structurally suitable for this concept can be processed with various methods and made into a product for the first use or other purposes, or following the needs are the recycling processes in which they are transformed into new products (Ministry of Science and Industry, 2017).

Recovery: It is the practices of making wastes ready for valuable purposes with the help of various physical and chemical processes applied according to the content and characteristics of the wastes to evaluate the materials used in production (Şenaydın, 2018) and Energy Recovery, a method of creating energy from waste using various methods.

Disposal: These are the procedures to make the materials considered harmless waste to humans and the environment or minimize their damage. This process is the last stage of waste management and is the method to be used if none of the other stages work.

Integrated waste management is essential for both the environment and health. A sustainable environment is also ensured through waste management processes. Objectives of Solid Waste Management Systems: To protect, protect and improve environmental health and quality, to protect human health and quality of life, to raise urban environmental standards to higher quality, to ensure the correct use of natural resources and even resources. reduce their use, support economic efficiency and competence, balance the environment and nature and change the perspective on them. To support and encourage national and international studies to examine environmental negativities in the regional and global arena (Sapmaz, Yiğitbaşoğlu, 2018).

2.2 Importance of Recycle

The importance of recycling has been developed with the definitions of sustainability and circular economy and more research has started. The definition of 'take-make-use' in the classical economy has begun to give its place to the concept of a circular economy, where R activities are more. Recycling has found a place in all concepts such as 3Rs (Reduce, Reuse and Recycle), 5Rs (Refuse, Reduce, Reuse, Repurpose and Recycle), 7Rs (Rethink, Refuse, Reduce, Reuse, Repurpose, Recycle and Rot). Recycling stands out with its economic and environmental advantages. These advantages are actually provided by the fact that recycling provides raw materials. (Kägi and Dinkel 2018) can list some advantages in this regard as follows; PET bottles or other plastic-based materials do not disappear rapidly in nature, they release high carbon during production due to petroleum products, so recycling provides ecological and environmental advantages. Studies in the field of Waste Electrical and Electronic Equipment Directive (WEEE) have focused especially on high-value and difficult-to-find resources such as gold. The value of gold comes from the fact that it is hard to find and is a limited source. Therefore, Researchers are working in the field of finding and recycling gold in WEEE, (Awual and Ismael 2014.) In addition, in sectors such as textile, furniture, and automotive, recycling provides many advantages such as reducing carbon emissions, reducing costs, reducing the supply chain, increasing resource diversity, and protecting the environment.

For all these reasons, countries attach great importance to recycling. The 25 countries that are the best in the field of recycling are as follows.

2.2.1. Process of Waste Management

Progress in the industrial field and, therefore, the rapid increase in the population in urban centers, the negative on the environmental health of human impacts in Turkey and worldwide enhances their effects every day. While the shaping in the industrial and marketing fields has increased our natural resources, the massive amount of waste generated due to the increase in consumption has become a significant problem in terms of their quantity and losses. For this reason, environmental protection has begun to be among the political priorities of all countries in the world, and waste management has become an important issue and needs in terms of environmental protection policies.

Waste management plans, which aim to reduce the consumption of natural resources and bring the harmful effects of the wastes under control, are indispensable elements of the concept of "sustainable development," which is universally accepted as an important political goal.

By the 1930s, the concept of waste management has been included in many legal regulations. This period has continuously increased the number of institutions and organizations to take responsibility in the environment, which is essential to be considered a turning point. With the Environmental Law published in 1983, the number of public institutions that have authority and duties in the environment has increased. However, the overlapping of powers and responsibilities among institutions in this field confused authority at specific points. In contrast, the cooperation and coordination between the relevant institutions and organizations were disrupted, and in practice, the system occasionally caused incomplete or incorrect operations. Besides, the insufficiency of financial incentives and technical personnel and equipment in this field has created an obstacle for a good waste management system.

While the establishment of waste management policies *and their* systematic functioning should be a priority in environmental strategies and sustainable development plans, our country has not yet gained the desired priority in its policies. Waste management systems aiming to improve the arrangements *were* now in the thick of the plans and projects designed to transfer their applications. However, we have commitments made internationally (UAYP) "National Waste Management and Action Plan" was prepared by the Ministry of Environment and Urbanization only in 2016.

In Turkey's European Union (EU) harmonization process, the environmental issue comes first in the situations that are seen as the most problematic. With the financial and technical support provided during the European Union harmonization process, new projects have been carried out in the environmental field. Within the scope of these projects, unprecedented steps have been taken to bring legal regulations to European Union standards and determine the path to be followed in the harmonization process. Studies on this issue are carried out regularly.

Net Data on waste occurring in Turkey in general but it has not yet been fully gathered together, TSI when we consider the 2004 data of about 35 million tons of municipal waste in Turkey and consists of 18 million tons of industrial waste. According to these data, the production of waste per person in Turkey is 2 kg per day. It can be said that each person produces about ten times the amount of waste of their own mass.

Considering the practices of developed countries, it is seen that 55-65% of ordinary wastes are fully recovered as economic input. When we look at our country, it is known that the recycling rates are still very insufficient, although the wastes generated are primarily recyclable. Since there is still no adequate waste management infrastructure planning in our country, waste recycling cannot be traded at sufficient levels (Court of Justice, Waste Management in Turkey, January 2017 Performance Audit Report).

Although the cost of the development of waste management and the planned studies in this field looks high in the first place, non-industrialization in the field of waste management certainly causes more significant financial losses and irreversible, adverse effects. If the waste generation cannot be effectively reduced and recycled, the waste piles will create significant problems. It will be inevitable that these wastes will be reintroduced into nature, and the ecosystem will face extinction. Besides, the new storage areas are needed in the construction, operation, and so on. Considering the costs, the rehabilitation costs of the existing waste storage areas in the urban habitats, and the vast transportation costs, financial losses will be much higher. Besides, when the indirect costs such as health expenses caused by air, soil, and water damage are considered, the losses can produce even more severe consequences. In some studies carried out with the current approach, the economic recycling waste for the management of investment was expected to reach up to 4 times the investment cost (SAI, Waste Management Performance Audit Report in Turkey in January 2017).

2.2.2. Effective Factors In Waste Management

There are many factors affecting waste management. As an example of local government, (Karakaş 2010) handled the analysis of environmental solid wastes in a financial framework through the Sakarya Metropolitan Municipality study. The purpose of this study is an economic analysis of waste management through sustainable economic development. According to this research, although the Sakarya metropolitan municipality constitutes 1.3 of the 100 units of waste produced in our country with the rising population and industry, it has been observed that it can be disposed of in our country, and urbanization is relatively low for areas where it is relatively crowded. In the province of Sakarya in 2001, when strong waste management could not be established due to problems such as lack of financial workers, it was determined that an environmental, financial resource was allocated above the country average in 2010. Sakarya metropolitan municipality has carried out positive proposals and projects on managing environmental solid wastes with an effective method, has continuously worked for healthy urbanization and healthy life, and adapted this to a systematic situation. It is a necessary form of application for an effective waste management operation in the undertakings applied. It has been revealed that the existing waste materials are not useless materials that need to be disposed of. On the contrary, they are evaluated as recyclable raw materials or intermediate products with an economic input logic (Karakaş, 2010).

Quoting from (Kolukısa, 2019) examined the global and national solid waste management hierarchy of the solid waste process and discussed the recycling management practices and the Malatya Municipality model results at the municipal level. In his study, there were rapid developments in waste management in Turkey, which existing waste is a profitable business line, the recovery and recycling process is domestic, and discussed the shift of foreign capital towards this sector. Thanks to the private sector's interest in this issue, the burden on local governments has been reduced, and it has taken part in the administrative positions of local governments. For local governments to succeed in solid waste, it is necessary to organize private organizations and business elements. However, in the model of the city of Malatya local government, it was noted that there was no such initiative available, and no extensive research was conducted (Durmaz Bekmezci and Çetin, 2020).

Quoting from (Yetiş et al., 2013) revealed the problems faced by Bitlis city waste management and BİKA (Bitlis Union of Municipalities Solid Waste Landfill) and discussed Bitlis city waste management in a profound way in the study they aimed to find a solution and develop (Durmaz Bekmezci and Çetin, 2020).

Quoting from (Durmaz Bekmezci and Çetin 2019), addresses that, under the title of the use of solid wastes and in the agricultural field, the method used at the stage of clustering and recycling of wastes and the benefits of recycling agriculture, environment, and economy are examined with national and global approaches. In the present study, it was emphasized that the countries suffering from economic problems and developing countries should put an end to waste to provide sustainable benefits of natural resources and to regain the economy by doing better research on the substances that have economic value (Durmaz Bekmezci and Çetin 2019).

Quoting from ((Durmaz Bekmezci and Çetin 2019) obtained numerical data distributions by following the waste analyzes of the city of Hatay, which is located on the border of the Mediterranean Region. The same research interpreted food waste with other wastes and its relation with population and socioeconomics. A decrease in the percentage of food waste has been determined in areas with high economic income in high-density areas in the center of Hatay. It was understood that the amount of waste is at minimum levels due to internal migration in accidents located in high regions in the highlands in winter

Quoting from (Gündüzalp & Güvenin 2016), conducted a recycling subject research for

Çankaya Municipality, which is working on waste types, waste management, recycling, and consumers. In this regard, models belonging to informational studies based on global and solid waste management and recovery in our country were examined.

As can be seen in all these studies, factors affecting waste management can be collected under the following titles:

2.2.2.1. Economic Factors

When it comes to waste management, we often come across the terms "sustainable development" and "sustainable waste management." The rapid increase in environmental problems and the global depletion of natural resources constitute the outcome of livability and sustainability, and solutions to environmental issues have been sought. The 1972 Stockholm United Nations Environment Conference, which is regarded as the beginning of the international partnership in the name of environmental protection, put forward the expression "development that does not exclude the environment" (Keleş and Hamamcı, 2002).

This expression was developed over time and turned into the expression "sustainable development/development" in the study titled "Our Common Future" (Bruthland Report) in 1987 (Kaplan, 1997).

In this study, this expression is defined as “planning today's needs by considering the possibility and competence to meet the needs of the next generations” (Bozlağan, 2002).

Sustainable development, which aims to achieve the most appropriate and universal economic growth, was once again discussed in international meetings such as the 1992 Rio Conference, 1996 Habitat II, 1997 World Summit, and 2002 Johannesburg Conference, reports on the agenda and all decisions were then prepared.

While sustainable development was included in economics in 1980 as an economic development approach intertwined with the environment, it was later associated with different disciplines such as social science, urban planning, and administrative science

Sustainability can be described as *"protecting social,* economic and ecological *systems,"* there is also another phrase that explains it, as *"using renewable* resources sparingly should be a priority for their contestability" (Bozlağan, 2002).

Development *is* an economically viable means of improving people's living standards.

Therefore, “environmental sustainability in *terms of preventing and* minimizing negative impacts in the environmental sense, including all wastes arising after resource use and production*;* There is, of course, a wealth of ecological sustainability aspect is used according to need of *protecting*, the appropriate size of the expenditure incurred and is being interpreted by the direction that will provide services to all classes of society, economic sustainability and based on social qualifications and participatory plans and programs with social sustainability accept understanding each other, they are complementary" as described and can be associated with numerous branches of science.

Sustainability is one of the main areas of a solid waste management system. The necessity of disposing of the waste that is harmless to the environment and the economy has increased the importance of sustainable waste management. Because waste management, recycling, and use of the site based on raw materials is a concept that provides continuity. Significant savings will be achieved in production with recycling projects. The use of methane gas obtained by the fermentation of non-recyclable organic wastes and the incineration of wastes with calorific value, gaining heat and electrical energy, and composting for fertilizer will contribute to the protection of resources.

The concept of sustainability in waste management requires the system to be evaluated following the regional characteristics of the region with its political, institutional, social, economic, financial, and technical conditions and to determine local administrative institutions, public, non-governmental organizations, and operators in an entirely appropriate manner (Palabıyık, 2001).

Economic sustainability in waste management is primarily related to cost reduction. This will be achieved by recovering qualified wastes suitable for recycling lost by methods such as storage and incineration in waste dumps resulting from vital activities and reusing them in production.

It has become an inevitable necessity to take new essential steps in line with waste management continuity. These steps are; minimizing the amount of waste production, classifying where it is produced, re-evaluating and recycling, disposing of non-recyclable wastes in a manner that will not harm the environment. Ensuring a good audit and relationship network between institutions and operators, and developing the necessary financial grounds, facilities, providing clean and high-quality urban living environments, and making legal arrangements that will guide all stakeholders in this sense (Bound, 2001).

When the recycling projects are supported, the consumption of resources and the emergence of new wastes will be prevented. The targeted conditions will be achieved when this issue is taken into account and applied by both the consumer and the producer. Besides, the establishment of administrative units that will determine the cooperation and sharing of duties and powers among all relevant stakeholders will significantly contribute to the process.

Recourse to different applications from the country's structural management may be needed to achieve their sustainability goals, including sociological and environmental features. Various problems can be encountered and may not be solved in economically and socially underdeveloped societies. These are generally technical, financial, institutional, and economic problems (Ogawa, 2008).

Technical problems start from the lack of solid waste management planning and are further increased by the lack of emphasis and priority on specialization, research, and development. Financial problems arise, especially in countries with low economic power. Providing insufficient financial resources for waste management, not using the resources allocated for these activities in place and accordance with their purpose, taxation, penalty, etc. The inadequacy of the regulations, the insufficiency of the necessary incentives and obligations for the appropriate facilities to be planned and implemented form the basis of the problems encountered.

Industrialization and production are seen as the primary goal in developing societies, and the protection of environmental factors remains in the background. The idea of the "development will be caught with industrialization" causes the uncontrolled consumption of existing resources and the destruction and plundering of natural life. Since natural life protection is not at the top of the list of primary goals and is always left among the following goals, investments and expenditures in this area are seen as a luxury in countries with poor economic conditions. To eliminate these problems encountered in waste management, local characteristics should be considered systematically (Akdoğan and Güleç, 2007).

2.2.2.2. Political Factors

Local governments generally carry out solid waste management in our country. Besides, the investment and operating obligations in this regard can be transferred to private and legal investor enterprises. However, projects and applications carried out at this stage are also controlled and followed by local governments. The first legal regulations covering the duties and services performed by local governments within the scope of cleaning work (Public Sanitary Law No. 1593 and Municipal Law No. 1580) were made in 1930. The regulation prepared in 1991 took its place in the field as the first regulation directly related to this subject. The emergence of accidents in landfill sites and sometimes-fatal accidents in our country required the importance and development of solid waste studies.

Nevertheless, in those times, no one had created the foundations of a professional organization under the name of institutionalization concerning environmental activities in Turkey. Ministry of Environment and Forestry, Ministry of Tourism, Ministry of Health, SPO, Under-secretariat of Treasury, Presidency of Special Environmental Protection Agency, General Directorate of Iller Bank, GAP Regional Development Administration, and so on. While similar duties and powers related to waste management within the institutions' scope of authority sometimes created conflict between institutions and sometimes uncertainty, services could not be carried out effectively. Due to the increasing importance of the subject, many national and international studies have been initiated. The inclusion of our country in the European Union harmonization process has accelerated the efforts in terms of environmental problems and environmentally sustainable development, made investments in this field, applied to advanced technologies, and increased sensitivity in the social field. In this sense, the form and level of the work carried out differed according to the governments' political and economic policies.

2.2.2.3. Social Factors

In addition to the development of industry, urban population growth, and rapid urbanization, the difference in consumption areas has also affected the character, quantity, and diversity of waste generated in urban areas. Even if the characteristics of the wastes are located within the same country borders, they have different features and the contents of the waste depending on the geographical and soil structure of the cities, the life and financial earning of the people living in those cities, consumption habits, income distribution, traditions and customs.

2.2.2.4. Environmental Factors

In our country, solid wastes were dumped in uncontrolled fashion onto plains and valleys; dry and low yield potential tea and riverbeds, marshes called slime, or directly discharged into seas and lakes until recently. The current understanding of this situation's evaluation caused the deterioration of the ecological balance scale, the irreversible destruction of the environment's environmental health, and the unplanned and irresponsible consumption of natural resources. We can cite people's awareness-raising seminars and meetings under the name of public service and public interest and the insufficiencies in planning non-governmental organizations on the public. The world alarms; Air pollution, especially climate changes, the extinction of sea creatures in the ocean and sea pollution, soil pollution, the destruction of radioactive and hazardous wastes buried in fertile land and soil. Minimizing all these adverse effects, preventing damage to natural balance and solid waste management have become the most critical need today for a more realistic use of natural resources.

2.3. Recycling

Metal, paper, glass, electronic waste, car battery, plastic bottles, plastic, etc., to include and reuse some wastes that can be used and reused in the industrial production process with the help of various physical and/or chemical applications. It is also possible to recycle organic wastes. Diverse physical or chemical processes applied for the post-recycling use of wastes can also be called recycling (Dur, 2019).

2.3.1. Historical Development of Recycling

Recycling has always been a necessity due to the difficulty and limitation of natural resources and financial losses. Centuries ago, the swords, shields, helmets, and various metal food containers, which were made by civilizations in the past, were pounded over furnaces, melted and re-obtained metal coins and other items to be used with the help of molds, and the foundations of recycling were laid centuries ago. In some archaeological excavations, traces of recycling were found due to studies on some metal coins, broken tool pieces, and ashes, which were found to belong to ancient times when it was challenging to obtain natural resources.

The main primary purpose of these recycling applications is to obtain new and needed materials from existing materials as waste instead of using new raw materials in production. The need for recycling has increased as a result of the increasing demand for resources due to the rapidly growing industrialization, the rapid decrease of existing natural resources, and the destruction of natural life in the process of seeking and obtaining resources. Besides, scrap metals, worn fabric and cloth scraps, etc. obtained with a lower budget than obtaining, processing, and supplying raw materials. It provides great economic benefits with the recovery of substances. The financial return of recycling is substantial. Before the industrial revolution, bronze metal, silver, scraps, and other metals were collected, melted, and reused continuously by Europeans.

Fig 3. Poster on Recycling Used During WWII

Dust and ash particles from the burning of resources such as wood and coal used for heating in England, and even fires in forests, were brought together and reused for brick production. As of the 1800s, bottles and packages used for liquid products were sold with the deposit system and collected again. In 1813, Benjamin Law succeeded in obtaining pure cotton from fabric wastes that lost their characteristics.

The periods of World War II have been recorded in history as the brightest periods of recycling in Europe as can be seen in Figure 3. The importance of recyclable goods and wastes has emerged due to the financial quota experienced due to long wars and the raw material problem that has become impossible to reach due to their effect. To meet this need, countries have encouraged their citizens to recycle them through several campaigns, announcements, and posters with instructions. This way, it aims to recycle people's wastes and old metal-containing items to be used as long as possible and to be used for other products that are needed.

2.3.2. Benefits of Recycling in General

In summary, recycling ensures the protection of natural resources and saves a large amount of energy consumed in the production area. Simultaneously, it reduces the amount of waste and saves the land used for waste storage areas and the operating costs of these fields. It balances the use of valuable underground and aboveground natural resources by minimizing them. Helps maintain the natural balance. It prevents the waste of valuable and economical materials. It prevents unnecessary waste. It leaves a livable environment, nature, and natural resources to future generations. It is a large sector that provides employment worldwide while making a significant contribution to the economy.

2.4. Recycling of Wastes in Urban Transformation

It is essential to recycle construction and demolition wastes primarily to protect natural resources, prevent waste, reduce the amount of waste to be stored and use them as secondary raw materials. It is necessary to separate the wastes at their source to obtain good quality recycling material and reduce costs. Construction and demolition waste is highly recyclable. Recycled construction and demolition wastes are reused in the same sector or in different areas.

When planning the recycling of demolition wastes, the 4R (recycling, reuse, recovery, reduction) principle should be strategically implemented. In the management of construction and demolition wastes, recycling should be considered very important. The 4R principle should be applied meticulously in terms of good management of resources and sustainable environmental management. To understand recycling well, it is crucial to understand and know these concepts well to know exactly what is meant by 4R (Lauritzen, 2019).

Recycling: Conserve resources and reduce the amount of waste discharged for reuse, recovery and is a common term used to reduce the amount of waste.

*Reuse***:** After processing the location and new buildings or renovation and demolition of buildings and the use of more or less original shape of the material for the original purpose.

Recovery: We can express it as obtaining resources from waste. For example, materials obtained from wastes and used as secondary raw materials, such as the utilization of scrap metals as raw materials, are in this group.

Reduction: Changing the waste state, as is the degree, size reduction, or mitigation actions. For example, the size or amount of waste is made smaller by obtaining energy in incinerators. The use of non-recyclable wood wastes or hazardous wastes to obtain energy by burning is in this group.

Fig 4. 4R Cycle in Recycling Construction and Demolition Waste

Figure 4 above shows the 4R cycle for recycling construction and demolition waste. If waste management is acted strategically following this cycle, waste generation will be prevented since it will act under zero waste management processes from the beginning to the end. As in all waste groups, the waste management hierarchy should be followed in waste recycling management, and reuse should be considered a priority to complete its final life to avoid waste. Afterward, wastes suitable for recycling should be processed and evaluated as raw materials. Then, waste reduction should be the main goal, especially hazardous and "inert wastes" should be disposed of by storing them if possible. They should be used for energy recovery in incineration plants. Even the slag formed in incinerators can be used for filling purposes because it is sterile. While doing all these, one should act following the principles of not polluting the environment and occupational health and safety.

In the construction and demolition processes, there are methods to be followed to reduce the occurrence of waste recycling. This process, especially wrong and excessive amounts of materials, should not be ordered, and wasteful materials should not be purchased. In order not to damage the purchased materials, they should be stored appropriately and well protected until they are used. It is necessary to make preparations so that the remaining materials are not wasted. It is essential to ensure the recycling of waste recycling by making a plan in which wastes will be reused and recycled by creating an area where wastes can be separated and stored in the construction or demolition area (Ölmez and Yıldız, 2008). If waste is managed correctly, the amount of recyclable material will be more recyclable. Before the contractor firm starts to work in the area where the construction will be made, it must issue a work program related to the waste recycling. It should specify in the work program where and how to use construction and demolition wastes

Construction and demolition waste (CDW) can be defined as waste materials generated during the construction, renewal, restoration or demolition of buildings. CDW constitutes the majority of urban waste. CDW, which generates 350 million tons per year in the European Union, (EU) is the largest amount of waste, (Whittaker et al., 2019). 30% to 40% of waste in China originates from CDW, (Huang et al., 2018) and this rate is 27% in Canada, (Yeheyis et al., 2012). The garbage and pollution created by such a large amount of waste are environmentally and socially uncomfortable. The recycling of these wastes both reduces the number of landfills and has economic advantages. The most important of these advantages is the acquisition of recycled raw materials and the employment of those who will collect, separate, and recycle.

2.4.1 Construction and Demolition Waste Content

CDWs contain many types of recyclable materials. Although these recyclable materials have many sub-items, they can be evaluated in four main groups. These main groups can be classified as aggregate, metal, wood, and plastic. In the study conducted by (Stenis and Hogland, 2014), the wastes generated were divided into twenty-five groups, and the material analysis of these wastes was made. These twenty-five items: Steel scrap, Wood, Copper scrap, Porcelain and tile, Galvanized steel plate, Stainless steel, PVC, Aluminium scrap, Zink scrap, Galvanized steel, PE/PP, Asphalt, Chipboard, Plaster, Plywood, Concrete, Gravel or stone, Sand gravel, Garden waste, Gypsum Glass wool, Rock wool, Water-based paint, Solvent-based paint, Lightweight concrete blocks. (Yeheyis et al., 2012), it divided the recyclable CDWs among Canada into thirteen groups: Asbestos, Aluminum, Brick and Block, Cardboard, Concrete, Gypsum board, Steel, Insulation, Glass, Ceramic, Plastic, Paint, Wood. In addition, the distribution of construction and demolition wastes in 1992 was given in this study. Figure 5, shows these separated product groups with their percentage values.

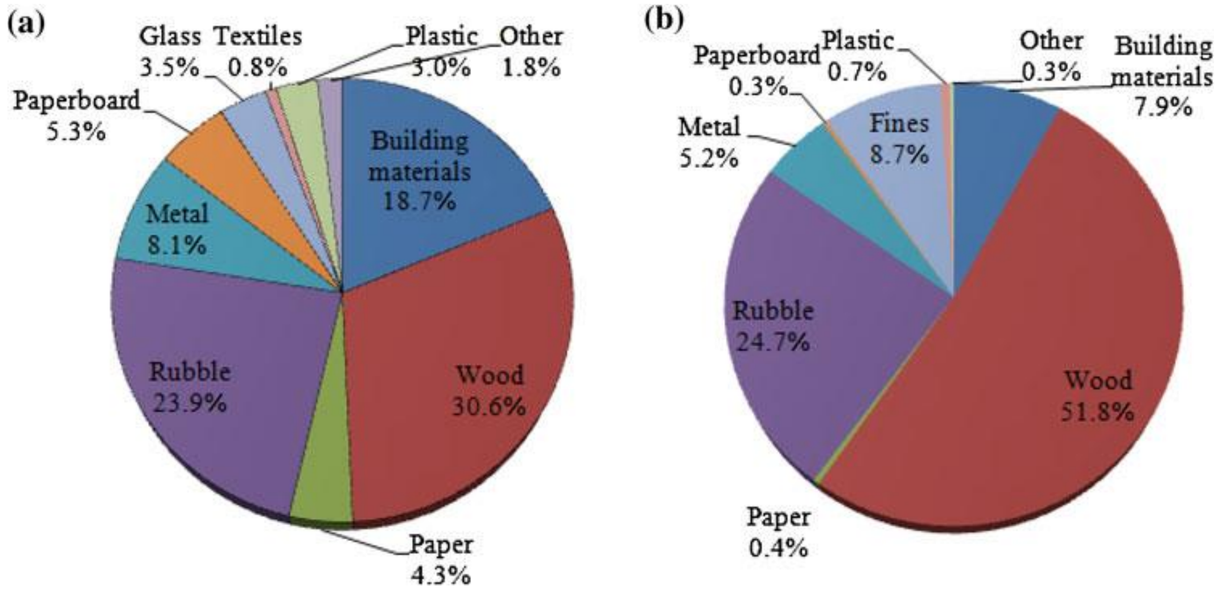

Fig 5. A- Construction Waste B- Demolition Waste Source: (The Canadian Construction Association 1992)

2.4.2 Debris calculation

(Wu et al., 2014; Zainun et al., 2016; and Zainun and Othman 2015) contribute to the debris amount calculations with their studies on debris, shows on Figure 6. Calculating the amount of waste from CDWs provides convenience in excavation, logistics, and sorting. Certain methods are used to calculate debris. The first of these is the weighing of waste with a truck, box, or similar vehicle. The second method is to collect and calculate the debris.

If the debris is pyramid-shaped: $Vs = 1/3 \times B \times L \times H$

If the debris is cube or rectangular: $Vg = L \times B \times H$

where L is the length,

B is the width, and

H is the height of the waste

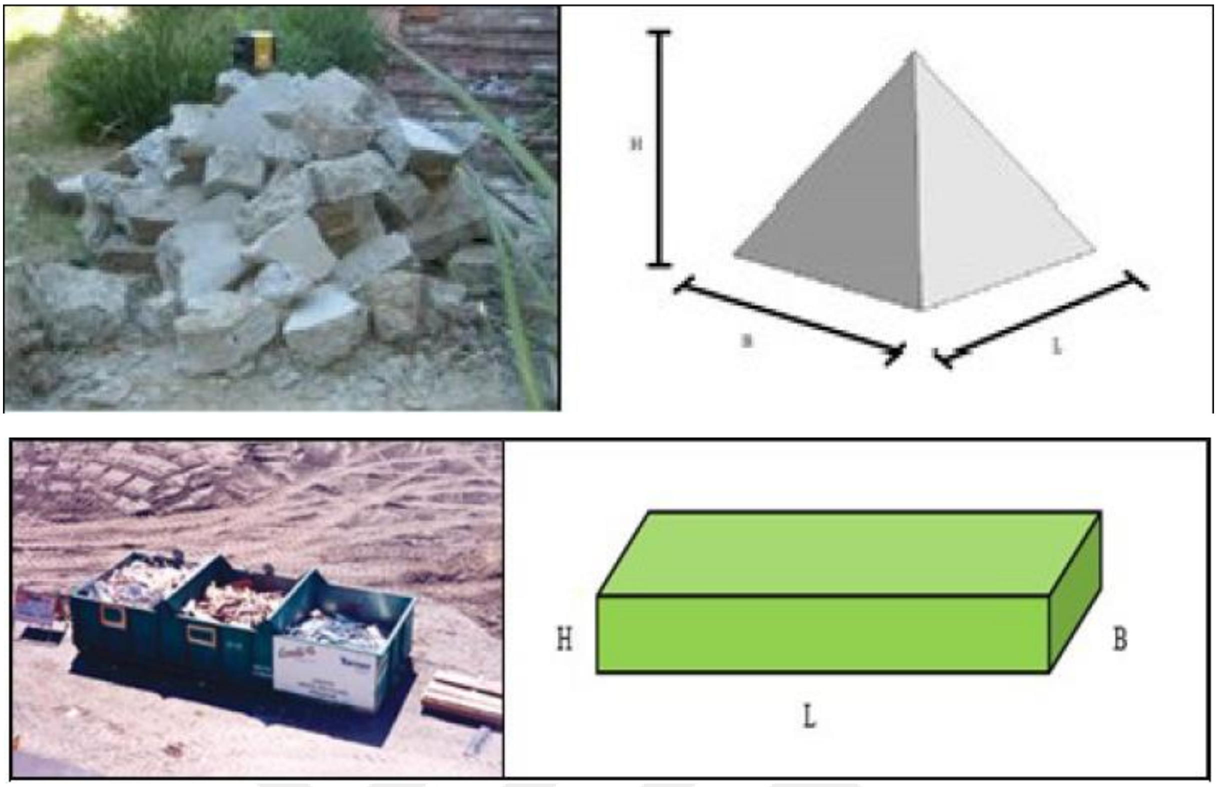

Fig 6. Pyramid-shaped debris and Source Rectangular-shaped debris Source: (Zainun and Othman 2015)

This method is used in the calculation of debris as bulk cargo. The weights for one cubic yard of debris types after separation are as follows;

Mixed Waste 175kg, Commercial-industrial waste between 150-300kg, Residential waste between 75-150kg, Asphalt between 2025-2070kg, Aluminum cans between 25-38kg, Corrugated Cardboard Uncompacted between 25-75kg, Corrugated Cardboard Compacted between 150-250kg, Concrete 2.000kg, Rubble 700kg, Drywall 250kg, Scrap Metal for loose metals 500kg, Wood and pallets 143kg. However, the weight of asphalt one square yard one inch thick between 55-57 kg, and the weight of a pallet of wood or plank is between 15 and 25 kg.

FEMA has conducted studies on CDW, especially as it encounters natural disasters such as hurricanes and storms seasonally. FEMA conducted an empirical study following Hurricane Floyd in North Carolina in 1999, and developed a formula for estimating debris associated with demolished single-family residences:

Length x Width x S x 0.20 x VCM = CY

S = number of floors in the building

0.20 = a constant based on study data

VCM = vegetal cover multiplier

CY = cubic yard

To estimate the amount of debris generated by a building, it is necessary to take into account the air gap in the building. The formula developed by FEMA is as follows.

(Length x Width x Height x 0.33) / 27 = CY

The scales used to calculate the weight of CDWs according to their types are Construction and demolition debris: 1 ton = 2 Cubic Yard, Mixed debris: 1 ton = 4 Cubic Yard, Vegetative debris: Hardwoods: 1 ton = 4 Cubic Yard, Softwoods: 1 ton = 6 Cubic Yard. FEMA has developed the HAZUS-MH software to calculate the potential damages of natural disasters such as hurricane, storm, flood, earthquake.

In this section, information was given about the importance of recycling, the amount of waste in the world and in Turkey, and the recycling activities carried out with these wastes. The social, economic, and environmental effects of recycling and recycling studies were mentioned. In addition, the types of wastes and debris calculations in construction wastes were mentioned. In the next section, the Analytic hierarchy process system (MDCM) and Gray Relational Analysis (GRA), which are Multi-criteria decision-making systems, will be introduced.

CHAPTER 4

RESEARCH FRAMEWORK AND METHOLODOGY

Construction waste and recycling is an important issue, as explained in the previous sections. As the number of constructions and residences increases, the rate of raw materials required increases accordingly. For this reason, it is important to meet some of the needs from here by recycling construction wastes, in terms of protecting resources. For this purpose, performance evaluations will be made by comparing the companies engaged in construction and excavation work using the methodology of this thesis, gray relational analysis. First of all, a set of criteria will be determined in order to compare the companies, and the weights of these criteria will be calculated with the help of the Analytical Hierarchy Process (AHP) and expert opinions. Then, using this calculated GRA model, evaluation and ranking will be made among these companies. At the end of this study, the weaknesses and strengths of public and private companies in the construction and demolition waste (CDW) business will be revealed and evaluated.

3.1 Grey Relational Analysis (GRA)

The gray relational analysis (GRA) system was developed by Deng Julong in 1982 and the foundations of the theory were opened in 1989.

By the (Deng Julong 1989) The application fields of the Grey System involve, agriculture, economy, ecology, meteorology, medicine, history, geography, industry, earthquake, geology, hydrology, irrigation strategy, military affairs, sports, traffic, management, material science, environment, biological protection, judicial system etc.

3.1.1 Grey Relational Analysis Computing

Figure 7 shows, the analysis is done in six steps while calculating the GRA method.

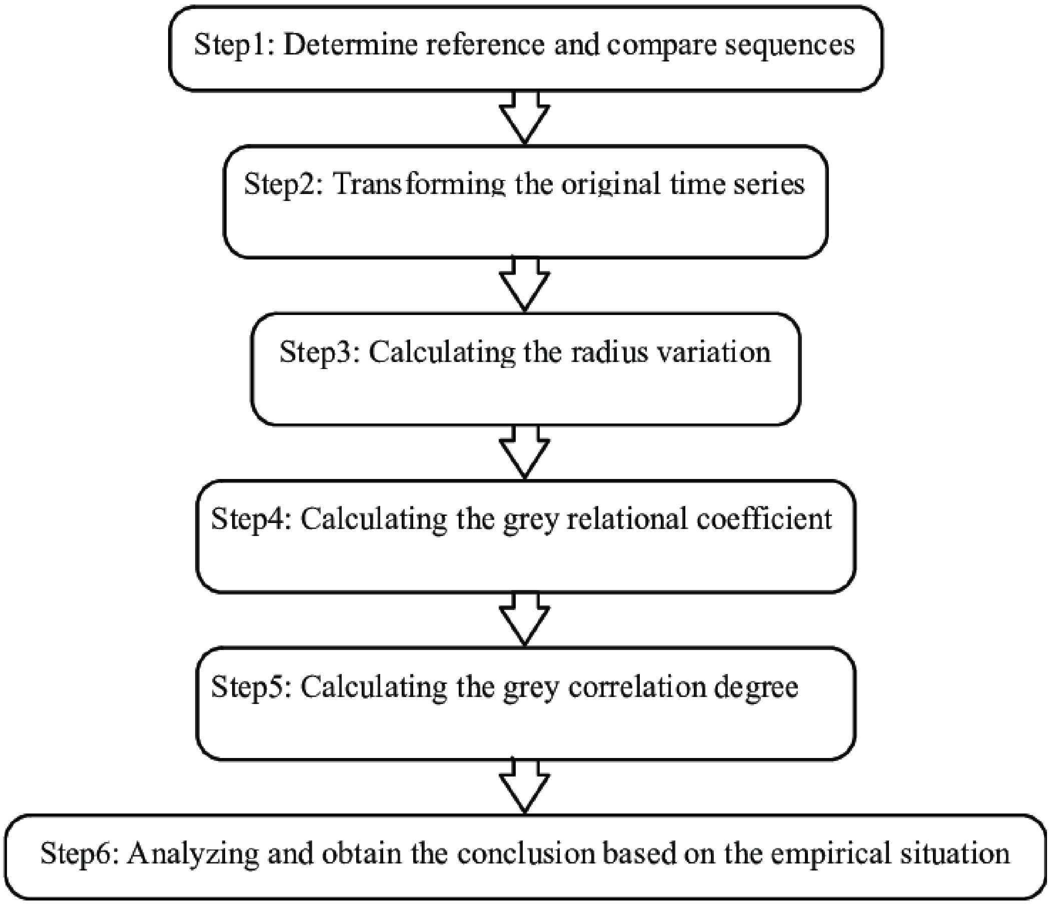

Fig 7. Gray Relational Analysis steps

Step 1. Data set preparation and decision matrix creation

Suppose there are m pieces of alternative, each alternative has n pieces of evaluating criteria. Sign the alternative as row subscript i, while sign the evaluating criterion as column subscript j,

Let's say there are m alternatives, each alternative has n evaluation criteria. Alternatively signed as row subscript i, evaluation criteria as column index j,

$$x_i = \left(x_i(j), \ldots, x_i(n)\right), \qquad \begin{array}{l} i = 1, 2, \ldots, m \\ j = 1, 2, \ldots, n \end{array}$$

then construct the first decision matrix. xi(j), j. corresponding to the criterion i. is the entity in the data array.

$$X = \begin{bmatrix} x_1(1) & x_1(2) & \cdots & x_1(n) \\ x_2(1) & x_2(2) & \cdots & x_2(n) \\ \vdots & \vdots & \ddots & \vdots \\ x_m(1) & x_m(2) & \cdots & x_m(n) \end{bmatrix}$$

Step 2. Creating the reference series and comparing the matrix

The reference series used to compare alternatives.

$$x_0 = \left(x_0(j), \ldots, x_0(n)\right) \qquad j = 1, 2, \ldots, n$$

The reference series are derived from the normalization matrix from the best indicator of the alternative. Provides the useful indicator x0 (j) on the equation. Then the reference series are added to the decision matrix and converted to the comparison matrix.

Step 3. Normalization process and creation of the normalization matrix

Since different scales and measurement units are used in the decision problem, we need to convert the data set to a single scale for a healthy comparison. There are 3 types of normalization processes belonging to the properties of the criteria.

Benefit attribute (the more the better): If the larger value positively affects the target, the Equation is used to calculate the normalization values.

$$x_i^* = \frac{x_i(j) - \min\limits_j x_i(j)}{\max\limits_j x_i(j) - \min\limits_j x_i(j)}$$

Cost attribute (the less the better): If the lower value positively impacts the target, the Equation is used to calculate normalization values.

$$x_i^* = \frac{\max\limits_j x_i(j) - x_i(j)}{\max\limits_j x_i(j) - \min\limits_j x_i(j)}$$

Optimal attribute: If the decision maker determines the optimal values, Equation uses it to calculate the normalization values.

$$x_i^* = \frac{\left|x_i(j) - x_{0b}(j)\right|}{\max\limits_j x_i(j) - x_{0b}(j)}$$

Step 4. Creating the absolute values table

The absolute value between x*0 and x*i is found by Δ0i (j) and calculate with Equation.

$$\Delta_{0i} = \left| x_0^*(j) - x_i^*(j) \right| \qquad \begin{matrix} i = 1,2,\ldots,m \\ j = 1,2,\ldots,n \end{matrix}$$

$$\Delta_{0i} = \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \cdots & \Delta_{01}(n) \\ \Delta_{02}(1) & \Delta_{02}(1) & \cdots & \Delta_{02}(1) \\ \vdots & \vdots & \ddots & \vdots \\ \Delta_{0m}(1) & \Delta_{0m}(2) & \cdots & \Delta_{0m}(n) \end{bmatrix}$$

Step 5. Calculating the gray correlation coefficient for each alternative

Gray relational coefficient matrix Calculation by equation

$$\gamma_{0i}(j) = \frac{\Delta_{\min} + \zeta \Delta_{\max}}{\Delta_{0i}(j) + \zeta \Delta_{\max}}$$

$$\Delta_{\max} = \max_i \max_j \Delta_{0i}(j)$$

$$\Delta_{\min} = \min_i \min_j \Delta_{0i}(j)$$

In the equation, the parameter ζ indicates the discriminant coefficient and represents the significance of Δmax, where 0≤ ζ ≤1 and the smaller the ζ, the higher the distinguishability. Most studies in the literature ζ = 0.5 because it offers moderate discriminative effects and good stability.

Step 6. Calculating the grey relational degree

The gray relational rating calculation is calculated in different ways of priority weight for criteria.

If criteria have equal priority weights, use equation to calculate.

$$\Gamma_{0i} = \frac{1}{n}\sum_{j=1}^{n} \gamma_{0i}(j)$$

If criteria have different priority weights (w), use Equation to calculate gray relationship degree

$$\Gamma_{0i} = \sum_{j=1}^{n} \left[w_i(j) \cdot \gamma_{0i}(j) \right]$$

3.1.2 Grey Relational Analysis (GRA) in Literature

In today's literature, it can be used in many areas such as system analysis, selection and sustainability, especially in material planning. Twenty-five publications are given below, with their subjects, keywords and journals published.

(Gugulothu et al., 2021), the electrical discharge machine was optimized using the GRA and Taguchi method. (Sarraf and Nejad 2020) conducted improvement analyzes based on performance evaluation of research, water, and wastewater companies. Prior to this (Ip et al., 2009) conducted a study on Water quality assessment (WQE), Water quality index (WQI) using the GRA method. (Shunmugesh and Pratheesh 2020) investigated micro drilling optimization in carbon fiber reinforced plastics using the GRA and Taguchi method. (Kung and Wen 2007) conducted a study in economics and examined venture capital firms in Taiwan with GRA and Gray Decision-Making. (Karthikeyan et al., 2018) performed Kerf quality optimization in mild steels. (Tharian et al., 2019), using the GRA method, optimized the use of electric discharge machines. (Uzun 2019) made a performance evaluation of austempered vermicular graphite cast irons. (Canbolat et al., 2019) work on the optimization of refrigeration systems using GRA, ANOVA and Taguchi methods. (Sun et al.,2018) conducted a study using Gray relational analysis (GRA) and Hesitant fuzzy sets (HFSs). (Hung et al., 2019), optimization of internal cylindrical grinding in alloy steels was made. (Ananth et al., 2018) a study was conducted on the corrosion of gray cast iron. In this study, GRA, ANOVA, and Taguchi methods were used. (Sehgal and Meenu 2018) conducted a study on optimizing the iron casting process. (Chauhan et al., 2018) There has been a study of micro electric discharge machine optimization. (Deepthi and Krishna 2018) study was on the optimization of electroless copper plating parameters using Taguchi method, Gray relational Analysis, ANOVA methods. (Khedekara and Gogte 2018) study was on the optimization of age hardenable alloys. (Škrinjaric 2020) conducted a study on optimizing the dynamic portfolio optimization process using the GRA model. (Chen and Ren 2018) conducted a study on the sustainability of alternative aviation fuels using the fuzzy GRA and AHP method. (Daniel et al., 2018) conducted a study on the optimization of multi-objective estimation and control parameters. (Deshmukh et al., 2019) optimized process parameters of wire electrical discharge using GRA and Taguchi method. Using the GRA model, (Yin et al.,2018) explained the economic and sectoral relationship of the sea-land. (Huang et al., 2018) Using the GRA model, they evaluated the carbon emissions in China and made their forward estimates. (Rajesh and Ravi, 2015) conducted a study using the GRA method to select a supplier. (Lin and Wu 2011) investigated whether gray relational analysis can be used to predict financial crises and is superior to conventional methods. (Yazdani et al., 2019) shows the use of GRA with a Fuzzy multi-featured decision framework.

Author / year	Key words
Gugulothu et al. 2021	Electrical discharge machining Grey relational analysis Taguchi method and Multi-response optimization
Sarraf and Nejad 2020	Grey relational analysis Data envelopment analysis Balanced scorecard Water and wastewater Companies
Ip et al. 2009	Grey relational analysis (GRA) Triangle relational degree (TRD) Water quality evaluation (WQE) Water quality index (WQI)
Shunmugesh and Pratheesh 2019	Micro drilling; Optimization; CFRP composites; Grey relational analysis; Delamination factor; Taguchi method
Kung and Wen 2007	Grey Relational Analysis; Grey Decision-Making; GM (0, N); Venture capital enterprises
Karthikeyan et al. 2018	CO2 Laser cutting, Cutting speed, Power, Pressure, Kerf width, Kerf ratio and Grey Relational Analysis
Tharian et al. 2019	Grey Relational Analysis; Taguchi technique; Signal to Noise ratio
Gültekin Uzun 2019	Vermicular graphite cast irons, Milling Tool wear, Cutting force, Surface roughness, Grey relational method

Canbolat et al. 2019	Absorption refrigeration system, Taguchi method, Grey relational analysis, ANOVA, COP, eCOP
Sun et al.2018	Grey relational analysis (GRA) Hesitant fuzzy sets (HFSs) Pattern recognition Difference of the HFSs Slope of the HFSs HFSs synthetic grey relational degree
Hung et al. 2019	Internal cylindrical Grinding, 9CrSi alloy steel, Orthogonal array, Grey relational analysis, ANOVA, Optimization.
Ananth et al. 2018	Grey cast iron, Sliding wear, Taguchi technique, GRA, ANOVA
Sehgal and Meenu 2018	Turning; energy dispersive X-ray spectroscopy, scanning electron microscopy; response surface method; ductile iron; grey relation analysis; principal component analysis, optimization
Daniel et al. 2018	Silicon carbide, Temperature, Surface roughness, Cutting forces, Artificial neural network, Grey relational analysis
Chauhan et al. 2018	Micro EDM, Microhole, GRA, ANOVA, Taguchi

Chen and Ren 2018	Aviation fuel, Sustainability, Multi-criteria decision analysis, Fuzzy analytic network process, Fuzzy grey relational analysis
Deepthi and Krishna 2018	Electroless process; Taguchi method; Grey relational Analysis; ANOVA
Khedekara and Gogte 2018	Age Hardenable Alloy, Cryogenics, Gray Relational Analysis, Gray Relational Coefficient, Gray Relational Grade, Solutionizing
Deshmukh et al. 2019	WEDM; AISI 4140; Surface roughness; Kerf width; Taguchi method; Grey relational analysis; ANOVA
Tihana Škrinjaric 2020	Dynamic portfolio selection Grey relational coefficient Stock performance
Yin et al.2018	Grey relational analysis Periodic relational degree Industrial relevance between marine-land economy Energy consumption education
Huang et al.2018	Carbon emissions Influencing factors Long short-term memory Principal component analysis Grey relational analysis
Rajesh and Ravi, 2015	Resilient supply chain Resilience Grey relational analysis Resilient supplier Supplier selection
Lin and Wu 2011	Grey relational analysis (GRA) Credit riskFinancial crisis

	Warning system Grey system
Yazdani et al. 2019	Fuzzy decision making, Grey relational analysis, Interval valued fuzzy, Multi attribute decision making, Quality function deployment

Table 3. Studies on Gray Relational Analysis

When we examine these twenty-five articles, it is seen that eleven of them are published by 'Materials Today: Proceedings', a material planning journal. Next comes the four publications, Journal of Cleaner Production and Expert Systems with Applications. The other six publications were published in journals on different subjects. According to the result, we can reach the information that the Gray relational analysis model is used more in Engineering, Material Science, Energy, Environmental Science. In addition, Taguchi model was used with GRA in eight and ANOVA model in six articles. In other words, it can be said that Taguchi and ANOVA models are the most frequently used models with GRA. These data, which is extracted from Table 3, can be used efficiently in many fields such as materials science, environmental sciences, and system analysis.

3.2 The Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) (Saaty, 1977) is a way of addressing measurable and/or abstract criteria in the decision-making process. It is a multi-objective, multi-criteria decision-making approach based on the idea of pairwise comparison of alternatives according to a criterion. he computations made by the AHP are always guided by the decision maker's experience, and the AHP can thus be considered as a tool that is able to translate the evaluations both positive and negative made by the decision-maker into a multi-criteria ranking.

3.2.1 The Analytical Hierarchy Process (AHP) Application

AHP consists of three main stages. First, a hierarchical structure is created for the solution of the problem in AHP. After the hierarchical structure is created, the pairwise comparison matrix showing the relative importance of the criteria and the superiorities are determined and calculated (An, Kimb and Kang, 2007). The eigenvector method is used to calculate the relative importance. Then the consistency ratio is determined and the consistency of the values in the matrix is checked (Garcia-Cascales and Lamata, 2009). If the consistency rate is at an acceptable level, priority is given to alternatives. Thus, the alternative with the highest value is selected.

Step 1: Establishing a Hierarchical Structure and Formulating the Problem:

Preferring a hierarchical structure in solving problems in AHP means dividing the problem into various levels. The process of creating a hierarchical structure is called modeling. With modeling, the decision-maker is given the opportunity to compare criteria, sub-criteria, and alternatives effectively. First of all, at the top of the created hierarchy is the ultimate goal of the problem. Under the goal, the criteria necessary to achieve the said purpose; At the lowest level of the hierarchy, alternatives are given (Wang, Liu and Elhag, 2008). As can be seen in Figure 8, criteria and alternatives are compared to reach the goal.

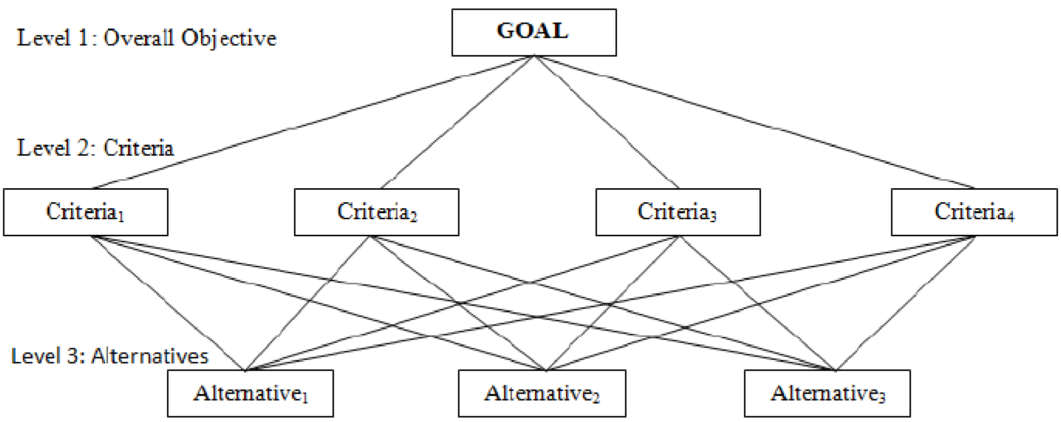

Fig 8. The Analytical Hierarchy Process (AHP) hierarchy structure Source: (Agarwal et. Al. 2014)

Step 2: Creation of matrix and Scale of preference between two elements

The second step of AHP is the pairwise comparisons matrix. After creating a hierarchical structure, the relative importance of each criterion is calculated. The relative importance of the criteria can only be found by making a pairwise comparison, that is, by comparing the two criteria with each other. Pairwise comparison is based on the experience and knowledge of the decision maker (Garcia-Cascales and Lamata, 2009).

Preference weights/ level of importance	Definition	Explanation
1	Equally preferred	Two activities contribute equally to the objective
3	Moderately preferred	Experience and judgement slightly favour one activity over another
5	Strongly preferred	Experience and judgement strongly or essentially favour one activity over another
7	Very strongly preferred	An activity is strongly favoured over another and its dominance demonstrated in practice
9	Extremely preferred	The evidence favouring one activity over another is of the highest degree possible of affirmation
2,4,6,8	Intermediates values	Used to represent compromise between the preferences listed above
Reciprocals	Reciprocals for inverse comparison	

Table 4. The scale of preference between criteria

After creating the comparison matrix and giving the numerical values to the criteria with the help of the table in Table 4, what needs to be done is to calculate the relative importance levels between the criteria. The relative importance level is calculated in the binary comparison matrix (Saaty, 1994). Then the consistency analysis begins.

Step 3: Consistency analysis

Consistency analysis is applied while calculating the consistency rate of the AHP Method. For this, this equation is applied and CI: Consistency index is found. $CI = \lambda_{max}/(n-1)$

The consistency ratio is reached by dividing the consistency index by the incidental indicator shown in the table

CR = TI/RI.

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 5. Random consistency index

According to Table 5, the CR value must be less than 0.10. If a value greater than 0.10 comes out, all matrices written by the evaluations should be examined. After the arrangements to be made, the steps should be repeated. The repetition of the steps continues until the consistency ratio is less than 0.1.

In this section, the definition and formulation of GRA and AHP, which are the methods we used for research, were mentioned. In addition, information was given about how these methods are used in the literature and for their purposes. In the next section, performance evaluations of the companies will be made, the criteria used for this and the data of various companies will be evaluated.

CHAPTER 5

PERFORMANCE EVALUATIONS OF CONSTRUCTION WASTE AND RECYCLING COMPANIES

The aim of this thesis is to evaluate the performance of companies working on the recycling of construction waste. Developing and changing technologies, social and environmental factors that emerged as a result of demographic changes have caused this issue to be emphasized. The main motivation in this study is that while there are many studies in the literature that evaluate social, environmental, economic, and technological factors while examining CDW sector, there are not many studies in the literature on the evaluation of companies currently engaged in CDW work against each other. Depending on the development of this sector, the number and variety of studies on this subject have increased. (Huang et al., 2002) conducted a study showing the importance of machinery in the separation of construction wastes and showed how technological developments affect the construction industry. (Li et al., 2020) examined the environmental impact of demolition waste and addressed environmental problems in the study. While the research by (Garbarino & Blengini 2013) talked about the economics of recycling in the construction and demolition sectors, the later study (Boa & Lu 2020) explained the productive circular developments created by CDWs in developing economies. By conducting more analysis-based studies on this subject, important information has been obtained for the academic and business environment. (Yuan 2013) made a SWOT analysis of successful construction waste management with his study. (Lu et al., 2021) conducted a study on the density of construction waste with the help of big data. (Wang et al., 2019) showed the relationship of the construction industry with society with the study. Along with these social, environmental, and scientific researches, economic feasibility studies were also carried out. The financial and economic assessment of construction and demolition waste recycling examined the Hanoi region of Vietnam, a similar study (Zhao et al., 2010) revealed the economic feasibility of recycling construction and demolition waste in the Chongqing region of China.

In this study, the performances of companies currently engaged in CDW work will be evaluated. For this purpose, the AHP and GRA methods mentioned in the previous chapter will be used. The AHP method will be used to determine the criterion weights, and the GRA method will be used to choose among the options.

The research started with the data collection process. The quality, quantity, and accuracy of the data to be obtained are important for the quality of the research. In Turkey, excavation soil construction waste control regulation, determination of excavation areas, license and licensing procedures are carried out by the municipalities and the Ministry of Environment and Forestry with the law published in the Official Journal dated 18.03.2004 and numbered 25406.

The construction wastes branch directorate, which is under the Waste Management Department, deals with construction wastes in Izmir metropolitan municipality. As a result of the application made to this directorate, an annual report containing the information of three companies was obtained. Among these companies, which we will describe as A, B, and C, A is a state subsidiary, while companies' B and C are private organizations. After the data received, phone and face-to-face interviews were held with the officials of these three companies in order to confirm the data and obtain new information. Similar studies were examined to create an appropriate criteria set up after data collection. Considering the negative and positive features, an evaluation criteria set consisting of nine criteria was prepared. These criteria are; Number of excavation facility, number of recycle facility, vehicle value, machine value, employee amount, employee education degree, stored amount, and distance to the customer. Construction industry experts, architects, architecture students and lecturers were consulted to evaluate these criteria.

4.1 Data and Criteria

With the data obtained from the Izmir metropolitan municipality and companies, we made three companies able to compare. A set of criteria was created with the data obtained from these companies and a performance index will be revealed. These criteria can be grouped under two main headings as Positive Criteria and Negative Criteria. Positive criteria, higher means better. Negative criteria mean the lower the better.

4.1.1 Positive Criteria

As the number of positive criteria increases, they have positively affected values. As the positive criteria increase, the quality and efficiency of the work increase at the right rate. Seven positive criteria were determined for this study. The purposes of determining these criteria are as follows: A number of Excavation Facilities; (Coelho and Brito 2013) CDW used the Number of Facilities as a criterion while choosing the location for its facilities. In the study (Guo and Kluse 2020), the number of facilities is a criterion for the selection to be made in establishing a photovoltaic recycling network. (Louwers et al., 1999) used the number of facilities as a criterion in his study to determine the location of recycling facilities for carpet materials. A number of recycling facilities; There is a criterion similar to the number of excavation facilities. (Karagöz et al., 2020) mentioned the importance of the number of recycling facilities while examining the recycling facility location problems in his study. (Ahmadi-Javid et al., 2017) also used the other number as a criterion in determining the location of health care facilities. In addition, (Current et al., 1998) explains that research will be difficult in cases where the number of facilities is uncertain. Machine and vehicle costs are a significant factor in terms of affecting the working volume and efficiency. While (Kursunoglu et al., 2017) showed this cost within the investment cost in the study, (Öztürk et al., 2016) used machine costs as a criterion for the textile company sector. (Kheybari et al., 2019) used the workforce as a criterion in the selection of a facility to be established in Iran. (Queiruga et al., 2008) used the appropriate workforce as a criterion in the study. Another study (Sagnak et al., 2021) mentions the importance of the workforce and the job opportunity it creates. Education is the other criterion; (Özceylan et al., 2016) used university education as a criterion in the study. (Kheybari et al. 2019; Sagnak et al., 2021) used education and competence as criteria in their research. Sales figures form the backbone of the economic part of the research. (Rubio-Aliaga et al., 2021) sales figures show itself as an economic criterion. In another study (Propfe et al., 2012), he evaluated the sales value as a criterion in the cost analysis. The amount and capacity stored are some of the most general criteria. In almost every study, capacity and limits were used as criteria. (Coelho and Mateus 2017) used plant capacity as a criterion. Many studies such as (Gomes et al., 2011; Listes and Decker 2005; Realff et al., 2004; Schultmann et al., 2003; Jayaraman et al., 1999) are similar studies using capacity as criteria. The distance to the customer, destination, or facility is used as a criterion in research, especially in MCDM research using Global information system (GIS), this criterion is definitely used, for example (Özceylan et al., 2016; Macharis et al., 2015).

Number of Excavation Facility: The increase in the number of excavation facilities reduces logistics costs by facilitating transportation and providing economic advantages (Coelho and Brito 2013; Guo and Kluse 2020; Louwers et al., 1999)

In this research, there are six storage areas belonging to three companies.

Three of them are from company A, two of them from company B and one from company C.

Number of Recycle Facility: The number of recycling facilities is as important as the number of excavation areas. Because if construction waste cannot be recycled, it can only be used for reuse as a filling material. Therefore, the number of recycling facilities is also very important in terms of creating benefit (Karagöz et al., 2021; Ahmadi-Javid et al., 2017). Among these three companies, each company has one recycling facility.

Vehicle Value: One of the criteria is the value of the vehicles. Thanks to these vehicles, it is ensured that the wastes are transported quickly from the construction area to the excavation area. Many companies in Turkey outsource this transportation business to third-party companies. The main reason why the intermediate value is preferred according to the number of vehicles; there is a wide variety of vehicles and their different capacities. This was chosen because the instrument value would provide more accurate data for research. In this research, only Company A among three companies has a vehicle fleet worth 42,695,557.88 TL, while two other companies work with third-party companies (Özceylan et al., 2016).

Machine Value: The machines used are the main assistants at the point of stacking and recovery of excavation loads. With the help of machines, many activities such as stacking, sorting, reprocessing, shredding are carried out. In parallel with the vehicle values, it was seen that the evaluation of the values of the machines would be more consistent rather than the number of machines, considering the diversity, capacities, sizes, and working speeds of the machines used (Kursunoglu et al. 2017; Ozturk et al., 2016). Machine value data is given in Table 6. As can be seen, the machine values of company A are more than eleven times higher than the sum of company B and C.

Operating Company	**Machine Value (TL)**
A	56.729.252,78
B	3.150.015,82
C	1.610.000,00

Table 6. Data of Machine Value

Employee Amount: A large number of employees directly helps in sharing the workload, arranging the working hours better, and increasing the productivity of the employees by reducing the work intensity (Kheybari et al., 2019; Queiruga et al., 2008; Sagnak et al., 2021). As can be seen in Table 7, company A has 851 employees, while company B has 30 and company C 18 employees.

Operating Company	Employee Amount
A	851
B	30
C	18

Table 7. Data of Employee Amount

Employee Education Degree: The fact that an employee is educated and qualified directly affects the working efficiency. For this reason, the education level of the employees is an important criterion in terms of performance. In this study, we count those who have a vocational school or a bachelor's degree among the three companies as trained personnel (Özceylan et al., 2016). When we apply the figures in table 7 to table 8, it is seen that 129 people in company A, In company's b and c, two people a bachelor or vocational school graduates.

Operating Company	Employee Education Degree %
A	15,16
B	6,66
C	11,11

Table 8. The ratio of vocational school and bachelor's degree

Sales (weight): Sales figures come to the forefront with the benefits it brings back to the economy, the environment, and recycling, rather than the income benefit. Waste that is recycled or sold as filling material creates an economy by reprocessing or using it. As can be seen in Table 9, it is seen that companies A and B recycle much more construction waste than Company C or sell them to be used in filling processes.

Operating Company	Sales (weight KG)
A	220.148.410,00
B	155.849.000,00
C	36.953.250,00

Table 9. Data of Sales Numbers

4.1.2 Negative criteria

Negative criteria are the factors that provide disadvantages, those that are high in these elements are more disadvantageous, and those that are lower are better data. There are two negative criteria in this study; Stored amount and distance to the customer.

Stored amount: Although the amount stored may seem like a good amount at first glance, the number that should be specified here is the amount of waste that is idle, not used in 6R activities, and is complete garbage. Since these wastes cannot be recycled to the economy and create environmental pollution, the smaller the amount, the better (Coelho and Mateus 2017; Gomes et al., 2011; Listes and Decker 2005; Realff et al., 2004; Schultmann et al., 2003; Jayaraman et al., 1999). When you look at the amount of waste stored in Table 10, a big difference can be seen between companies A, B, and C. Company C stored 58 tons of waste, Company B stored 178 tons of waste, while Company A is well ahead of the other two companies, storing almost 1,420 tons of waste.

Operating Company	Stored Amount KG
A	1.419.969.020
B	178.053.000
C	58.326.754

Table 10. Data of Stored Amount

Distance to the customer: Distance to the customer is a negative factor because it increases logistics costs and makes transportation difficult. In this research, the research was also included due to the transportation and traffic difficulties caused by the fact that the excavation areas are far from the construction areas in the city (Özceylan et al., 2016). When you look at Table 11, the distance of companies A and B to the city center where the population density is close to each other, while the distance of company C is greater than other companies.

Operating Company	Distance to Customers KM
A	29
B	34
C	70

Table 11. Distance to Customers

In this chapter, we showed the three CDW companies operating in the province of Izmir with negative and positive criteria. The characteristics of each firm such as area, manpower, and financial possibilities were shown in these criteria. In the next section, inter-firm performance evaluation will be made using AHP and GRA methods using these criteria.

CHAPTER 6

IMPLEMENTATION OF THE STUDY

With this research, an evaluation will be made between CDW companies operating in Izmir. The purpose of this research is to examine how CDW waste is used and whether these wastes are recycled into the economy and nature. As explained in the previous sections, the housing needs of people increase in direct proportion to the population. Because, as stated in Maslow's hierarchy of needs (Maslow 1943), shelter is one of the most basic human needs and every human needs it in order to survive. Therefore, the amount of housing needed increases in direct proportion to the population. On the other hand, the materials used to open new houses in demolished houses are mostly recyclable materials. It is predicted that some materials from construction waste, such as zinc and copper, will become hard to find metals in the next two decades, and the availability of two metals, iron and aluminum, which are the basic materials of construction waste, will increase. will decrease significantly in the current century (Valero et al., 2010). On the other hand, even if these wastes are not recycled, they can be used as filling material and recycled to nature.

In order to make this research productive and useful, the main purpose of this research is to evaluate the data of the CDW companies, whose information has been reached, with a correct set of criteria and to reach the performance values of these companies. To make this assessment, analysis and evaluation will be made, consisting of five steps. AHP and GRA methods will be used for this analysis and evaluation. In the first step of the evaluation, the companies and criteria to be compared will be brought together, in the second step, the matrix created with expert opinions will be made, criteria weights will be calculated using the data in the first two steps, in the fourth step, the normalization process will be done using GRA and the last step will be, the ranking between the companies with the table that emerged in the last step and evaluation will be made.

Step 1: Data collection; In the first stage, using the available data, these data are specified as positive or negative. As seen in Table 12, this table was created by evaluating three companies in nine different criteria. Seven of these criteria are positive and two are negative criteria.

Company	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
A	1419969020	29,00	220148410,00	3	2	42695557,88	56729252,78	851	15,21
B	178053000	34,00	155849000,00	1	1	0	3150015,82	30	6,66
C	58326754	70,00	36953250,00	2	1	0	1610000,00	18	11,76
+/-	-	-	+	+	+	+	+	+	+

Table 12. Data of Companies and criteria

Step 2: Matrix creation: A matrix is created by taking expert opinions. In this section, we asked the experts to rate the importance of the criteria against each other as 1,3,5,7,9 (Equally preferred, moderately preferred, strongly preferred, very strongly preferred, extremely preferred) using 'Preference weights/ level of importance '. While creating the matrix in Table 13, Information was obtained from architecture faculty members and students, contractors, construction and demolition experts through face-to-face, telephone and internet interviews.

	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
Stored	1,00	3,00	0,20	3,00	0,33	7,00	0,33	5,00	5,00
Distance to Customers	0,33	1,00	0,20	1,00	0,20	0,33	0,33	3,00	3,00
Saled	5,00	5,00	1,00	3,00	3,00	9,00	5,00	7,00	9,00
Excavation Facility	0,33	1,00	0,33	1,00	0,33	5,00	1,00	3,00	5,00
Recycle Facility	3,00	5,00	0,33	3,00	1,00	7,00	3,00	5,00	7,00
Vehicle Value	0,14	3,00	0,11	0,20	0,14	1,00	0,14	0,33	3,00
Machine Value	3,00	3,00	0,20	1,00	0,33	7,00	1,00	3,00	7,00
Employee Amount	0,20	0,33	0,14	0,33	0,20	3,00	0,33	1,00	3,00
Employee Education Degree %	0,20	0,33	0,11	0,14	0,14	0,33	0,14	0,33	1,00
Sum	13,21	21,67	2,63	12,68	5,69	39,67	11,29	27,67	43,00

Table 13. Matrix Created After Expert Opinions

Step 3: After the companies to be compared, criteria and expert opinions were taken, criterion weights were determined by using the AHP method. When we examine the criteria weights in

Table 14, we see that the sales value constitutes the highest value with 0.32 for all criteria. While the number of recycling facilities is in the second place, the machine value and the amount of storage have equal importance with 0.12. The least important is the education level of the employees with 0.02.

	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %	Criteria Weights
Stored	0,08	0,14	0,08	0,24	0,06	0,18	0,03	0,18	0,12	0,12
Distance to Customers	0,03	0,05	0,08	0,08	0,04	0,01	0,03	0,11	0,07	0,05
Saled	0,38	0,23	0,38	0,24	0,53	0,23	0,44	0,25	0,21	0,32
Excavation Facility	0,03	0,05	0,13	0,08	0,06	0,13	0,09	0,11	0,12	09
Recycle Facility	0,23	0,23	0,13	0,24	0,18	0,18	0,27	0,18	0,16	0,20
Vehicle Value	0,01	0,14	0,04	0,02	0,03	0,03	0,01	0,01	0,07	0,04
Machine Value	0,23	0,14	0,08	0,08	0,06	0,18	0,09	0,11	0,16	0,12
Employee Amount	0,02	0,02	0,05	0,03	0,04	0,08	0,03	0,04	0,07	0,04
Employee Education Degree %	0,02	0,02	0,04	0,01	0,03	0,01	0,01	0,01	0,02	0,02

Table 14. Calculation of criteria weights

At this stage, the information along with the weights of the collected data is revealed, and thus, by completing the AHP, the data is made suitable for the GRA model.

Comp	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
A	1419969020,00	29,00	220148410,00	3,00	2,00	42695557,88	56729252,78	851,00	15,21
B	178053000,00	34,00	155849000,00	1,00	1,00	0,00	3150015,82	30,00	6,66
C	58326754,00	70,00	36953250,00	2,00	1,00	0,00	2167094,50	18,00	11,76
Weights	0,12	0,05	0,32	0,09	0,20	0,04	0,12	0,04	0,02
+/-	-	-	+	+	+	+	+	+	+

Table 15. Companies and criteria with weights

Step 4: Applying Gray Relational Analysis, in this step, using the GRA method, ranking among the three companies will be provided. The GRA method is applied by using the reference series and performing the normalization process. Also, 'State Value of the coefficient' is determined in this section.

Comp	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
A	1419969020,00	29,00	220148410,00	3,00	2,00	42695557,88	56729252,78	851,00	15,21
B	178053000,00	34,00	155849000,00	1,00	1,00	0,00	3150015,82	30,00	6,66
C	58326754,00	70,00	36953250,00	2,00	1,00	0,00	2167094,50	18,00	11,76
Weights	0,12	0,05	0,32	0,09	0,20	0,04	0,12	0,04	0,02
	-	-	+	+	+	+	+	+	+

	Min	Min	Max	Max	Max	Max	Max	Max	Max
Referential Serie	58326754,00	29,00	220148410,00	3,00	2,00	42695557,88	56729252,78	851,00	15,21

Max	Max	Min	Min	Min	Min	Min	Min	Min
1419969020,00	70,00	36953250,00	1,00	1,00	0,00	2167094,50	18,00	6,66

Normalization	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
A	0,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
B	0,91	0,88	0,65	0,00	0,00	0,00	0,02	0,02	0,00
C	1,00	0,00	0,00	0,50	0,00	0,00	0,00	0,00	0,60

Max	Max	Max	Max	Max	Max	Max	Max	Max
1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Min	Min	Min	Min	Min	Min	Min	Min	Min
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

State Value of the coefficient	0,5

Table 16. Normalization according to the GRA model

Step 5: After all these stages, the coefficients were obtained with the GRA model. The final table will be obtained by multiplying the coefficients obtained from here with the weights obtained from the AHP method. These coefficients and weights are given in Table 17.

	calculation of the grey relational coefficients								
	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %
A	0,33	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
B	0,85	0,80	0,59	0,33	0,33	0,33	0,34	0,34	0,33
C	1,00	0,33	0,33	0,50	0,33	0,33	0,33	0,33	0,55
Weights	0,12	0,05	0,32	0,09	0,20	0,04	0,12	0,04	0,02

Table 17. Calculation of the grey relational coefficients

Using the calculation of the gray relational coefficients, the data comes to the evaluation stage. After this stage, a ranking can be made between the companies with the available data. The final table can be obtained with the calculation of the gray relational coefficients and the weights calculated with the AHP. With the obtained table 18, a ranking can be made among the companies and the evaluation of these data can be made.

	grey relational coefficient * weight of the corresponding criteria										
	Stored	Distance to Customers	Saled	Excavation Facility	Recycle Facility	Vehicle Value	Machine Value	Employee Amount	Employee Education Degree %	Sum	Rank
A	0,04	0,05	0,32	0,09	0,20	0,04	0,12	0,04	0,02	0,92	1
B	0,10	0,04	0,19	0,03	0,07	0,01	0,04	0,01	0,01	0,50	2
C	0,12	0,02	0,11	0,05	0,07	0,01	0,04	0,01	0,01	0,43	3

Table18. Final comparison between companies

With the method used and the research done, the performance evaluation within three companies emerged. Among these companies, company A, a state subsidiary, got a better score than the other two companies. Evaluations on this subject will be presented in the next chapter, the discussions and implications.

As a result of all these steps and methods, the following data was obtained in Table 18. Among these companies, company A, which is a state subsidiary, scored 0.92 better than the other two companies. Company B is in the second place with 0.50, while Company C is in the last place with 0.43.

Detailed analysis of all these data will be made in the discussion and applications section.

CHAPTER 7

DISCUSSIONS & IMPLICATIONS

When we examine all these companies and data, it is not an unexpected result that company A is ahead. This state-owned company, which is ahead in all positive parameters, is ahead of other companies because it is affiliated with the municipality and does not have to make a profit. That is, this company wrote the local government support at the beginning while making its own SWOT analysis. So while there are many strengths in this SWOT analysis, there are only two minor and general weaknesses.

When the amount of accepted construction waste of the companies is collected, Company A accepted a total of 1,640,117,430 KG of waste and separated 13,42% of it, used in recycling or sold as filling material, 86.58% of these CDWs remained as garbage. Likewise, Company B accepted a total of 333,902,000 KG of CDW and sold 155,849,000 KG of this, ensuring that 46.67% of the incoming waste was somehow recovered. In company C, this rate is 38.78% with 95280004 KG CDW acceptance amount and 36953250 KG recovery. The accepted CDW ratio is found by adding the quantity stored and the quantity sold or recycled and dividing the quantity sold.

If we examine the criteria, the amount of storage is an important criterion with 0.12. The reason why the amount of storage is a negative criterion is; In these three companies, there is no storage space capacity problem and they can accept all incoming CDWs. In the information just given, the recycling rates of these companies are given. Since these companies generate income from the incoming loads, they take CDW far more than they can sell or convert, and store them and turn them into useless garbage. Therefore, the amount of CDW remaining as waste has a negative impact on the performance of these companies.

Another criterion, the distance to the customer, is another negative criterion with a weight of 0.05. As mentioned at the beginning of the study, the population is increasing in urban areas, so the fact that the facilities are far from the city center is a negative factor due to increased logistics costs, increased carbon emissions, and decreased accessibility.

The sales figure is the most important criterion with 0.32 among the criteria. There are basically two reasons for this. The first reason is the income obtained from the sale, and with the increase in this income, the recycling business will become more attractive and develop and create new business opportunities. The second reason is that the amount sold is somehow recovered and returned to the economy and nature. This will provide an environmental advantage as it will help conserve the world's dwindling resources as these sold resources come from recycling. In short, since sales are actually effective both environmentally, socially, and economically, it is quite acceptable that being the biggest weight.

The number of excavation sites is actually important in terms of increasing accessibility, but the reason why it is not as important as the recycling facility is that the CDWs coming to these areas can only be sold as filler material and the remaining amount is garbage. But ultimately, if the number of excavation sites is small and inaccessible, people will start to find other places for these wastes. In some places in Turkey, seen that rubble and waste are piled up in various places due to the shortage of excavation places.

The number of recycling facilities is the second most important criterion with 0.20. The features we mentioned in the number of excavation facilities are valid for these facilities. The reason why the recycling facility is more important is that these facilities are not a waste or filling material center, but they enable activities such as separation, shredding, reprocessing and this CDWs to be used more efficiently.

Although the value of the vehicle seemed to be an important criterion at the beginning, the following result emerged as a result of the data obtained and the interviews with the experts. There are companies or persons engaged in earthworks transportation as a third party business in Turkey, therefore it is stated by experts and companies that do this business that it is more important to invest in recycling machines for CDWs by renting vehicles if needed, rather than investing in vehicles. Although it was insignificant among other factors, the presence of vehicles is important in terms of reducing logistics costs, easy accessibility, and spreading the service to a wider area.

Although the number of employees seems important with the creation of manpower and employment, considering the weight of the waste and amount, it is understood that the machine is more important than manpower. Although the number of employees affects factors such as shifts, working hours, and productivity, it is a factor with a low weight of 0.04

It is understood from the weight of the employee education degree criterion that works experience is more important than academic education for those who will work in this sector. When we look at the ratio of educated people in these companies, the reason for the low rate is that employers do not need highly educated personnel other than the experts required by the government, and educated people do not prefer these jobs due to their workload and physical difficulty.

According to the research, the performance of company A dominates other companies in all criteria except stored. The comparison between company's B and C can be evaluated as follows. Company C takes first place in the stored ratio and is ahead of Company B by 0.02 points and Company A by 0.08 points. When the distance to the customer is taken into account, Company A is 0.05, while Company B is 0.04, and Company C is far behind, with 0.02 points. This is because Company C was established in a town far from the center of Izmir. When we look at the sales figures, this is the most important criterion, and the main difference between the companies stems from this. Here the weight of company A is greater than the combined weight of company B and C. Here, the difference of 0.08 from company B to company C is the largest difference between these two companies. Apart from these six criteria, company A has absolute leadership, while the difference between company's B and C is only tiny differences that cannot be seen in the first two digits.

In short, when making an evaluation among these three companies, company A performs close to perfection. If they make the necessary investments in recycling CDWs in the future instead of storing them, their performance will be excellent. When evaluating company B, they can increase the number of excavation and recycling facilities, invest in machinery or sell more CDW to increase their performance quickly. In company C, they cannot change their location due to cost, but they can find places closer to the city center for new facilities to be opened. They can also increase the recycling rate by 38.78%, other than that everything said for company B applies to company C.

CONCLUSION

In this study, first of all, the concept of urban transformation is emphasized. Examples of urban transformation in history are mentioned. The reasons and importance of my personal transformation were examined, and the human and natural reasons that caused it was mentioned. Urban Transformation, Revitalization, Gentrification, Quality Improvement, Redevelopment, and Rehabilitation methods were mentioned. In addition to all these, the purpose of urban transformation is mentioned.

In the next part, information was given about the urban transformation in the world, developed, developing, and applications in Turkey. In developed countries, the United States, Hong Kong, and Germany were selected. The main purpose in these elections is that the three countries adopt different ways of urban renewal, while the studies in the United States are carried out with the priority of the private sector, Hong Kong urban renewal processes are carried out by "Land Development Corporation (LDC) and later by the government agency named Urban Renewal Authority (URA)''. with government institutions such as. But in Germany and other developed European states, urban transformation processes are carried out by the private sector under the guidance of the government. As for the urban transformation activities in Turkey. There are two main reasons for urban transformation in Turkey. The first of these is the rapidly increasing urban population and the increasing need for housing. The second reason is the natural risks of the forgiveness that took place with the 1999 Marmara earthquake. The construction sector, which is currently the backbone of the Turkish economy, has developed rapidly with the financial and legal advantages it provides.

In the second part, issues such as garbage management and construction waste were discussed. First of all, the amount of waste in the world and in Turkey and their recycling were mentioned. Then, information was given about the types of waste such as Domestic, Industrial, Agricultural, Construction and Demolition, Hazardous, Medical, and Special waste types. After this part, the hierarchy in waste management is mentioned. This hierarchy consists of six stages. These six stages are prevention, reduction, reuse, recycling, recovery, and disposal, respectively. In the first stage, it is aimed to prevent the products from turning into waste, in the second stage, if the conversion to waste cannot be completely prevented, it is aimed to save the salvaged part. If neither of these can be done, recycling the material is the best option. If the product is a waste that has lost its integrity and turned into another substance, making a chemical and physical change is another solution. If this waste cannot be evaluated in any way, it is the best solution to dispose of it and render it harmless to nature.

The reason why all these are mentioned in the second part is to explain the importance of recycling. Many studies have been carried out on waste management due to laws related to waste management in Turkey, plans such as the National Waste Management and Action Plan (UAYP), and European Union harmonization studies. Information was given about the recycling works carried out by many municipalities. In the continuation of the research, the economic, social, political, and environmental importance of recycling was examined.

Recycling is an important part of waste management. Recycling is something that has been around since the earliest times of humanity. It is a method that has gained more importance especially in case of scarcity or a decrease in a substance. The importance of recycling increases especially in difficult periods such as the second world war period. In urban transformation, recycling is basically done over 4R. These; Recycle, Reuse, Recovery, Reduction. A significant part of the products in construction waste is recycled and used. These products are; Asbestos, Aluminum, Brick and Block, Cardboard, Concrete, Drywall, Steel, Insulation, Glass, Ceramic, Plastic, Paint, Wood. It is also the distribution of construction and demolition. A serious financial gain can be obtained from the recycling of these raw materials. Many government agencies are working on the calculation and recovery of debris and construction waste.

In the remainder of the research, a study was conducted to evaluate the performance of earthmoving companies. First, the research framework and methodology were determined. It was decided that the GRA model was suitable for this study and the AHP model was used to calculate the criterion weights. Because, as a result of the literature study, it was revealed that the GRA model is a model applied for many similar studies. In addition, the AHP model is a suitable model for determining criterion weights by taking expert opinion.

In the next section, the process of examining the existing data and creating the criteria is done. The available data were obtained by applying to the Izmir metropolitan municipality. Nine criteria were considered in the study. Seven of these criteria are positive and the remaining two are negative criteria. As a result of all these processes, our case study was conducted and the company, which is a state subsidiary, gave the best result among the three companies in the study. The most important reason for this result is the superiority in the number of vehicles and workers, and private companies try to do their business for profit at the lowest cost. As a result of our research, the result of the work of the company, which is a state subsidiary, by putting the service before the income is clearly seen.

The urban transformation has turned into a need rather than a desire today. As it can be seen in the research, the city population is increasing with the snowball effect. In this case, there is a serious need for housing. In addition, an urban transformation has become very important today in order not to experience a human drama like the 'Rıza Bey' apartment again.

In summary, the amount of waste in the world is increasing day by day. This is a big problem for both land and sea. While on land garbage islands and garbage cities such as Mansheya Nasir were formed, many garbage areas were formed in the seas, such as the Great Pacific dump. With this research, studies and developments in waste management are explained.

Due to the decreasing resources in the world, recycling is gaining value day by day, and environmental, social, economic, and political recycling processes are examined. In addition, it was tried to help in the separation and calculation of the valuable materials from the demolished construction wastes.

For this purpose, a comparison of the companies operating in the Izmir region with the excavation companies operating in the Izmir region was made. With the research conducted, it has been seen that the performance of private companies is close to each other, while the performance of state companies is much higher.

In summary, the aim of this study is to provide information about the recycling of excavation wastes from constructions and to evaluate the performance of companies that carry out excavation work.

For further research, this research was only made for the Izmir region and can be applied to other cities as well. In addition, the internal performance of the recycling facilities can be based on raw materials.

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