ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

Sustainable Design Thinking and the Site Selection of Recycling Center of Packaging Waste in Izmir by Using the AHP Approach

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Abstract*-- Wastes are materials which are no longer required by an individual, institution or industry. Thus ,wastes are considered end products of the production and consumption process respectively. In most of the countries, local authorities are responsible for waste handling issues such as collection, transportation and disposal. In relation to waste management , the whole cycle of generation of wastes, their storage, collection and transport, and their eventual treatment and disposal are taken into condsideration. The most common collection of waste is organised in many kinds of containers on a communal basis. In Turkey , the large majority of municipalities are small with very limited capacity , and lack the capacity in themselves to deliver effective local governance. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Izmir, the third largest city in Turkey, consists of the metropolitan municipality and thirty district municipalities. Achievement of municipal solid waste management (MSWM) goals requires sustainable solid waste management systems, which are adapted to and carried by the municipality and its local communities. In order to develop improved products or services , design thinking for municipal solid waste can serve as an approach to support creativity and problem solving within organizations. In this study an application to choose an appropriate recycling center for packaging waste in Izmir city using the analytic hierarchy process is carried out. The software of Expert Choice which supports AHP has provided data to be analyzed statistically.

***Index Terms*—AHP Approach, Design thinking , Packaging Waste Recyling , Sustainable Development**.

I. INTRODUCTION

The growth of the world's population, increasing urbanisation, rising standards of living, and rapid developments in technology have all contributed to an increase in both the amount and the variety of solid wastes generated by industrial, domestic and other activities. Municipal wastes in developing countries have a higher proportion of organic materials compared to lower paper materials. However, changes in the composition of municipal wastes in developed countries have undoubtedly taken place both at the community and national levels, but data are still relatively sparse [1],[2]. Waste is defined in various forms. For instance , according to the European Union legislation , the waste is any materials which are required to discard by the holders [3]. By Agenda 21, the definition of solid wastes includes all domestic refuse and non-hazardous wastes such as commercial and institutional wastes, street sweepings and construction debris [4]. However , in some countries, the solid wastes management system also handles human wastes such as night soil, ashes from incinerators, septic tank sludge and sludge from sewage treatment plants. The amount of waste generated in the world is continously increasing. Thus , the local goverments have responsibility for providing solid waste management services. According to the most common accepted waste hierarchy , there are six main waste handling options starting from the most preferred option to the least preferred option such as reduce, reuse, recycle, recover (digestion, composting), incineration and landfiling and controlled dump[2]. The most widely formalization on sustainable development is that of sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs[5]. On the other hand , it was also noted that sustainability requires the reconciliation of environmental, social and economic demands[6]. Design thinking is an approach to develop improved products or services . It is capable of addressing a broader system of values, design methodologies or a frame of mind that can infuse design into an organization's culture[7],[8].

As introduced by T. Saaty , the Analytic Hierarchy Process (AHP) is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision [9]. Complex decisions are reduced to a series of pairwise comparisons and then the results are synthesised. Thus, the AHP helps to capture both subjective and objective aspects of a decision. A typical simple decision hierarchy involves a goal, criteria or objectives, sub-criteria and alternatives of choice.The AHP combines the criteria weights and the options scores, thus determining a global score for each option, and a consequent ranking. The global score for a given option is a weighted sum of the scores it obtained with respect to all the criteria. There are many commercial software products which are based on the AHP. The software Expert Choice is used to synthesise all the judgements into a unified whole and then the provided alternatives are clearly prioritised from best to worst. This allows the decision-maker to derive geometric means as weights or priorities instead of using an eigenvector method [10].

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
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II. MUNICIPAL SOLID WASTE (MSW)

MSW is a term usually applied to a heterogeneous collection of wastes produced in urban areas, the nature of which varies from region to region. The characteristics and quantity of the solid waste generated in a region is not only a function of the living standard and lifestyle of the region's inhabitants, but also of the property and type of the region's natural resources[11].

This category of waste generally refers to common household waste, as well as office and retail wastes, but excludes industrial, hazardous, and construction wastes. Sources and types of municipal solid waste are described in detail in the literature [12]. A typical classification is as shown in Table I.

Table I: Classification of materials comprising municipal solid wastes

Type	Sources
Organic	Food wastes , yard waste , wood , furniture , residues of animal , fruit or vegetable
Paper	Paper scraps , cardboard , newspapers , magazines , bags , boxes , wrapping paper, boxes , shredded paper , paper beverage cups.
Plastic	Bottles , packaging , containers , bags , lids , cups.
Glass	Bottles , broken glassware , light bulbs , colored glass
Metal	Cans , foil , tins , non-hazardous aerosol cans , appliances (white goods), railings, bicycles.
Other	Textile , leather , rubber , multi-laminates , e-waste , appliances , ash , other inert materials.

Source : UNESCAP 2000

MSW can be also subdivided into two major components, organic and inorganic. In general, the organic components of MSW can be classified into three broad categories: putrescible, fermentable, and non-fermentable [12]. As described by UNESCAP, rubbish wastes are combustible and non-combustible solid wastes, excluding food wastes or putrescible materials. Combustible rubbish mostly includes materials such as paper, cardboard, plastics, textiles, rubber, leather, wood, furniture and garden trimmings. However , the content of non-combustible rubbish is related to materials such as glass, crockery, tin cans, aluminium cans, ferrous and non-ferrous metals, dirt and construction material. Ashes and residues are normally composed of fine, powdery materials,cinders,clinkers,and small amounts of burned and partially burned materials such as wood, coal, coke, and other combustible wastes[11]. Municipal wastes in developing countries have a higher proportion of organic matter up to 85% of all wastes. Per capita generation of municipal wastes varies between 2.75 and 4.0 kg/day in high income countries, but is as little as 0.5 kg/day in countries with the lowest income levels. Despite the large amounts of waste produced by individuals in the wealthy industrialised nations, municipal wastes account for a small proportion of total wastes generated[13],[2]. As mentioned earlier , waste composition is influenced by many factors, such as level of economic development, cultural norms, geographical location, energy sources, and climate. The MSW composition for the entire world at present shows that organic waste comprises the majority of MSW, followed by other wastes, paper, plastic, glass , and metal[2]. As a country urbanizes and populations become wealthier, consumption of inorganic materials (such as plastics, paper, and aluminum) increases, while the relative organic proportion decreases. According to the World Bank estimates of a country's gross domestic product (GDP per capita) , countries are classified into four income levels: High: $12,746 or above; Upper middle: $4,126-12,745; Lower middle: $1,046-4,125; and Lower: $1045 or less[14]. The organic proportion of waste composition tends to be highest in low-income countries and lowest in high-income countries. Total amount of organic waste tends to increase steadily as affluence increases at a slower rate than the non-organic proportion. By the year of 2009 , low-income countries have an organic proportion of 64% compared to 28% in high-income countries . The very similar proportions are given by the year 2025 estimates [2]. For comparison, countries are classified into seven regions as follows where Turkey is included in the region of Europe and Central Asia (ECA) :

- Africa (AFR)
- East Asia and Pacific (EAP)
- Europe and Central Asia (ECA)
- Latin America and the Caribbean (LAC)
- Middle East and North Africa (MENA)
- Organisation for Economic Co-operation and Development (OECD)
- South Asia (SAR)

As the data given by reference [2], for 2009 : The East Asia and the Pacific Region has the highest proportion of organic waste (62%) compared to OECD countries, which have the least (27%). The amount of paper, glass, and metals found in the MSW stream are the highest in OECD countries (32%, 7%, and 6%, respectively) and lowest in the South Asia Region (4% for paper and 1% for both glass and metals). On the other hand , considering the lower and upper limits , reference [2] also provides data for MSW projections by regions for the year 2025 . According to data on upper limit of organic waste , AFR region has the highest proportion (88%) compared to OECD countries, which have the least (56%). However , according to data on upper limit of paper waste, OECD countries have the highest proportion (68%) compared to SAR coutries, which have the least (17%). For comparison, data on waste generation for several regions have been brought together where , by the year of 2009 estimates , OECD countries generate approximately half of the world's waste, AFR and SAR countries produce the least waste. The South Asia Region

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
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(SAR) has the lowest amount of waste of kg per capita (0.45) compared to OECD countries, , which have the highest (2.15). The same trend may be seen for the projected urban MSW generation for 2025 [2],[15]. There is insufficient reliable data on the MSW of Turkey. However, there are important pieces of legislation in place that give an indication of the future trends in MSW practises. Most of the EU waste management directives concerning MSW have been transposed into Turkey's national legislation 16]. In relation to the data given by TUIK and the Turkish Ministry of Environment and Urbanization (MoEU), formerly the Turkish Ministry of Environment and Forestry (MoEF) , the waste composition is shown in Table II [17].

Table II: Waste composition

Waste Type	Waste Composition(%)	
	TUIK Data	MoEF Data
Organic Waste(kitchen,park,garden,etc.)	65.45	49
Ash,slag,stone and soil,etc.	22.48	13
Recyclable waste	12.07	38

Source : RETech 2009

III. MANAGEMENT OF MUNICIPAL SOLID WASTE(MSWM)

Waste management deals with the whole cycle of generation of wastes, their storage, collection and transport, and their eventual treatment and disposal. The practices related to solid waste management include the waste hierarchy : collection, recycling, disposal on land, treatments such as incineration and composting , controlled dumping. The recycling activities will affect the amounts of waste entering into other management and treatment systems . Thus, the changes in emissions in production processes and transportation are covered under other sectors [15]. For several reasons, resource recovery is a major element in solid waste. The first goal of MSWM is to protect the health of the population, particularly that of low-income groups. Other goals include promotion of environmental quality and sustainability, support of economic productivity and employment generation. Achievement of MSWM goals requires sustainable solid waste management systems, which are adapted to and carried by the municipality and its local communities. Municipal solid waste management is a complex task which depends as much upon organisation and cooperation between numerous public and private sector actors and as it does upon appropriate technical solutions. According to data given by the reference[18] , goals and principles of MSWM can be summarized as follows :

- Protecting environmental health,
- Promoting the quality of the urban environment,
- Supporting the efficiency and productivity of the economy,
- Generating employment and income.

To achieve the goals of MSWM, sustainable systems of waste management must be established. Thus, the principles of sustainable waste management strategies include: minimising waste generation , maximising waste recycling and reuse and finally ensuring the safe and environmentally sound disposal of waste.

IV. MANAGEMENT OF MSW IN THE WORLD

For a comparison on wastes generated in developing countries and those generated in industrialised countries , the higher proportion of organic waste is the characteristic of the developing countries. Due to the implementation of modern solid waste management practices, both the public health and the quality of the environment are benefited directly and substantially. A modern solid waste management program can be implemented for a reasonable cost. This is an important fact that solid waste management costs in developing countries are high and the level of service low. Waste management costs are increasing. Developing countries spend 60 to 70 percent of their waste budget in collection, with complete MSW related services consuming 1 to 2 percent of a country’s gross domestic product (GDP). In industrialised nations the waste management practices evolved with the reducing environmental impacts. For, the waste management system as it aims at sustainability, should function within the principles of Agenda 21 and within its local manifestation [4]. MSWM is major responsibility of local government. It is a complex task which requires appropriate organisational capacity and cooperation between numerous stakeholders in the private and public sectors. Although it is essential to public health and environmental protection, solid waste management in most cities of developing countries is highly unsatisfactory.The basic structure of the EU’s waste management policy is the ‘waste management hierarchy’ and ‘producer responsibility’[19]. The hierarchy starts up from the least preferred option (controlled dump) to the incineration, landfill , recover , recycle , reuse and the most preferred option (reduce) , respectively.

V. MANAGEMENT OF MSW IN TURKEY

In Turkey, the beginning of legal arrangements related to waste management goes back to very early years, 1930s , and municipalities are allocated as the main implementation authority. Nowadays, the waste

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

management strategy is generally framed with several laws and secondary legislation, which are directly or indirectly related with the arrangements about waste management[20]. The municipalities are responsible for management of municipal solid waste as well as monitoring and enforcement of waste-related legislation. The municipalities construct and operate the required waste management infrastructure and provide related services such as waste collection. In reality, many municipalities do not have the necessary financial resources for high cost projects such as waste treatment and disposal facilities. The municipalities can seek financial, technical and construction assistance from the Iller Bank and from the Turkish Ministry of Environment and Urbanization (MoEU). The municipalities may also seek loans or grants from foreign donors. In Turkey , there are no any common standard methods for collecting and disposing of municipal wastes , which vary according to settlements and regions of the country. The most common method of waste collection is that the waste bins left on the edge of the pavement or containers placed in front of residents are picked up daily or every 1- 3 days in a week according to settlements[21]. According to data given by TUIK , there are 81 provinces and 2950 municipalities in Turkey . As there are a large number of municipalities, all of which possess different characteristics, development and implementation of a certain waste management model has become extremely difficult [22],[23]. Fundamental indicators for MSW inTurkey are given in Table III.

Table III: Fundamental indicators for MSW in Turkey, 2012

Turkey population	75 627 384
Total number of municipalities	2 950
Total municipal population	63 743 047
Number of municipalities served by municipal waste services	2 894
Rate of population served by municipal waste services in total population (%)	83
Rate of population served by waste disposal and recovery facilities in total municipal population (%)	64
Rate of population served by waste disposal and recovery facilities in total population (%)	54
Amount of municipal waste collected (thousand tonnes/year)	25 845
Amount of municipal waste per capita (kg/capita-day)	1.12
Amount of municipal waste per capita in summer season (kg/capita-day)	1.14
Amount of municipal waste per capita in winter season (kg/capita-day)	1.09

Source : TUIK 2012a , TUIK 2012c

According to data on the waste disposal and recovery facilities given by TUIK , only 37.8 % and 59.9 % of the municipal waste are stored in municipality's dumping site and controlled landfill site , respectively. The remaining 2.3% is involved as either undergoing biological treatment or disposed of by other methods[22],[23]. With the aim of solving the problem, the provinces have been classified in sub-groups representing similar demographic and socio-economic characteristics for management of municipal waste. Thus, Turkey was divided into a total of 3 main regions and 11 sub-regions [21]. The first of the main regions comprises of the Marmara and Aegean regions in the west of Turkey; the second main regioncomprises of the Black Sea, Mediterranean and Central Anatolian regions whereas the third main region consists of the East and Southeast Anatolia. In addition to the municipalities a large number of ministries and public institutions in Turkey are also involved in the management of the waste sector. The necessary arrangements in Turkey have been made for packaging waste to be collected separately and the municipalities are assigned as responsible for separate collection at source within the framework of regulation on control of packaging waste, which was published in the official gazette of 24.06.2007 and thus came into force. In the region of metropolitan municipalities, district municipalities are responsible for taking necessary measures. Real and legal entities aiming to recycle packaging waste are obliged to obtain a license from the MoEF. The reason of this implementation is to impose a certain discipline to the facilities where such waste is collected, sorted and recovered or recycled. The licenses are given in two categories : one for collection and sorting of waste, and the other one for recycling. It is planned to evaluate this process in three separate operations : collection, sorting, and recycling . In practice , collection and sorting are carried out in an interactive manner. In the existing situation the reuse, recovery and recycling of packaging waste can be carried out on a limited scale. The recovery and recycling of packaging waste has not reached to the desired level while the municipalities still do not show sufficient interest in separate collection of waste at source, not all packaging materials entering the market is registered, the organizations which collect and sort waste do not favor separate collection at source and etc. Furthermore, the number of licensed collection and sorting companies is still insufficient. The existing organizations do not have

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

adequate administrative, financial and technical capacities to cope with collection and sorting of all the packaging waste formed in a province[17]. According to data provided by TUIK and MoEU , the statistical results have been estimated for the years up to 2020(see, Table IV).

Table IV: Targets for recycling of packaging waste in Turkey (as % of generated) per material

Years	Glass	Plastics	Metal	Paper/Cardboard	Wood
2005	32	32	30	20	-
2006	33	35	33	30	-
2007	35	35	35	35	-
2008	35	35	35	35	-
2009	36	36	36	36	-
2010	37	37	37	37	-
2011	38	38	38	38	-
2012	40	40	40	40	-
2013	42	42	42	42	5
2014	44	44	44	44	5
2015	48	48	48	48	5
2016	52	52	52	52	7
2017	54	54	54	54	9
2018	56	56	56	56	11
2019	53	58	58	58	13
2020	60	60	60	60	15

Source : ETC/SCP 2013

Thus, for 2020, the targets for recycling of packaging waste in Turkey (as % of generated) per material are 60 %, 60%, 60%, 60% and 15% for glass, plastics, metal ,paper/cardboard and wood , respectively [16]. As the population of Turkey is also increasing , the ever-increasing consumption creates larger amounts of waste materials and adversely affects the environment and human health. It is well known that many different departments and institutions deal with the management of solid waste and there is no integration or interaction between them. If the waste is not disposed of properly the problems will increase in the future[24]. In Turkey there are lots of informal recyclers who may be called as garbage sorters or street scavengers. . After they collect the necessary part of the waste such as the aluminium cans, card-board, plastics and bottles , they take them to the related collection centres and sell them for profit.

VI. MANAGEMENT OF MSWIN IZMIR

Izmir is the third biggest city located in the West Anatolian Region of Turkey with a population of 4005459 . There are 30 administrative districts within the municipal borders of Izmir (see , Fig.1) .

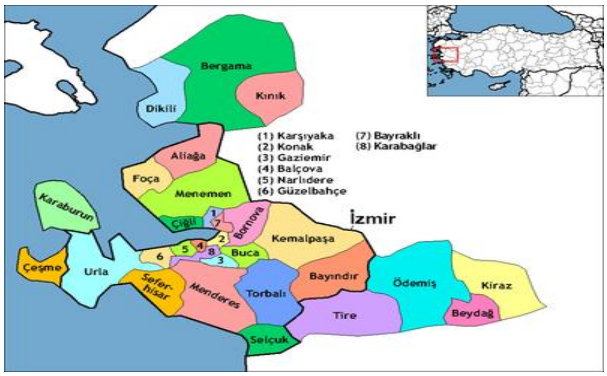


Fig 1: Overview of Izmir metropolitan region

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

Statistical indicators of principal characters in Izmir Metropolitan Region are as shown in Table V. According to data of year 2012 by the reference[25] , the quantity of municipal waste of Izmir is 1 685 662 ton/year and waste per capita is 1.26 kg/cap-day compared to Turkey, which is 25 276 698 ton/year and 1,14 kg/cap-day , respectively. Data on amount of municipal waste per capita related to the districts indicate that Karaburun has the highest proportion (4.77) compared to Narlıdere, which has the lowest proportion (0.65). However , Karabağlar has the highest amount (256 276 ton / year) compared to Kiraz , which has the lowest amount (2 981 ton / year). According to the amount of waste delivered to controlled landfill site , the district of Karabağlar has the highest proportion (approximately 20%). For comparison , an overview of solid waste management in Izmir metropolitan area as percentage of municipal waste by disposal methods is summarized as shown in Table VI. As will be seen in Table IV, in Izmir for the year 2010, only 22.9% and 77.1 % of the municipal waste are stored in municipality's dumping site and controlled landfill site , respectively. The wastes which undergo biological treatment or disposed of by other methods are in very small amount and therefore are not taken into consideration when compared to the amount of total waste generated in Turkey.

VII. SUSTAINABLE DESIGN THINKING APPLICATIONS FOR MSW

The first definition that has been quoted most widely was formalized by the World Commission on Environment and Development in 1987: "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [5].

- At the 2005 World Summit it was noted that sustainability requires the reconciliation of environmental, social and economic demands – the three pillars' of sustainability [6]. Additionaly, according to data given by Farkas, preventions on three pillars are as follows[26]: Sustainable production : low waste industry and agriculture (producer responsibility)
- Sustainable product design : eco-design and eco-quality and management control
- Sustainable consumption : attitude of the public

Agenda 21 acknowledges "environmentally sound waste management must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption." This implies the application of life-cycle management concept, which presents a unique opportunity to reconcile development with environmental protection. Agenda 21 proposes four waste- related programme areas:

- Minimising wastes;
- Maximising environmentally sound waste reuse and recycling;
- Promoting environmentally sound waste disposal and treatment;
- Extending waste service coverage.

Table V: An overview of principal characters in Izmir metropolitan region, 2012

	Rate of population served by municipal waste services in municipal population (%)	Amount of waste collected by municipal or other waste services (ton/year)	Amount of municipal waste per capita (kg/capita-day)	Total municipal population (thousand)	Total environmental expenses (million TL)
Aliağa	100	28 706	1,38	77	4,4
Balçova	100	49 870	1,76	78	6,4
Bayındır	100	9 460	1,11	41	1,7
Bayraklı	100	115 650	1,03	309	12,2
Bergama	100	23 278	0,93	101	2,1
Beydağ	100	4 743	2,28	13	0,45
Bornova	100	152 685	1,01	423	15,8
Buca	100	160 346	1,05	446	14
Çeşme	97	37 022	3,52	35	3
Çiğli	100	38 930	0,68	169	15
Dikili	100	19 448	2,43	35	0,8
Foça	100	12 251	0,83	32	0,47
Gaziemir	100	43 276	0,91	128	4,2

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

Güzelbahçe	100	10 345	1,23	28	0,61
Karabağlar	100	256 276	1,53	466	17,8
Karaburun	100	10 360	4,77	9	1,7
Karşıyaka	100	102 180	0,9	315	18
Kemalpaşa	100	45 990	1,76	95	2,8
Kınık	99	14 843	2,13	28	1,7
Kiraz	100	2 981	0,95	44	1,9
Konak	100	226 865	1,53	391	17,7
Menderes	100	53 600	2,65	75	6,5
Menemen	95	62 554	1,51	138	3,04
Narlıdere	100	17 155	0,65	63	4,7
Ödemiş	100	38 850	1,12	129	20,6
Seferihisar	100	15 717	1,47	31	6,8
Selçuk	95	20 941	2,01	35	4
Tire	100	33 520	1,7	80	7
Torbalı	100	36 500	0,86	138	2,9
Urla	100	26 780	1,62	55	4,3

Source : TUIK 2012b

Table VI: Percentage of municipal waste by disposal methods, 2012

	Turkey(2012)	Turkey(2010)	Izmir(2010)
Waste disposal methods		Percentage (%)	
Amount of municipal waste collected	100	100	100
Municipality's dumping site	37.8	43.5	22.9
Waste delivered to controlled landfill site	59.9	54.4	77.1
Waste delivered to composting plant	0.6	00.8	-
Burning in an open area	0.4	00.5	-
Lake and river disposal	0.1	00.2	-
Burial	0.4	00.1	-
Other	0.8	00.5	-

Source : TUIK 2012a , TUIK 2012b , TUIK 2012c

In order to provide a comprehensive and environmentally responsive framework for managing municipal solid wastes , the four programme areas are interrelated and mutually supportive and must therefore be integrated. It is also emphasised that effective control of the generation, storage, treatment, recycling and reuse, transport, recovery and disposal of hazardous wastes is of paramount importance for proper health, environmental protection and natural resource management, and sustainable development. As Minthberg and Dumas state out, 'design thinking' is not a clear cut management approach, but design thinking is capable of addressing a broader system of values, design methodologies or a frame of mind that can infuse design into an organization's culture[7]. It is a process for practical, creative resolution of problems or issues that looks for an improved future result. In other words, design thinking can therefore serve as an approach to expand creativity and problem solving within organizations in order to develop improved products or services such as packaging for instance [8].

In Turkey, better developments are expected concerning solid waste by creating the 'waste management action plan for 2008–2012' in the country [21]. As in every other country, the relationship between the population and environment is based on economic development in Turkey. The conditions determined by economic development give rise to demographic activities such as rapid population growth, high fertility, high dependency rates and migration from villages to the cities. The relationship between the population and the environment in Turkey has been viewed in terms of a 'sustainable development' approach. To ensure sustainable development, national development policies need to

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

involve environmental issues and introduce appropriate precautions [24]-[27]. According to data given by MoEU also , as solid waste management services must be satisfactorily operated at a sustainable cost, the population served must not be less than a certain number. In Turkey , considering the fundamental parameters like the geographical features, population density and transportation network situation , a number of around 300 000 can be taken as a population density. In order to develop plans relating to the setting up of regular storage facilities, a reduction in the amount of solid waste, achievement of recovery, a reduction in the cost of transporting solid waste, and use of waste transfer stations with suitable technology when necessary in the manner envisaged in the respective regulations to be realized, MoEU has established Inter-Municipality Regional Management Associations for disposal of solid waste in overall Turkey with the aim of developing Type Projects for regular waste storage facilities and amelioration of landfills[17].

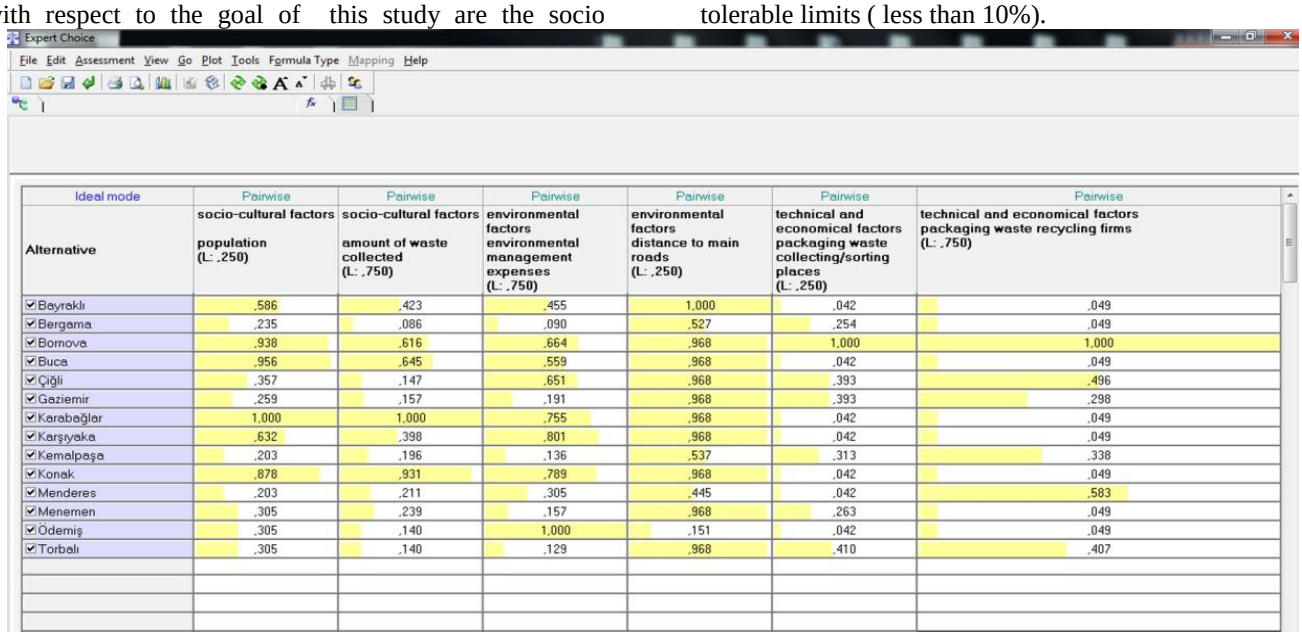
VIII. THE AHP APPROACH FOR THE SITE SELECTION

In this study, to determine the most appropriate site selection for the recycling packaging waste in Izmir, the AHP approach uses 3 main criteria , 6 sub criteria and 14 alternative districts of Izmir(see,Table VII).

Table VII: Hierarchy structure

Goal	Site selection of recycling center of packaging waste		
Main Criteria	A. Socio-cultural	B. Environmental	C. Technical and economical
Sub Critera	A1. Population	B1. Environmental management expenses	C1. Packaging waste collecting/sorting places
	A2. Amount of waste collected	B2. Distance to main roads	C2. Packaging waste recycling firms
Alternatives	Bayraklı , Bergama , Bornova , Buca , Çiğli , Gaziemir , Karabağlar , Karşıyaka Kemalpaşa , Konak , Menderes , Menemen , Ödemiş , Torbalı		

In Izmir, according to data related to packaging waste business , there are 23 collecting / sorting firms , 24 recycling firms and 11 waste transfer stations. On the othe hand , there are 252 firms registered which are partly in the sector of waste recycling [28]. After the hierarchy is established , the criteria are evaluated in pairs so as to determine the relative importance between them and their relative weight to the global goal. The priorities with respect to the goal of this study are the socio cultural factors of 0.648 , technical and economical factors of 0.230 and environmental factors of 0.122 with inconsistency of 0.00352. Table VII which has been simulated and calculated using ExpertChoice 11.5 for Windows, demonsrate the priority results for the sub-criteria for each one of the main criteria groups . Their respective inconsistency indices are obtained as 0.01 , 0.01 , 0.01 , 0.00 , 0.05 and 0.06 which s are below tolerable limits (less than 10%).



Ideal mode	Pairwise	Pairwise	Pairwise	Pairwise	Pairwise	Pairwise
Alternative	socio-cultural factors population (L: ,250)	socio-cultural factors amount of waste collected (L: ,750)	environmental factors environmental management expenses (L: ,750)	environmental factors distance to main roads (L: ,250)	technical and economical factors packaging waste collecting/sorting places (L: ,250)	technical and economical factors packaging waste recycling firms (L: ,750)
Bayraklı	,586	,423	,455	1,000	,042	,049
Bergama	,235	,086	,090	,527	,254	,049
Bornova	,938	,616	,664	,968	1,000	1,000
Buca	,956	,645	,559	,968	,042	,049
Çiğli	,357	,147	,651	,968	,393	,496
Gaziemir	,259	,157	,191	,968	,393	,298
Karabağlar	1,000	1,000	,755	,968	,042	,049
Karşıyaka	,632	,398	,801	,968	,042	,049
Kemalpaşa	,203	,196	,136	,537	,313	,338
Konak	,878	,931	,789	,968	,042	,049
Menderes	,203	,211	,305	,445	,042	,583
Menemen	,305	,239	,157	,968	,263	,049
Ödemiş	,305	,140	1,000	,151	,042	,049
Torbalı	,305	,140	,129	,968	,410	,407

Fig. 2. Priority results

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

By considering the data in relation to the chosen criteria of decision - makers , the alternative districts towns are pair-wisely compared . The final priority results for all alternative districts is shown in Fig.3.

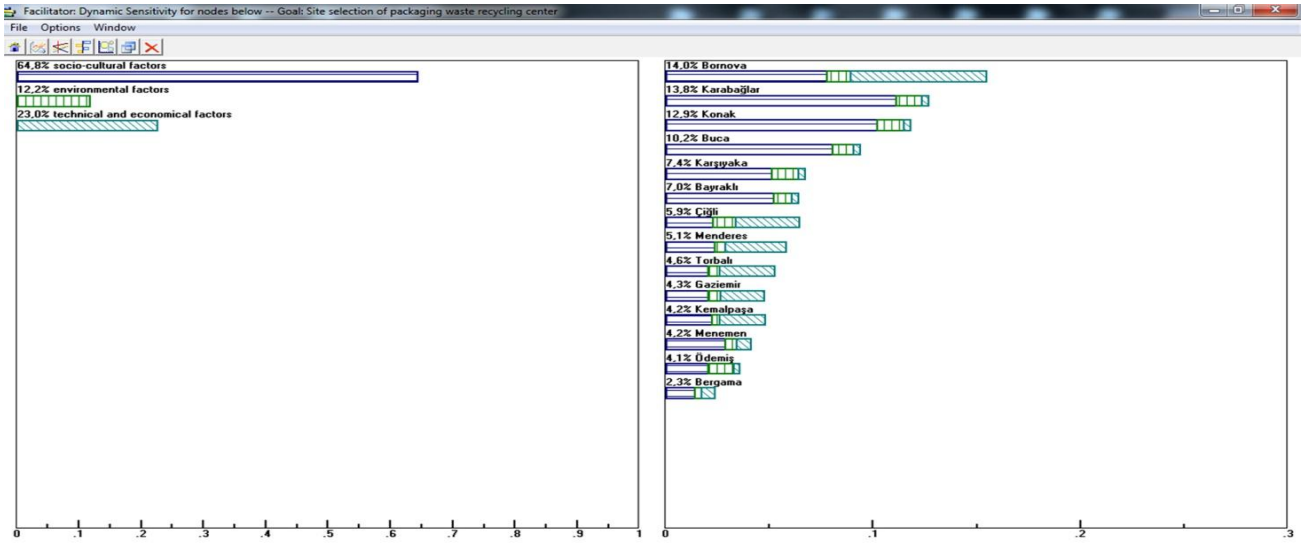


Fig. 3: Final priority results for the location of recycling center

As will be seen in Fig. 3 site selection with the highest level of adherence to the defined goal is the district of Bornova which contributes 14 %.

IX. CONCLUSIONS

In Izmir, solid wastes management systems are progressing but further developments are required. According to data given by MoEU also, the percentage of organic waste coming to controlled landfill sites is projected to drop. Some aspects on the sustainable targets for solid waste areas can be as follows:

- To create waste plans related to a regional and national scale.
- To create a waste monitoring inventory system, establish electronic databases and ensure sustainability.
- To encourage waste minimization technologies to be used in production.
- To support and take into account international trade in waste materials in relation to the EU criteria.
- To provide fulfillment of international environmental agreements by carrying out co-operation of all groups .
- To apply an education program on the waste disposal methods in relation to waste minimization , waste producers , public and waste legislation.
- To provide arrangements on design thinking to build up them.
- To provide training of personnel on solid waste.
- As in every other country, the sustainable methods for MSW include basically the areas of landfill, incineration , composting and recycling. Opportunities in sustainable design thinking are thus related to source reduction and encourage supportive public policy. Source reduction activities reduce the amount of wastes before they enter the MSW management system , which mostly include:
  - Minimizing the volume of packaging material required to deliver products by selecting products packaged efficiently or buying in bulk.
  - Defining opportunities to reuse products and packaging in the home or community rather than disposing or recycling them.
  - Encouraging companies to implement source reduction programs and purchasing products with post-consumer recycled content.
  - Reducing consumption of disposable goods and purchasing products from reuse centers.
  - Reducing food waste through efficient meal planning and composting of scraps.
  - Having implemented programs such as reuse centers, food rescue and encouragements.
  - Designing of 'pay as you throw' programs to limit the volume of waste collection per household.
  - Recycling and composting programs on solid waste are encouraged to reduce the burden of waste disposal.
  - Restricting landfill disposal of some potentially hazardous wastes such as oil, batteries, scrap tires and electronics although the most of them are hard to recycle and have limited management options.
  - Encouraging the return of empty containers for refunds.

The AHP method is a powerful tool to solve site selection problems and is used to deal with the difficulties that decision- makers encounter in handling large amounts of complex. . It generates indices that give information regarding site selection suitability. The AHP has the potential to assist planners , decision - makers and other agents involved in the sector. As an implementation of the AHP approach using Expert Choice software ,14 districts in the region of Izmir have been prioritized. District of Bornova is ranked the highest. However, as also pointed out by the related authorities in Izmir, any

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

final priority results for the location of recycling center can be influenced according to an improved waste monitoring inventory system parameters and applications of political decision- makers in the near future , especially.

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