



## **A Research on Turkish Packaging Industry in terms of Sustainability**

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### **ABSTRACT**

The concept of sustainability refers to sustainable development or sustainable life, whereas it is broadly acknowledged as being multidimensional. In the Bruntland Report it is defined, as "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Later on, during the environment and development conference (UNCED, The Earth Summit), organized by United Nations, significant decisions were taken and the terms "sustainable consumption" and "development" began to gain more importance. Within the scope of this study, the effects of the concept of sustainability on administrative decisions of companies and the subsequent effects of these decisions on sustainable product design are covered. The aim of this study includes "denoting important points to producers to consider during the design process of sustainable products and putting these points into use" and "building a sustainable model for product design which allows for the assessment of global energy consumption, labor costs, material consumption, product service systems and recycling actions". With the case study carried out in packaging sector, the aim is to determine the effects of sustainable design criteria of packing products on the organizational structure of companies. For the analysis of selected evaluation units, in the life-cycle analysis phase, the sustainability of energy and materials are researched. This study was conducted with two members of Packaging Industries Association: Anadolu Glass Inc. and Plaş Plastics Inc in Turkey.

**Keywords:** sustainable design, packaging design, life cycle assessment, glass packaging, PET packaging, Turkish packaging industry

## **1. THE CONCEPT OF SUSTAINABILITY**

After The World Commission on Development and Environment published the report entitled *Our Common Future* in 1987, the concept of sustainable development began to be discussed in public domain. In the report, a series of social and environmental obstacles were defined including the unsustainable industrial development requiring global attendance. To remove these obstacles, the following were advised; efficient utilization of resources in the industry and activities related to industry, less pollution and less waste production, utilization of renewable resources instead of non-renewable resources, reducing side effects on human health and the environment (Gertsakis and Lewis, 2003). According to Bruntland Report published in 1987, the source of interest in sustainable development lies in the belief that existing human actions harm the environment and these actions will lead to serious negative results (Bhamra et al., 2001). United Nations General Secretary Kofi Annan (2001) says: "Our biggest challenge in this new century is to take an idea that seems abstract –sustainable development– and turn it into a daily reality for all the world's people".

Later in 1992, during United Nations' Conference on Environment and Development (UNCED, The Earth Summit) organized in Rio, following significant decisions taken, the terms "sustainable consumption" and "development" began to gain more importance. The aim of the concept of sustainable development includes rational use of natural resources by protecting environmental values, reducing the use of resources and elevating quality of life (Tischner and Charter, 2001).

### **1.1 Sustainable Product Design**

The word "to design" is defined as "the creative act of stating a problem —consisting of decisions made to achieve the aims of the design— and solving it during various stages of the design act" (Bayazit, 1994). Design is described as a creative activity incorporating the aim of establishing versatile features of objects, processes, services and systems through their overall lifecycles (ICSID, 2014). Otto (2005) defines sustainable product design as follows: "Sustainable design should deliver the best (social, environmental, and economic) performance or result for the least (social, environmental and economic) cost". This strategic approach is defined as the design of products, processes, services and systems. It is concerned with the instability between the demands of the society, environment and the economy. The system defined here is a system that aims to dissolve this instability and it incorporates an overall thinking process about the effects of these three areas now and in the future (Otto, 2005).

Papanek (1984) states, "Industrial designers, industries and administrations should all together give an answer to the question of how much social and ecological harm is done to our society". In his book entitled *Design for the Real World*, Papanek claims industrial designers, industries and administrators are all subject to environmental responsibility.

Tischner and Charter (2001) argue that sustainable design means more than eco-design or design for the environment. In design for environment and eco-design, it is intended to unify the idea of environment into product design. As for sustainable design, social and ethical components are juxtaposed together with economic and environmental ideas into the life-cycle of the product. Sustainable design may also be defined as environmentally responsible product design and development, which incorporates a product life-cycle perspective together with approaches integrating work, culture and organizational skills (Kim, 2008).

"The eco-design of energy-using products" directive (EUP) defines sustainable design as "environmental features should be integrated into product design to improve performance, sustainable design criteria should be provided all throughout the life-cycle, it should include purchase of raw materials, manufacturing, packaging, transportation and distribution, installation and maintenance, use and end-of-life stages based on sustainable design needs" (EC, 2003b; EU, 2005; Goosey, 2004). Sustainable design should be compatible with the current corporate culture in order to increase economic value and reduce environmental damage. The word sustainability refers to ecology and economics that are inextricably adhered to good design in design practices (Tischner, 2001).

Design actions for sustainability are different from general design activities with their environmental assessments, solution-seeking methodologies and strategy definitions. Moreover, the designer's expertise in sustainable design is more influential than sustainable design tools in defining environmental assessment and strategy (Vallet et al., 2013).

## **2. OVERVIEW OF PACKAGING SECTOR**

### **2.1 What is Packaging?**

What is meant by commercial packaging today was developed in the 1700s. With the developments taken place in those years, the focus was on the practical function of the package rather than on its aesthetic quality. In the 19<sup>th</sup> century, exceptional advancements in transportation occurred. As transportation opportunities increased together with the production boom resulting from the industrial revolution, product

selling rate accelerated, time for preparing the products needed to be shortened and various machines that could fill in, weigh, label and seal products came about. When transcontinental travel and shipping started, the travel time was quite long so a need to pack and ship products safely without spoilage arose (Ertem, 1999).

As Robert Opei (1991) states: "the main function of packaging is to protect the product (as we expand its existence and provide distribution) make the product meet other products but avoid drawing the product away from its own standing position". Opei points to packaging design as an element of marketing and underlines its consequence for today. Paul Southgate, the author of *Total Branding by Design* (1994), and James Pilditch, the author of *The Silent Salesman* (1973) both write about the significance of packaging as an instrument of marketing.

Every industrial product –produced by an industry– is packaged somehow and is sent to its final consumer. Because of this reason, the main function of packaging is to preserve and protect the product it carries in. However, packaging plays an intermediary role in communication taking place between the product and the consumer in the retail area (Bayazit, 2005).

Results of research presented in International Association of Packaging Research Institutes(IAPRI) conference in2004 show that it is difficult for most of the participants to define packaging and sustainability as complementary (Lewis and Sonneveld, 2004). The organization argues that for sustainable packaging, the products should comply with the following four qualities; **Efficient**: meet social and economic targets; **Effective**: meet targets of effective use of materials, energy and water as much as possible; **Cyclic**: recyclable within industrial and environmental systems, and **Safe**: non-toxic and non-polluting.

Another organization Sustainable Packaging Coalition (SPC) provided a 7-way definition (Lewis et al.,2007). According to SPC (2006), sustainable packaging should obtain the following criteria:

1. All throughout the product life-cycle, it should be safe and healthy for the consumers of the product and for the whole society.
2. It should provide for the needs of the market in terms of performance and price.
3. Sustainable energy should be used in production, distribution and recycled material sources... etc.
4. Maximum amount of recycled material should be used.

5. Production techniques and applications that are respectful to the environment should be chosen.
6. Product life-cycle analysis should be conducted and materials used should be a part of healthy solutions all throughout the process.
7. It should be designed physically with an aim to balance material and energy use.
8. It should incorporate reuse and renewable qualities and it should have an industrial cradle-to-cradle cycle.

## 2.2 Packaging Industry and Market in Turkey

For marketing various agriculture and food products and other non-food products produced in present and lately developing industrial branches and specifically for export goods, packaging has an increasingly vital role. Turkish packaging industry is growing by 10% each year and becoming an important competitor in the global market. Approximately 5000 manufacturers are producing packaging products in Turkey. Most of these manufacturers are located in Istanbul, Izmir, Kocaeli, Gaziantep, Adana, Ankara, Konya and Balıkesir (Bektaşoğlu and Esen, 2007).

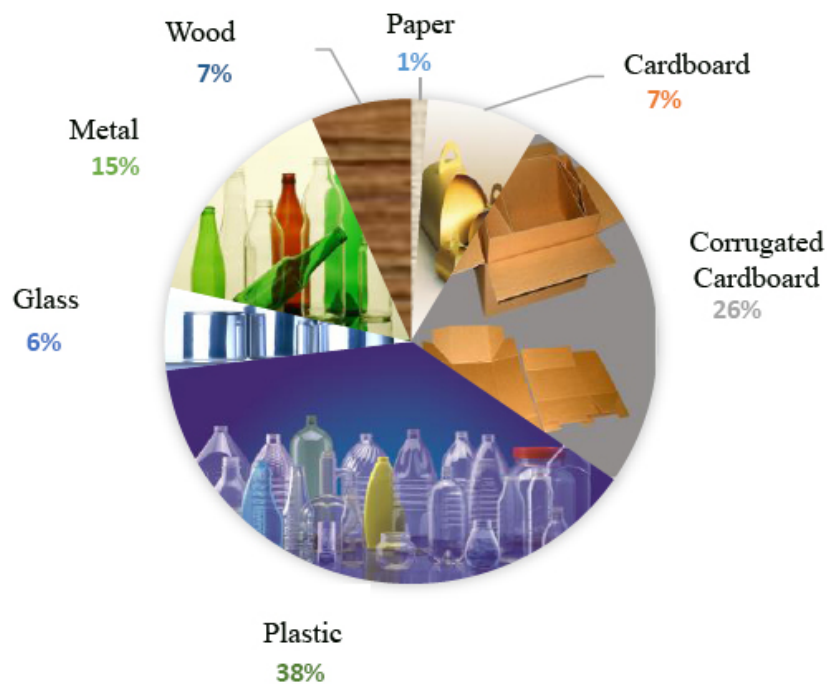
In the last decade, significant changes have been taking place in life standards as a result of increase in per capita income. Growing tendency for urbanization increases in average life span, changes in consumption habits and consumer expectations all lead to development of self-service methods in consumption centers. Moreover, these changes also promote spreading of hypermarkets, supermarkets and market chains, which provide direct sale of products to the consumers, throughout the country. During the process of such retail sales systems, development and usage of single item style packaging is supported. The organized retail trade percentage, which was a little above 20% in 2000s, rose above 40%. Since this percentage is above 80% in economically developed European Union countries and countries in North America, it may be argued that the demand for packaged goods will rise in Turkey too (ASSR, 2016). Gross production capacity of packaging industries in Turkey is presented in Table 2.1.

**Table 2.1:** Turkish packaging industry capacity (2007-2016)

Production types	2007 (tons)	2011 (tons)	2012 (tons)	2013 (tons)	2014 (tons)	2015 (tons)
Paper	60.000	106.300	110.000	88.000	101.000	85.000
Cardboard	415.000	564.000	534.250	568.000	460.000	577.000

Corr. Cardb.	1.370.000	1.702.500	1.772.000	1.879.00	1.970.000	2.031.000
				0		
Plastic	1.470.000	2.012.700	2.160.000	2.519.00	2.800.000	2.988.000
				0		
Metal	299.500	363.700	375.250	385.000	393.000	428.000
Glass	659.000	857.000	951.000	978.000	1.080.000	1.153.000
Wood	385.000	453.600	469.500	484.000	498.000	510.000
<b>Total</b>	<b>4.658.50</b>	<b>6.059.80</b>	<b>6.372.00</b>	<b>6.901.0</b>	<b>7.302.00</b>	<b>7.772.00</b>
	<b>0</b>	<b>0</b>	<b>0</b>	<b>00</b>	<b>0</b>	<b>0</b>

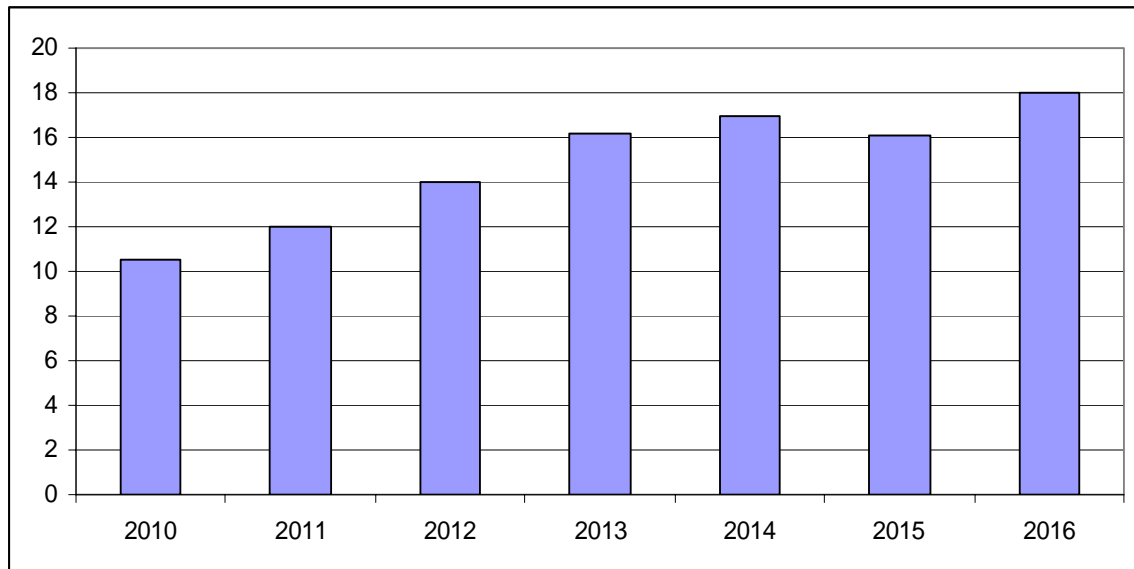
According to data collected between 2007-2016, it can be seen that glass packaging production increased from 659,000 tons to 1,153,000 tons. In the case of plastic packaging production, the production capacity increased from 1,470,000 tons to 2,988,000 tons. Statistics of production rates in Turkish packaging sector are shown in Figure 2.1.



**Fig. 2.1.** Turkish packaging sector production rates (ASSR, 2016).

Per capita consumption of packaging can be taken as an indicator of high life standards. For 2010, global average of per capita consumption of packaging was \$110. When North America/Canada with \$350-400 per capita consumption of packaging, Western Europe with \$250-300 per capita consumption of packaging and Japan with \$550 per capita

consumption of packaging are taken into consideration, it can be argued that Turkey has a long way to go. Volume of Turkish packaging industry can be seen in Figure 2.2.



**Fig. 2.2.** Turkish packaging sector production volume per year (billion \$) (ASSR, 2016).

### 2.3 Conclusion of Section

For the present and still developing industry in Turkey, packaging design has become a significant issue. As it will be discussed in section 3 of this article, according to the research on Turkish packaging industry, Turkish packaging industry is growing by 10% each year and becoming an important competitor in the global market. In 2015, Turkish packaging industry had reached a capacity of \$16 billion approximately. Turkish packaging industry is growing by 10% each year and becoming an important competitor in the global market. For the period between 2001-2016, volume of plastic packaging production had tripled while glass packaging production had doubled. In the light of all these acquired information, it is seen that packaging design is quite significant for Turkish industry. Further studies in sustainable packaging design are crucial for both packaging sector and the local economy.

## 3. RESEARCH METHOD

### 3.1 Framework of Method

Bayazit (2004) define research conducted in the field of design as follows: "Design research is a systematical research and information acquisition on design and design action". The objectives of design research are the study, research, and investigation of the artificial made by human beings, and the way these activities have been directed

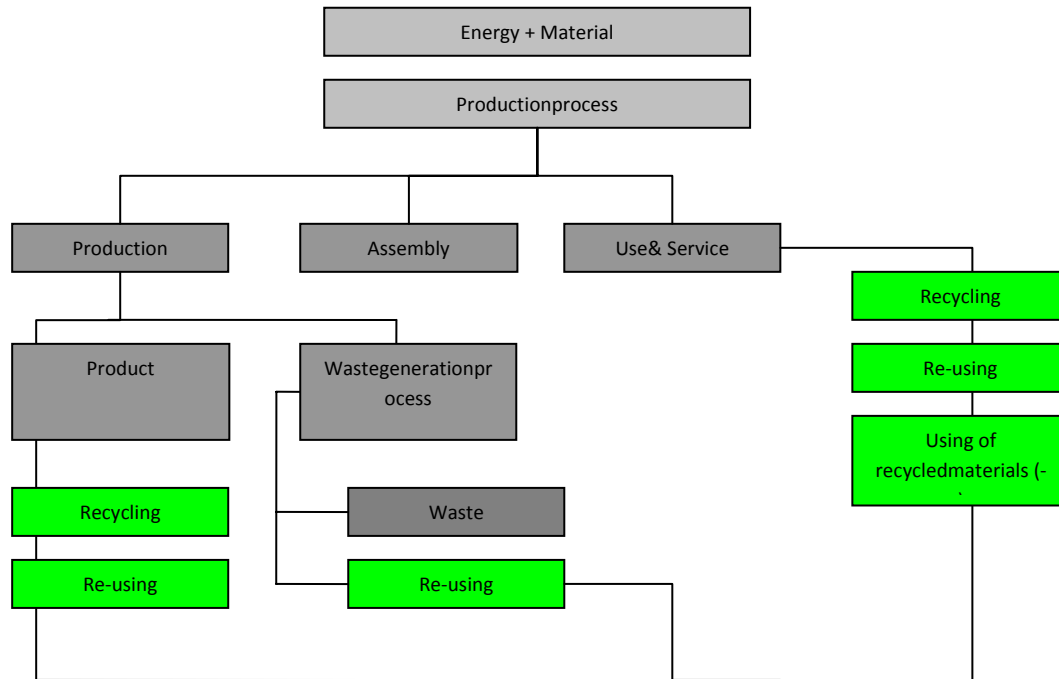
either in academic studies or manufacturing organizations (Bayazıt, 2004). There is another definition about the design research made by Simon that we can call overall activities of design research, "the sciences of the artificial". With the lights of these definitions, the scope of this research includes packaging industry applications in Turkey including both sides of academic backgrounds and productions of companies.

In the context of real life research, descriptive and revealing case studies are designed to collect research findings (Yin, 2003). This research consists of two parts: 1. Background studies. 2. Case studies. Background studies consist of screening of publications on sustainable design in academic literature, printed sectorial information and discussions of the issue with academics and professionals in the sector. These background studies constituted the basic knowledge for interviews conducted within the scope of the case study. The case study is considered as the most effective method for a research in which a researcher cannot control or predict the experiment outcomes in real life context (Yin, 2003). The two cases in which the case study method can be used optimally are described as follows. One of these is the search for a direct descriptive question "What happened?" or an explanatory question "Why and how?". The other one is used in natural environment studies where the researcher intends to gain an in-depth perspective through direct observation and data collection. This research aims to produce information through design and production models in today's packaging manufacturers.

### **3.2 Framework of Case Study**

Packages designed by manufacturers Anadolu Glass Packaging Industry Inc. and Plaş Plastics Inc. are analyzed in accordance with the criteria defining sustainable packaging, and product-centered environmental management systems. For the products selected as evaluation units, life-cycle analysis method (energy consumption, material usage) are taken as an examples to determine the effects of sustainable design. In Figure 3.1, the analysis of evaluation units are illustrated schematically.





**Figure 3.1** The analysis of evaluation units

Three types of information resources were used: interview, documentation and physical objects. According to the model explained by Chung (1992), interviews were held at three levels. For this research, both open-ended and close-ended interviews were carried out at strategic, tactical and operational levels. The information was recorded with a voice recorder.

An evaluation unit is needed to determine data collection and evaluation techniques (Yin, 2003). Glass and PET packaging are identified as the evaluation units. Three types of evidence sources have been used for these evaluation units. These are: the product itself as a physical object, the company documents-reports of the products as documents and interviews.

Van Hemel and Brezet (1997) formulated the product design strategy wheel to measure the sustainable design level of companies. Among the thirty-three criteria, Van Hemel (1998) suggests most important ten criteria. Many organizations, such as SPA and SPC, have also developed a sustainable design assessment tool to measure sustainable packaging (Lewis et al., 2007). Closed-ended and open-ended interview questions in the study were created by using these evaluation tools. A mixed method was used in the analysis of interviews; quantitative and qualitative research methods. The results obtained are reported.

Langrish (1993) notes six basic models of case studies. This study aims to obtain representative information on "sustainable product design and production application" through the two packaging companies that carry out the best applications. In this way, "representative", "next door" and "best application" approaches are used in the selection of the case study. According to Stake's (1995) classification, this study is a multi- or comparative case study. Repeated logic was used in the multi-case case study.

#### **4. FINDINGS**

This study is based on the data presented in the thesis entitled "Analysis of the Concept of Sustainability on Package Design in Terms of Company Strategy" (Özgen, 2013). All data used in the findings section are obtained from closed-ended and open-ended interviews and the reports of production facilities presented in this thesis.

##### **4.1 General Evaluation**

###### **4.1.1 Awareness of Sustainable Design**

Closed-ended interview participants indicate that decisions on sustainable design are made mainly by the "Design Department" and the "Marketing Department". In response to the participants' answers to interview questions, the state and producers have a major role in the evaluation of responsibilities towards environmental issues and sustainability.

###### **4.1.2 Main Routers**

Within the scope of the closed-ended interviews, companies are asked to specify the legislations related to their products and activities. These legislations are pointed out as Packaging Waste Regulation, ISO 1440, Turkish Food Codex, EU Packaging and Packaging Waste Regulation and REACH. Participants are asked to evaluate the products produced by their companies in terms of compliance with the environmental legislations specified.

According to the answers given within the scope of the closed-ended interviews, participants from Anadolu Glass Packaging Industry Inc. and Plaş Plastic Inc. state that economic, environmental, and social elements related to the concept of sustainability are included in the mission of the participants' organizations. It is seen that both administrations of the two producers examined in the study have a supporting role in sustainable product design activities. It is also observed that the design and production departments are aware of where sustainable design ideas can be conveyed within the company organization and have knowledge of sustainability. Furthermore, people in the organizations take regular trainings on sustainable design and carries out work in this

direction. Company employees have stated that environmental issues and actions need to be more effective in the organization compared to the current situation.

#### 4.1.3 Importance of Environmental Issues

In the closed-ended interview, companies are asked to evaluate the impact of environmental factors on their markets, taking into account their own products. Anadolu Glass Inc. states that the impact was extremely effective, where as Plaş Plastic Inc. states that it is less effective. Manufacturers are asked to rate the market pressures on the business in case of environmental issues. Both companies underline that there is little pressure.

The companies are asked to evaluate how the development of environmental issues will provide a market advantage for their companies. It is seen that all employees of the both companies think that the development of environmental issues will increase brand reputation, effect corporate identity positively and this will provide competition power. It is observed that environmental issues are primarily important in terms of environmental effects, legal compliance and customer satisfaction for both companies.

In response to the answers given by the company participants, the factors leading the companies to sustainable design are legislation, customer demand, contribution to the image of the company and trend of the sector.

#### 4.1.4 Obstacles

Company employees have stated that environmental issues are very important to them, but they underline that there is no competition in this sector about environmental issues. The difficulties faced by companies in implementing environmental issues seem to be expressed in terms of lack of understanding about environmental benefits, lack of financial resources, lack of customer demand, system and culture.

#### 4.1.5 Product Development Process

The employees of the companies surveyed within the scope of this research were asked about the actions they performed during the product development process and were asked to evaluate upon them. Selecting harmless materials, reducing weight and volume, using materials efficiently and reducing energy consumption are seen as the most important applications.

The company's employees are asked about the main reasons for their actions in the product development process. Environmental causes and laws appear to be at the top of the reasons list for doing the actions that are the subject of this question.

#### 4.1.6 Application of Sustainable Design

Participants of the companies surveyed in the research are asked to evaluate the sustainable design criteria applied to their products. Reducing material usage and diversity, reducing energy consumption, reusing the product, reducing the weight and volume of the product are the main issues.

### 4.2 Analysis of Evaluation Units







As the evaluation units, olive oil bottles, carbonated beverage bottles, fruit juice bottles and small jars are selected as the most preferred and sold bottles of both packaging manufacturers. For this analysis, eight products from four different product groups with similar forms produced by the two companies are examined within the scope of this research.



#### 4.2.1 Comparison of Glass and PET Packaging

No detailed material and energy consumption reports have been generated for each product in the production facilities under review. In this context, the anticipated value of recycling energy for analysis is unknown. In accordance with the Turkish Food Codex, the use of recycled material is taken as "0" for PET packaging. The rate of use of recycled glassware is assumed to be 30%. Energy items spent for recycling, reuse, improvement, waste, transportation and service for the packages produced from both materials are not included in the production reports.

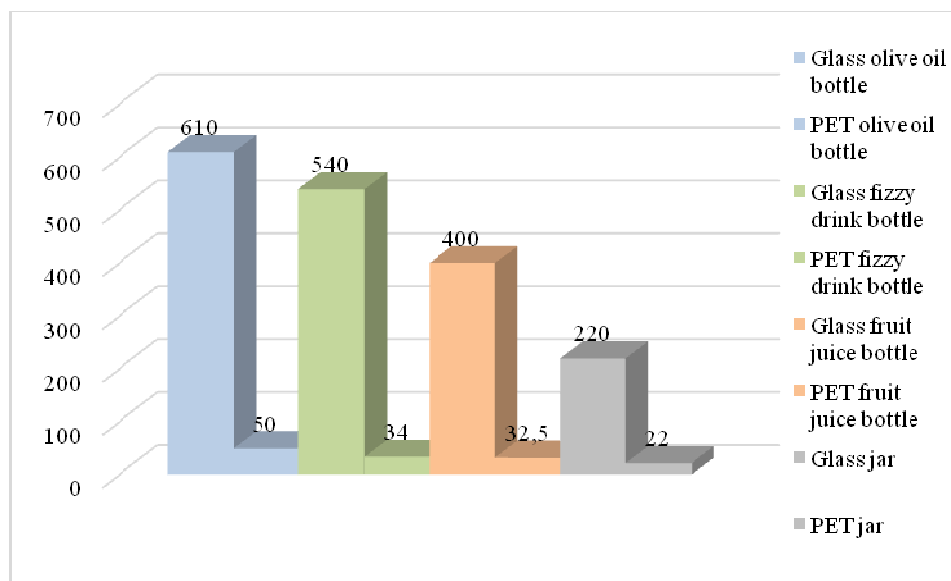
As a result of observation of production processes, dual conversations and production evaluations, information on raw material usage amounts, energy values for production, amount of recycled material usage, type of vehicle used for transport and transportation quantities for the packages are gathered. 1lt olive oil bottles, 1lt carbonated beverage bottles, 1lt juice bottles and 350ml jars are examined and compared. Table 4.4 below provides this research information.

**Table 4.4:** Analysis of glass and PET packaging

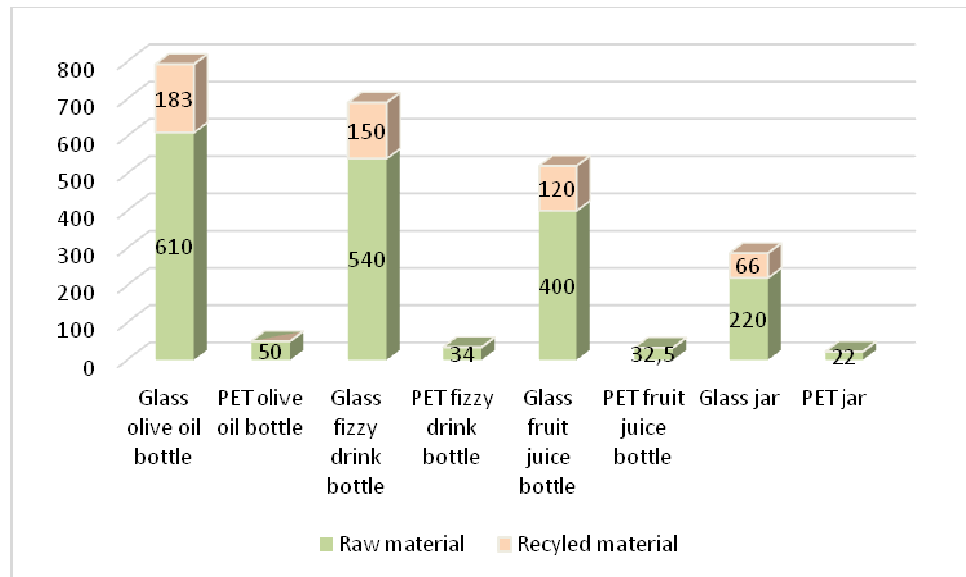
Product	Producer	Weight	Energy for production	Use of recycled material	Transportation (10 tons truck)	Photo
Olive oil bottle 1000 cc 123399	Anadolu Glass Glass bottle	610 gr	1,0467 kwh	%30 of recycled glass: contains 183 gr of broken glass	10 pallets x 1465 pieces total weight: 8936,50 kg	
Olive oil bottle 1000 cc Efes	Plas Plastic PET bottle	50 gr	0,043 kwh	0 gr	12 pallets x 2000 pieces total weight: 1200 kg	
480999 Fizzy beverage bottle 1000 cc	Anadolu Glass Glass bottle	540 gr	0,9282 kwh	%30 of recycled glass: contains 150 gr of broken glass	10 pallets x 1050 pieces total weight: 5670 kg	
PET Fizzy beverage bottle 1000 cc	Plas Plastic PET bottle	34 gr	0,028275 kwh	0 gr	12 pallets x 1690 pieces total weight: 689,52 kg	
418699 Fruit juice bottle 1000 cc	Anadolu Glass Glass bottle	400 gr	0,688 kwh	%30 of recycled glass: contains 120 gr of broken glass	10 pallets x 1106 pieces total weight: 4424 kg	
PET Fruit juice bottle 1000 cc	Plas Plastic PET bottle	32,5 gr	0,02795 kwh	0 gr	12 pallets x 1900 pieces total weight: 741 kg	

147735 Glass jar 350 ml	Anadolu Glass Glass bottle	220 gr	0,378 kwh	%30 of recycled glass: contains 66 gr of broken glass	10 pallets x 4320 pieces total weight: 9504 kg	
PET square jar 350 ml	Plas Plastic PET bottle	22 gr	0,01914 kwh	0 gr	12 pallets x 4500 pieces total weight: 1188 kg	

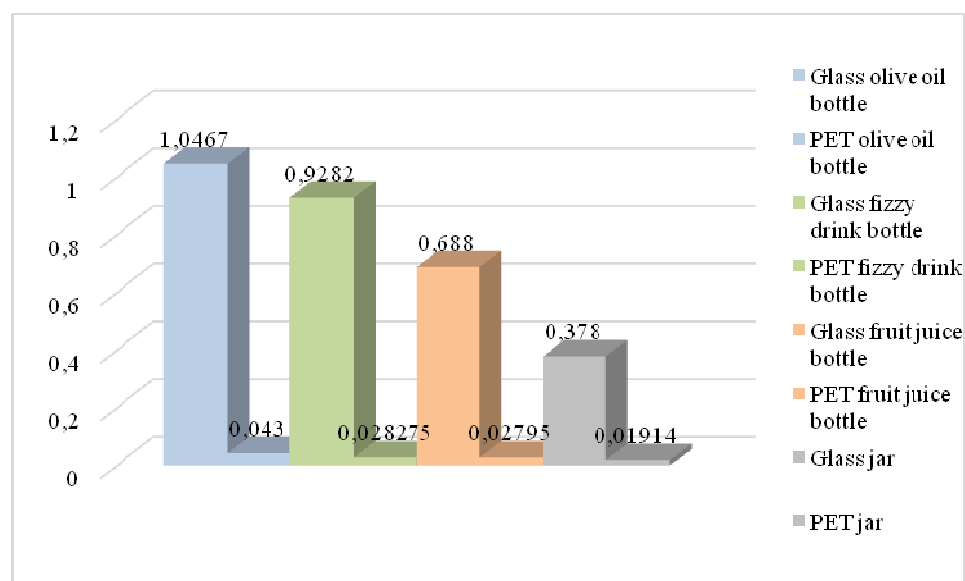
Analysis of packages is made from glass and PET materials and are presented in Table 4.4. Both are shown graphically in Figure 4.1, Figure 4.2, Figure 4.3, Figure 4.4 and Figure 4.5.



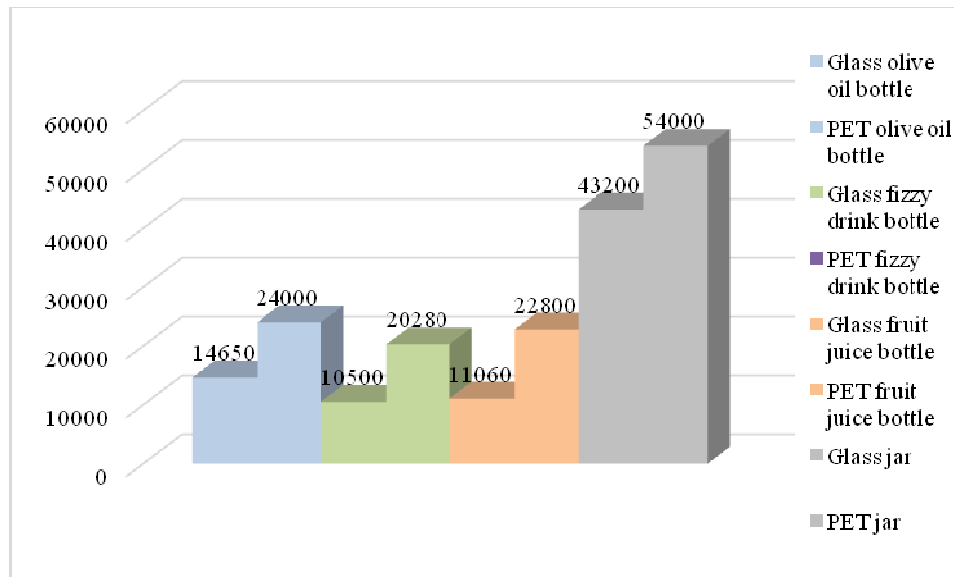
**Figure 4.1.** Glass and PET packaging weighs (gr)



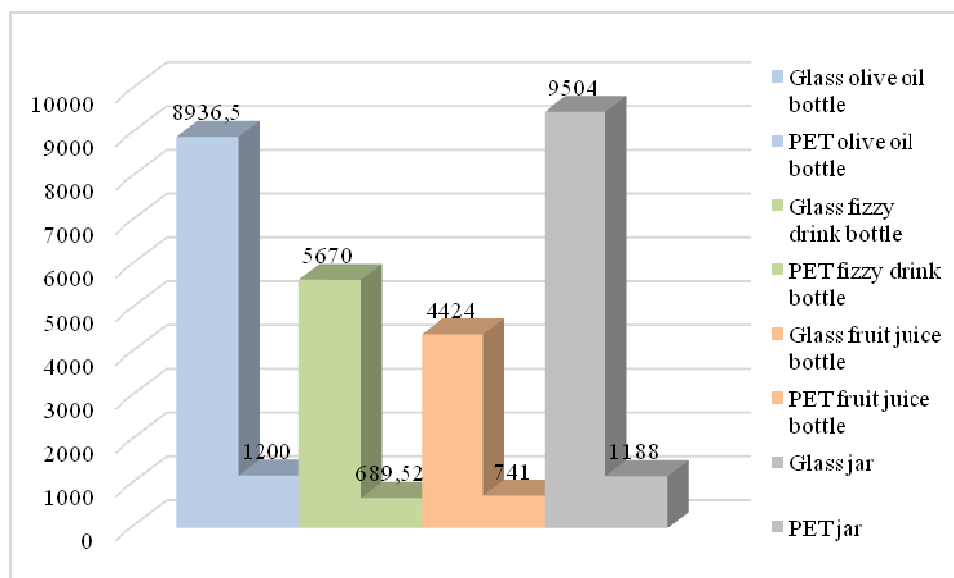
**Figure 4.2.** Quantity of recycled materials and raw materials used in glass and PET packaging production (gr).



**Figure 4.3.** Production energy for glass and PET packaging (kwh).



**Figure 4.4.** Amount of glass and PET packaging carried out by truck of 10 tons (pieces).



**Figure 4.5.** Transported loads of glass and PET packages carried out by a 10 tons truck (kg).

The automatic calculators in Url-1 (2013) are used for the calculation of CO<sub>2</sub> emitted in transporting glass and PET packages. The parameters used in these calculations are given in Table 4.5. A simulated-road of 1302 km has been applied in the calculations carried out with these parameters. Table 4.6 shows the CO<sub>2</sub> releases. Figure 4.6 shows CO<sub>2</sub> emission figures for trucks carrying glass and PET packaging. Figure 4.7 shows the fuel consumption of glass and PET carrying trucks.

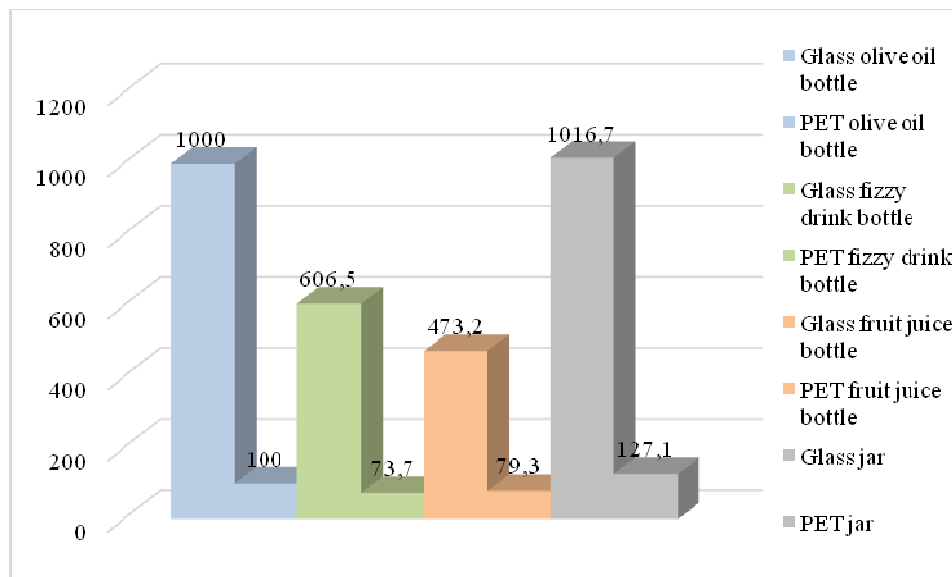


**Table 4.5:** Parameters use of CO<sub>2</sub> calculation

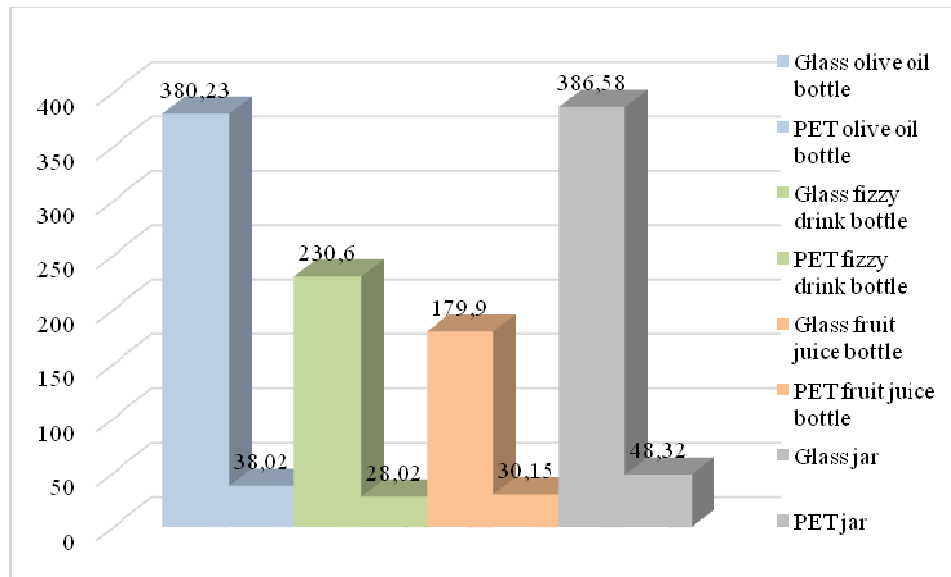
Truck volume	16 tons
Fuel consumption	0.40 lt/km
Truck loading factor	% 80
CO <sub>2</sub> emission/ fuel consumption	2.630 kg/lt

**Table 4.6:** CO<sub>2</sub> emission figures

Truck volume 16 tons truck	CO <sub>2</sub> emission (kg)	Productivity gr CO <sub>2</sub> /tkm	Weight (kg)
Truck carrying glass olive oil bottles	1000	82	8936
Truck carrying PET olive oil bottles	100	82	1200
Truck carrying glass fizzy drink bottle	606,5	82	5670
Truck carrying PET fizzy drink bottle	73,7	82	689,52
Truck carrying glass fruit juice bottle	473,2	82	4424
Truck carrying PET fruit juice bottle	79,3	82	741
Truck carrying glass jar	1016,7	82	9504
Truck carrying PET jar	127,1	82	1188



**Figure 4.6.** CO<sub>2</sub> emissions of trucks carrying glass and PET packaging bottles (kg).



**Figure 4.7.** CO2 fuel consumption of glass and PET bottles carrying trucks (lt).

## 5. CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

Brundtland Report (1987), which redefined the development approach, proposed "Sustainable Development" to the agenda and with the Rio Declaration (1992) the issue has begun to be widely discussed. It is observed that until the 1980s, companies has been regarding environmental activities as obligations imposed on them. Towards the 1990s, this situation has changed. According to Porter and Van Der Linde (1996), this issue has led companies to make new environmental innovations that improve competition, and as a result, less polluting production processes have been developed.

Within the scope of the research, it is seen that in the applications of the companies surveyed, the idea of designing sustainable products is not targeted directly but because of the laws and regulations, competition creation and economic reasons, sustainable product criteria are applied partially. It is seen that the work carried out within the framework of company strategic plans generally includes reduction of materials at the product level, applications for easy and rapid production at the production stages, and reduction of the energy consumed in production. About the companies examined within the scope of the research, how much they know about sustainability and how much they are trying to apply it to their own products are determined from the answers given to the closed-ended interview questions. And these answers are presented in the findings section of this study. In order to be able to sustain their assets in the packaging industry and to be able to respond to the competition, it is stated that the relation of packaging with the environment is taken into consideration in product design and presentation to the market.

In the findings section, it is observed that according to the common view of the companies, the government and producers both have vital roles about environmental issues and responsibilities towards sustainability. On the issue of being environmentally conscious in the designs they produce, manufacturers are mostly influenced by industries and other producers; and the customer factor comes as secondary. A further influential factor is determined as the European Union and consumers. It is seen that the most significant inducement about the environmental consciousness in the companies' work on sustainability can be listed as being in compliance with the legislation and regulations, consumer needs and market opportunities. In this framework, it has been pointed out that the regulations of "Packing Waste Regulation", "Turkish Food Codex", "European Union Packing and Packaging Waste Directive" are well known and practiced by the companies.

It is seen that the companies have a consensus on the necessity of being more active about environmental issues and actions in their organizations. Further observations show that all the employees of both of the companies think that the development of environmental issues will increase their brand reputation and positively effects corporate identity. When developing products, choosing harmless or non-toxic materials, reducing the weight or volume of the product, using the material efficiently and reducing the amount of waste are often preferred methods of the companies. Reducing energy consumption is seen as the most emphasized application. It is observed that the companies use materials efficiently, reduce the weight or volume of the product, and reduce the waste amount due to economic gain.

#### 5.1.1 Results from the Evaluation Units Analysis

The model used for the analysis of glass and PET packaging produced in two companies is given in the methodology section. In Figure 4.3, in the schematic representation of the problem for evaluation, the planned life-cycle stages for the analysis of products are illustrated. Information on the amount of energy used to produce the product, the amount of material used to produce the product, the amount of recycled material usage, and the shipping conditions of the product from the production facility have been collected in the production, assembly, use-service and retirement phases. The production stages of glass and PET packaging in production facilities are examined and it is determined that the production stage for both packaging types are formed by one step. Since the packages made from glass and PET materials are not subject to deposits or similar applications, it is seen that lifetime usage is ending in the consumer, who becomes the end-user. As this is the case, there is no application for the service of the products.

When packaging is considered in the context of recycling, it is seen that packages made from glass materials can be recycled, but it has been determined that packages made from PET materials cannot be reused in food packaging as recycled PET materials.

For the analysis of the products examined within the scope of the research, the following material-energy use analysis model is carried out in accordance with the current production stages and the information obtained. Figure 5.1 shows the model of evaluation analysis used for the packages and examined in the research.

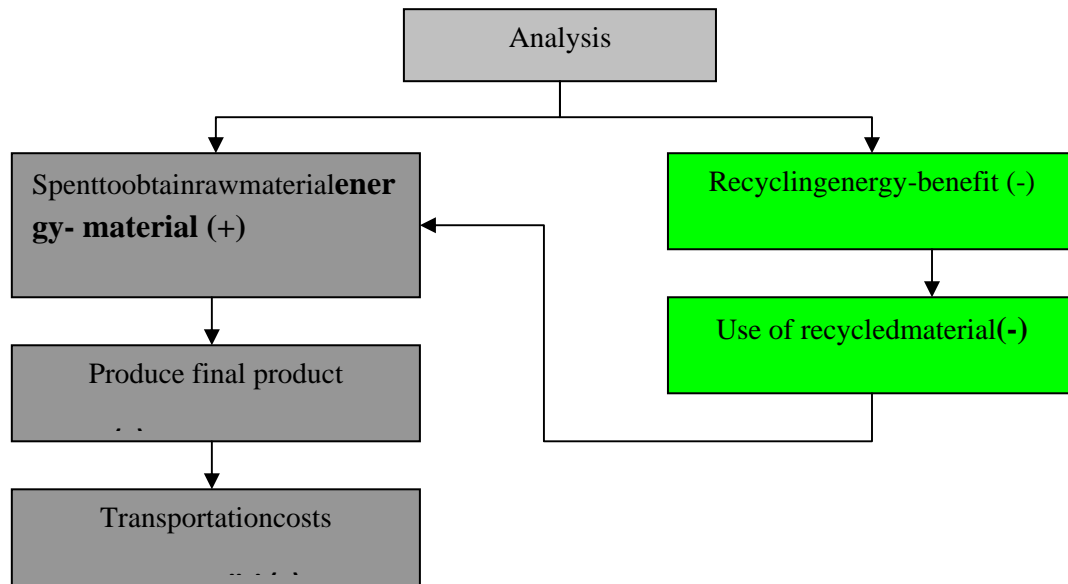


Figure 5.1: Model of evaluation unit analysis

Analysis based on packaging clearly shows that PET packaging is produced using much less material and energy than glass packaging, CO<sup>2</sup> emissions are less in transportation of PET and in parallel to that less fuel is consumed during the transportation. These evaluations can be seen in Table 5.1.

**Table 5.1:** Comparing production values of glass packaging with production and transportation values of PET packaging (glass packaging / PET packaging ratio)

	Weight	Production energy	Amount of transport in the same kind of truck	Transportation amount per unit kg-CO <sub>2</sub>
Production of PET bottles for 1 glass of	12,2 pieces	24 pieces	1.6 pieces	16, 4 pieces

<b>olive oil bottles</b>				
<b>Production of PET bottles for 1 glass of fizzy drink bottles</b>	15,9 pieces	32,8 pieces	1.93 pieces	16,05 pieces
<b>Production of PET bottles for 1 glass of fruit juice bottles</b>	12,3 pieces	24,33 pieces	2,061 pieces	12,3 pieces
<b>Production of PET bottles for 1 glass jar</b>	10 pieces	19,7 pieces	1.25 pieces	10 pieces

Similar results have also appeared in the results of a study of baby food jars produced from glass and PET bottles. Humbert et al. (2009) reported that plastic containers produced using 14-24% less energy, caused 28-31% less input on global warming, contained 31-34% less respiratory inorganic materials, caused 28-31% less terrestrial acidity and pollution.

As a result of the findings obtained, how realistic the discourse "glass is a nature-friendly material" has been open to debate. Although petroleum-derived PET material is seen as the enemy of the environment because of its source material, in accordance with the findings of this study and due to the efficiency of the production methods and transportation of PET, this acceptance turns out to be not true.

## 5.2 Recommendations

It is clear that sustainable production design and methods are important contributors to the solution of environmental problems such as waste reduction and natural resource conservation, reducing production costs and thus reducing product prices and operating profits. In order for sustainable production systems to be implemented in a healthy and effective way, it is necessary for the term sustainability to be in the management decisions of the company, and starting from the design stage, the products should be dealt with and developed in line with these criteria.

How much the concept of sustainability is presented in design and production in Turkey is an issue of debate. Turkey's institutional capacity in terms of sustainability has been reported as limited compared to examples from the European Union (TCÇOB & TTGV, 2010, Küçüksayraç et al., 2015). Küçüksayraç (2015) underlines that intermediary services for sustainable design are developing in Turkey, which are limited to educational services, and they are often aimed at creating awareness. Küçüksayraç further states

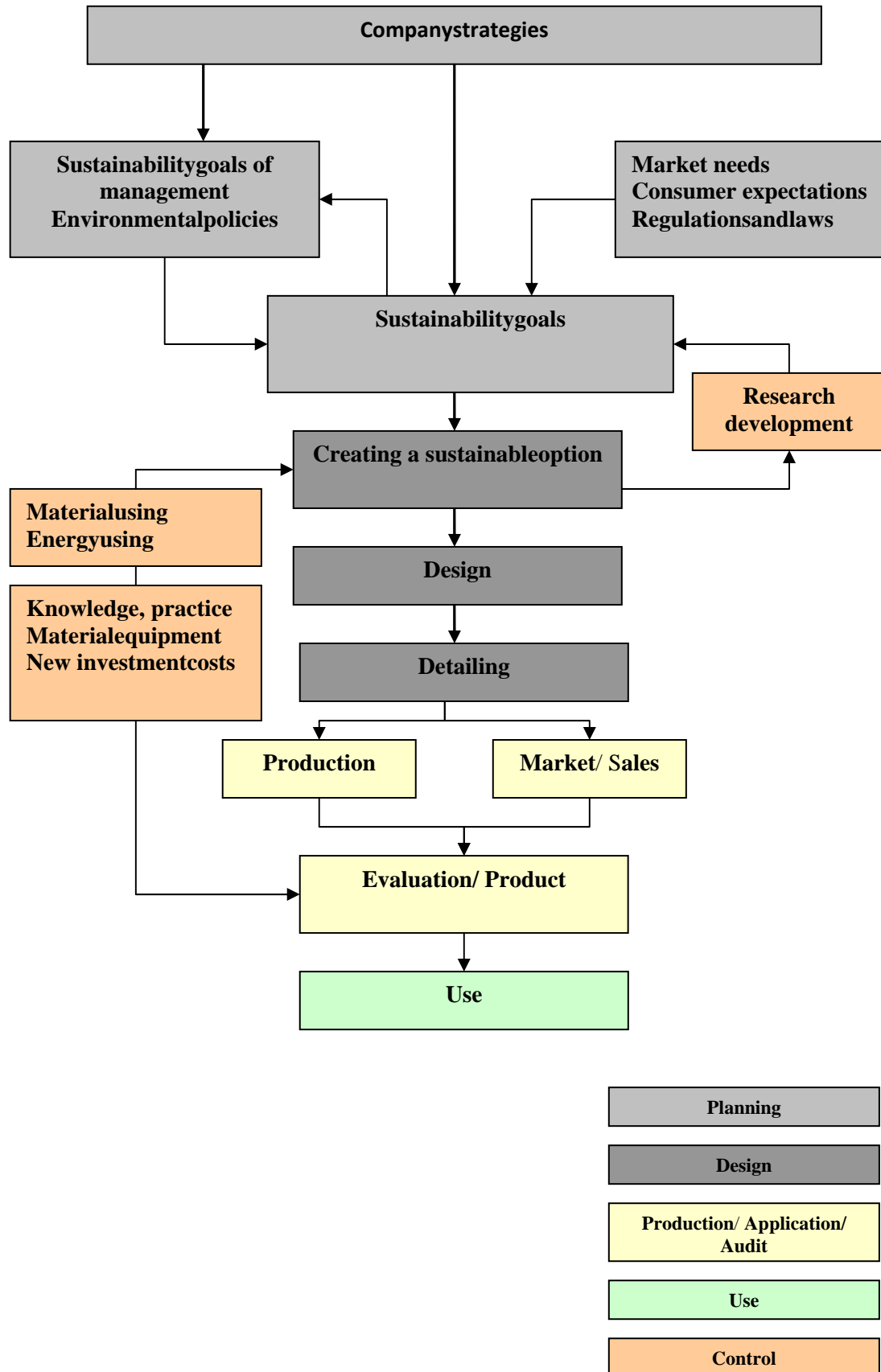


that for the first stage of innovation support, sustainability-related services and tools need to be developed more quickly for sustainable design.

The European Union Compliance Criteria Framework, Kyoto Protocol guidelines and related laws and regulations point to the fact that, manufacturers have to use sustainable product design and manufacturing methods and inevitably have to be informed and implement necessary applications. The benefits that can be achieved with sustainable design offer great advantages in the sustainability of development, and reductions in costs as a result of the reduction of material-energy use help the manufacturers dominate the competitive environment of the local and global markets.

Comprehensive laws and legislation are needed to encourage sustainable product design and manufacturing methods. At the same time, these laws and regulations must be imposed on producers and consumers and be sanctioned. The importance of this issue has been underlined in interviews conducted with the employees of the companies. In the revised Packaging Waste Control Regulation (AAKY, 2011), the scope of the regulation is defined as "This regulation covers all packaging distributed to the market and waste of these packages". However, in the same regulation the responsibilities of manufacturers (packaging producers) and consumers (users) are not adequately defined. For the municipalities, packaging producers, suppliers, market supporters and consumers that are mentioned in the regulation; their obligations should be increased, their lack of responsibility for the collection of packaging wastes should be eliminated, and the enforcement of sanctions and penalties for all stakeholders who fail to fulfill these obligations should be applied seriously.

As a result of interviews, evaluation of closed-ended interview responses and review of production facilities and production methods, the model in Figure 5.2, which can be used in company strategic decisions and applications in the design of sustainable products for packaging producers, is proposed.



**Figure 5.2.** A model for company's strategic decisions and applications of sustainable products

It is of utmost importance to supply raw materials for developing countries and to use these materials in the most efficient way in terms of both the amount of usage and the amount of energy consumed. From this point of view, the contribution made to the economy of the country by the studies carried out on behalf of sustainability in design and production planning issues will be great. As we have seen in the glass-PET packaging products examined in Turkey, there is a great difference between the amounts of using energy, transport energy and raw materials using in the production of packaging materials. Compared of glass packaging to PET packaging in Table 5.1, it is seen that production and transportation, energy use and raw material usage require much more consumption. In countries such as Turkey that depend on foreign suppliers for energy and raw materials, it is important that the material preferences in packaging products must be shaped in this direction.

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