Examining Responsible Furniture Design in Terms of Sustainability: A Review on Cafe Furniture

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ABSTRACT

The concept of sustainability is generally referred to as being permanent. Today, with the effect of population growth and increasing resource consumption, the concept of sustainability has gained great importance. Sustainable design is responsible for society and the environment, so designers should understand the importance of sustainability in designs and develop creative solutions. Especially in the public spaces that the society uses in common, the designs that people interact with the most are furniture. Independent organizations in sustainable furniture design prepare various standards and certification systems. However, in these certification systems, environmental sustainability criteria are prioritized, and the score weight is higher. To develop furniture in a human-centered manner, a need was felt for an evaluation system in which social sustainability has an equal value with environmental sustainability.

The aim of this study is to create a checklist that can help architects and interior architects in the problem of sustainable furniture design, evaluating environmental and social sustainability equally. In addition, since the existing sustainable furniture certification systems have a complex scoring system, designers are hesitant to approach sustainability. This research aims to help designers to design sustainable furniture by preparing this checklist that can be easily followed during the design process. For this purpose, as the first step a vast literature review was realized to define environmental and social sustainability and to find out the current criteria for sustainable furniture design which shaped the base for the proposed checklist.

Then, using the suggested checklist, chairs and table furniture in selected cafes in Çanakkale are evaluated in terms of environmental and social sustainability. In the case study, the researcher experienced the field practice in situ and collected data with measurements, photographs, and drawings. By using the information and experiences obtained, the checklist for sustainable furniture design and the evaluation tables of the furniture were created and the study was concluded by summarizing the findings.

Keywords: Furniture Design, Environmental Responsibility, Social Responsibility, Public Space, Sustainability, Eco-Friendly Use

ÖZ

Sürdürülebilirlik kavramı genel olarak kalıcı olma şeklinde tanımlanmaktadır. Günümüzde nüfus artışı ve artan kaynak tüketiminin etkisiyle sürdürülebilirlik kavramı büyük önem kazanmıştır. Sürdürülebilir tasarım toplumdan ve çevreden sorumludur, bu nedenle tasarımcılar tasarımlarında sürdürülebilirliğin önemini anlamalı ve yaratıcı çözümler geliştirmelidir. Özellikle toplumun ortak kullandığı kamusal alanlarda insanların en çok etkileşime geçtiği tasarımlar mobilyalardır. Sürdürülebilir mobilya tasarımında bağımsız kuruluşlar tarafından çeşitli standartlar ve sertifikasyon sistemleri hazırlamaktadır. Ancak bu sertifikasyon sistemlerinde çevresel sürdürülebilirlik kriterleri ön planda tutulmakta ve puan ağırlığı daha yüksek olmaktadır. Mobilyaları insan merkezli geliştirmek için sosyal sürdürülebilirliğin çevresel sürdürülebilirlik ile eşit değerde olduğu bir değerlendirme sistemine ihtiyaç duyulmuştur.

Bu çalışmanın amacı, sürdürülebilir mobilya tasarımı probleminde mimarlara ve iç mimarlara yardımcı olabilecek, çevresel ve sosyal sürdürülebilirliği eşit olarak değerlendiren bir kontrol listesi oluşturmaktır. Ayrıca mevcut sürdürülebilir mobilya sertifikasyon sistemleri karmaşık bir puanlama sistemine sahip olduğundan, tasarımcılar sürdürülebilirliğe yaklaşmaktan çekinmektedirler. Bu araştırma, tasarım sürecinde kolaylıkla takip edilebilecek bu kontrol listesini hazırlayarak tasarımcıların sürdürülebilir mobilya tasarlamalarına yardımcı olmayı amaçlamaktadır. Bu amaçla, ilk adım olarak, çevresel ve sosyal sürdürülebilirliği tanımlamak ve önerilen kontrol listesinin temelini şekillendiren sürdürülebilir mobilya tasarımı için mevcut kriterleri bulmak amacıyla geniş bir literatür taraması gerçekleştirilmiştir.

Ardından, önerilen kontrol listesi kullanılarak Çanakkale şehrinde seçilen kafelerdeki sandalye ve masa mobilyaları çevresel ve sosyal sürdürülebilirlik açısından değerlendirilmektedir. Vaka çalışmasında araştırmacı, saha uygulamasını yerinde deneyimlemiş ve ölçümler, fotoğraflar ve çizimlerle verileri toplamıştır. Elde edilen bilgilerden ve deneyimlerden yararlanılarak sürdürülebilir mobilya tasarımı için oluşturulan kontrol listesi ile mobilyaların değerlendirme tabloları oluşturulup bulgular ile özetlenerek çalışma sonlandırılmıştır.

Anahtar kelimeler: Mobilya Tasarımı, Çevresel Sorumluluk, Sosyal Sorumluluk, Kamusal Mekan, Sürdürülebilirlik, Çevre Dostu Kullanım

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DEDICATION

The support is given to me by my dear wife, Gizem, to whom this thesis is dedicated. She has always been believing in me and always supported me that I could succeed.

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Chapter 1

INTRODUCTION

1.1 Background

The human population in the world is increasing day by day. Nowadays, the concept of sustainability has gained great significance with the effect of population growth and increasing resource consumption. Along with industrialization, with the emergence of new spatial and vital needs and the emergence of new non-natural design materials, to provide people with a more comfortable life, unconsciously, many resources in the world were rapidly consumed. Now the World is facing with a serious environmental crisis resulted from this unconscious consumption. Serious measurements should be taken to stop these damages to the environment otherwise it will be too late. In fact, the truth is; sustainability is no longer a choice but a requirement.

In the twenty-first century, the pollution that emerged with the proliferation of industrial production and the introduction of plastic material created a need for these sustainable methods to come to the fore. These methods, which require follow-up and planning, can be a brake in polluting the world, especially if they are applied in the production area.

Even for a sustainable purpose, many unconscious practices damage the atmosphere that creates the ecosystem in the world. For this reason, the sustainability issue with many concepts should be examined in detail with its subtitles and dynamics.

Sustainable furniture design and production can be one of the steps that will make the world livable .

In essence, sustainability; is defined as maintaining the ability to be continuous while maintaining diversity and productivity. Sustainability describes the least harm to nature in its content. For instance, bamboo, which is a furniture production material, is a material that is easy to carry, can grow fast, and has a lot of energy content. However, in bamboo growing climates, many pandas die as a result of bamboo cutting. As in the case of Panda, knowing the environmental damage and the benefits to be obtained is one of the rules of sustainability (Moxon, 2012).

Many interior spaces are designed with cheap and environmentally harmful materials. The items purchase and use for our comfort and luxury might not be environment-friendly. According to Thiermeyer, indoor pollution caused by building materials has been brought to the agenda in recent years. Public opinion has been formed in our world against asbestos-based building materials. However, several materials used in the building and interior continue even though it contains harmful and dangerous substances. While most chemicals are harmless in low-intensity short-term contact, they are dangerous in long term and repeated contact. As a criterion, it has been taken as the highest intensity of a substance known to be harmless to health in an average of 40 hours long contact with a human for eight weeks a day (Thiermeyer 1994). Today's scenario makes us aware of the fact that our environment is in trouble. A depleted ozone layer, constant global warming, and ever-increasing pollution levels are quite alarming. Therefore, humans must struggle to correct the situation by removing ourselves from harmful activities.

When upstream energy generation is included, buildings and construction account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO2) emissions. Growth towards sustainable buildings and construction continues, but developments are still unable to keep up with the growing building sector and increasing demand for energy services. Compared to 2015, the energy density per square meter of the global building sector should improve by an average of 30% to meet the global climate targets set in the Paris Agreement by 2030. (Global Status Report, 2017).

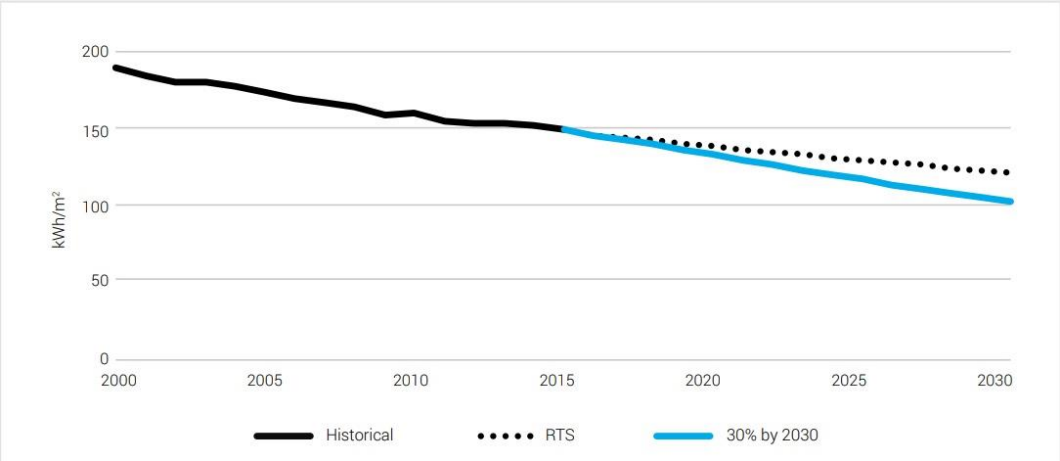


Figure 1: Building sector global final energy use per square meter (Global Status Report, 2017).

According to researches, in the 2000s, global warming, changes in environment and climate, environmental impact in the woodworking and furniture industry, and efficient use of raw materials have gained importance (Fruhwald, 1999). It is stated that the “urban population” has exceeded the “rural population” in the world by 2007, and even by 2050, the urban population is expected to increase by 65% (UN-Habitat 2006; UNESCO, WHO, CIGF and Space Group 2008).

Considering the rapid population growth and gradually increasing construction, a very serious resource consumption emerges. It can be said that design, which is directly related to consumption, is one of the factors that needs to be re-evaluated for a sustainable life. With the raising of conscious designers, concepts such as form-function-material are evaluated from the beginning. Worldwide standards are being developed in different areas, and certificates are awarded to designers and users to evaluate the applied methods taken in the context of sustainability and play an encouraging role in creating conscious audiences (Bovea & Vidal, 2004).

Factors such as sustainable materials, energy, lighting, recycling, thermal comfort, and clean air come into play in the quest for creating sustainable environments. It is evident that these factors, which are examined in detail in the study, will progress more and more in the context of developing technology, and awareness of designers and consumers towards and creating healthy environments increases.

There is a lack of understanding of the concepts of nature and sustainability. Simply and understandably, sustainability is meeting your own needs while not compromising the ability of future generations to meet their needs. Sustainability can be called the ability to be permanent. The basis of sustainability is not only environmental but also economic and social effects. Sustainability is not about recapturing a lost natural world but about recognizing that humanity has changed that natural world. A decision must be made about how much humanity and the remaining natural world can be supported within the resources of a single planet. Currently, humanity uses more resources than the planet can produce as it uses stored fossil fuel reserves, so the idea is emerging that the planet is crossing the global limit (Meadows et al., 1992.).

The living and non-living things that make up the environment are in constant interaction. The physical and chemical conditions of the environment shape the type, quantity, and harmony of the living things living in that environment. The concept of environment in general consists of living and non-living beings that interact directly or indirectly with each other and the physical, chemical, and social elements that affect them (McLennan, 2004).

Environmental pollution emerged when people began to live in communities. Ecological pollution; includes everything produced by humans that cannot be decomposed by nature and therefore do not return in natural cycles. Another definition of pollution is that the cycles are disrupted by the over or underproduction of any natural substance, and as a result, the natural balance changes. When the world population was less and industrialization did not reach these dimensions, pollution did not have significant consequences. However, today, people disrupt the balance of nature by producing harmful wastes and polluting the environment (McLennan, 2004).

An ecological crisis has emerged due to processes such as the pollution in nature reaching dangerous levels, the balances in the natural environment changing irreversibly, the health problems arising from environmental pollution coming to the fore, and the rapid consumption of natural assets. The search for a solution to this problem has brought different orientations to the plan. To eliminate environmental issues, effective measures should be taken around the world. For this purpose, the concept of sustainability has emerged, which will ensure the protection and development of environmental values of both present and future generations (McLennan, 2004).

The researchers thought that ecological design would be productive when applied in accordance with certain criteria, and some governments have established various evaluation institutions. These institutions set out a number of rules for issuing these certificates, and they are recognized as prestigious by the companies to meet these requirements (H. Scofield, 2013).

Environmental sustainability is the paces of manageability asset collection, contamination creation, and non-inexhaustible asset consumption that can be proceeded inconclusively. (Goodland, 1995). Moreover, environmental problems caused by unconscious resource consumption should be taken into consideration, and environmentally friendly materials should be directed to furniture design (Chumiran & Abidin, 2014).

Sustainable design is responsible to society and needs to address all parts of society. For this reason, it is important that interior architects adopt the universal design approach accepted by all the civilized world in the spaces designed especially for public use (Ghavampour & Vale, 2013).

There are two models used to describe the meaning of sustainability in relation to the three main involving factors, the environment, the economy and the society. These are the strong and the weak models. According to Ghavampour and Vale (2013), the concept of sustainability needs to be balanced between three main headings: environment, society, and economy. Sustainability cannot be fully achieved by protecting the environment alone. The concept of economy enters into a change depending on the environmental resources that change over time. In this process of change, society has to be a partner in this process. While defining the concept of

sustainability, all this need for balance has led to the need for a concept model that should work in harmony with the main topics such as environmental, social, and economy. In the first model, the environment, economy, and society cover an area of equal size and intersect at equal areas. In the strong model, the environmental factor is much more important and covers the society and the economy (Ghavampour & Vale, 2013).

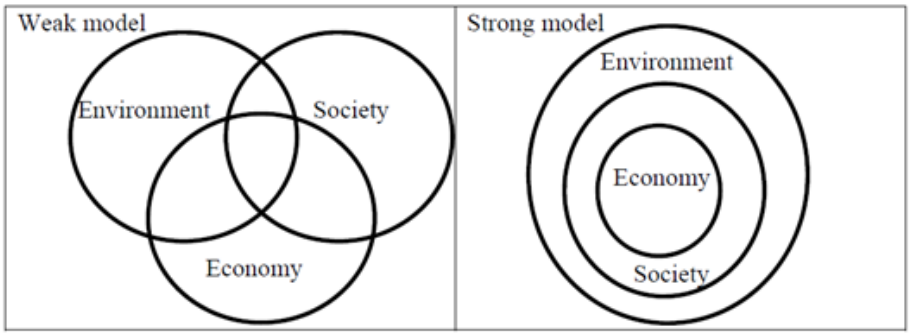


Figure 2: Comparison of weak and strong models of sustainability (Ghavampour & Vale, 2013).

As seen in the model above, an interrelated relationship between environment, society, and economy for sustainable design constitutes a strong model. When all these studies are considered, it is seen that the concept of sustainability should be taken into consideration, especially in terms of social sustainability, and environmental and social dimensions should be handled together in the design process.

There have been times when humanity has seen itself as separate from nature, designing beautiful gardens and demonstrating its power to mold nature as desired. Table 1 presents how the perception of nature has changed in different periods of history but as can be seen, there is no clear line between them (Ghavampour & Vale, 2013).

Period of history / Perception of nature	Intrinsic nature	External nature	Universal nature	Awarness of power to change	Harmony with nature
Hunter gathering			x	Low	High
Greek thinking	x			Moderate	High
Renaissance thinking		x	x	Moderate	Moderate
Modern thinking		x		High	Low
Sustainability theory	x	x	x	Hight	High

Figure 3: Comparing different views of nature from hunter-gathering until the 20th century with sustainability theory (Ghavampour & Vale, 2013).

Nowadays, when observed the relational dimensions of sustainability with humans, it is seen that every product designed in particular has started to become widespread with the motto of use for everyone. There seems to be a tendency to increase the popularity of universal design, and universal design acts in relation to social sustainability. Universal design aims to provide services and participation in the social life according to the widest possible audience. Therefore, it is vital to consider the inclusion and progress of persons excluded from interaction in society for different reasons. Design is often associated with making good looking, expensive products. However, as the Rio Declaration set out in 2005, designers can also contribute to a better quality of life in society, and global design can work as an important factor in this progress (Vavik & Keitsch, 2016).

The concept of sustainability has been in a strong relationship with the concept of social sustainability from past to present. For this reason, it has become a problem for every designer to consider public spaces in terms of sustainability and designing them according to social criteria. There is no doubt that quality environments are produced to benefit people's daily lives, and these places contribute to people's social activities and daily behavior (Dempsey, 2008, Gehl, 1996).

Most of the sustainable designs today show these features in engineering rather than design, but the results of the newly developed design approaches can be seen slightly. In order to increase productivity and maintain physical and mental health, sustainable design should be able to improve comfort as well as improve the cultural structure and living standards (McLennan, 2004).

When all past studies are examined, it is seen that the concept of sustainability has a relationship with the human as well as the environment. Therefore, the criteria required for a product design to be sustainable should be handled together in environmental and social aspects. Many green certificate criteria have been created to be used in designing environmentally sustainable designs. Generally, in these criteria the social sustainability is ignored.

This research will try to investigate the factors and criteria that affect the sustainable design of furniture in public interior spaces and will create a checklist addressing both environmental and social dimensions of sustainable design of public indoor furniture.

1.2 Problem Statement

With the increasing world's population and needs, the supply has grown uncontrollably to meet the demand, and with the industrial revolution, a mass production model has been adapted to meet this need. In this case, raw material consumption and waste management during production was constructed by the producers in a way that the costs were low, and the results were ignored. This has led to a for-profit lifestyle rather than to care for nature and people. Unlike the sustainable cycle, which is the mechanism in nature, people have adapted to the culture of consumption. According to William Mc Donough:

> Human beings don't have a pollution problem; they have a design problem. If humans were to devise products, tools, furniture, homes, factories, and cities more intelligently from the start, they wouldn't even need to think in terms of waste, or contamination, or scarcity. Good design would allow for abundance, endless reuse, and pleasure (McDonough & Braungart, 2013).

The researches carried out on sustainability generally contain sufficient information, developed around a framework focused on environmental sustainability. When the standards and certification systems established for sustainable furniture design are examined, it is seen that the environmental sustainability dimension has more points and more criteria in the concept of sustainability. However, when the concept of sustainability is evaluated as reducing or eliminating environmental damage alone, a realistic, sustainable design may not be obtained. Since the user of furniture is human, it is necessary to establish an evaluation system that includes social sustainability criteria that put people at the center of the design and equally with environmental criteria. Another sustainable design problem is that standards and green label certification systems have a very complex and extremely detailed scoring system, causing designers to be frightened and distanced from the concept of sustainability at the first stage of their designs.

1.3 Aim of the Study

Designers responsible for furniture design in indoor public spaces that are open to the common use of society should have knowledge and requirements for sustainable design. Categorizing the main topics that should be considered in the sustainable design process will be a positive approach.

In a research conducted by Knight and Jenkins (2009), they surveyed about the opinions of designers about eco-design tools and assessment techniques. According to the survey results, the checklist evaluation method got the highest score for its ease of

follow-up and applicability. Thus, the purpose of this research is to create a valuable checklist for sustainable furniture design that interior architects and designers can easily follow, implement without fear, and continuously improve.

To achieve this main aim, this research tries to answer the following question:

1. What are the criteria to be considered in design of furniture to have a design that is both environmentally and socially sustainable?

Besides this research also looks for the answers to the following questions:

1. What are the dimensions of the concept of sustainability and its evolution from past to present?
2. What factors affect the concept of sustainable product design, and which certification systems are used to evaluate green design?
3. What are the certification systems in creating the "sustainable design" discourse in furniture design, and how is the furniture-user relationship evaluated in terms of social sustainability?

1.4 Methodology

As the method of this study, it consists of two parts: Literature survey and case analysis study. This research will use a large number of literature searches on sustainable design to provide the theoretical framework. This study will examine and interpret resources such as articles written by experts, international reports, journals, books, and analyses.

Afterward, an evaluation checklist is created based on the literature review data. This list includes the evaluation criteria to be used in the field study. The indoor public spaces have been chosen as the target for the field research. Interpersonal relationships

and activities are the essential features of public spaces because people can see, hear and interact in public spaces.

Based on these reasons, the researcher chose cafe areas, which have become socialization centers with today's developing structure, to conduct a case study. As a qualitative observation condition, the researcher visited the selected field areas, took the furniture's dimensions, and experienced the furniture in the spaces. Top and side views of furniture designs in cafe spaces were drawn using Autocad and SketchUp programs. The researcher used the proposed checklist to evaluate the furniture in these spaces with regard to environmental and social dimensions of sustainability.

1.5 Limitation

This study examines the concept of sustainability, which has become an essential topic of discussion today. The concept of sustainability is a concept that is examined in many different branches, such as architecture, engineering, and economics. Today, with the increasing energy consumption, architects, interior architects, and designers have to turn to sustainable designs.

There are strong links from various aspects between interior architecture and sustainability. In different research by the researchers accepted mainly by the opinion; Sustainability has three triptychs whole headings. These; are ecological, economic, and social sustainability. When viewed in interior architecture, the close relationship of these three headings is observed. Interior architecture directly connects with the use of natural resources, energy, and water expenditures through ecological sustainability. Interior architecture directly relates to economical sustainability through economic resources and personal, social, and global material expenditures. Interior architecture

has effects on humans and society. Values have a direct relationship with the active role in social rights and social relations with social sustainability (Geçimli & Kaptan, 2019). Interior architects and designers have a more robust initiative on environmental and social factors than the economic factor at the design stage. Because in the economic factor complex indicators such as user and employer budget, production costs and production facility data come into play, and a comprehensive literature search is required. Therefore, economic sustainability will be discussed only in terms of concept. As a result, this research will focus on addressing the concept of sustainable furniture from environmental and social aspects.

Many sustainable certification systems, such as LEED, BREAM, and LEVEL related to sustainable design, have produced comprehensive and scoring system-based studies in environmental, social, and economic aspects. Therefore, this research is limited to creating an easy-to-follow checklist that can help designers in the initial stage of sustainable furniture design or furniture selection. Although there are many indoor spaces, cafe areas, which are semi-public spaces used by people for socialization, are chosen as an example. The most commonly used chair and table furniture in cafe areas are examined, but this checklist can be used for any indoor furniture.

1.6 Structure of the Research

The thesis is organized into six chapters. The first part is the introduction part, and this part explains the problem with which the thesis work started and which method was used.

In the second chapter, the meaning of the concept of sustainability, how many dimensions it has, and the emergence process are examined. The sustainability

approaches that have influenced the process from the past to the present are examined, and the foundations that determine today's definition of sustainability and the reports prepared on a global scale are investigated. At the end of the second part, the designers who contribute to sustainable furniture design are discussed.

In the third chapter, the concept of sustainability in product design is discussed. Then, green building certification systems created to guide designers are examined. After that, the concept of environmental labeling is interpreted together with ISO standards. At the end of the chapter, the importance of the Life Cycle Assessment (LCA) concept and recycling in sustainable product design and the designer's role in this process are discussed.

In the fourth chapter, sustainable furniture certification systems, including environmental sustainability, developed based on these reviews, are analyzed. Then, the applicability of the obtained data with eco-design tools and techniques is evaluated. In the findings obtained, the R concept and the designer's role in sustainable design are discussed. Then, social sustainability approaches in furniture design and the concept of human-oriented social sustainability in furniture design are examined.

In the fifth chapter, using all these findings, a sustainable furniture checklist, which aims to guide designers and is easy to follow, was created. A case study was conducted on chair and table furniture in cafe spaces.

In the conclusion part, the findings regarding the evaluation system created for sustainable furniture design are summarized and interpreted to be developed in the future.

Chapter 2

SUSTAINABILITY CONCEPT, AND DIMENSIONS

2.1 Sustainability Term

In this section, first, the definition of the concept of sustainability will be explained in general. Then, the development of the concept of sustainability from past to present will be discussed. In the last part of this section, the fundamentals that determine the definition of sustainability and international reports prepared on a global scale will be examined.

Population, production and raw material usage have increased at the right rate from past to present. With the increase in production, consumer individuals consumed more, and wastes approached a dangerous limit in the regions where production and consumption are high. Pollution in everywhere including oceans untouched by human hands, has been observed. This is a responsibility that designers, manufacturers, and consumers should not forget (Yeang, 2012).

Sustainability can generally be defined as “the ability to be permanent,” and its main goal is to develop and implement the idea of sustainable development. Sustainable development is basically an effort to increase the level of economic growth and prosperity by protecting the environment and the quality of life of all people on earth (Moxon, 2012).

Its counterpart in the environmental field is to ensure the continuity of the diversity and productivity of biological systems. To protect the welfare of people, it is necessary to find new methods to meet the needs and to develop production and consumption practices that will protect natural resources. If the continuous population growth, energy, and substance consumption continue, the majority of people will be unable to meet their needs. The number of hungry and poor people will increase.

Sources in nature and energy are in transformation. Disruption of balance in this transformation reduces the availability of resources or energy, damaging the areas of nature that are important to humans (Yeang, 2012).

The first of the aims of the sustainability concept, whose reason and the process is examined, is to present an economic and social development model that respects the environment. This model proposes a growth plan that reconciles economic, environmental, and social factors on a common denominator. The main characteristics of these three factors are as follows:

- Economic factors: In addition to classical financial performance, the business can contribute to the economy of the region where it is established.
- Social factors: protection of social and legal rights (such as the working conditions, salary rates.) of business employees.
- Environmental factors: the harmony between business activity and ecosystem; reviewing the environmental impact of the enterprise and the resulting products in terms of resource consumption, waste amount, and harmful emissions (Moxon, 2012).

The United Nations General Assembly meeting held in 1983 played an important role in the development of sustainability with its report titled “Our Common Future.” According to this report, published by the World Environment and Development Commission President Gro Harlem Brundtland, in 1987 and generally referred to as the Brundtland Report, sustainability is defined as “meeting the needs of the day but not removing the ability of future generations to meet their own needs” (Markley, 2012).

The report, which recommended ‘sustainable development’ so that prosperity can continue, caused the word ‘sustainability’ to take on a global meaning. Of course, these concerns have been present since the Industrial Revolution and the rapid consumption of fossil fuels (Markley, 2012).

Another goal of the concept of sustainability is to enable future generations to meet their current needs. The Brundtland report’s definition of sustainability draws attention to the diversity of animal and plant species and the need to protect all ecosystems. In order to protect and improve the quality of the environment within the framework of the concept of sustainability, the main principles are restoration, replacement, and maintenance of the main habitats, as well as ensuring the continuity of animal and plant species used for feeding purposes. According to Markley (2012), the three main objectives of the Report are as follows:

- They are establishing relationships between nations, living beings, and generations on a global scale.
- Major economic regions (such as the European Union, Latin America, Asia.) establishing a relationship.

- Increasing the environmental responsibilities of businesses and individuals (Markley, 2012).

One of the most important goals of the concept of sustainability is equality in terms of people, time, and space. In other words, it is ensuring that all nations, living beings, and generations have equal rights over the world's resources. An excellent understanding of its requirements is essential to make the concept of sustainability viable, rather than remaining a theoretical guide. Considering in this context, the concept of sustainability is important with its environmental dimension, as well as in terms of its social dimension; it is essential to know and implement its requirements.

In summary, especially in the last 40 years, the definition of sustainability, the creation and presentation of its principles, and the search for solutions to established problems have been widely carried out. The historical process of sustainability is examined in line with the research and results developed by various national and international institutions and organizations.

The next section deals with the process of development of the concept of sustainability during the time. Sustainability has emerged as a concept that has increasingly increased its importance in historical periods. In the process from past to present, many countries of the world have contributed to the historical development of the concept of sustainability by publishing various meetings and reports. This will be discussed in detail after that.

2.2 Evolution of the Sustainability Term

Although sustainable architecture is new in concept, its applications date back to ancient dates. Human history carries traces of the perfect samples of living in harmony

with the nature. For example, Socrates said that in the houses facing south, the winter sun could be taken in, but in summer, the sun passes over the roofs, and the house is in the shade so to get the winter sun, He proposed that the north facade be lowered to be protected from high, cold winds. Likewise, Vitruvius, in De Architettura, which he wrote in 25 BC, stated that for private housing designs to be correct, the country and climate conditions in which they were built should be observed. Along with these examples, it was common to use local and natural building materials that provided sufficient heat insulation, were breathable and were produced with little energy. The concept of sustainable architecture, which is put forward today, also depends on past knowledge. The most important feature of this information is the obligation to be related and interdependent to the natural environment (Eryıldız, 2003).

Over time, the increase in pollution has attracted the attention of environmentally conscious manufacturers and designers. This issue, which was already discussed in the 20th century, started to attract the public's attention after 30 years of discussion with the work of different researchers. According to Stern's research, possible tragedies that may arise from human empowerment of this problem were first mentioned emphatically in the 1957 study of Revelle and Suess. (Stern & Stern, N.H., 2007).

The most important development that reminds people that resources will be exhausted in the future was the energy crisis in the 1970s. In the USA, due to the energy crisis experienced as a result of the oil embargo in the 1970s, architects and designers sought alternative solutions and developed new sustainable technologies and materials. In this period, environmentalism has emerged in connection with ecology under the name of “green design,” but ecological movements in design have been limited to small-scale structures (Spindler, 2013).

In the 1980s, besides energy saving, human health started to come to the agenda. Studies on the toxicity of the materials used, the effects of artificial air conditioning and artificial lighting have been carried out, and the concept of "design for human" has gained importance. Green design started to be referred to as Eco-design. Ecological design can be defined as designing environments, projects, systems, materials, and products that are friendly to the ecology of the earth and the species living on it (Yeang, 2012).

As shown in Table 1, starting from the industrial revolution of the early 18th century, concepts such as social approaches, energy movements, industrial design, and green design are discussed. As a result, the concept of "Sustainability" emerged in the 1990s with the efforts to create a common platform by using concepts such as energy, raw materials, health, natural balance, and economic balance, together with the criticisms made against design practice (Spindler, 2013).

Table 1: History of Sustainability Paradigm (Spindler, 2013)

Years	**Paradigm**
18th century	Industrial Revolution (acceptance of the concept of unlimited growth)
The 1960s	Socio-Political Approaches (defining environmentalism as a radical protest movement)
The 1970s	Energy Movement (profit-oriented design concept)
The early 1980s	Improving space (a concept of design for human)
The 1980s	Post Industrial Design (criticizing current industrial practices)
The late 1980s	Green Design (discussed with technical/political view of design and environment)
The early 1990s	Eco Design (criticism of design practice)

The late 1990s	Sustainable Design (efforts to build a compromise platform)

After the publication of Silent Spring by Rachel Carson in 1962, the "New environmental policy" gave a new boost to the concept of sustainability. Thanks to this eco-classic, environmental protection has become an essential interdisciplinary subject, and environmental awareness of society has increased globally. The National Environmental Policy law, which was enacted in the USA in 1970 and had a significant impact on the world, especially in large projects, which requires a detailed "Environmental Impact Assessment" (EIA), was adopted in 1969 as a result of environmental discussions. This concept was later adopted in other European countries. According to article 2 of the EIA law, this law defines, estimates, and evaluates the impacts of a project on citizens (Spindler, 2013).

The evaluation criteria of the EIA law are as follows:

1. There is a lack of understanding of the terms human, animal, plant and biodiversity health
2. Soil, water, air, climate, and landscape
3. Cultural goods and other tangible assets
4. Interaction of all of the above good (Spindler, 2013).

The new global environmental policy has been significantly influenced by the UN Environment Conferences, presented in chronological order in Table 2. These conferences are events where environmental issues are discussed, environmental development is researched, and at the same time, the term sustainability has emerged and gained significant popularity (Spindler, 2013).

Table 2: UN Environmental Conferences (Spindler, 2013)

UN Environmental Conferences
1st Environmental Conference in 1972 in Stockholm
2nd Environmental Conference in 1982 in Stockholm
3rd Environmental Conference in 1992 in Rio de Janeiro
4th Environmental Conference in 2002 in Johannesburg
5th Environmental Conference in 2012 in Rio de Janeiro (Rio+20)

For the first time, ecological problems were discussed by United Nations experts and Western Bloc countries at a panel held in Switzerland in 1971. In the report published after this meeting, it stated that the production and consumption systems of industrialized countries caused environmental problems and caused a massive public opinion on sustainability. This result enabled many developed countries to participate in a second meeting held in Stockholm in 1972. At the United Nations Environment Conference held in Stockholm in June 1972, the interrelationships between the concepts of eco-development, ecology, and economy and the models of development of the North-South countries were discussed (Spindler, 2013).

At the Rio Summit held in June 1992, sustainability principles were adopted and started to be used widely all over the world. Industrial disasters (Chernobyl, Seveso, Ekson Valdez, etc.) that have occurred in the last thirty years have awakened environmental awareness in public. They have led environmental non-governmental organizations such as WWF, Greenpeace to speed up their work. At the summit, which was held with the participation of 179 countries, it decided to spread global sustainability. One of several international agreements signed as a result of the meeting is the 'Framework Convention on Climate Change,' which contains suggestions to

bring sustainability from the theoretical field to practice. The purpose of this contract is to slow down or stop the harmful effects of essential climate changes, such as global warming, that affect human life. It aimed to eliminate these adverse effects through sustainable design through various substances (Drexhage & Murphy 2010).

At the International Union of Architects World Congress held in Chicago in 1993, it was discussed that designers should carry out their work within the framework of sustainability. Some of the decisions taken at the congress are as follows:

- To place environmental and social sustainability at the center of our work,
- Developing methods, products, services, and standards that will ensure the implementation of sustainable design and ensure their continuity,
- To educate our colleagues, construction industry members, owners, employers, students, and all segments of society about this issue and its importance,
- Making sustainable design a common practice by preparing government-level policies, various regulations,
- Developing methods, products, services, and standards that will ensure the implementation of sustainable design and ensure their continuity,
- To bring the existing and future elements of the artificial environment to sustainability standards in terms of their designs, production, and use (Sev, 2009).

At the Johannesburg summit, which started in August 2002 and was attended by nearly a hundred heads of state and thousands of government representatives, an agreement was signed, which included protecting biodiversity and natural resources. In 2005, the Kyoto Protocol on reducing harmful gas emissions that cause the greenhouse effect came into force. The Kyoto Protocol, ratified by 189 countries, experienced a decrease

in greenhouse gas emission intensity with an annual average reduction rate of 0.9% to 5.1% compared to 1990 when EU countries had greenhouse gas emissions in 2008-2012 shown in figure 4. Under a post-Kyoto agreement, the EU has emphasized that a 50% reduction in emissions is necessary to limit global average temperatures to 2 degrees Celsius above pre-industrial times. (Hammons, 2006).

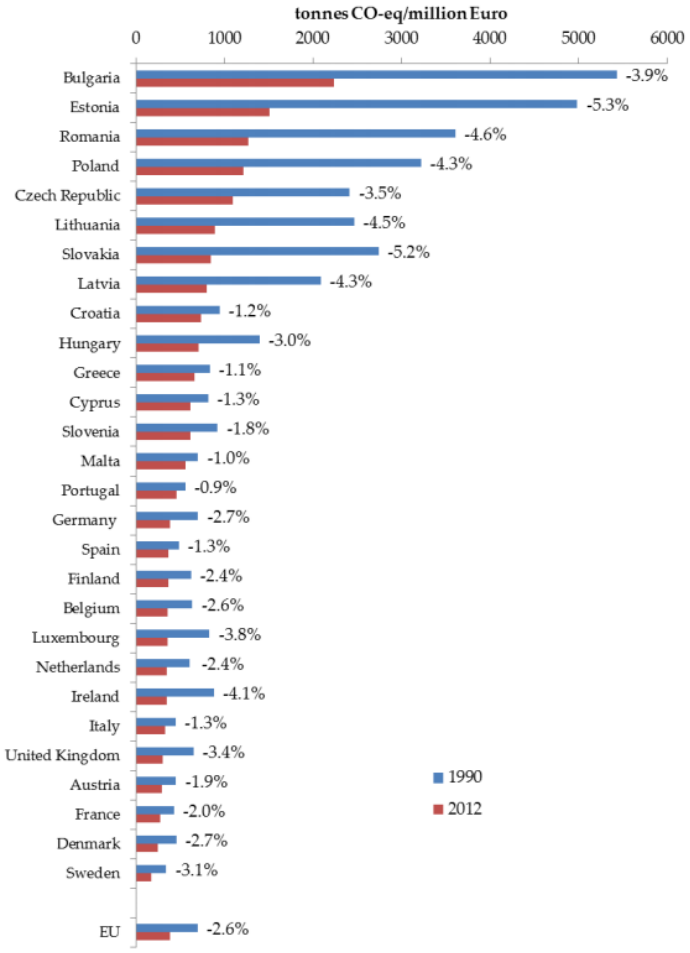


Figure 4: Greenhouse Gas emission intensity, 28 members of the European Union, 1990-2012 (Europea, C. 2014).

To sum up, the concept of sustainability is still in constant change. ‘‘Sustainable development is not a static state. Just as valid 20 years later is the Brundtland observation that sustainable development is ‘not a fixed state of harmony but rather a process of change’’(Massey, 2007, p.6). Because of the dynamic development of

sustainability, it can be applied to all areas of life; it can be considered as the sustainability of life with another discourse. In addition to ecological issues, social and economic platforms are also included in a sustainable life. Along with environmental sustainability, social sustainability also stands out. Environmental sustainability mainly covers ecological studies and is essential for the balance of ecosystems. Social sustainability, on the other hand, is on the list in social and economic areas and aims to create a balanced society. In the next section, these factors that play a role in the concept of sustainability will be examined in detail.

2.3 Major Factors in the Sustainability Concept

According to Kidd (1992), the concept of sustainability has developed over a long period and research. It is important to note that this evolution has been affected by various "intellectual and political thought streams that shape the concepts of sustainability" (Kidd 1992, p.3). In this section, the researcher will examine the relevant literature addressing the concept of sustainability according to different thought streams. A review of these studies allows for the identification of three main discourses that shape and characterize the evolving debate on sustainability. These will be treated as" environmental," social, "and" economic" discourses.

2.3.1 Environmental Sustainability

According to Drexhage and Murphy, common discourses on the concept of sustainability have focused on the study of the relationship between nature and humans. Even if the idea of sustainability has always been treated as a multidimensional concept, it has been segmented as an environmental problem due to increased energy consumption for more than 30 years (Drexhage & Murphy 2010). In the early 1970s, the term sustainability began to be widely used concerning environmental issues. Along with the introduction of the concept of sustainability for

ecological problems, various books have been published that address sustainability issues from an environmental point of view. In this context, the United Nations has begun to address global environmental problems and the excess of industrial pollution, which is considered as an obstacle to development (Kidd 1992, p. 15).

The UN Conference on the Human Environment, held in Stockholm in 1972, is one of the most critical steps in this direction. At the conference, 26 principles were developed that address most environmental problems in the scientific literature, principally relying on the concept of carrying capacity. The third principle declared that "the capacity of the Earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved" (UN 1972, p. 4). The Stockholm Conference has had a significant impact on creating the United Nations Environment Program (UNEP) and several national conservation agencies. In the UN context, the term sustainability appeared for the first time in UNEP (Kidd 1992). Collaboration and strong leadership in environmental protection have been one of UNEP's most essential goals since its establishment. UNEP also highlighted the importance of the concept of "eco-development," which is the simultaneous observation of the efficiency of renewable resources and the depletion of non-renewables. UNEP took the concept of sustainable efficiency in its definition of eco-development (Giovannoni & Fabietti, 2013).

The World Conservation Strategy (WCS), created by the International Union for Conservation of Nature (IUCN) in 1975, emphasized the need for research on developments in human life and conservation of natural resources for Sustainable Development. Identifying priority protected areas to promote sustainable development has been the main objective of WCS (Drexhage & Murphy, 2010). The most popular

definition of sustainable development, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” was created in the report titled “Our Common Future” of the World Environment and Development Commission in 1987 and provided an overview of the situation. This report represented a rise for the landmark 1992 Rio Summit (Drexhage &Murphy, 2010). The researchers of the UN Conference on Environment and Development (UNCED) in 1992, known as the Rio Summit, prepared an action plan for sustainable development, including the Rio Declaration, Agenda 21, and the Sustainable Development Commission tittles. Although Agenda 21, in particular, provided recommendations and acceptable practices for achieving sustainable development with great emphasis on environmental considerations, the Kyoto conference in 1997 revealed weak progress in achieving Agenda 21 goals (Drexhage & Murphy, 2010).

As can be seen from the information explained above, countries and companies, acting reactively in the 1970s, waited for environmental crises to occur and then made great efforts to reduce their negative effects. This situation was not ignored by the companies and countries in the 1990s and enabled them to take a more proactive approach. In this way, companies began to predict the environmental impact of their activities and gain a business advantage from ecological performance management. Over the past time, companies have tried to gradually place environmental problems in their business cultures and management processes by commissioning Environmental Management Systems (EMS). EMS is considered necessary for complying with regulations and reducing waste. Among these systems, developed in 1993 by the European Commission, the voluntary tool environmental management, energy efficiency,

material efficiency, biodiversity, emissions, water consumption, and waste, including a broad range of indicators, has been adopted (Melnyk, Sroufe & Calantone, 2003).

It is inevitable that the discipline of architecture also has its share and responsibility areas in the functioning of this model. In the 1993 agenda of the world architecture congress, which meets regularly and discusses the current dynamics of the profession, sustainable development was included in detail for the first time. The importance of framing the professional activities of architects in accordance with sustainable design conditions was emphasized in congress. Putting environmental and social sustainability at the center of work and professional responsibilities, establishing procedures, products, curricula, services, and standards that will ensure the implementation of sustainable design and continuously improving them, educating experts, the building industry, customers, students, and society about the critical importance and opportunities of sustainable design, Establishing policies, restrictions, business and government practices that will ensure that sustainable design becomes current practice; It was emphasized that all existing and future elements of the built environment should be brought into compliance with sustainable standards in terms of designs, production, use and reuse (Civan, 2006).

As shown above, from the 1970s to the 1990s, sustainability was primarily concerned with environmental concerns. Conscious use of natural resources and the development of human resources are also included in the development processes to carry out development processes fairly, efficiently, and without being destructive. Even if development programs in which social dynamics are ignored provide economic development, no real development can be achieved because social equality and welfare cannot be achieved. Therefore, the importance of the social dimension of sustainable

development that addresses socio-human factors should also be emphasized. In the next section, the term of social sustainability will be examined in detail.

2.3.2 Social Sustainability

While discussing the concept of sustainability, discussions around environmental criteria have developed without neglecting the social aspects. The best example of this is the reconciliation of present and future generations, mentioned in the definition of sustainable development by the World Commission on Environment and Development (WCED). According to the study of Dempsey, Bramley, Power, and Brown (2011), essential elements of social equality such as intergenerational equality, social justice, distributive justice, and equality of conditions are found in WCED's definition of sustainable development. Benefiting from common human social rights and equal use of rights by all individuals in society without racism and discrimination are at the most fundamental center of the concept of social sustainability.

In addition to this argument, the concept of social sustainability has begun to evolve across companies, and researcher Howard Bowen (cited in Dempsey et al, 2011) has argued that social responsibilities are one of the most critical duties of business people and that desired lines of action must be followed. These discourses of Bowen have created a touchstone effect in the context of the development of social sustainability (Dempsey et al, 2011).

The United Nations states that economic development, social development, and environmental protection are the three inseparable components of sustainable development (WHO, 2005). Besides, UNESCO adds the culture component to these three components as the fourth in its universal declaration on cultural diversity. According to UNESCO (2001) research, just as biological diversity is indispensable

for nature, cultural diversity is indispensable for humanity. According to Magnoli, Bonanni and Khalaf (2002), environmental sustainability is a requirement for the balance of the ecosystem, while social sustainability is a necessity for a balanced society.

Among the goals reflecting the social dimension of sustainable development is the establishment of facilities such as education, health, recreation, and socially adequate and accessible human settlements. Besides, it includes the struggle with discrimination and exclusionary policies and practices among people, and the recognition and respect of the rights of all people, especially vulnerable groups such as women, children, the elderly, the disabled, and the poor.

Social sustainability; who can preserve their cultural diversity, are in harmony with their natural environment, live in a relative social balance and peaceful relations and have mechanisms to protect this situation, have a pluralist and democratic political structure, provide equal opportunities and opportunities to all its members and it is defined as a society that can realize continuous growth under these conditions (GAP, 2018).

Local Agenda 21(LA21), which discusses environmental sustainability, consists of three main and complementary parts. The first part, which examines the social and economic dimensions, and the third part, titled developing the roles of the main groups, are the parts that emphasize the social dimension of sustainability. In the first part, which examines the social and economic dimensions, the sections on combating poverty, protecting and improving human health, and supporting sustainable human settlements development contain expansions related to the social dimension of

sustainable development. Moreover, the third part, which deals with the development of the roles of major groups, discusses the positions of women, children, youth, indigenous peoples, and communities in sustainable development. The third part also supports the participation of non-governmental organizations and local governments in the execution of development programs. While the primary responsibility for implementing Agenda 21 belongs to the governments, the main success of the program lies in the promotion of active participation of non-governmental organizations and the public in the process. Multi-actorship and the search for social consensus are vital to the successful implementation of programs. In this way, individuals who are aware of their own agenda, aware of the problems, and involved in the solution proposals will play an active role in the realization and continuity of the programs. This process emphasizes the importance of multi-actorship and social consensus (Evans & Theobald, 2003).

The awareness that not all problems can be solved by the public sector alone supports the participation of local actors in these processes and the sharing of ideas and experiences. One of these actors is the designer and architect. Architects and interior architects can participate in long-term development projects by working with local governments on sustainable development goals. Designers can produce projects that can be articulated to sustainable development goals for those who cannot reach services and social facilities in urban and rural areas with individual initiatives. Long-term development projects are problem-oriented single examples apart from comprehensive development projects. It can be accepted as the articulations presented by the discipline of architecture through its channel in ensuring sustainable development. Especially, the designs that will be planned based on the equality in use

in public spaces and the design manifesto for everyone will contribute greatly to the concept of social sustainability.

2.3.3 Economic Sustainability

The third topic emerging in the sustainability debate is the term of economic sustainability. As Gray points out (2010, p.56), capitalism and its destructive tendencies manifest themselves through its most incredible creation, the company. Considering the depletion of natural resources, companies use recyclable production techniques and various replacement products to protect the biological system and absorb accumulated emissions. Thus, economically sustainable companies do not engage in activities that disrupt the ecosystem.

The first intervention of the economy-centered growth model was made to solve the problem of social inequality. With the emergence of non-governmental organizations and trade unions in the second half of the 19th century, this way of thinking was revised, and "socio-economic" development started to be supported. Meanwhile, developed countries (Nordic countries) had to face the fact that their wealth depends on the intensive use of natural resources and that these resources will be depleted after a while because they cannot be renewed. Some researchers on the subject have argued that only a socio-economy-centered growth model should not be applied in the environmental plan due to reasons such as climate change, depletion of natural resources (fossil energy resources, raw materials), destruction of ecosystems, and decrease in biodiversity. Thus, the concept of "Eco-development" was introduced by Ignacy Sachs in the early 1970s and with the decisions taken at the International Environment Conference held in Stockholm in 1972, Eco-development, also known

as the sustainable development model, added the principle of environmental protection to the economic progress and social justice criteria (Gray 2010).

In this chapter, three sub-headings, including environmental, social, and economic terms that constitute sustainability, are discussed one by one. When the studies are examined, it is seen that these terms affect each other through various factors. The term sustainability, which first developed within the framework of environmental problems, started to create with the effect of researches and conferences focused on the sub-title of environmental sustainability. These studies show that it is impossible to achieve adequate, sustainable development by addressing ecological problems alone. As a result, the term social sustainability was introduced to contribute to the sustainable development of society, and the term economic sustainability was coined to perpetuate the sustainable development of the countries. This research will focus on environmental and social sustainability terms, where architects, interior architects, and designers have high individual initiative in the design phases. The following section discusses the designers who have contributed to the sustainability process in the early development stages of sustainability in the past years.

2.4 Designers Contributing to the Sustainability Process

The environmental problems have attracted designers' attention too and new searches have been done in this direction. There are two different general attitudes toward environmental issues in furniture design. The first is using easily recyclable natural materials, and the second is the use of recycled materials.

It is seen that natural materials such as wood and stone are predominantly used in furniture designs made with traditional production. However, the fact that with the

growing population the demand for furniture could not be met only with natural materials, made it necessary to develop new materials. Firstly, it is seen that wood by-products are used in furniture design. Products such as plywood, particleboard, fiberboard are the materials developed with the first environmentalist approaches. These cheap and easily manufactured products can respond to a wide range of industrial furniture production needs. Thus, it is ensured that the wooden material is economical and can be used when necessary. The similar use of metal materials such as recyclable aluminum has given furniture design many formal advantages. Along with industrial production, the development of new materials has affected furniture design. Designers' experimental works draw attention to this subject. Designers' pursuit of original searches on this subject is an important development in terms of environmental design.

The design has evolved from the conceptual phase of the 1960s into an expressive and figurative form. The rules of modernism and functionality in architecture and design are reversed. Design has played an important role not only in advertising, marketing but also in individual life. The design has become a game in the media and exhibitions. Besides, there is a renunciation of ideological functionality in the new design approach (Erdem, 2019).

As Ettore Sottsass called it in the 1980s (cited in Erdem, 2019), “We use everything we do today. Our productions are devoted to life, not to future generations.' In 1981, he produced legendary symbols on the shelves he designed, and he produced furniture made of colored plastic." This discourse has lost its validity today and is interpreted

differently. Because excessive, unnecessary, and only formative approaches lost their validity and were not regarded as ecological (Erdem, 2019).

Fashions have been created, such as creating new designs and replacing the old and replacing after each product is produced. As a result of this approach being criticized by environmentalists, designers' perspective on the subject has changed (Yüksel, & Kiliç, 2015).

Movements such as "Ready-made," which emerged using existing materials that bring a different perspective to sustainable design, aimed to create furniture from ready-made objects. The aim here is to use many products produced and to evaluate the materials produced. The purpose of such movements is to be an alternative to the furniture design method in that period. According to this approach, pioneered by Marcel Bruer and Andy Warhol, any object can be used as a seating element. Ron Arad's waste car seat and chair designed with rusty bent metal pipes are a prime example. In addition, considering Mark Maden's "Topos" armchair design, the chair in which waste pieces of hard-textured wood materials are cut in certain curved forms is an excellent example of recycling (Yararel & Sever, 2019).

Figure 5: Ronard ‘Rover Chair’ & Mark Maden ‘Topos Chair’ (Yararel, Sever & İmert 2019).

Gunnar Anderson, who gained prominence in the 1950s and 1960s, used many industry-related wastes in his design. His designs are produced with unusual materials such as aluminum, fiberglass, and newsprint. Even if the design made with these extraordinary materials is not very useful, it emphasizes environmental sensitivity. The materials used are the precursors of the paper material that will later be used in industrial production (Yararel et al., 2019).

Figure 6: Gunnar Aagaard Andersen, Chair, 1952 (Yüksel, & Kiliç, 2015).

The furniture that Gunnar Andersen made using materials such as newsprint in the 1960s attracted the attention of different designers. Thanks to the material formed by combining the dough with PLA (biodegradable plastic), thin section, weight, stress, humidity, and temperature properties have increased. It is a valuable material because it is cheap and easily recyclable. Murdoch's use of paper material in furniture design has brought an alternative perspective to sustainable furniture design with its different design approaches. Although this design is supported by mixing some of the additives contained in the paper, it is designed for children due to its low carrying capacity. It has effectively created a brand-new form for designers, as the paper is recyclable and the material is used more economically (Yararel & Sever, 2019).

Figure 7: Peter Murdoch, Spooty Chair, 1952 (Yüksel & Kiliç, 2015).

Frank Gehry was impressed with the chair model Murdock designed for children. Gehry produced armchairs and chairs with the material obtained by molding and pressing the pulp with the low bearing capacity of the paper. Mutual grooves are formed between the cardboard layers to ensure strength and flexibility. These products, obtained from laminated cardboard carriers, took their place in furniture stores after a while. This model took the form of a single material consisting of thick laminate layers. Gehry has shown that recyclable and flexible models can be obtained at a low cost in this design (Yararel & Sever, 2019).

Figure 8: Wiggle Side chair Frank Ghery 1972 (URL 1).

This chapter, which examines the historical development process of sustainability and the main factors affecting it, aims to understand the necessity of using environmental and social sustainability paradigms, which are the focus of the study, in the design

process. In addition, at the end of this section, the designers who contributed to the concept of sustainability are examined, and it is tried to emphasize that sustainability is applicable in many conditions. Today, responsible designers should especially consider environmental and social aspects in their designs. The idea of sustainability is an ever-changing concept influenced by these two main criteria. This shows that the concepts of design and sustainability are paradigms that are in constant communication with the same motivations. The following section discusses the place of sustainability in design, the concept of sustainable products, and sustainable certification systems.

Chapter 3

SUSTAINABILITY IN DESIGN

As stated in the previous section, the concept of sustainability has increased in importance since the early 1970s and has become a factor that increases its value day by day. Considering the meaning of the design, people and their environment are the most potent factors that help shape the design. With the widespread use of industrial production and the introduction of plastic material into our lives, the pollution that has emerged has made sustainable methods come to the fore. These methods, which require monitoring and planning, can act as a brake for us, who are rapidly polluting the world, mainly if applied in design and production. Therefore, this chapter first discusses the concept of sustainable product design. Then, green building certification systems that form the basis of the green product certification system are examined. In the continuation of the research, the concept of environmental labeling is reviewed together with ISO standards. Towards the end of the section, the importance of the Life Cycle Assessment (LCA) concept in sustainable product design and cradle to cradle process are discussed.

3.1 Sustainable Production Concept

The “sustainable production concept,” which emerged at the United Nations Conference on Environment and Development in 1992, is a fundamental component of sustainable development that balances three primary needs such as social, economic, and environmental destination (Fig. 9).

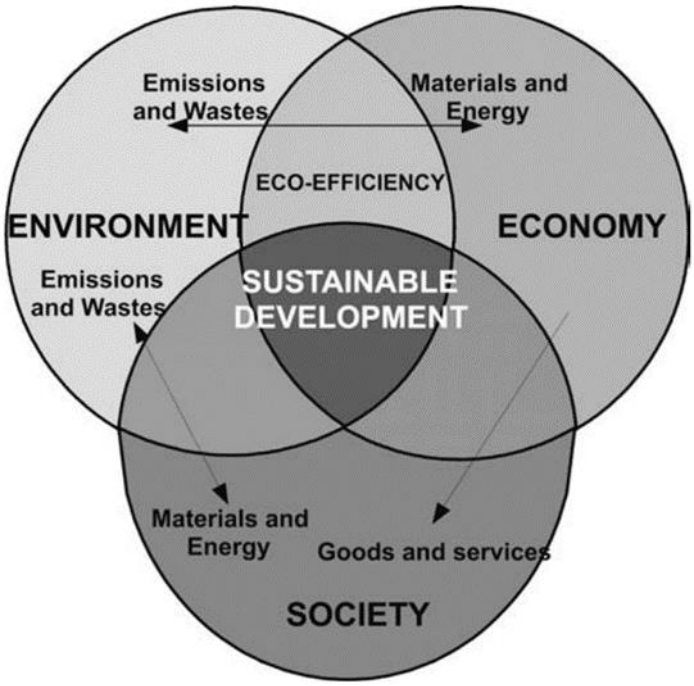


Figure 9: A model of sustainable development (Krajnc, & Glavic, 2003)

Sustainable production is defined as reducing the risks to people and the environment by continuously applying a holistic and preventive environmental strategy to products and processes. Sustainable production refers to the prevention of environmental impacts at the source before they occur. Contrary to "pollution control" approaches that try to eliminate environmental problems after they occur, ecological issues are discussed in terms of industrial, urban, agricultural, etc. It requires that all kinds of human activities be included in the planning processes as a parameter during the design phase (Krajnc, & Glavic, 2003).

3.1.1 Sustainable Production Performance

Products and materials used in products must have specific properties in order to reduce their environmental damage during production. Producers' minimization of all kinds of waste, raw material, and energy use will enable them to reach their sustainable production targets. Companies must produce, distribute, and recycle products that have environmental impacts and have resource use levels designed in line with the world's

estimated carrying capacity to achieve the goal of sustainable production. The energy and other resources used in processing should be used, taking into account all stages of a product's life cycle and produced with the help of clean technology systems, which reduces the level of harmful emissions that may arise (O'Brien, 1999). A number of necessary conditions that producers must meet to be sustainable are shown in table 3.

Table 3: Sustainable production conditions (Krajnc & Glavic, 2003).

Number	Conditions
1	Reducing material and energy use in products and production.
2	Shutting down material loop systems to conserve resources and prevent waste.
3	Waste minimization or prevention.
4	Reuse and recycle products.
5	Environmentally-friendly disposal of non-recyclable products or production waste.
6	Planning products that are easy to repair, adaptable, durable, and longer-lasting.
7	Minimizing transportation needs.
8	Cleaner production technologies and procedures throughout the product life cycle.
9	Developing a process technology.
10	Environmentally sound research and development technologies.
11	Evaluation of the social role played.

Many manufacturers have developed some key indicators to reduce and monitor harmful effects on the environment. However, the results are not immediately comparable, as these indicators are developed internally in the business sectors. Some manufacturers and designers may be efficient at certain stages of sustainable design but fall short in different categories. Therefore, specific indicators are needed to make an appropriate sustainable production and design (Callens & Tyteca, 1999).

3.1.2 Sustainable Production Indicators

Although evidence demonstrates the difficulty of establishing sustainability indicators applicable to any manufacturer or design, several different green certification systems have been proposed so far. There are no difficulties with common issues such as the use of environmentally sensitive materials, energy use, and water use as these are familiar to all manufacturers and designers. However, more specific indicators should be defined separately on a sectoral basis (Callens & Tyteca, 1999).

Recently, some experts have developed complex mathematical models to evaluate sustainable development. Due to the difficulties in the practical implementation of these complex models and the exponentially growing rules, designers and manufacturers cannot be transparent about sustainable development in a short time and avoid these rules in practice (Krajnc & Glavic, 2003).

It is recommended that a designer start with resource efficiency and environmentally sound material use measures that are simple and easy to implement, and then move towards more complicated indicators such as social impacts and life cycles. As Albert Einstein said, “Everything should be made as simple as possible, but not simpler.” On account of this, sustainable production indicators should first begin from adopting low-level measures, and then all indicators of sustainable production should be gradually improved and used (Veleva & Ellenbecker, 2001). In Figure 10, the primary indicator factors for sustainable production are presented in their simplest form. These factors inevitably need to be discussed for any design and production to be sustainable.

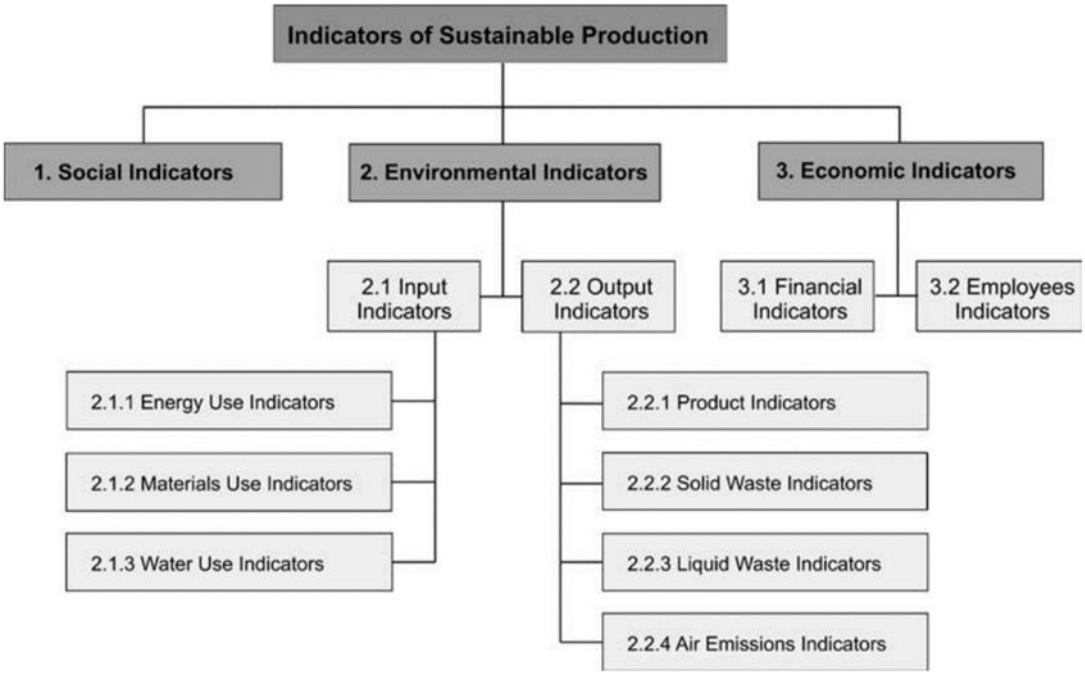


Figure 10: Organization chart of sustainable production indicators (Krajnc & Glavic, 2003).

In this section, the definition of sustainable production and the factors that affect its development are discussed. These discussions have tried to explain what the main criteria that should be applied mainly for sustainable design are and how the simple to complex system inherent in these criteria should be applied to create awareness for designers. In the next section, green certification systems with various standard indicators found in the world that have become a little more complex and specific are mentioned.

3.2 Standards and Green Certification Systems

As the idea of sustainable design became widespread, many organizations felt the need to develop certain standards, codes, and grading systems that governments, professionals working in the building sector, and consumers could be based on, and worked in this direction.

3.2.1 Green Building Certifications

Green certification systems have started to develop on the level of building structures as a priority. Green Buildings are ecological structures that appear under many names such as sustainable, ecological, green, and environmentally friendly. It is designed with a holistic approach and an understanding of social and environmental responsibility, where the building is evaluated within the scope of its life cycle, starting from the land selection. Green buildings are turning to renewable energy sources that are suitable for climate data and conditions specific to that location, consuming as much as needed. Green buildings can define as structures sensitive to ecosystems that encourage participation, using natural and non-waste-producing materials (Kosanović et al., 2018).

The National Green Building Councils around the world have revealed that one of the right ways to make green buildings widespread is to give buildings a "green label." Sustainable building grading systems play an essential role in determining the degree of the environmental impact of buildings. Buildings that meet the factors supporting sustainable design (water saving, energy use, materials, etc.) are credited according to the determined system. The credit received by the building determines its success in terms of sustainable design. These standards are also a guide for architects and engineers who want to design sustainable buildings (Kosanović et al., 2018).

Buildings and construction activities account for 36% of global energy use (figure 11) according to the Global Status Report published jointly by the International Energy Agency (IEA) and the United Nations Environment Program (UNEP) in 2017. At the same time, buildings and construction activities emit 39% of the carbon dioxide (CO2) in the atmosphere that causes global warming. The ecological effects of building and

construction activities on the environment are not limited to only the CO2 gas they release. At the same time, they are responsible for approximately 12% of water use, 65% of waste, and 71% of electricity consumption. (Global Status Report, 2017).

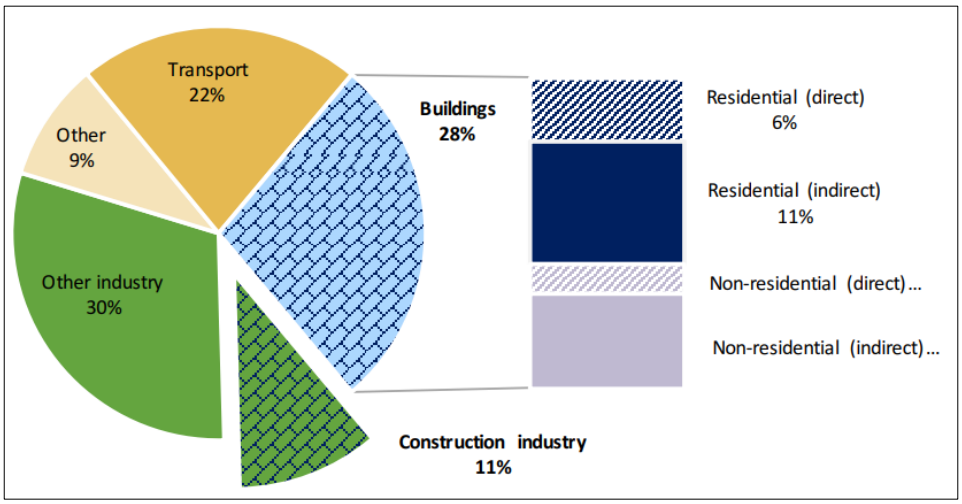


Figure 11: Share of global final energy consumption by sector, 2015 (Global Status Report, 2017)

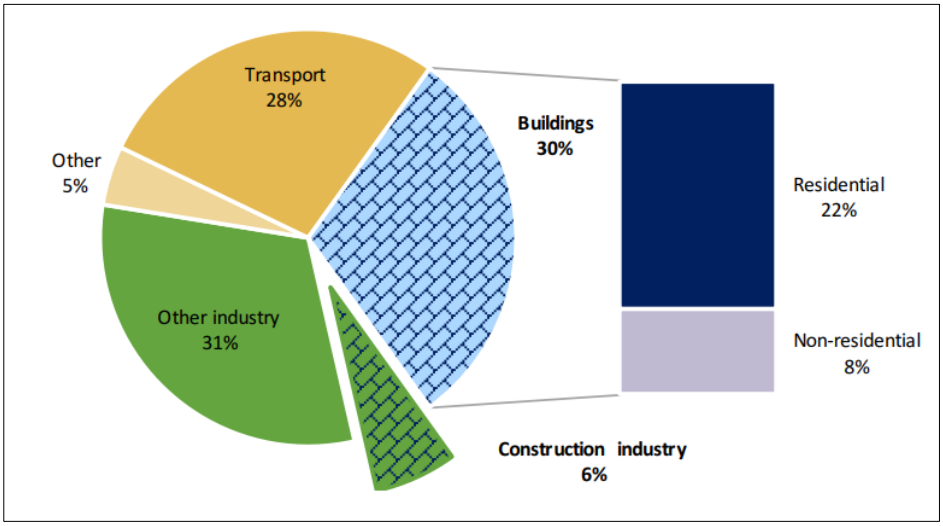


Figure 12: Share of global energy-related CO2 emissions by sector, 2015 (Global Status Report, 2017)

For these reasons, green building certificates have emerged. BREEAM (Building Research Establishment Environmental Assessment Method), which emerged in England in 1990, LEED (Leadership in Energy and Environmental Design), which

emerged in the United States in 1998, and DGNB (Deutsche Gesellschaft fur Nachhaltiges Bauen), which emerged in Germany in 2009 are some of internationally recognized green building certificates. Below is a brief overview of these green building certification models.

3.2.2 BREEAM (UK)

Building Research Establishment Environmental Assessment Method (BREEAM) is one of the world's leading green building rating systems for infrastructure and buildings. It sets out requirements for a range of life cycle stages for new construction, renovation, and existing buildings. The first version was released in 1990 to evaluate new office buildings. This was followed by versions for other buildings, including super markets, industrial units, and existing buildings (Lowe & Watts, 2011).

Some general criteria set by the BREEAM certification system for sustainable design are presented in figure 13.

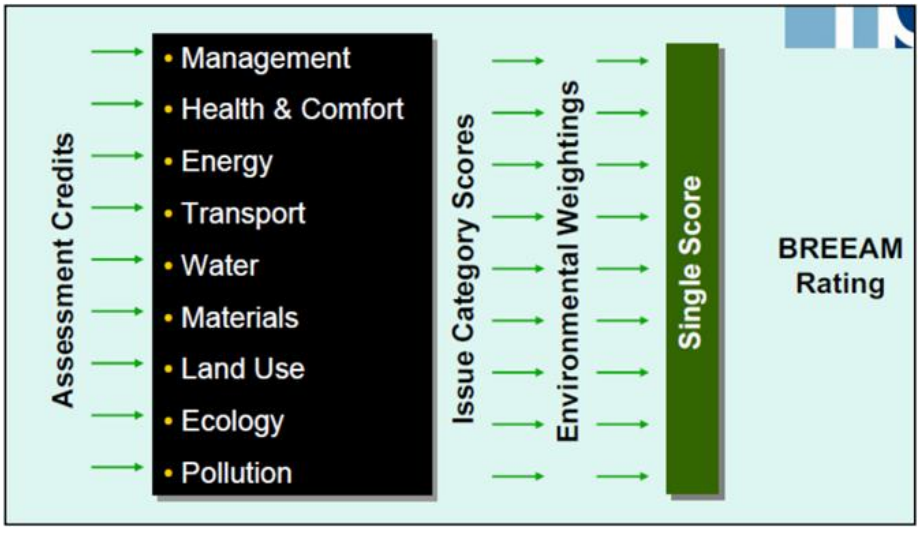


Figure 13: BREEAM, sustainability categories for evaluation (Lowe & Watts, 2011).

The BREEAM certification system aims to prevent the increasing pollution and the rapid depletion of natural resources, especially in cities, and to raise the awareness of

the user. Today, many building materials and furniture companies produce in a way that meets the requirements of these certificates. It is applied according to a certain point system, primarily based on energy efficiency. Figure 14 shows eight factors and score weights that affect the certification score of the BREEAM certification system in the building refurbishment process. Energy use and health are the two indicators with the highest scores. In this scoring process, designs that collect at least 30 points reach the lowest score, "Pass."

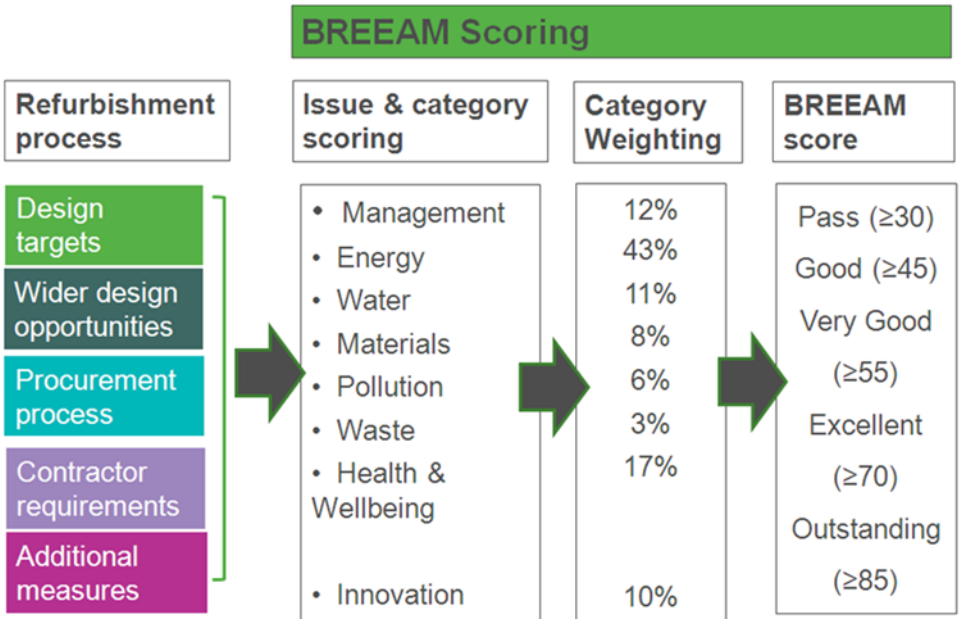


Figure 14: BREEAM refurbishment process scoring methodology (URL 2).

Recent studies reveal that BREEAM has achieved 4.5 million tons of CO2 emission gains since its first implementation in 1990, which is equivalent to the total emission of 40,000 homes in the United Kingdom (ÇEDBİK, 2017).

3.2.3 LEED (USA)

Leadership in Energy and Environmental Design (LEED) is a worldwide green building certification program. It is a set of criteria developed by the Green Building Council (USGBC) in the USA. The development of LEED began in 1993 under the

leadership of Robert K. Watson, senior scientist at the Natural Resources Defense Council (NRDC). Until 2007, Watson was the founding chair of the LEED Steering Committee. It led a broad-based consensus process that brought together nonprofits, government agencies, architects, engineers, developers, builders, product manufacturers, and other industry leaders (Çelik, 2009).

Different LEED certification systems have been developed for different projects:

- LEED-NC: New construction and renovation
- LEED-EB: Existing Buildings
- LEED-CI: Commercial Interiors
- LEED-CS: Core-and-shell projects
- LEED-H: Houses
- LEED-ND: Neighborhood Development (Çelik, 2009).

The scoring of this system is made in 8 categories, and the categories for each LEED version create a different score effect. Figure 15 shows this scoring system.

Green Building Design and Construction LEED v4	New Construction and Major Renovation (NC)	Schools (SCHOOLS)	Core and Shell (CS)	
Location and Transportation (LT)	16	15	20	
Sustainable Sites (SS)	10	12	11	
Water Efficiency (WE)	11	12	11	100 Base Points
Energy & Atmosphere (EA)	33	31	33	
Materials & Resources (MR)	13	13	14	
Indoor Environmental Quality (EQ)	16	16	10	
Innovation (IN)	6	6	6	10 Bonus Points
Regional Priority (RP)	4	4	4	

Figure 15: LEED certification leaderboard example (URL 3).

Buildings can be certified in four different areas:

- Certified: 40 - 49 points
- Silver: 50 to 59 points
- Gold: 60 - 79 points
- Platinum: 80+ points

Figure 16: Degrees of LEED certification (URL 4).

3.2.4 DGNB (Germany)

DGNB (Deutsche Gesellschaft fur Nachhaltiges Bauen) certificate is a system established to be used in the planning and evaluation of buildings. As a classification system, it includes all relevant, sustainable building issues. Projects that meet the requirements are classified in bronze, silver, and gold categories. The German Sustainable Building Certificate is a system created in partnership with the German Green Building Council and the United Ministry of Transport, Construction and Urban Relations to build planning and evaluation, with a perspective that attaches importance to quality (ÇEDBİK, 2017).

The German Sustainable Building Certificate, which has an arranged and understandable structure, includes all relevant, sustainable building issues. The six items that affect the evaluation are stated as follows:

- Ecology

- Economy
- Social Cultural and Operational issues
- Technical issues
- Land Settlement and Processes (ÇEDBİK, 2017).

	DGNB Platinum	DGNB Gold	DGNB Silver	DGNB Bronze*
Total performance index	80% and higher	65% and higher	50% and higher	35% and higher
Minimum performance index	65%	50%	35%	-- %

* This award only applies to certification of existing buildings/the Buildings in Use certificate.

Figure 17: Degrees of DGNB certification (URL 5).

The certificate must be made by notifying the needs at the very beginning of the project creation phase. Thus, sustainable buildings can be designed with today's technology and certify their quality with this new certificate. Certificates for product design have been developed based on certificates created for the sustainability of buildings, and those commonly used for product design are discussed in the next section.

3.3 Environmental Labeling

Product labeling programs are used to achieve sustainable production and consumption. These programs, which inform consumers about the environmental effects of products and are explained with specific standards, are referred to as environmental labeling (Dendler, 2014). The standards used in these labels can be developed by national governments, non-governmental organizations, and international organizations (e.g., ISO, European Union, United Nations). While

designers do not have to comply with these standards, designers can apply standards voluntarily.

According to ISO (14020: 2000), environmental labeling can take place as an expression, symbol, or graphic on the packaging of the product, in advertisements, in telemarketing, in digital media and are discussed in three groups (ISO, 2000).

3.3.1 Environmental Labels and Declarations Type I (ISO 14024:2018)

The green label certification systems are shown in Tables 4, and 5 constitute Type I and Type II ecological labels. Governments established type I organizations in Table 4. Type I labels adopt the principles and procedures of the ISO 14024 declaration as assessment standards. Type II foundation shown in Table 5 are voluntary labels with standards developed by independent third parties that deal with multiple environmental aspects. Type II labels can often be administered by private organizations and national, regional, or international (ISO, 2018).

Table 4: Green Label Certification ISO 14024 Type I Eco-Labels Government Foundations (URL 6).

No.	MyHIJAU Mark Category	Certification/ Labelling Scheme	Logo	Standard Compliance	Certification Body	Country
1	**Green Label Certification (ISO 14024 Type I Eco-labels)**	SIRIM Eco Labelling Scheme		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	SIRIM QAS International Sdn. Bhd.	Malaysia
2	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Singapore Green Label Scheme		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Singapore Environmental Council	Singapore
3	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Thai Green Label		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Thailand Environment Institute	Thailand
4	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Green Choice Philippines		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Philippines Centre for Environmental Protection and Sustainable Development	Philippines
5	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Indonesian Ecolabel		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Ministry of Environment	Indonesia
6	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Vietnam Green Label		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Ministry of Natural Resources and Environment	Vietnam
7	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Korean Ecolabel		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Korea Eco-Products Institute	Korea
8	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Eco Mark Program		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Japan Environment Association	Japan
9	**Green Label Certification (ISO 14024 Type I Eco-labels)**	China Environment Labelling		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	China Environmental United Certification Center	China (CEC)
10	**Green Label Certification (ISO 14024 Type I Eco-labels)**	China Environmentally Friendly Certification		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	China Quality Certification Centre	China (CQC)
11	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Green Mark Program		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Environment and Development Foundation	Chinese Taipei
12	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Hong Kong Green Label Scheme		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Green Council	Hong Kong (GC)
13	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Hong Kong Eco-Labelling		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Hong Kong Federation of Environmental Protection	Hong Kong (HKFEP)
14	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Indian Ecomark Scheme		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Ministry of Environment and Forests	India
15	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Environmental Choice Australia		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Good Environmental Choice Australia	Australia
16	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Environmental Choice New Zealand		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	The New Zealand Ecolabelling Trust	New Zealand
17	**Green Label Certification (ISO 14024 Type I Eco-labels)**	Vitality Leaf		ISO 14024 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures	Ecological Union	Russia

Table 5: Green Label Certification Type II Eco-Labels Private Foundations (URL 6).

No.	MyHIJAU Mark Category	Certification/ Labelling Scheme	Logo	Standard Compliance	Certification Body	Country
1	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Energy Efficiency Rating & Labelling Scheme		1. Domestic Fan 2. Television 3. Refrigerator 4. Air Conditioning	Suruhanjaya Tenaga	Malaysia
2	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Energy Star Program		1. Appliances 2. Building Products 3. Commercial Food Service Equipment 4. Electronics 5. Heating & Cooling 6. Lighting 7. Office Equipment 8. Water Heaters	U.S. Environmental Protection Agency	United States
3	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Energy Efficiency Program		1. Dishwashers 2. Washers and Dryers 3. Hot Water Systems 4. Fridges and Freezers 5. Lighting 6. Heating 7. Air Conditioning	International Energy Agency	Australia
4	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	**High Efficiency Appliances Certification Program**		1. Lighting Installation 2. Electric Power Equipment 3. Boilers and Air Heating & Cooling Facilities 4. Insulation Facilities	Korea Energy Agency	Korea
5	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	**China Certificate for Energy Conservation Scheme**		1. Home Appliances 2. Lighting Products 3. Industry Products 4. Standby Power Products 5. Building Materials	China Standard Certification Centre (CSC)	China
6	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Water Efficient Product Labelling Scheme		1. Water Taps and Mixers 2. Water Closet 3. Urinal Equipment 4. Shower Head 5. Washing Machine	Suruhanjaya Perkhidmatan Air Negara	Malaysia
7	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Water Efficiency Labelling Scheme		1. Shower Taps and Mixers 2. Basin Taps and Mixers 3. Sink/Bib Taps and Mixers 4. Dual-Flushing Cisterns 5. Urinal Flush Valves and Waterless Urinals 6. Clothes Washing Machines	Singapore's National Water Agency	Singapore
8	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Malaysian Timber Certification Scheme		PEFC ST 2002:2013 Chain of Custody of Forest Based Products	Malaysian Timber Certification Council	Malaysia
9	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Programme for the Endorsement of Forest Certification (PEFC) - Chain of Custody		PEFC ST 2002:2013 Chain of Custody of Forest Based Products	PEFC International	Global
10	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Forest Stewardship Council (FSC) - Chain of Custody		FSC STD-40-004 Chain of Custody Certification V3-0	FSC International	Global
11	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Malaysia Palm Oil Certification Scheme		MS 2530:2013 Malaysian Sustainable Palm Oil	Malaysian Palm Oil Board	Malaysia
12	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	Global Recycle Standard		1. Textile Products 2. Packaging 3. Eco-compatible Building Materials 4. Furniture 5. Publications	Istituto Certificazione Etica E Ambientale	Italy
13	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	GREENGUARD Certification Program		Low Emission Products	UL Environment	Netherland
14	**Green Label Certification (Other Type I-like Voluntary Sustainable Scheme; VSS)**	OEKO-TEX Standard 100		Textile Products	OEKO-TEX	Switzerland

3.3.2 Environmental Labels and Declarations Type II (ISO 14021:2016)

It is not legally possible for businesses and designers to deliver their products to various parties such as manufacturers, importers, distributors, and retailers under the green label without being verified by independent third parties. It explains the conditions related to recyclable, recycled content used in type II labels, reusable, reduced resource use, waste reduction. It is crucial to ensure reliability in declaration-based labels, and descriptions must be clear, transparent and scientifically documented (ISO, 2016).

3.3.3 Environmental Labels and Declarations Type III (ISO 14025:2006)

By providing quantitative data on the environmental impact of the product in its life cycle, it can enable comparison between products that perform the same function. It is specially designed for inter-business use, has certain execution principles, and is based on voluntary participation (ISO, 2016). Table 6 shows the green labels created based on type III environmental label.

Table 6: Green Label Certification, ISO 14025 Type III Eco-labels (URL 6).

No.	MyHIJAU Mark Category	Certification/ Labelling Scheme	Logo	Standard Compliance	Certification Body	Country
1	**Green Label Certification (ISO 14025 Type III Eco-labels)**	SIRIM Product Carbon Footprint Certification Scheme		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	SIRIM Berhad	Malaysia
2	**Green Label Certification (ISO 14025 Type III Eco-labels)**	Thailand's Carbon Footprint Reduction Label		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	Thailand Greenhouse Gas Management Organisation	Thailand
3	**Green Label Certification (ISO 14025 Type III Eco-labels)**	Korea Carbon Footprint Labelling		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	Korea Environmental Industry & Technology Institute	Korea
4	**Green Label Certification (ISO 14025 Type III Eco-labels)**	Japan Carbon Footprint Labelling Scheme		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	Ministry of Economy, Trade and Industry	Japan
5	**Green Label Certification (ISO 14025 Type III Eco-labels)**	Taiwan Product Carbon Footprint Reducing Labelling Scheme		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	Taiwan Environmental Protection Administration	Taiwan
6	**Green Label Certification (ISO 14025 Type III Eco-labels)**	Ecogloballabel NSO-NAP 3 Standard		ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures	Integrated Business Institute (NSO)	Global

In this type of environmental label, the program manager can be a business, trade associations, public institutions, or an independent scientific organization. These programs and statements are based on the life cycle assessment addressed by the ISO 14040 series of standards approved by an independent party (ISO, 2006).

With the use of ISO 14000 standards series in product design, evaluation criteria such as Life Cycle Assessment (LCA), was formed. The next section discusses the LCA evaluation criteria.

3.4 Life Cycle Assessment (LCA)

Life cycle assessment; It is an evaluation method that provides information including resource efficiency and waste generation, in which the environmental impacts of a product are calculated throughout its entire life cycle, from the acquisition of its raw materials to processing, production, use, end of life and disposal. Today, it is no longer enough to take a single step in production, so in the modern era, a system perspective is needed rather than a single product perspective. Indeed, industrial activities are a complex network of activities involving many different parts of society. The Life Cycle Assessment methodology has been developed to address this inclusive approach (Andersson, Simonson, Rosell, Blomqvist, & Stripple, 2003).

As William Mcdonough points out; Products whose life cycle cannot be calculated will produce solid waste. If the solid waste production of the product increases, it becomes non-recyclable. Because while trying to recycle the product, more energy is spent during recycling, and more damage is done to nature (Mcdonough and Braungart, 2010). The LCA's “cradle-to-grave” accounting concept is illustrated in Figure 18.

The widely accepted procedures for conducting LCAs are contained in the International Organization for Standardization (ISO) 14000 series environmental management standards, in particular ISO 14040 and ISO 14044 (Nieuwlaar, 2013).

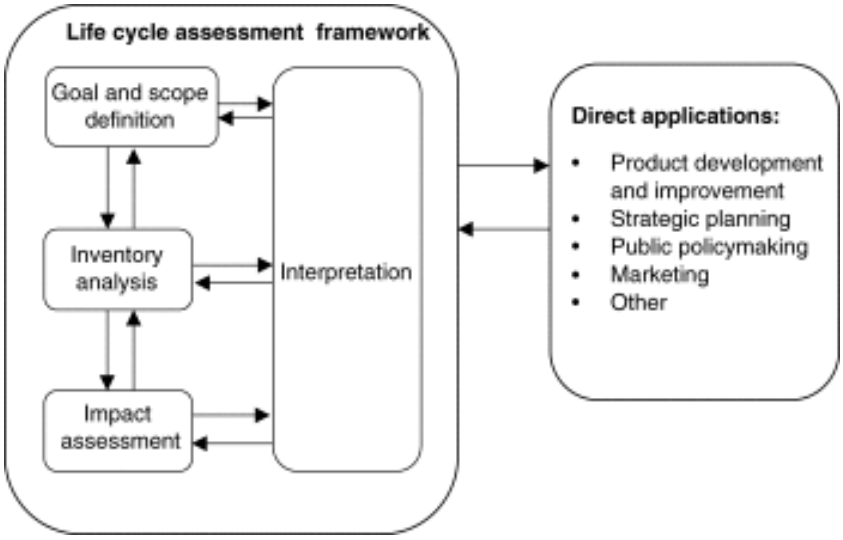


Figure 18: Illustration of the general stages of a life cycle assessment as described in ISO 14040 (Nieuwlaar, 2013).

The LCA process is a systematic, phased approach and consists of four components, and this framework, which is based on the ISO 14040 standards shown in figure 18, is described in detail in table 7.

Table 7: Four Components of Life Cycle Analysis (Brusseau, Pepper, & Gerba, 2019).

Component	**Related Criteria**
1.Goal and scope definition	Describe the product, process, or activity. Determine the context in which the assessment will be made and determine the boundaries and environmental impacts to be examined for the assessment.
2.Inventory analysis	Identify and measure energy, water, and material use and environmental emissions (e.g., air emissions, solid waste disposal).
3.Impact Assessment	Evaluate the potential human and ecological impacts and environmental emissions of energy, water, and material use identified in the inventory analysis.
4. Interpretation	Evaluate the results of inventory analysis and impact assessment to choose the preferred product, process, or service, with a clear understanding of the uncertainty and assumptions used to generate the results.

The LCA concept is a circular approach to create a sustainable design that all steps interact with each other from production to the waste process. Based on this approach, a design strategy like in Figure 19 has been developed for a sustainable product design.

Figure 19: Components of life cycle analysis (Brusseau et al., 2019).

Based on the design strategies in Figure 19, a sustainable product design can be created throughout the life cycle, and the evaluation criteria in Table 8 are introduced to design a sustainable product in this life cycle design. Life cycle assessment design is referred to by many different names. There are design models with philosophies close to the life cycle design logic, such as eco-design, ‘‘Cradle to Cradle’’ design. These design conceptions constitute the conceptual structure of green furniture certification systems and sustainable furniture criteria and, therefore, are briefly mentioned below.

Table 8: Sustainable Product Design throughout the Product Life Cycle (Nieuwlaar, 2013)

Life Cycle	Content
Resources	- Reducing the number and amount of materials used. - Nature of the raw material. - Reduction or elimination of non-renewable use. - Replacement with less harmful or harmless raw materials. - Enabling recovery, reuse, recycling. - Extraction and processing of raw material. - Transport from the supplier.
Material Processing and Product Manufacturing	- Optimization of production technology - Reduction or elimination of emissions. - Not using dangerous materials. - Reduction or destruction of waste materials. - Reducing energy use.
Distribution	- Is transport required? - The volume and nature of transport. - The type of fuel used for transport. - Reduction or elimination of emissions. - Energy spent on transportation. - Reduction of disposal of waste.
Use	- Reduction or elimination of waste from the product. - Reduction or elimination of waste from use. - Reduction or elimination of waste from wrapping. - Using environmentally friendly packaging.
End of Life	- Extending product life span - Repairable design. - Flexible and modular design for product upgrades. - Product recovery for component reuse. - Dismountable. - Product recovery for recycling and disposal.

3.5 Cradle to Cradle (C2C)

The Cradle to Cradle(C2C) design was introduced as an ideology by William McDonough and Michael Braungart. It is the design of all the stages that a product will go through from the moment it is produced until it becomes a raw material. Cradle to Cradle is a revised version of the Cradle to the grave system, which was previously tried to be implemented with the eco-label project but was not considered sufficient for sustainable furniture production. Products produced from the Cradle to the grave examine a product from raw material to becoming waste in post-use disposal.

However, this situation means that the raw material enters the decay process and is lost. In cradle-to-cradle design, the aim is to make the components of a product whose life is over in a way that can be the raw material of another product (McDonough & Braungart, 2010).

According to Bjørn and Hauschild (2013), C2C's approach to sustainability is "maximizing the benefit to ecological systems" rather than the eco-efficiency approach to reducing damage, as shown in figure 20. The concept states are based on three basic principles: waste equals food, using available solar energy, and celebrate diversity (Bjørn & Hauschild, 2013). The Waste Equals Food principal advocates for the complete elimination of waste, inspired by the nutrient cycle in nature. The focus is on designing systems with emissions that can be used by other processes when it comes to disposal, instead of reducing the amount of waste as it advocates eco-efficiency for the emissions in the production and use phases of a product.

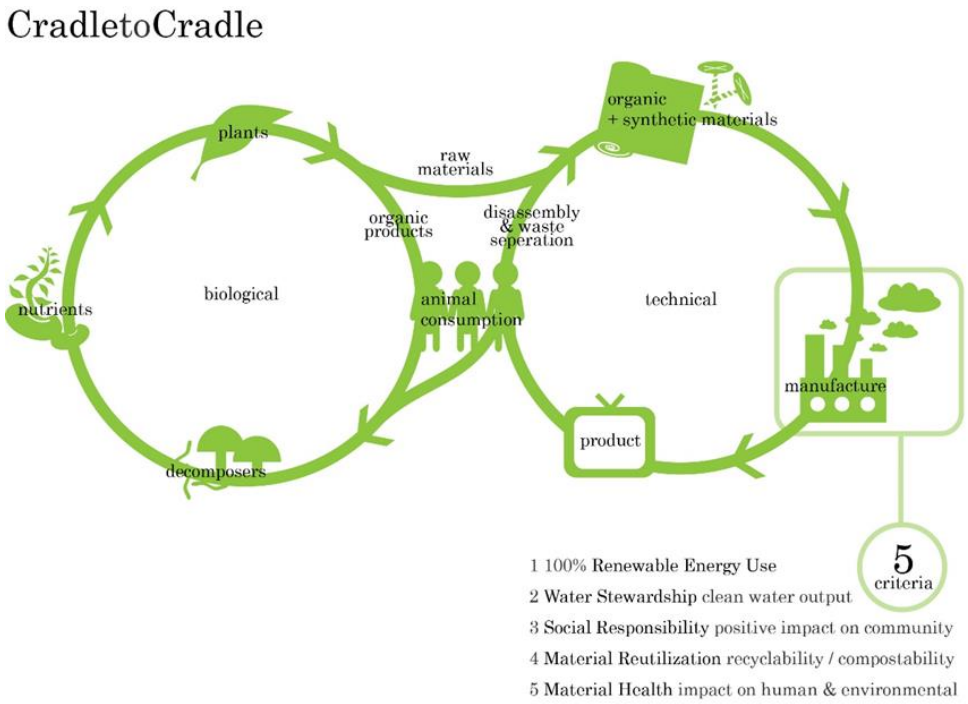


Figure 20: Biological and Technical Nutrients in the Cradle to Cradle Design Framework (Bjørn & Hauschild, 2013).

The second basic principle of using energy is to provide the energy used throughout the life of a C2C product from renewable energy sources (such as wind, hydro, and solar). Finally, the focus of the Celebrate Diversity principle is to avoid a one-size-fits-all solution. Products and systems should be designed locally according to the culture, environment, and economy. The person is expected to be indigenous and fulfill its role as a species among other species (Bjørn & Hauschild, 2013).

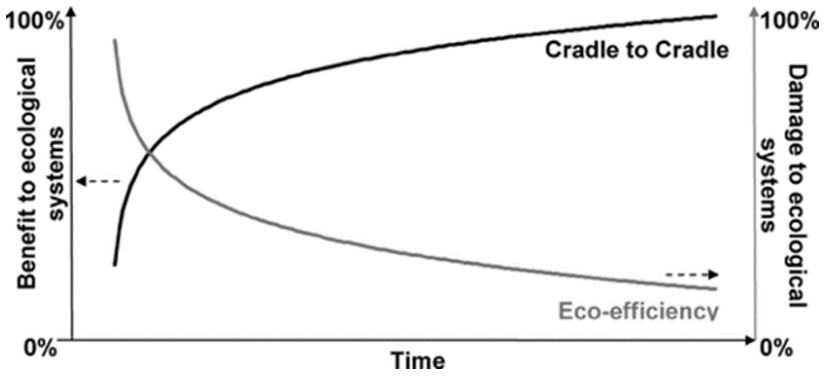


Figure 21: The eco-efficiency and cradle-to-cradle (C2C) concepts (Bjørn & Hauschild, 2013).

Founded by Michael Braungart in Germany in 1987, the Environmental Protection Encouragement Agency (EPEA) is an international research and consulting institute working to apply the cradle-to-cradle methodology in the design of new processes, products, and services around the world. According to the design concept from Cradle to Cradle, applications continue to be carried out in all areas, from composting T-shirts that enter the biological cycle to office chairs that enter the technical cycle, from carpets that clean the air to sports shoes and architectural structures. The “right of use” is sold to the consumer, not the property of the products produced according to the Cradle to Cradle concept. While the consumer is still buying the product, a contract is made that he will return the product (to be recycled) at the end. In this way, it is

guaranteed that the materials go into continuous cycles (McDonough & Braungart, 2010).

3.6 Eco Design

Eco-design generally means reducing environmental problems, minimizing, if possible, and obtaining energy from the environment through the consumption of energy resources, construction, and recycling processes. In eco-design, to be included in life by observing the movements of nature, the design must be created together with nature itself and its trends. Consequently, the goal in eco-design; is the harmonious and flawless bio integration of the built environment with the natural environment. This goal should be the basic principle of built environmental design (Gürbüz & Arıdağ 2013).

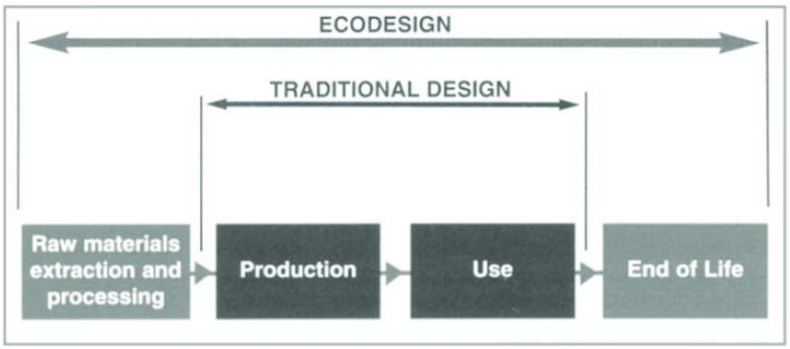


Figure 22: Eco-design Scope (Knight, & Jenkins, 2009, p.550)

According to Ken Yeang, there are three basic ethical principles in eco-design (Yeang, 2012, p.96):

- Taking responsibility for the welfare of future generations.
- Using energy resources efficiently and not pushing the limits of the earth's carrying capacity.
- To give every living creature the right to life, including humans.

Ken Yeang often expresses his admiration for nature when talking about eco-design. Echo mimic (bio-mimic) is a method that is particularly recommended in terms of form and system (Yeang, 2012). Since a perfect harmony with nature is mentioned, it is thought that by taking as an example from nature the design will work as a whole with nature. For example, unlimited energy could be obtained by looking at a plant that makes photosynthesis, and solar energy was used in this way. It is accepted that sustainable furniture design will develop if eco-imitation is included in our designs.

According to Ken Yeang, there are several product design processes, such as transportation, storage, recycling from production to use and after use. Eco-design should also make the designer think about how the product will end and rejoin the eco-system after it is filled. Products that are not considered reintegrated after use will most likely take their place in solid waste fields and become unusable (Yeang, 2012).

As Ken Yeang (2012) points out, the key difference between building design and product design is to consider incorporating it into ecology when product design ceases to be used. Based on this discourse, it is obvious that designers are responsible for the environmental and social aspects of product design.

3.7 Recycling

Almost every life form starting from the primary cell is interconnected. It reacts to its environment, communicates, thrives in diversity, and mixes with nature without producing solid waste.

There is no such thing as "waste" in natural systems, as everything is assimilated and reintegrated into the system. In the natural environment, every waste is food. Today's society and built environment are exceptional in this respect. Designers should solve

how to create the built environment with a zero-waste policy by taking ecosystems' functioning as an example.

There is no such thing as a pollutant in natural systems. Toxins are not stored and transported in bulk at the system level and are synthesized and used by individual species when necessary. Despite the nature that acts as a constant solvent, 85% of human products in the built environment quickly become waste in the production process. This high rate must be reduced and eventually reduced to zero. Due to the right to life mentioned in human rights, today's generation owes this to future generations (Yeang, 2012).

It is necessary to abandon products that require large-scale recycling by consuming too much energy. It is necessary to turn to designs that are long-lasting and where quality is more important than quantity. The wastes left in nature should be reunited with microorganisms in time. However, some materials take a long time to recycle and cause pollution. Among these are materials such as glass, plastic, and aluminum. While organic compounds dissolve rapidly in nature and form raw materials for a new product, inorganic compounds that have made stronger bonds and become larger molecules have a long decomposition life (Yeang, 2012).

For this reason, it is necessary to follow a conscious method to realize material recycling quickly. After these physical and chemical effects, new wastes emerge, the waters are polluted, and unnecessary energy consumption is experienced. Suppose precautions are taken and implemented at the beginning of the design. In that case, it is possible to minimize the loss of raw materials by using less energy during the recycling of the product after use.

Today, many raw materials are recovered. Some of them are used mainly in furniture design:

- Paper, cardboard
- Glass
- Metals
- Plastic
- Rubber, leather
- Textile
- Wooden

Examining the concept of sustainable product design and certification systems, this chapter focuses on the development of criteria that should be considered in the sustainable design process. This section aims to explain the basis of the green product certification systems and the scope of ISO standards in product design. At the end of this section, the cornerstone of sustainable design, Life Cycle Assessment, the functioning of cradle-to-cradle and eco-design concepts, and correct sustainability methods are examined. In the findings, it has been revealed that criteria such as energy consumption, recycling, transportation, and raw materials are essential to creating a sustainable design, and principles such as social equality and employee rights are taken into account. In addition, the recycling logic is briefly mentioned at the end of the section. In the next section, the researcher discusses sustainable furniture design and certification systems. In the continuation of the section, the designer's role in sustainable design and social sustainability approaches are discussed.

Chapter 4

SUSTAINABLE FURNITURE DESIGN

This part of this thesis discusses the sustainability criteria required in sustainable furniture design by examining green furniture certification systems. The following sections of the discussion investigate which methods are used to evaluate sustainable furniture design and which methods can be easier to use and follow for designers. Afterward, the designer's role in sustainable design is discussed with the different concepts. Also, the importance of the concept of social sustainability in furniture design is examined.

4.1 Sustainable Furniture Certification Systems

Sustainable furniture criteria regulated by independent organizations are generally prepared based on ISO 14000 family standards. In addition, using sustainable furniture, which has a green label certificate, in interior designs has the effect of gaining extra points in green building certifications such as LEED and BREAM. The certifications guide interior architects and designers working on furniture design. Thanks to the global orientation and the interest in the certificates created in line with the era requirements, ecological pollution acceleration can be prevented, albeit a little.

4.1.1 FSC-Forest Stewardship Council

FSC is a stakeholder system that aims to encourage the most accurate management of all forests globally, help the forestry be carried out with sustainable forest management principles, protect and maintain forests, and spread these practices internationally (FSC, 2015).

Forest management considering environmental conditions; aims to obtain timber and non-timber forest products without harming the forest's biological diversity, productivity, and ecological processes. Socially beneficial forest management; aims to establish systems where local people and society will benefit from forest and forest products in the long term but participate in long-term management plans that support these resources' sustainable use. Economically beneficial forest management aims to change all kinds of interventions against forests with a profit-oriented aim to those acts that do not disturb the balance of the ecosystem and society. As shown in Table 9, the FSC has fundamental principles such as workers' rights, community relations, high conservation values, and environmental values and impacts (FSC, 2015).

Table 9: The FSC Principles and Criteria (FSC, 2015).

Principle 1: Compliance with Laws
Principle 2: Workers Rights and Employment Conditions
Principle 3: Indigenous Peoples' Rights
Principle 4: Community Relations
Principle 5: Benefits from the Forest
Principle 6: Environmental Values and Impacts
Principle 7: Management Planning
Principle 8: Monitoring and Assessment
Principle 9: High Conservation Values
Principle 10: Implementation of Management Activities

4.1.2 GreenGuard Certification

GREENGUARD Certification helps manufacturers create indoor products and materials with low chemical emissions to indoor air during product use. All certified products meet strict emission standards according to established chemical exposure criteria. Products that earn the GREENGUARD Certification are scientifically proven to meet some of the world's strictest third-party chemical emission standards and help reduce indoor air pollution and the potential health risks of exposure to chemicals.

GREENGUARD Certification, taken over in 2011, is now provided by UL Environment (Underwriters Laboratories), a division of UL (Underwriters Laboratories) (GREENGUARD Certification, 2020).

4.1.3 LEVEL Certification

Developed by The Business and Institutional Furniture Manufacturer's Association (BIFMA), Level is one of the rare certificates, especially for furniture production. It is the most comprehensive standard created to evaluate furniture products' environmental and social impacts and provide the most open and transparent tools. LEED V4 requirements are also met with the BIFMA Level certification, which is the certificate of compliance with the most comprehensive sustainability standard in the furniture industry. The LEVEL program has three performance levels; LEVEL 1, 2, and 3. The higher the number, the more criteria will be considered and met (Level, 2015).

- level 1 = 32-44 points
- level 2 = 45-62 points
- level 3 = 63-100 points.

Level certificate within the scope of Furniture Sustainability Standard evaluates products in 4 different categories:

- Materials
- Energy and Atmosphere
- Human and Ecosystem Health
- Social Responsibility

Table 10: BIFMA level Scorecard for Materials (Level, 2015).

BIFMA level® Scorecard-MATERIALS		
Elements	**Category**	**Points Available**
5.1	Life Cycle Assessment	3
5.2	Climate Neutral Materials	1
5.3	Efficient Use of Materials	2
5.4	Bio-based Non-wood Renewable Materials	2
5.5	Bio-based Renewable Materials - Sustainable Wood	2
5.6	Recycled Content	3
5.7	Recyclable and Biodegradable Materials incorporated into the product	1
5.8	Extended Product Responsibility (Durability/Upgradeability, Remanufacturing, Recycling)	6
5.9	Solid Waste Management	2
5.10	Water Management	4

Table 11: BIFMA level Scorecard for Energy (Level, 2015).

BIFMA level® Scorecard-ENERGY		
Elements	**Category**	**Points Available**
6.1	Energy Boundary	2
6.2	Energy Inventory	4
6.3	Energy Reduction	3
6.4	Energy Management	1
6.5	Lighting Products	1
6.6	Product Energy Allocation	1
6.7	Transportation	2
6.8	On-Site & Off-Site Renewable Energy	4

6.9	Greenhouse Gases	5
6.10	Greenhouse Gases Reduction	3
6.11	Greenhouse Gas Reporting	2
6.12	Greenhouse Gas Allocation	1

Table 12: BIFMA Level Scorecard For Human And Ecosystem Health (Level, 2015).

BIFMA level® Scorecard-HUMAN AND ECOSYSTEM HEALTH		
Elements	**Category**	**Points Available**
7.1	Demonstration of Compliance with Human Ergonomics	
7.2	Key Chemical, Risk, & EMS Policies	
7.3	Systems & Strategies	4
7.4	Maintenance & Operations Chemicals	2
7.5	Process Chemicals	5
7.6	Product Level Chemicals	12
7.7	Low Emitting Furniture	3
7.8	Reduction of Hazardous Wastes and Air Emissions	4

Table 13: BIFMA Level Scorecard For Social Responsibility (Level, 2015).

BIFMA level® Scorecard- SOCIAL RESPONSIBILITY		
Elements	**Category**	**Points Available**
8.1	Employee Health & Safety Management	
8.2	Labor and Human Rights	
8.3	Policy on Social Responsibility	1
8.4	Safety Performance	2
8.5	Inclusiveness	1

8.6	Community Outreach & Involvement	1
8.7	Social Responsibility Reporting	3
8.8	Local Persistence Supply Chain	4
8.9	Excellence in Social Responsibility	3

With the Level certificate, designers attach importance to social sustainability and being sensitive to the environment in furniture design. Although the "Level" certification system is an essential resource for designers in sustainable furniture design, it is difficult to use with its complex scoring system and high costs for the initial design stage. Using a simplified checklist at the beginning of the design can encourage designers for sustainability.

Figure 23: ‘Adaptabilities,’ furniture group with Level 3 certification (Level 2015).

The design named 'Adaptabilities' have a Level 3 certification degree (Figure 23), owned by Global Furniture Group, it provides the ultimate adaptability, flexibility, and modularity. It features a wide variety of versatile components that can be configured to multi-user workstations suitable for intensive task functions or specialized executive suites that require elegance and labor functions. Besides, its desk and storage units are

made of sustainable wood. In this way, it has managed to be both functional and environmentally friendly.

4.1.4 EPD (Environmental Product Declarations)

EPD defines the environmental performance of a product or service defined by ISO 14025 (Type III), according to predetermined categories, raw material recovery, energy use, and efficiency, material and chemical content. It is a certification system that quantitatively expresses waste products such as emissions into the air, water, and soil and presents the results in reports. (Fet, Skaar, & Michelsen, 2009).

A key requirement in Type III EPD is to conduct an LCA (Life Cycle Assessment) of the product following the ISO 14040 series of standards (ISO 14040; ISO 2006b, ISO 14044; ISO 2006c) and obtain third-party validation LCA. A central term in EPDs is the product category, a defined group of products that perform the same function. Product category rules (PCR) define criteria for a particular product category and specify the requirements met when preparing an EPD for products under that category. PCR aims to set and define rules for the EPD creation process to allow a comparison between products. Therefore, PCR should define the products' functional and performance characteristics, define the criteria for the LCA study of the products belonging to the category, and specify the information to be reported in the EPD. It has a commercial purpose and considers the ecological footprint of economic activities and the various emission results that occur during the production process within the scope of the Life Cycle Assessment (LCA). EPD is prepared independently with the manufacturer's data consisting of the product's technical description, the manufacturer's company details, and LCA results (Fet et al., 2009).

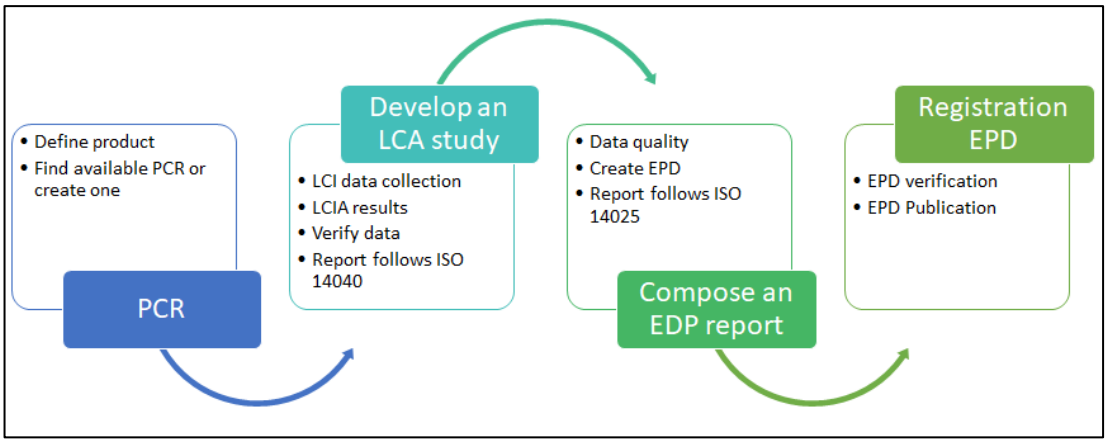


Figure 24: Framework for creating the EPD certificate (Dvecheve, 2019).

EPD certificate is an essential sustainable product declaration used by many companies around the world. The reasons for preferring the EPD certificate are as follows;

- EPD Certificates, which are defined within the scope of sustainability in Europe and comply with EN 15804, have been requested by the European Construction Products Regulation since 2013. In order to obtain a certificate of conformity with EU legislation (CE), sustainability and production resources are evaluated with EPD certification.
- According to their use, EPD documents can document quantitative environmental impacts such as carbon footprint, energy, and water consumption.
- Product manufacturers can also show environmental awareness as a social responsibility by declaring their impact on the environment.
- As a result of LCA studies based on EPD certification, it provides the opportunity to examine the processes in its products and the environmental impacts arising from the supply chain and develop new policies.

- It forms the basis of eco-design approaches in energy and resource efficiency (EPD Turkey, 2014).

The EPD certificate is used in various sectors in many countries worldwide, especially in Europe. For example, there are thirty-seven parts of the EPD declaration published in the furniture sector in Turkey. Twenty-nine of these documented products are used in office furniture, four in wooden products, three in the home furniture, and two in general areas (EPD Turkey, 2014).

Figure 25: Distribution of Products with EPD by Main Sectors and Furniture Sub-Sectors (EPD Turkey, 2014).

There are some main reasons why there are few such products with EPD. Some of these are shown in table 11 (Wikipedia, 2020).

Table 14: Difficulties Encountered in Creating EPD (Wikipedia, 2020).

Factor	**Content**
Wide variety of PCR	Since PCRs are not uniform for the same products, they may cause erroneous comparisons between products during the adaptation phase. They also vary according to the product's geographical scope.
Complex and inconsistent database	Due to the complexity and time-consuming data collection and evaluation processes due to the Life Cycle Assessment (LCA) system's nature, the LCA development process for EPD is prolonged.

Lack of satisfactory and acceptable third-party critical review	There is no common opinion in different aspects, and that the features that need to be examined more specifically are generally investigated cause similar EPDs to be interpreted differently.
Financial Constraints	The 'LCA' study's financial burden, which must be implemented before the EPD is published, is onerous for small-scale companies, and financial restrictions prevent the EPD publication.
Incomplete occurrence and interpretation of results	The lack of EPDs and PRCs of many products makes it challenging to evaluate previous processes in the life cycle of products transparently and compare products.

Requirements for publishing an EPD vary. For example, furniture usage time, the information about the material it contains, and the amount of waste that the materials will generate when they end their lives should be taken into account. Figure 26 shows an example of creating an EPD furniture analysis chart for a furniture model (Fet et al., 2009).

Chair I

Product category:	*Seating*
Seating maintained for 15 years	
Number of seats:	*1*
Period [year]:	*15*
Disposal scenario:	*Scenario II*
Product lifetime [year]	*15*

Product composition

Descrition	Material/ Process	Amount per part	Material specification	Number of parts	Waste [%]	Total
Frame						
Chair legs	*Steel, type I*	*1.4*	*Steel*		*1.0 %*	*1.414 kg*
Backrest	*Aluminium*	*0.6*	*Aluminium*		*1.0 %*	*0..606 kg*
Seat						
Upholstery	*Textile, wool*	*0.65*	*Textiles*		*8.0 %*	*0.702 kg*
Nails		*0.003*	*Steel*	*10*	*2.0 %*	*0.0306 kg*

Not included
Aluminium
Leather

Figure 26: EPD system furniture analysis chart example (Fet et al., 2009).

In a sustainable furniture design, the user plays a significant role as well as the designer. Each product has a certain lifespan, and it is at the user's initiative to re-enter the cycle under the LCA when the product reaches its end of life, so some environmentally friendly furniture vendors sign contracts with their users on product recycling (Fet et al., 2009).

Figure 27: Calder Seating Group (EPD Turkey, 2014).

The EPD certified 'Calder Seating Group' belonging to the furniture company 'Koleksiyon' in Figure 27 is a modular seating system developed for work areas and common areas such as hotel and hospital waiting for areas. It consists of four different pouf units and an aluminum tray. The user can create many different combinations by Calder, which allows the puff units to be connected in different ways. The modules are interconnected with unique connection parts and can be shaped according to different needs and requests. This furniture has achieved EPD certification with its modular use, natural wood with a low carbon footprint, and organic fabric material. Another essential feature of this furniture is a legal agreement between the manufacturer and the user to be returned to be reused after the end of its life in the system boundary under LCA (EPD Turkey, 2014).

4.1.5 Cradle to Cradle Product Program

The Cradle to Cradle system's certificate program, which has been discussed in detail in the previous chapters of the research, is an independent and multi-departmental

certificate program managed by the Cradle to Cradle Products Innovation Institute. It is based on the Cradle to Cradle design principles created by Michael Braungart. Institute, besides the life cycle analysis of a product, also examines the effects on human and environmental health. The program supports companies focused on technically recyclable or biologically compostable materials. Unlike other eco-labels that focus on a single feature, it deals with designing the material from cradle to cradle and the processes during its production with a holistic approach. Materials and production processes are evaluated under five factors in terms of environmental and social performance: material health, material reuse, renewable energy and carbon management, water stewardship, and social fairness (C2C Products Innovation Institute, 2020).

Figure 28: Cradle to Cradle Certificate Evaluation Categories(C2C Products Innovation Institute, 2020).

The purpose of this certificate is to ensure that an end-of-life product becomes a raw material for another product after it becomes waste. Thanks to the C2C logo, businesses understandably reveal that they are making an ecological and smart design.

The consumer can easily see that the product bearing the C2C logo has relevant ecological quality requirements. C2C certification is handled under five different achievement levels: Basic, Bronze, Silver, Gold, and Platinum. The certification process is evaluated as part of any successful protocol for continuous product improvement, and all evaluations result in a common result. The purpose of continuous improvement is not "zero" or to reduce the impact of a product on humans and the environment, but instead to ensure that the negative effect is positively transformed (C2C Products Innovation Institute, 2020).

Figure 29: 'Group Work® Tables' work surface furniture with Bronze C2C certificate (C2C Products Innovation Institute, 2020).

Shown in Figure 29, the office furniture named "Group Work® Tables," which has C2C certification receives the Golden level C2C certificate in recyclable material design thanks to the leather, nylon, and polyester material selections. Also, it has PVC-free edge bands. This furniture group, which also has a Golden level C2C certificate in social rights, was awarded the Bronze level C2C certificate in general evaluation (C2C Products Innovation Institute, 2020).

4.2 Evaluating the Applicability of Eco-Design Tools and Techniques

For the eco-design application to be successful, it is necessary to determine the evaluation tools used since architects, and interior designers need a common language with manufacturers before going through ecological tests (Pascual, Boks, & Stevels, 2003).

According to the questionnaire conducted by Knight and Jenkins (2009), they have brought together a series of eco-design assessment methods with a better understanding of eco-design tools and knowing the possible process areas in which they can be applied. Knight and Jenkins addressed eco-design tools with the following eight questions;

- Does the tool support meeting product requirements?
- Does the tool address environmental product criteria?
- Can the tool be used by designers or will outside expertise be needed?
- Does it reduce the risk of forgetting important elements?
- Does it match the way products are marketed?
- Is the tool user-friendly, easy to adopt and implement?
- Does it save time in the overall development process?
- Is it affordable? (Knight & Jenkins, 2009).

In Figure 30, eco-design tools evaluated by Knight and Jenkins are listed in order of preference by researchers. In this ranking, the assessment tools with the highest scores emerged with the personal opinions of the researchers. Instead of eco-design tools such as LCA, which are not user-friendly and based on a complex system, researchers preferred tools included in the design review and easy to follow, such as a checklist.

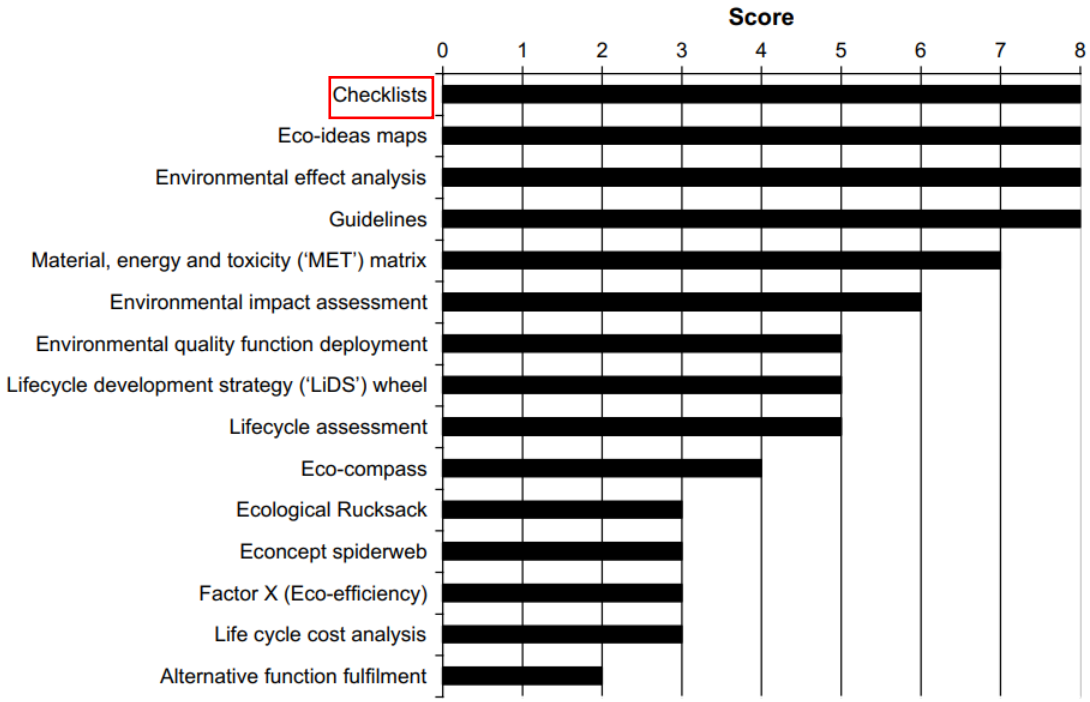


Figure 30: Analysis of determined eco-design tools (Knight & Jenkins, 2009, p.552).

Knight and Jenkins listed their eco-design tools independently of their own scoring and presented them as a yes/no questionnaire to a designer-focused group from different companies. In the survey, the designers were asked to write down three design tools they would like to choose for eco-design on the form in order. According to the survey results, a ranking was made according to the eco-design tool that received the most votes numerically. As this sequence is shown in figure 31, the checklist tool was chosen as the most preferred eco-design method (Knight & Jenkins, 2009).

Ranking	Tool
1st	Checklists
2nd	Guidelines
3rd	MET matrix
4th	Environmental effect analysis
5th	Eco-ideas maps
6th	Environmental Impact assessment
7th	House of environmental quality
8th	LiDS wheel
9th	Life cycle assessment

Figure 31: Focus group eco-design tool ranking results (Knight & Jenkins, 2009, p.553).

One of this thesis's main objectives is to create a checklist that designers can use in environmentally and socially responsible furniture designs. In Knight and Jenkins's research, eco-design evaluation methods using 'checklist' provide designers with ease of use and follow-up rather than being complex and difficult to follow like LCA. In this way, designers can evaluate eco indicators more easily in design reviews and be involved in sustainable design in the most basic design form (Knight & Jenkins, 2009). Therefore, this thesis study aims to use the 'checklist' methodology to evaluate sustainable furniture.

As exemplified in Figure 32, it has been found that it is possible to create checklists for the 'New Product Entry' process. According to researches, it has been determined that the first tool that a company or a designer starts to use when entering ecological design is the checklist. Because it is easy to understand and helps determine the disassembly and recycling potential of products for later stages in electronic data entry (Adams, 2006).

Lifecycle phase:	Considered…	Y/N, N/A	Comments / evidence of compliance / reasons for non-compliance
System Design	Simplicity		
	Source reduction		
Procurement	Avoided hazardous substances ?		
Manufacturing & Distribution	Designed for manufacture ?		
	Designed for minimum energy use?		
	Designed for pollution minimisation ?		
	Packaging: designed for re-use ?		
	Designed for waste minimisation ?		
	Designed for minimum use of hazardous substances ?		
Use	Designed for minimum energy use?		
	Designed for minimum consumables use?		
	Designed for pollution minimisation ?		
	Designed for waste minimisation ?		
	Designed for minimum use of hazardous substances ?		
	Designed for upgrade ?		
End-of-life	Designed for material recovery ?		
	Designed for component recovery ?		
	Designed for disassembly ?		
	Designed for recovery ?		
	Designed for seperability ?		
	Designed for waste recovery and re-use ?		

Figure 32: Checklist example for New Product Introduction process (Knight & Jenkins, 2009).

The long and demanding process of product approval for ecological labels causes companies to stay away from eco-labels. Besides, as shown in Figure 32, either the concept of social sustainability is not included in ecological design parameters or lacks user focus. Therefore, this thesis work is to create a checklist that includes environmental and social aspects so that it can guide designers and companies in the furniture design phase.

4.3 Designer Role and R Concept in Sustainable Design

While designers address environmental and social impacts in sustainable design, they have many vital roles, such as the use or disposal of waste at the end of the product's

life cycle, and the selection of materials with the least harm to the environment, in addition to designing products that can be used by everyone. Unfortunately, many designers have little awareness of sustainable design (Howarth & Hadfield, 2006). A designer from the industry stated that a "green product" comes from a good design perspective (Chumiran, Abidin & Sirat, 2014).

The LCA framework for sustainable furniture design, which relates to sustainable green production, shown in Figure 33, is fundamental for designers to follow the development of the process. This framework helps sustainable designers understand the conceptual flow of furniture designs. (May, Stahl, Taisch & Kiritsis, 2017; Safian et al., 2020).

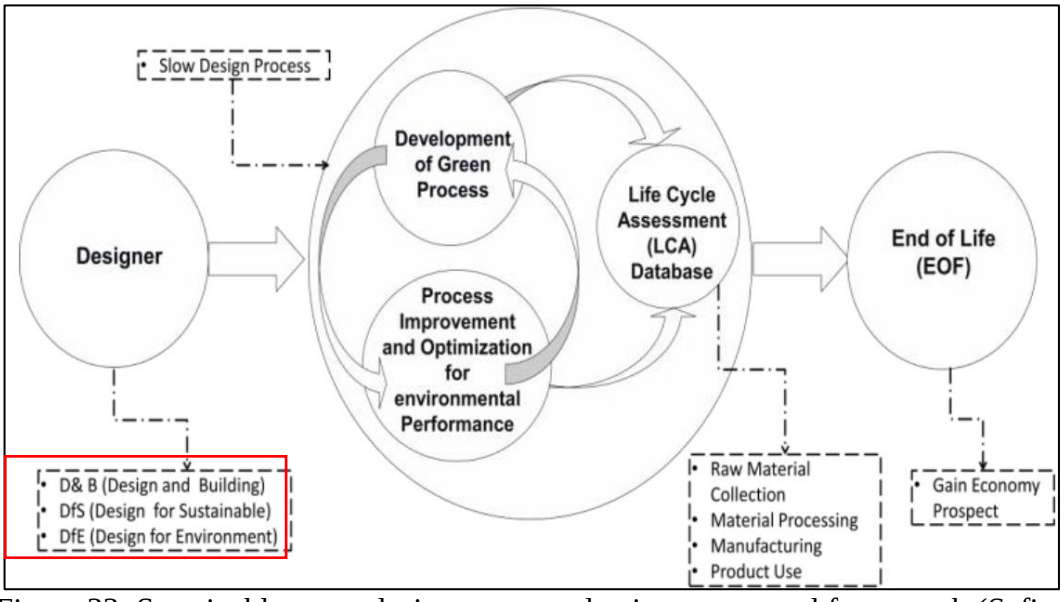


Figure 33: Sustainable green design mass production conceptual framework (Safian et al., 2020, p.94).

D&B (Design and Build) is seen as the first guide for designers to use the LCA framework. This framework helps designers learn the simple production and mass production required before moving on to sustainable design (Safian et al., 2020).

The D&B framework has been expanded by Roger (2010) under three headings: eco-center, techno-center, and socio-center. Later Humphries-Smith (2008) potentially used these three design ideas in the development of the process in the material and production stages in sustainable furniture design. As a result of these researches, the DfS (Design for Sustainable) framework has been developed for designers dealing with natural waste materials. Based on the DfS framework, the importance of using natural biocomposite materials in furniture designs has been understood, unlike the old designs of the designers (Safian et al., 2020).

Designers use the DfE (Design for Environment) framework to benefit from natural waste material for future designs through efficiency and provide optimum benefit to the environment in the design process (Rosen & Kishawy, 2012; Safian et al., 2020). As the DfE framework's goals reach more and more global dimensions, it has turned into the concept of DfR (Design for Recycling). According to Kalpakjian and Schmid (2010), two main factors may be related to recycling. The first of these is the 'biological cycle' related to disposable organic materials with no environmental hazards. The second is 'the cycle to an industry' where materials used in products can be recycled and reused beneficially (Chumiran et al., 2014, p.142).

The issue of material selection in sustainable design is one of the most critical roles undertaken by designers. Knowing recycling or recyclable materials and using the right materials in sustainable designs is one of the most basic sustainable design roles for designers. Designers interpret their designs in terms of sustainability, especially by using tools such as checklists arranged according to ecological criteria (Chumiran et al., 2014; Nowosielski, Spilka & Kania, 2007).

R Concept

Within the scope of sustainable design, an " R " concept has been developed to reduce and prevent damage to the environment. These " R " concepts created primarily within the framework of waste management are gathered under three main headings: Reduce, Reuse, and Recycle. The concept of " R " emerged from the idea of providing broader positive contributions to sustainable design and minimizing people's resource demands. Later, these " R " concepts started to be expanded in line with the needs. According to Brusseau's research, the idea of "Rs" has been expanded under six titles: Refuse, Reduce, Reuse, Recycle, Repair, and Rethink. Here, especially as the concept of Rethink, designers can put forward their contributions in sustainable design. The concept of "Responsibility" helps to create sustainable development components to discuss the effect of user behavior on sustainability. Table 15 shows the concept of "RS" in sustainability grouped in 5 categories. (Brusseau, 2019).

Table 15: The ‘‘RS’’ of Sustainability (Brusseau, 2019, p.589).

Number	Categories
1	Rethink-Reinvent-Replace
2	Refuse-Reduce
3	Repair-Remediate-Reclaim-Restore-Renew-Rehabilitate
4	Recycle-Recover-Reuse-Repurpose
5	Responsibility-Respect-Relationships

According to their research, Sherwin and Bhamra found that the most substantial impact in sustainable design begins in the early stages of design, creating innovative potential in ecological design integration. As shown in Figure 34, the conceptual model created by Charter and Chick schematically indicates the importance of rethinking and redesigning for environmental benefit. (Sherwin & Bhamra, 2001; Chumiran et al., 2014, p.143).

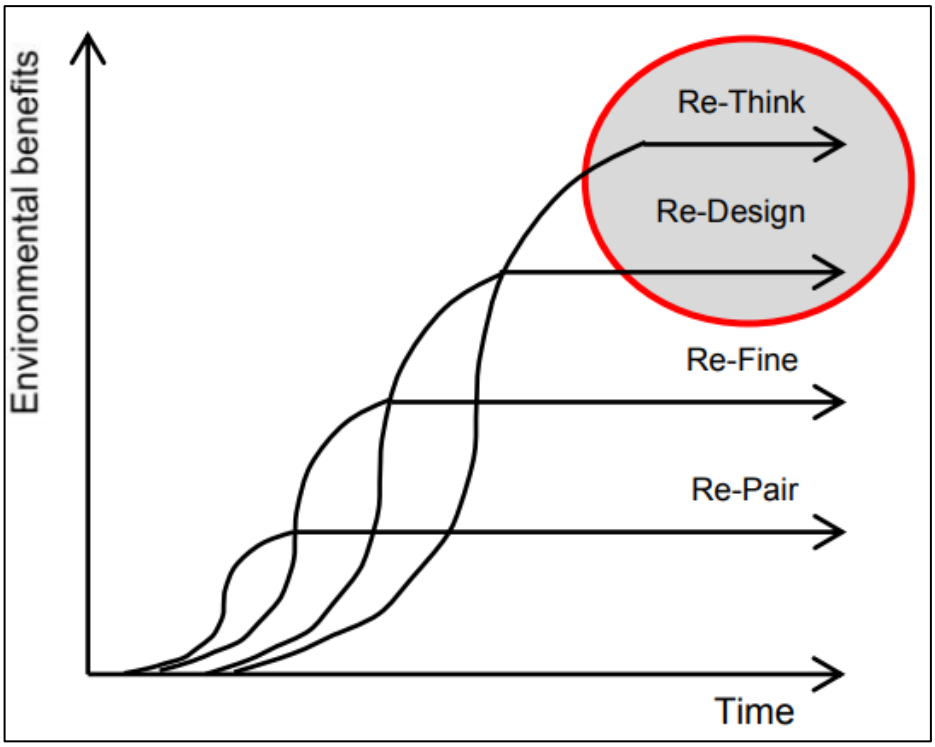


Figure 34: 'Factor 4' model by Charter and Chick. (Chumiran et al., 2014).

Sherwin and Bhamra, inspired by the "Factor 4" (Re-Fine; Re-Pair; ReDesign; and Re-Think) in their research, thought that rethinking concepts and redesigning to ensure environmental improvements were a touchstone for designers. Based on "Factor 4", they formed the conceptual model in figure 35. This model refers to concept design, basic design, and continuous improvement in early eco-design integration (Chumiran et al., 2014, p.143).

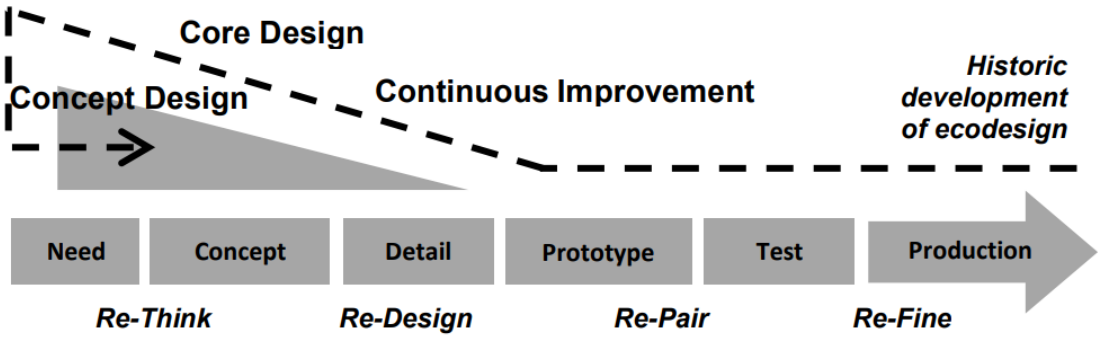


Figure 35: Sherwin and Bhamra's (2001) conceptual and descriptive model for eco-design (Chumiran et al., 2014).

According to these researches, it is understood that one of the crucial roles of the designer in sustainable design is to think well and redesign the design concept at the early design stage to create a positive impact on the environment. Considered the standards and green certification systems examined in the previous sections of the study, it is noticed that sustainable furniture design is mostly addressed based on environmental problems and social dimensions are less involved in evaluation systems. Also, the social dimensions mentioned in green design evaluation systems are not user-oriented. However, a realistic, sustainable design should also be good design, and good design should be environmentally friendly and appealing to all users in society. Based on this idea, the role of social sustainability in furniture design is discussed in the next section.

4.4 Social Sustainability Approaches

Considering the concept of sustainability, many designers address sustainability through environmental problems and improve design dimensions to reduce environmental damage. Nevertheless, environmentally-oriented designs do not fully carry a truly sustainable design understanding (Dempsey et al., 2011).

In today's conditions, the concept of sustainability, environmental awareness, economic development, culture, and the community's physical environment with support from each other is discussed as a concept that emphasizes the collaborative development of disciplines that emerges. Putting environmental and social sustainability at the center of work and professional responsibilities will enable the implementation of sustainable design. Various developments in recent years have caused the scope of sustainable development to expand and provide an environment for positive developments in a wide variety of fields. In order to prevent the accidents

of those who have to work in adverse working conditions in developing countries, voluntary inspection and certification programs have come to the fore in companies operating in the international arena. As a result, equal rights and moral values shared in society create human capital for social sustainability through cultural interaction. This human capital has started to have certain norms thanks to employment, health, education, and the equitable use of public spaces (Goodland, 1995). What should not be forgotten to ensure all these social rights is that the society does not only consist of physically and mentally fully qualified individuals, and the ratio of the elderly population to the general population is increasing worldwide. (Steinfeld & Maisel, 2012).

According to the research conducted by Geçimli and Kaptan (2019), the concept of social sustainability has three main approaches: development-oriented, environment-oriented, and people-oriented. In the development-oriented approach, actions related to sustainability should have a place in the social structure, social relations, and traditions. On the other hand, the environment-oriented approach examines the distribution of natural resources sharing between today and future generations by going deeper into the development-oriented interpretation. Finally, in the human-oriented approach, it is thought that social sustainability will be achieved with concepts such as increasing the quality of life, social cohesion, and integrity. In addition to all these approaches, the cultural approach is an important tool to ensure social sustainability. In the cultural approach, it is argued that social sustainability can be improved with the lifestyle of a society, the symbols and codes that come with the historical process, and the environmental conditions and resources of the geographical structure of the culture (Geçimli & Kaptan, 2019).

Interior architecture affects the social structure through these spaces by serving in a wide area, shaping the private living spaces, working spaces, and public interior spaces used by society. On the other hand, social relations can be shaped in of private spaces and interior spaces. Interior architects are responsible for designing public spaces used by society and establishing the social relationship between individuals that make the space meaningful (Geçimli & Kaptan, 2019).

In light of the information above, social sustainability includes essential topics such as employee rights and local economic employment and comprehensive criteria such as cultural continuity, human rights, social cohesion, and quality of life. In this study, the human-oriented approach dimension, which can be quickly followed by interior architects and designers at the beginning of the design and can directly affect the furniture design, is studied. Titles such as the concept of culture, local economic employment, and employee rights, which have extensive literature, can be studied in detail as a different research issue.

4.4.1 Human Oriented Social Sustainability

The concept of 'quality of life,' which we have heard frequently in recent years, leads to the emergence of product designs that can offer solutions to user needs and put human health above all else; With the demographic changes experienced, the health of the individual has gained more importance than in the past and plays an essential role in the development of new marketing areas; With the concept of barrier-free design, products that were thought to reduce aesthetic marketability in the early days are shown as the exact equivalent of the 'quality life' expectation with the introduction of the concept of design for everyone. Moreover, the world population's changing demography is now an open call for design understanding for everyone. When a

reading is made from the past to the present, a significant increase is seen in a person's life span. According to the 2012 data of the European Union Statistics Office, the life expectancy of 28 European Union (EU) countries is 80.3 years at birth (Dolap & Tutal, 2016).

The sustainability paradigm accompanies economic and technological development goals with a scope ranging from individuals to institutions, companies, States, and international structures, regardless of scale, to structure the present and future with efficient processes. To carry out development processes legally, efficiently, and without disruption, the intended use of Natural Resources and the development of human resources are also included in the development processes. Even if development programs in which social dynamics are ignored ensure economic development, real development cannot be achieved because social equality and prosperity cannot be achieved. Therefore, the social dimension of sustainable development that addresses socio-human factors should also be emphasized.

Among the objectives that reflect the social dimension of sustainable development: education, health, social equality among human settlements, and the creation of adequate and accessible property should be tackled. It recognizes the rights of all people, including vulnerable groups such as children, the elderly, the disabled, and the poor (Dempsey et al., 2011).

A balanced and realistic sustainable development goal should also include improving a person's quality of life because by economic and environmental projects that cannot achieve social equality and prosperity, human resources cannot be developed, and social participation cannot be successful and sustainable (GAP, 2018).

Designers come into play at this point. As can be seen, social sustainability is a wide-ranging concept based on the social equality paradigm and includes it in its culture. In a sustainable furniture design, the designer is responsible to society and the environment. In the early stages of furniture design evolving, a sustainable furniture designer needs to make designs that can appeal to all society segments and be used equally. In this part of the study, designers' primary role in the social sustainability of furniture and the factors affecting the social dimension of furniture design are examined by taking advantage of the universal design principles by addressing the concept of social sustainability with the motto of "design for all."

4.4.2 Commonly Used Furniture Materials and Their Effects on Quality of Life

Furniture is a product that is widely used in our daily life, especially in indoor environments. There are many developments in the furniture sector, these changes and developments are not always in favor of the users. Furnishings, which are increasing day by day in terms of color, type, and purpose of use, are presented to the user and take their place in home and workplace environments. However, this diversity brings with it new materials and chemicals used.

There are products containing formaldehyde, varnishes, furniture made of non-recyclable materials, and chemicals used to provide fire resistance in homes and public spaces. Formaldehyde itself or its compounds are frequently used in paints and coatings utilized in furniture manufacturing. Formaldehyde-containing plywood materials commonly used in interior furniture design are as follows:

- Chipboard (under floors, shelves, cabinets, and furniture)
- Hardwood wood panels (decorative wall coverings, furniture, and cabinets)

- Medium-density fiberboard (MDF) made of fibers (drawer doors, cabinets, and furniture coverings). Especially in MDF products, the fiber/resin ratio is the highest, and it is the product that emits the most formaldehyde (Aksakal, Vaizoğlu & Güler, 2005).

Formaldehyde causes nonspecific symptoms such as headaches, nausea, dizziness, and symptoms such as throat irritation, allergic reactions, redness of the eyes, watering, runny nose. It can cause chronic conjunctivitis, pharyngitis, laryngitis, bronchitis, and cough, especially in the presence of chronic involvement. It has been reported that formaldehyde may play a role in asthma development and is associated with nighttime breathing difficulties in asthmatics. Also, children are a vital risk group as they spend most of their time at home or in schools that are public places, and they are also at risk in terms of formaldehyde exposure from furniture and decoration materials in indoor environments. Many chemical materials used in furniture products release harmful gases into the atmosphere of the space. All these symptoms' adverse effects increase with the time people spend indoors. As a result, the decrease in the quality of the atmosphere and life and the situation called sick building syndrome (SBS) occur (Aksakal et al., 2005).

When designing furniture to improve quality of life, furniture should be designed using local materials, long-lasting and repairable when necessary. Furniture should be produced from natural materials that can be safely demolished in nature. Also, wooden materials with certification documents should be preferred instead of chipboard and MDF. It should be treated with water-based paints or varnishes. Soft, removable, and washable cushions should be designed in the furniture upholstery section.

4.4.3 Social Sustainability of Furniture Design with Universal Design Dimension

Designing products, services, and environments in a way that can be used by all people to the broadest possible extent without the need for personal adaptation or special presentations are called 'design for all' (Story, Mueller & Mace, 1998).

The concept of design for all, which Hanson (2004) describes as a macro-environmental approach, aims to reach situations where even a single user is not excluded by expanding the design parameters while rejecting all positive or negative discrimination. Moreover, design for all is one of the concepts on which the United Nations Convention on the Rights of Persons with Disabilities is based on.

Universal design has become a rising trend daily and can be associated with social sustainability in furniture design. Universal design aims to provide individuals' social participation in society and be appeal to the broadest possible user profile. Therefore, social sustainability must include even people with low interaction with the society, especially in public spaces, common in society (Vavik & Keitsch, 2010).

"Universal design" is defined as a holistic design approach that allows all products and environments to be used by many people regardless of age, skills, and status. The approach covers scales ranging from product design to architecture and urban design, from simple systems that provide environmental control to complex information technologies (Zeyrek & Güller, 2020).

"Universal design" was first used as a term in the mid-1980s by architect Ronald L. Mace. The environment, built according to this Universal design approach's principles, enables the use of all people without the need for adaptation. For example, solutions

such as eliminating the need for ramps, organizing step-less entrances, using adjustable height kitchen countertops are different arrangements considered within this understanding. The critical point here is that the designed environment or the product features look and feel standard. The products obtained with the universal design approach allow all users to benefit, and as a result, the disabled, the elderly, children, and other people different from the general are not labeled or stigmatized (Duncan, 2007).

Designs are usually created with aesthetic concerns. However, as stated in the Rio Declaration issued in 2005; Designers are responsible for increasing the quality of life in society. This event shows that universal design can act as a catalyst in this development. According to Tahkokallio (2003), universal design and social sustainability are two fundamentally related concepts.

Different terms are used in different countries of the world that evoke the concept of "universal design." "Design for all", "inclusive design", "user-oriented design", "transgenerational design" are some of them. Terminology and meanings differ from one country to another and generally reflect the social values of each nation. Universal design aims to reveal accessible designs for many users despite individuals' diversity in society. Ronald Mace, the founder of Center of Universal Design defines Universal Design as: “Universal design is the design of usable products and environments. It is the capacity to be used by all people to the widest possible extent without adaptation or specialized design” (Mace et al., 1991; Zeyrek & Güller, 2020, p.388). This statement is in line with the definition of social sustainability (Zeyrek & Güller, 2020).

The center, which was founded by Ronald L. Mace in 1989 and named The Center for Universal Design at North Carolina State University in 1996, published seven principles in 1997 in order to make the concept of "universal design" understandable and to be a guide. These principles and their definitions are shown in table 16 (Zeyrek & Güller, 2020).

Table 16: Universal Design Principles

Principle	**Descriptor**	**Image**
1) Equitable Use	The design should be available to individuals with different levels of competence. Equal conditions should be provided in design for different users. There should not be any discrimination between users and the user should not be stamped.	
2) Flexibility in Use	The design should cover different individual preferences and competencies. The possibility of different users should be provided. The product should be equally useful and usable for right and left-handed users.	
3) Simple and Intuitive Use	The design should be easy to understand, regardless of the user's experience, knowledge, language skills, and instant focus. Unnecessary complexity should be avoided. It should not go against the user's expectations and intuitive use.	
4) Perceptible Information	The design should present the necessary information for the user, regardless of the ambient conditions or the sensory perception of the user. The “readability” of basic information should be at the highest level.	

5) Tolerance for Error	The design should minimize the dangerous and bad consequences that can occur as a result of accidents or unwanted behavior. The most used design elements should be arranged in the most accessible way, and those that may cause danger should be destroyed, isolated, or sheltered.	
6) Low Physical Effort	The design should be used effectively and comfortably and should allow for minimal fatigue. The user should not have to put his body in unnatural positions. The product must be able to be operated using acceptable power.	
7) Size and Space for Approach and Use	Regardless of the user's body size, posture and mobility, appropriate size and space must be provided for approach, reaching out, manual handling, and general use. An unobstructed view of key operating items should be provided for both seated and standing users. All items of use should be equally easily accessible while sitting or standing.	

When universal design principles are examined, as in the concept of social sustainability, it accepts diversity as a fundamental value of socioeconomic and human development and emphasizes that every person contributes to this development.

When examining furniture design within the sustainability scope, designers should especially consider human-centered and holistic approaches in the social dimension of sustainability. Universal design principles also started with the physical barrier-free design logic and focused more on cognitive accessibility after the 1990s. In this situation, a designer needs to consider human-oriented cognitive concepts, behaviors,

and social patterns while using physical and ergonomic features within the scope of social sustainability in a sustainable furniture design. (Vavik & Keitsch, 2010).

As designers move towards inclusiveness, they meet the physical and ergonomic needs of users and the physical and environmental requirements in furniture design and take into account the psychological and cultural requirements. The point where universal design and social sustainability intersect is precisely at this point. Social egalitarian design understanding of universal design in public spaces, which are used jointly in societies with different lifestyles, ethnic identities, and cultures, is vital for socially sustainable development. The increase in the number of people with disabilities and older adults worldwide reveals the necessity to benefit from universal design principles for social sustainability in furniture design in common areas. As shown in the universal design pyramid in Figure 36, the period from the first to the fourth row covers childhood, youth, adulthood, and elderly, respectively. These are the stages that every healthy person will experience throughout life. In addition to these periods, the number of user profiles of the fifth and sixth row, the period of physical insufficiency, increases every year. Users in this group should be integrated into society. The seventh and eighth groups are composed of users who cannot perform their physical movements without assistance. Ensuring social sustainability in furniture design is through developing designs that adopt the inclusiveness of universal design principles and aim to protect and develop social equality in public spaces used as common spaces (Dolap & Tutal, 2016).

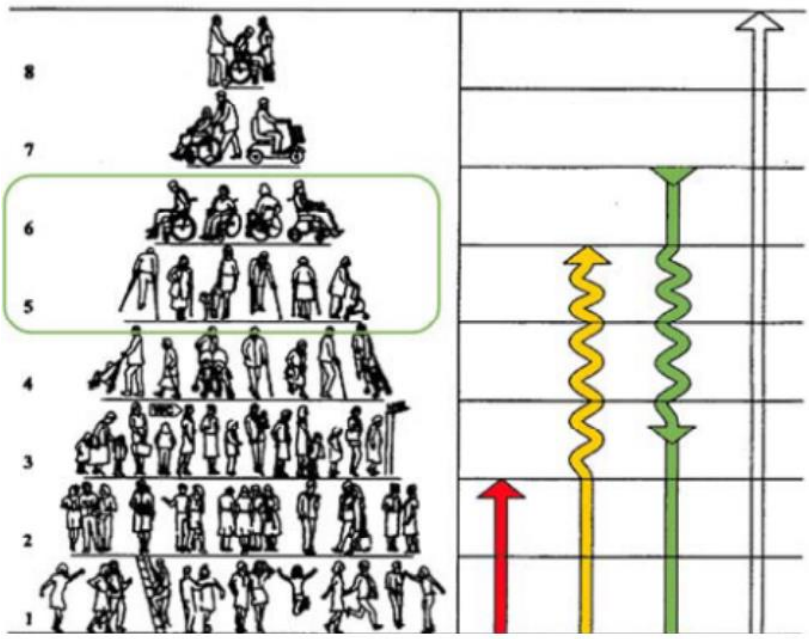


Figure 36: Universal Design Pyramid (Goldsmith, 1998; Dolap & Tutal, 2016).

As shown in the Universal Design Pyramid, the user profile that constitutes a society has various physical, mental, and age parameters. Social participation is one of the general goals of universal design to ensure the social integration of different social segments. Designers should develop designs that protect cultural values and social environment by treating all groups in the society with dignity and respect. Thus, the common language design, which will be created with universal design principles in furniture design, will be more inclusive. All individuals in the society will be able to reach design in an easy, fair, and flexible way. (Vavik & Keitsch, 2010).

As shown in Figure 37, there is a similar change in approach between universal design and sustainable development. The concept of physical accessibility in universal design has evolved over the years and turned into a human-centered design with cognitive accessibility. Sustainable development was similarly focused on environmental sustainability through eco-industrialism in the early 1960s, while it developed a social responsibility-centered approach in the early 2000s. This example demonstrates the

necessity of creating human-centered, socially responsible designs with environmental awareness for a correct sustainable furniture design

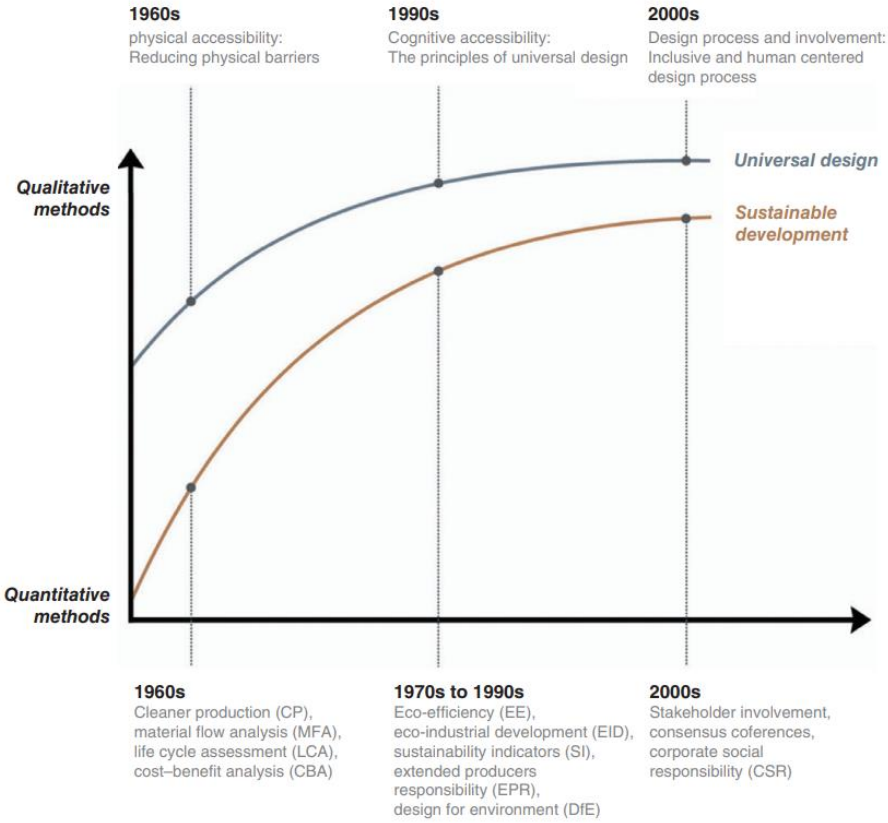


Figure 37: Method change process in Universal Design and Sustainable Development (Vavik & Keitsch, 2010).

As a result, research on sustainable furniture design from environmental and social aspects has revealed that various criteria are needed for a successful design. These criteria are specified in most of the certification systems created by different institutions and organizations. It presents various criteria in many independent voluntary organizations from different countries. In such a case, even though the number of resources that can be used for designers has increased, the evaluation of many different indicators over a complex point system during the application phase of the design makes the applicability of these certification systems difficult. In addition, since the literature on the concept of social sustainability has a wide-ranging structure

and is generally handled from an abstract perspective, its integration into furniture design is complicated.

This section examines sustainable furniture certification systems, and the necessary criteria for ensuring sustainability are discussed. It focused on the evaluation tools of sustainable furniture criteria and emphasized the importance of creating a checklist for easy follow-up and application. In the following parts of the research, the designer's role in sustainable design is discussed through concepts such as re-think and re-design. At the end of this chapter, social sustainability approaches are discussed and focused on the concept of human-centered social sustainability. Universal design principles for human-centered sustainable design are discussed, and its contribution to social sustainability is discussed. As a result, social sustainability criteria are needed and environmental sustainability criteria in sustainable furniture design. A checklist for this research will be created in the next section, and a case study will be made for cafe areas.

Chapter 5

A REVIEW ON SELECTED CAFE FURNITURE DESIGN

The standards and needs required for a sustainable design to be successful are the most challenging part of architects, interior designers, and designers work at the design's starting point. Because the standards and certification systems that have been established are in a complex assessment structure, it can make the design problem more difficult. Designers need a common language from the first moment they start planning the design in furniture design, and this common language can be achieved by creating a checklist most simply (Knight & Jenkins, 2009). One of this thesis's primary goals is to prepare an uncomplicated, easy-to-follow checklist that will help designers fulfill their responsibilities to environmental and social life in furniture design.

5.1 Research Methodology

The research methodology used in this case study is mainly observation. In this study method, first, necessary information is collected from sources such as articles, journals, books, and internet pages through a vast literature review which is shared in the previous sections. Afterward, an evaluation list is created based on the literature review data. This list includes the evaluation criteria to be used in the field study. The choice of the case study in field research has been the indoor public space. Interpersonal relationships and activities are the essential features of public space. In urban life, people always prefer to be in places with heavy circulation. Because human and human activities attract other people as well (Gehl, 1987).

Figure 38: Locations of the selected Cafes on the Çanakkale map.(Google Earth, 2021)

For this reason, the author has chosen cafe places where people spend more time and prefer socializing as a case study. Since the researcher lives in Çanakkale, this city has been chosen as the place for field research. The cafe areas along the cordon of 'Kayserili Ahmet Paşa Street', where people in Çanakkele city prefer to go, were chosen for the case study. Many cafes are closed during the COVID-19 pandemic. For this reason, the researcher identified the cafes on the coastline that remained open

during the pandemic period and where the number of users was high. Later, the researcher visited these cafes that had been selected at the cord location. Seven of the cafe owners agreed to participate in this research and gave permission to take photos and measure the furniture in the venue. The research focuses on seating group furniture, consisting of chairs and tables, which provides socialization in cafe areas. The researcher visited the chosen places, took the furniture measurements in the environment, and experienced the materials used on site. Table 17 demonstrates the photos of the chosen cafes.

Table 17: Exterior view of the cafes examined

Color on the map	**Name of cafe**	**Exterior view**
	Lodos Cafe	
	Fiyaka Cafe	

	Özsüt	
	Hangover Cafe	
	Leon Cafe	
	Bigfoot Cafe	

	Duvar Dibi	

According to some researchers, the relationship between public space and users suggests that public spaces should be interactive, democratic, and meaningful. Spaces designed to meet the needs of their users in an interactive concept contribute more to social sustainability. (Gehl, 1987). Furniture is one of the most crucial design elements that make these spaces meaningful and provide a social space atmosphere because it is the design element that has the highest relationship with the user in public spaces. As can be understood from this information, the sustainability of furniture designs created in public spaces depends not only on environmental factors but also on society's holistic user profile. As shown in figure 39, the height of the table should be between 0.75 m and 0.90 m from the floor for the seating groups in the cafes to be suitable for the use of everybody including the wheelchair users. The minimum depth under the table should be 0.60 m for the wheelchair to approach from all directions. (Hülagü, Yüksel, Gültekin, Güngör, Karasu & Çavuş, 2010).

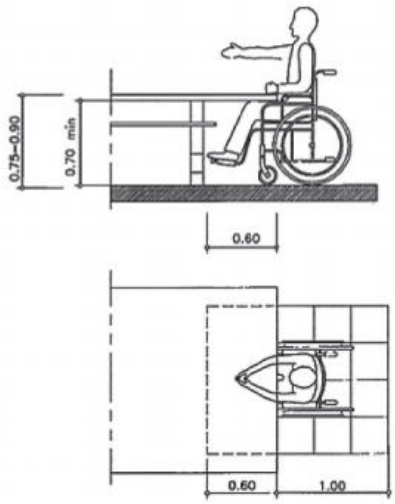


Figure 39: Standard sizes of the lounge table. (Dimensions are in m) (Hülagü et al., 2010).

Other essential standard for cafe seating areas is understood from the measurements given by Neufert (Neufert, 2008). The chair's back tilt angle should be 105 °, the seat height from the floor should be 45cm, and the backrest height should be 90cm. The depth of the chair should be between 45-50 cm, including the backrest. Besides, for the waiters to move freely, there should be a minimum space of 45 cm and above between the chairs facing each other (Figure 39). In the following parts of the study, furniture designs are interpreted using these fundamental dimensions.

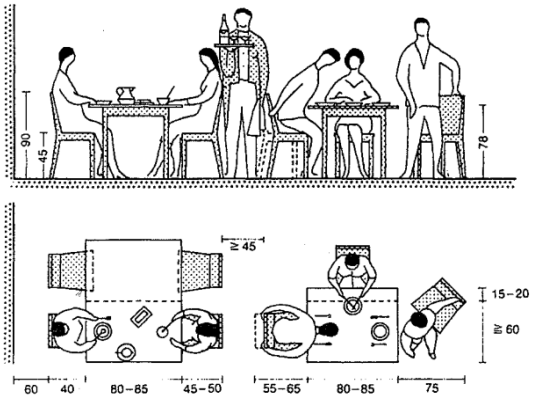


Figure 40: Standard dimensions of the chair and restaurant residential area (Dimensions are in cm.) (Neufert, 2008).

The anthropometric measurements given in the information above are necessary for wheelchair users and all other users to adequately use the furniture in the cafe areas. In the research, the furniture in the cafe places was measured, and sketches were made. Afterward, models and dimensions of furniture were prepared using SketchUp and AutoCAD programs. In this way, whether the furniture used in cafes is suitable for the anthropometric measurements mentioned in the research can be checked.

5.2 Basis for Checklist

When starting a design, architects, interior architects, and designers should first aim for their designs to reflect good design logic. The good design principles listed by Dieter Rams (table 18) in the early 1980s, while the term "design for all" has not even been used in terminology, is an example of an uncomplicated evaluation list that includes both designs for everyone and sustainability principles. This table is a simple expression of the integration of human- oriented social sustainability and environmental sustainability (Dolap & Tutal, 2016).

Table 18: Good design principles were created by Dieter Rams in 1980 (Dolap & Tutal, 2016).

Good Design Principles			
1) A good design is innovative.		6) A good design is honest.	
2) A good design is useful.	√	7) A good design is durable.	√√
3) A good design is aesthetic.	√	8) A good design fits right down to the last detail.	√√
4)A good design helps to understand the product.	√	9) A good design is environmentally friendly.	√√
5) A good design is unobtrusive.		10) A good design is less design.	√
√: Compatible with design principles for all. / √:Compatible with sustainability.			

Sustainable furniture criteria include the environmental and social aspects in furniture design that designers are responsible for. These criteria have emerged in line with the information obtained from the literature review. The factors that reveal the criteria are as follows;

- Knowledge of life cycle assessment (LCA) standards.
- Knowledge of sustainable furniture certifications and ISO 14000 standards.
- Knowledge of human-centered and Universal Design design principles.

Based on these standards, the criteria that designers should pay attention to for sustainable furniture design are divided into two main sections: social sustainability and environmental sustainability. The aim here is to create a checklist that designers can use in the initial thinking and planning stages of their designs since sustainability is a very large-scale and holistic concept. Thus, when designers begin to design, instead of getting lost among the standard evaluation criteria in a complex structure, they will be able to take the right step for sustainable design with a more basic list. Designers will then adapt to sustainable design standards more quickly in the later stages of their designs. The criteria created in this checklist have been created by considering the existing certification systems and the criteria in the standards. Because the current criteria consist of approved and controlled substances, this study aims to help designers in sustainable design by creating a checklist with an easy-to-use and simple-to-follow working principle. Table 19 shows the criteria of the certification systems and standards used to develop the requirements in the checklist. The researcher uses these criteria to prepare the checklist by determining the criteria common in environmental and social sustainability aspects.

Table 19: Certification systems and standards as a basis for the formation of the principles in the checklist.

Certification Systems, Organizations and Standards	Principles and Criteria	Certification Systems, Organizations and Standards	Principles and Criteria
Life Cycle Assessment (LCA) standards based on ISO 14040.	**1. Resources:** -Reducing the number and amount of materials used. -Nature of the raw material. -Reduction or elimination of non-renewable use. -Replacement with less harmful or harmless raw materials. -Enabling recovery, reuse, recycling. -Extraction and processing of raw material. -Transport from the supplier. **2. Material Processing:** -Reduction or elimination of emissions. -Not using dangerous materials. -Reduction or destruction of waste materials. -Reducing energy use. **3. Distribution:** -Is transport required? -The volume and nature of transport. -Reduction or elimination of emissions. -Energy spent on transportation. -Reduction of disposal of waste. **4. Use:** -Reduction or elimination of waste from the product. -Reduction or elimination of waste from use. -Reduction or elimination of waste from wrapping. -Using environmentally friendly packaging.	**LEVEL Certification System**	**1. Materials** -Life Cycle Assessment -Climate Neutral Materials -Efficient Use of Materials -Bio-based Non-wood Renewable Materials -Bio-based Renewable Materials -Recycled Content -Recyclable and Biodegradable Materials incorporated into the product -Solid Waste Management **2. Energy and Atmosphere** -Energy Reduction -Energy Management -Transportation -On-Site & Off-Site Renewable Energy -Greenhouse Gases **3. Human and Ecosystem Health** -Demonstration of Compliance with Human Ergonomics -Key Chemical, Risk, & EMS Policies -Process Chemicals -Product Level Chemicals -Low Emitting Furniture **4. Social Responsibility** -Employee Health & Safety Management -Labor and Human Rights

	5. End of Life: -Repairable design. -Flexible and modular design for product upgrades. -Product recovery for component reuse. -Dismountable. -Product recovery for recycling and disposal.		-Policy on Social Responsibility -Safety Performance -Inclusiveness -Community Outreach & Involvement -Excellence in Social Responsibility -Local Persistence
FSC-Forest Stewardship Council	1. Compliance with Laws 2. Workers' Rights and Employment Conditions 3. Indigenous Peoples' Rights 4. Community Relations 5. Benefits from the Forest 6. Environmental Values and Impacts 7. High Conservation Values	**Universal Design Principles**	1. Equitable Use 2. Flexibility in Use 3. Simple and Intuitive Use 4. Perceptible Information 5. Tolerance for Error 6. Low Physical Effort 7. Size and Space for Approach and Use
Environmental Aspects for Checklist - Recyclable and reused material selection. - Waste minimization. - Natural materials with low chemical content. - Simplicity and source reduction. - Long-lasting material. - Local resources to reduce transport energy. - Easy to produce using minimum energy consumption - Easy assembly and disassembly. - Packaged with less material. - Easily repairable.		**Social Aspects for Checklist** - Equitable use - Flexible use - Tolerance for error. - Low physical effort. - Size and space for approach and use. - Provides users with social communication area. - Local atmosphere - Community outreach and involvement. - Does not adversely affect human spine health by providing the correct posture. - Helps to construct social relations with people with various physical and characteristics.	

Considering the common criteria of the standards and certification systems in Table 19, a checklist for sustainable furniture design was created with an equal number of essential criteria, including environmental and social sustainability (Table 20). As this checklist covers the most fundamental sustainability needs, designers can also expand and develop the checklist criteria if needed in their work.

Table 20: Sustainable Furniture Design Checklist

Sustainable Furniture Design Checklist					
Furniture Group Photo			**Place Name:**		
			Types of Furniture:		
			Furniture Materials:		
Top View	Front View		3D Modeling		
Environmental Sustainability Criteria			Social Sustainability Criteria		
1) It uses recyclable and reused material selection.			1) It provides equitable use.		
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.			3) It provides tolerance for error.		
4) It provides simplicity and source reduction.			4) It requires low physical effort.		
5) It uses long-lasting material with high strength.			5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.			6) It provides users with social communication area.		
7) It is easy to produce using minimum energy consumption.			7) It provides aesthetic harmony with the local atmosphere.		
8) It provides easy assembly and disassembly.			8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.		
10) It is easily repairable.			10) It helps to construct social relations with people with various physical characteristics.		
Evaluation Comment					

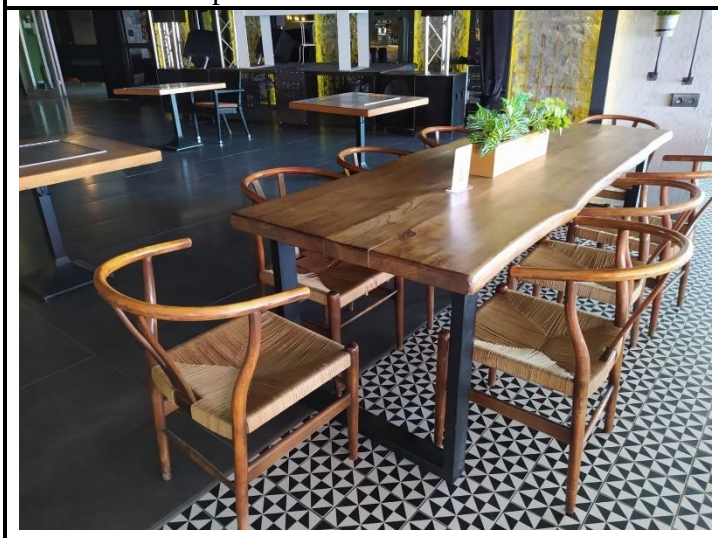
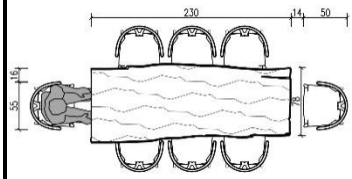
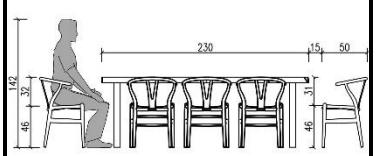
By using the literature review discussed in this study, sub-headings were created in sustainable furniture design standards and the checklist to be used was designed according to these general issues. When sustainable furniture certification systems are examined, it is revealed that many organizations give more points for environmental sustainability and fewer points for human-oriented social sustainability. This research aims to create a valuable checklist that interior architects and designers can easily follow and gain different perspectives on sustainable furniture design with this checklist. The second important goal is to encourage the creation of sustainable furniture designs where environmental and social sustainability criteria are discussed holistically. While creating these criteria, it is aimed to intervene in the first stage of the design before environmental problems occur, as well as the aim of reducing environmental damage with the aspect of environmental sustainability. Likewise, social sustainability criteria aim to avoid the problem of social equality by maximizing social inclusiveness.

5.3 Presentation of Checklist Charts and Findings

The criteria created from the collected data work as a control panel in the evaluation tables below. It also includes the dimensions, visuals, and material types of furniture in the cafe spaces examined in the case study. Considering that social and environmental sustainability have extensive dimensions, this checklist table aims to demonstrate the minimum and very basic necessary environmental and social conditions for a sustainable design. During the case study, the researcher realized visits to the site where he visually recorded the furniture used and collected data in relation to the furniture measurements, materials used, form and the other necessary information. This checklist tries to convey the minimum criteria that as the main target

group, interior designers should pay attention to in design and selection of furniture in respect to sustainability.

Table 21: Checklist chart 1 (Lodos Cafe)

Sustainable Furniture Design Checklist					
Furniture Group Photo				**Place Name:** Lodos Cafe	
				**Types of Furniture:** • Chair (C) • Table (T)	
				Furniture Materials: • Chair Materials: Teak Wood and Straw • Table Materials: Ash Wood, Varnish and Metal.	
Top View		Front View		3D Modeling	
					
Environmental Sustainability Criteria	C	T	Social Sustainability Criteria	C	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.		√
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.	√		3) It provides tolerance for error.	√	
4) It provides simplicity and source reduction.	√	√	4) It requires low physical effort.	√	
5) It uses long-lasting material with high strength.		√	5) It provides size and space for approach and use.	√	√
6) It uses local resources to reduce transport energy.	√		6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.	√		7) It provides aesthetic harmony with the local atmosphere.	√	√

8) It provides easy assembly and disassembly.	√	√	8) It provides community outreach and involvement.	√	√
9) It consists of small parts and can be packaged with less material.	√		9) It does not adversely affect human spine health by providing the correct posture.	√	√
10) It is easily repairable.	√	√	10) It helps to construct social relations with people with various physical characteristics.		√

Evaluation Comment

In Lodos Cafe's example, a Danish-style chair made of straw and teak wood and a table with metal legs and ash wood top covering was chosen, most suitable for space's sustainable furniture design.

Looking at the chair's example, designing it from natural and recyclable materials is positive for environmental sustainability. Simple and less material variety is used, and it has easy assembly and disassembly features. The richness of forest in Çanakkale and the forestry of mountain villages ensure that wooden materials can be found locally. Thus, the amount of energy to be spent on transportation is reduced. Besides, being a wooden material provides an easily repairable feature. In our chair example, its lightness in terms of social sustainability allows it to be moved with low physical effort. For example, when a disabled user comes to the place, chairs can be easily removed, and space is provided for approach. However, the chair's width and skeleton make it difficult for overweight users to use this chair and make it away from the understanding of equitable use. In summary, although the chair sample should be good in terms of environmental sustainability, social sustainability has been a sustainable design that needs to be developed in terms of equitable use and flexible use. This shows that outstanding environmental sustainability alone will not be enough.

The table sample in the venue was produced using recyclable ash wood and metal materials. The table is made of wood and metal material, and its simple metal leg design contributes to environmental sustainability in simplicity and resource reduction factors. The type of wood used and the structure of the metal allow it to be a long-lasting design. However, the amount of energy consumed during the production of metal legs of the table and the lack of local resources may negatively affect the amount of energy expenditure from transportation. Also, the fact that it consists of large and heavy parts causes problems with more resources to be used during the packaging phase. When the table is evaluated in terms of social sustainability, its height of 76 cm provides space for a disabled individual's approach. Thus, it provides social communication and participation of individuals with different physiological characteristics who use the space.

Table 22: Checklist chart 2 (Fiyaka Cafe)

Sustainable Furniture Design Checklist

Furniture Group Photo

Place Name: Fiyaka Cafe

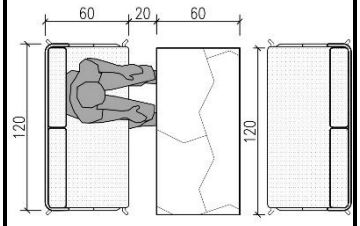
Types of Furniture:

- Bench (B)
- Table (T)

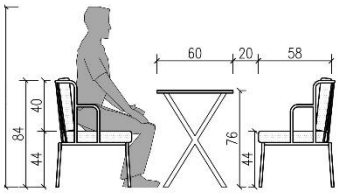
Furniture Materials:

- Bench Materials: Metal and Fabric Cushion
- Table Materials: Acrylic MDF paint, MDF Wood and Metal.

Top View



Front View



3D Modeling

Environmental Sustainability Criteria	B	T	Social Sustainability Criteria	B	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.	√	
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.			3) It provides tolerance for error.	√	
4) It provides simplicity and source reduction.	√	√	4) It requires low physical effort.		√
5) It uses long-lasting material with high strength.	√	√	5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.			6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.			7) It provides aesthetic harmony with the local atmosphere.		
8) It provides easy assembly and disassembly.			8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.	√	√
10) It is easily repairable.			10) It helps to construct social relations with people with various physical characteristics.		

Evaluation Comment

In the Fiyaka cafe example, a table with MDF wood flooring with a metal frame and bench furniture made of metal material was examined.

With advanced technology, many products can now be recycled. When we examine the bench example in terms of environmental sustainability, it consists of only a metal skeleton, making it a recyclable product. The fact that the Benc design consists of metal and only cushions have made it a simple product. It offers long-lasting use thanks to the metal material. However, factors such as the fact that metal is not a local material specific to Çanakkale, its chemical content is intense, tremendous energy is consumed in its production phase, and that it is not possible to disassemble due to the use of welding method in this furniture design, reduce the environmental sustainability score. As a suggestion, using elements such as screws and bolts would give better results if it consisted of smaller parts. In terms of social sustainability, the bench design positively affects the users' posture with its dimensions. Covering with soft cushions and armrests gives fault tolerance. It allows for equitable use to a certain extent by providing the comfort of overweight users or elderly users. With its close-positioned location, it allows users to establish social communication in the space easily.

When the table sample is examined in terms of environmental sustainability, it contains recyclable materials. It has a simple design, and its metal frame is long-lasting. However, MDF wood was used as the top cover and painted with acrylic MDF paint. It contains formaldehyde in MDF and is very harmful to both the environment and human health. When examined in terms of social sustainability, in the table example, a box profile is used instead of cast iron material to be moved with low physical effort due to its lightweight. However, it does not leave a suitable area for the approach of the disabled on the sides, but since it is 76 cm high, it allows the approach of individuals with wheelchairs if used with a single sitting group such as a chair.

Table 23: Checklist chart 3 (Özsüt)

Sustainable Furniture Design Checklist

Furniture Group Photo

Place Name: Özsüt

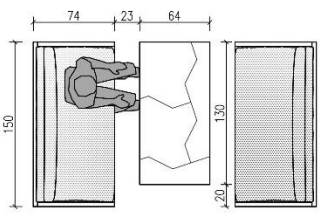
Types of Furniture:

- Bench (B)
- Table (T)

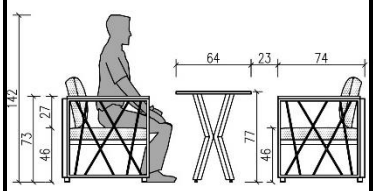
Furniture Materials:

- Bench Materials: Metal, Fabric Cushion and Plastic Plug
- Table Materials: Acrylic MDF paint, MDF Wood, Plastic Plug and Metal.

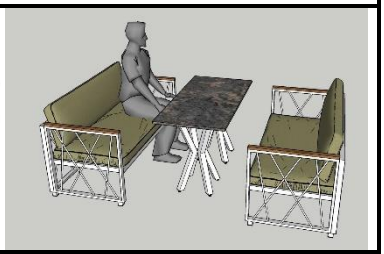
Top View



Front View



3D Modeling



Environmental Sustainability Criteria	B	T	Social Sustainability Criteria	B	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.	√	√
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.			3) It provides tolerance for error.	√	
4) It provides simplicity and source reduction.			4) It requires low physical effort.		
5) It uses long-lasting material with high strength.	√	√	5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.			6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.			7) It provides aesthetic harmony with the local atmosphere.		
8) It provides easy assembly and disassembly.			8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.		√

10) It is easily repairable.			10) It helps to construct social relations with people with various physical characteristics.		

Evaluation Comment

In Özsüt's example, bench and metal-framed MDF wooden table furniture consisting of metal and fabric mattresses are examined.

When the bench example is examined in terms of environmental sustainability, it offers a choice of recyclable materials. The metal material can contribute to environmental sustainability by increasing its usage time with its long-lasting structure. However, apart from these criteria, it has been a design that remains in the class in terms of many factors such as high energy consumption, production, chemical content, and non-local materials, and the difficulty of repair. When evaluated in terms of social sustainability, it is an aesthetic design that provides functional needs and interaction with the environment. However, heavy material and the fact that it covers a large area and is holistic prevent the equal use of physically disabled individuals. Instead, a design like the visual in the principle of equal use, whose example was given in table 16 in the previous sections, could be considered. The seating area could be opened and closed, made of two-piece material, and designed to allow a wheelchair user to close in and create space for him. The dense iron sticks added in the furniture's side areas for aesthetic purposes can be dangerous for the young children coming to the cafe, and they can grip their heads there. In addition, with its 74 cm sitting area width, it does not provide a suitable posture for a dining area.

When the table sample is examined in terms of environmental sustainability, metal and wood materials are recyclable. The metal skeleton has high strength, but MDF wood may not be as durable as metal. The plastic plugs in the metal foot part can be recycled, but the chemical content is very high. Since metal legs are joined by the welding method, there may be problems with assembly and disassembly. Generally, it is a design that is not compatible with environmental sustainability. When evaluated in terms of social sustainability, it is suitable for establishing social communication in the space. However, the metal leg design may make it difficult for individuals with physical differences to approach the table from the side because wheelchair individuals need a depth of 60 cm to approach. As a result, fair use criteria are not met. Because it is heavy, it may require high physical strength. In summary, it is a design that needs to be developed in terms of social sustainability.

Table 24: Checklist chart 4 (Hangover Cafe)

Sustainable Furniture Design Checklist

Furniture Group Photo

Place Name: Hangover Cafe

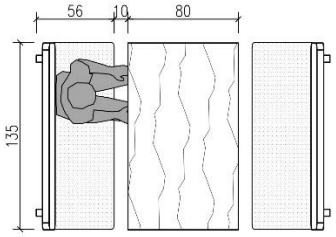
Types of Furniture:

- Bench (B)
- Table (T)

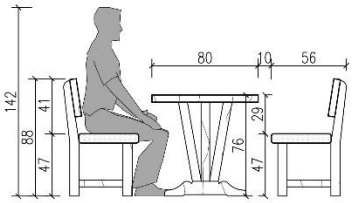
Furniture Materials:

- Bench Materials: MDF Wood, Fabric Cushion and Varnish
- Table Materials: MDF Wood and Varnish

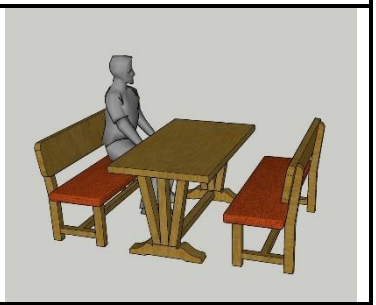
Top View



Front View



3D Modeling



Environmental Sustainability Criteria	B	T	Social Sustainability Criteria	B	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.	√	
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.			3) It provides tolerance for error.		
4) It provides simplicity and source reduction.	√	√	4) It requires low physical effort.		
5) It uses long-lasting material with high strength.			5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.	√	√	6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.			7) It provides aesthetic harmony with the local atmosphere.	√	√
8) It provides easy assembly and disassembly.	√	√	8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.		√

10) It is easily repairable.	√	√	10) It helps to construct social relations with people with various physical characteristics.		

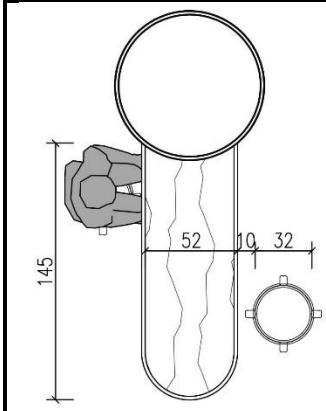
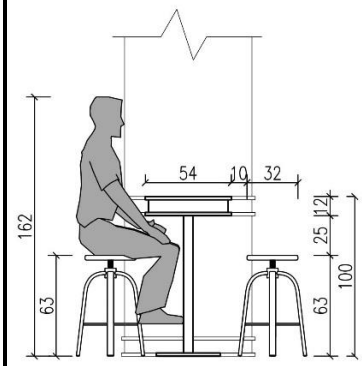
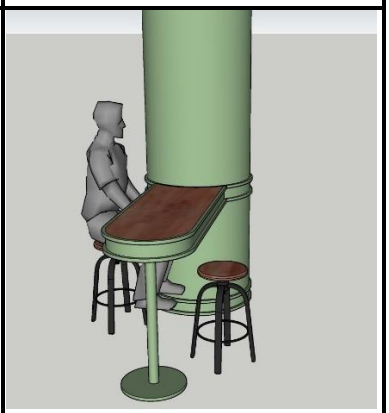
Evaluation Comment

In the Hangover cafe example, the bench and table sample made of wood MDF material is examined.

When the bench example is examined, MDF wood material constitutes the entire furniture. Since it is a recyclable material, it contributes positively to environmental sustainability. When the design is examined, it is a simple design that avoids unnecessary details and chooses a single type of material. Thanks to this simplicity, it has an easy assembly and disassembly features and can be easily repaired. This contributes to the sustainability of the design. However, MDF material is not a long-lasting material, and I also observed that this furniture is not very strong and can stretch when I experience it. Since the glossy varnish and MDF wood used on it are a formaldehyde source, they may cause harmful effects to the environment and human health. This situation negatively affects the environmental sustainability of the mobile. Water-based varnishes produced from natural sources may be more suitable for this type of furniture. When examined in terms of social sustainability, it meets the environmental interaction and functional needs. However, the absence of an armrest can cause various accidents and therefore do not provide users' fault tolerance. Since it is holistic in terms of equality of use, it limits physically disabled individuals' approach area. If it were made up of smaller individual parts rather than integral parts, it could have been a design that could contribute more to equality of use.

When the table sample was examined, MDF wood material was used as in the bench example, and it has the same environmental effect. Although it meets the functional need in the space in socially sustainable design, it can have a negative effect because it does not allow an approach to users with different physical characteristics. In the Çanakkale region, the local material being wood and its use provide a harmony with the local atmosphere.

Table 25: Checklist chart 5 (Leon Cafe)

<table>
<tr><td colspan="7">Sustainable Furniture Design Checklist</td></tr>
<tr><td colspan="3">Furniture Group Photo</td><td colspan="4">Place Name: Leon Cafe</td></tr>
<tr><td colspan="3" rowspan="2">  </td><td colspan="4">Types of Furniture:
• Bar Chair (BC)
• Bar Table (BT)</td></tr>
<tr><td colspan="4">Furniture Materials:
• Bar Chair Materials: Metal, Wood and Vernish.
• Bar Table Materials: Metal Polish Paint, Metal and Wood.</td></tr>
<tr><td colspan="2">Top View</td><td>Front View</td><td colspan="4">3D Modeling</td></tr>
<tr><td colspan="2"> 
</td><td> 
</td><td colspan="4">  </td></tr>
<tr><td>Environmental Sustainability Criteria</td><td>BC</td><td>BT</td><td>Social Sustainability Criteria</td><td>BC</td><td>BT</td></tr>
<tr><td>1) It uses recyclable and reused material selection.</td><td>√</td><td>√</td><td>1) It provides equitable use.</td><td></td><td></td></tr>
<tr><td>2) It provides waste minimization.</td><td></td><td></td><td>2) It provides flexible use.</td><td></td><td></td></tr>
<tr><td>3) It uses natural materials with low chemical content.</td><td></td><td></td><td>3) It provides tolerance for error.</td><td></td><td></td></tr>
<tr><td>4) It provides simplicity and source reduction.</td><td></td><td></td><td>4) It requires low physical effort.</td><td></td><td></td></tr>
<tr><td>5) It uses long-lasting material with high strength.</td><td>√</td><td>√</td><td>5) It provides size and space for approach and use.</td><td></td><td></td></tr>
<tr><td>6) It uses local resources to reduce transport energy.</td><td></td><td></td><td>6) It provides users with social communication area.</td><td>√</td><td>√</td></tr>
<tr><td>7) It is easy to produce using minimum energy consumption.</td><td></td><td></td><td>7) It provides aesthetic harmony with the local atmosphere.</td><td></td><td></td></tr>
<tr><td>8) It provides easy assembly and disassembly.</td><td></td><td></td><td>8) It provides community outreach and involvement.</td><td></td><td></td></tr>
</table>

9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.		
10) It is easily repairable.			10) It helps to construct social relations with people with various physical characteristics.		

Evaluation Comment

In the Leon cafe example, the bar table and bar chair were chosen for the case study. This example was chosen because it has a strong existing potential and has not been used sufficiently in the current design.

When the bar chair example is examined, it has a recyclable structure with metal and wood material selection. Due to the nature of the metal material, it can contribute to environmental sustainability by providing long-lasting use. However, dense metal parts used in chair design aesthetically can cause energy loss. Also, combining metal parts by welding method may cause more resource consumption in the product packaging section. When evaluated in terms of social sustainability, it contributes to space in terms of aesthetics and functionality and communicates with the environment. However, this chair, which has a weighty structure, requires high physical effort. Especially elderly users find it very difficult to use such heavy furniture. Besides, the dimensions of the chair do not provide an equitable use for short and overweight users. If the adjustable height feature and the soft, wider seat were used as a suggestion, more comfortable furniture would have been provided for all users.

When the bar table sample is examined, there is a design with a metal framework that receives structural support from a metal-clad column. The upper part of the table is covered with a wooden plate. When evaluated in terms of environmental sustainability, wood and metal materials can have a positive effect in terms of being recyclable. It can also offer long-lasting use. However, since the bar table's metal is combined with the column metal welding method, assembly and disassembly problems may occur. Since the energy consumed during metal material production is high and there is no local material, it can harm the environment. The shiny metal paint applied to the metal, and its chemicals may adversely affect those working indoors. A more positive effect in environmental sustainability could have been achieved if it consisted of recycled aluminum combined with screwing instead. In terms of social sustainability, the bar table's dimensions have a certain standard, but in this design, potentially, a rail system could be installed with the metal leg at the front end of the table. In this way, short people and physically disabled individuals who came to spend time in Leon cafe could adjust the table size according to their physical ergonomics and provide an equitable use.

Table 26: Checklist chart 6 (Bigfoot Cafe)

Sustainable Furniture Design Checklist

Furniture Group Photo

Place Name: Bigfoot Cafe

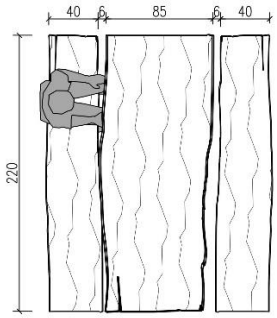
Types of Furniture:

- Bench (B)
- Table (T)

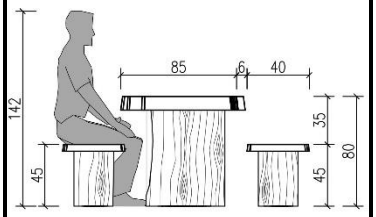
Furniture Materials:

- Bench Materials: Natural Tree Stump, Vernish And Wood.
- Table Materials: Natural Tree Stump, Natural Vernish And Wood.

Top View



Front View



3D Modeling

Environmental Sustainability Criteria	B	T	Social Sustainability Criteria	B	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.		√
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.	√	√	3) It provides tolerance for error.		
4) It provides simplicity and source reduction.	√	√	4) It requires low physical effort.		
5) It uses long-lasting material with high strength.	√	√	5) It provides size and space for approach and use.	√	√
6) It uses local resources to reduce transport energy.	√	√	6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.	√	√	7) It provides aesthetic harmony with the local atmosphere.	√	√
8) It provides easy assembly and disassembly.	√	√	8) It provides community outreach and involvement.		√
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.		√

10) It is easily repairable.	√	√	10) It helps to construct social relations with people with various physical characteristics.		√

Evaluation Comment

When we examine the Bigfoot example, bench and table furniture was chosen. In the case analysis study conducted for sustainable furniture design assessment, the common furniture set with the highest score in environmental sustainability is the Bigfoot cafe's furniture.

Since they are made of the same material, when we examine the bench and table example together, we see the legs of a log and a natural wooden seating area. According to the information given by the owner of the place, the logs used in this furniture group were grown with a sustainable forest project and produced from fast-growing industrial trees. The water-based natural varnish is applied to the furniture. When it is examined in terms of environmental sustainability, using easily recyclable raw billets has been a successful work with this information. Perhaps these products can serve different functions by producing different furniture from those log pieces in the future. A simple design has emerged by using only one type of material and processing it at a minimum level. Since the raw material is used, the energy consumed during its production is at low levels. Since they work with a local industrial wood producer in Çanakkale, the energy spent on transportation has been kept to a minimum. Small metal apparatuses combine the log legs with natural wood, thus providing both a durable design with long life and easy assembly and disassembly feature. However, the feature that poses a problem in environmental sustainability is that using large parts can increase the resource to be spent during packaging. When examined in terms of social sustainability, the biggest difference between them is that they do not appeal to every segment of the society due to the bench design and ergonomic features. The dimensions of the table are suitable for the approach of an individual with a wheelchair. Both provide users with the possibility of social communication. Both furniture needs improvement in fault tolerance. For example, the lack of a backrest in bench furniture can cause various problems. Since both are designed using natural products, they do not adversely affect human health. However, due to the ergonomic structures of the bench and table, it does not allow correct posture, which may cause spinal disorders in long-term use.

Table 27: Checklist chart 7 (Duvar Dibi)

Sustainable Furniture Design Checklist

Furniture Group Photo

Place Name: Duvar Dibi

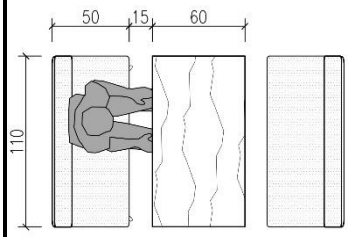
Types of Furniture:

- Bench (B)
- Table (T)

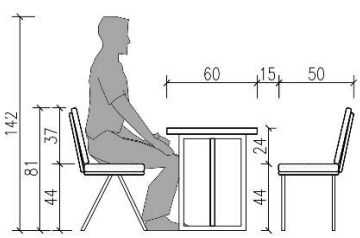
Furniture Materials:

- Bench Materials: Metal, Fabric Cushion and MDF Wood.
- Table Materials: Acrylic MDF paint, MDF wood and metal.

Top View



Front View



3D Modeling

Environmental Sustainability Criteria	B	T	Social Sustainability Criteria	B	T
1) It uses recyclable and reused material selection.	√	√	1) It provides equitable use.	√	
2) It provides waste minimization.			2) It provides flexible use.		
3) It uses natural materials with low chemical content.			3) It provides tolerance for error.		
4) It provides simplicity and source reduction.	√		4) It requires low physical effort.		
5) It uses long-lasting material with high strength.	√	√	5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.			6) It provides users with social communication area.	√	√
7) It is easy to produce using minimum energy consumption.			7) It provides aesthetic harmony with the local atmosphere.		
8) It provides easy assembly and disassembly.			8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.			9) It does not adversely affect human spine health by providing the correct posture.	√	

10) It is easily repairable.			10) It helps to construct social relations with people with various physical characteristics.		

Evaluation Comment

Metal material was chosen as the frame in the bench and table design and MDF woods were used as the top cover. When we look at environmental sustainability, the materials used are recyclable materials. Metal material can contribute to environmental sustainability with its long service life and high strength. However, apart from all these criteria, difficult assembly-disassembly stages due to the high energy required during their production, the chemicals they contain and the method of joining by welding are features that can negatively affect environmental sustainability. In addition, the absence of local materials and the fact that it consists of large parts can cause an increase in energy consumption in transportation and a harmful effect on the environment. When examined in terms of social sustainability, the two furniture are suitable for function and create harmony that communicate with their surroundings. However, both do not have features such as the use of social equality, flexible use and low physical effort. Therefore, both can have a negative impact on social sustainability.

In this section, checklist tables are tested on case studies. The checklists applied on the table, and chair furniture elements for cafes are discussed in terms of environmental and social sustainability. The researcher conveyed his various suggestions as comments for improving the furniture elements evaluated in the checklist. It is seen that the number of criteria marked in terms of environmental sustainability in the evaluated furniture elements is higher than the social sustainability criteria. In the next section, the data obtained are discussed separately under environmental and social sustainability headings, and the prepared checklist is evaluated.

5.4 Discussion

In order to collect data for the checklist, the researcher visited the cafe areas and experienced the furniture in place. First, the researcher determined the furniture in the cafe areas researcher visited that would be suitable for the research topic. Afterward, the researcher decided that the table and chair furniture groups in the cafe would be

suitable for the potential of the research. The table and chair furniture in the cafe areas were measured using the measuring tool and transferred to the paper as a sketch. Afterward, it was tried to create a more quantitative observation by modeling the furniture by using AutoCAD and SketchUp programs in the computer environment. Furniture designs in cafe areas are handled with a sustainable design approach. The environmental and social sustainability criteria prepared in the checklist are evaluated on the furniture in the cafe areas within the framework of various criteria, including anthropometric measurements, material type, material strength, flexible use, and inclusiveness. Of course, the possibility of finding a furniture design that fully meets all these criteria cannot go beyond an epic thought. Because the furniture examined is furniture that has already been designed and put into use. The aim here is to put the work into practice by experiencing the checklist on furniture and providing comments with suggestions for design improvement. During the evaluation phase of the furniture, the researcher also benefited from the cafe owners' personal information, such as from which companies the furniture was purchased and whether there was a certification label for the furniture. In the continuation of this section, the data of the checklist table created for each cafe sample were handled separately under the headings of environmental and social sustainability, and the comparison of meeting the criteria in the checklist was tried to be expressed with tables.

5.4.1 Evaluation in terms of Environmental Sustainability

The relationship between nature and human beings has passed through different phases from the past to the present and is constantly renewed, establishing a system that interacts with each other. Since the concept of sustainability has a multidimensional structure, it is discussed in various parts. The ecological problems that have emerged with the increasing consumption of resources and energy in the world have led to the

discussion of the term environmental sustainability. The concept of environmental sustainability, which has become a necessity rather than a choice with the effect of ecological problems, has become a responsibility that architects and interior architects should consider while creating their designs. In this study, while making the checklist criteria for environmentally sustainable furniture design, it has been tried to include standards that will prevent the occurrence of problems in addition to reducing environmental damage. Thus, designers can ensure that these problems are minimized at the initial stage of responsible furniture design. Tables 28 and 29 show the comparison of chairs and table furniture in seven cafes, for which case studies were conducted, in terms of environmental sustainability criteria.

Table 28: Evaluation of the Environmental Sustainability Furniture criteria checklist among cafes (Chair-Bench).

Environmental Sustainability Furniture Criteria (Chair-Bench)	**Lodos Café**	**Fiyaka Cafe**	**Özsüt**	**Hangover Cafe**	**Leon Cafe**	**Bigfoot Cafe**	**Duvar dibi**
1) It uses recyclable and reused material selection.							
2) It provides waste minimization.							
3) It uses natural materials with low chemical content.							
4) It provides simplicity and source reduction.							
5) It uses long-lasting material with high strength.							

6) It uses local resources to reduce transport energy.							
7) It is easy to produce using minimum energy consumption.							
8) It provides easy assembly and disassembly.							
9) It consists of small parts and can be packaged with less material.							
10) It is easily repairable.							

Table 29: Evaluation of the Environmental Sustainability Furniture criteria checklist among cafes (Table).

Environmental Sustainability Furniture Criteria (Table)	**Lodos Café**	**Fiyaka Cafe**	**Özsüt**	**Hangover Cafe**	**Leon Cafe**	**Bigfoot Cafe**	**Duvar dibi**
1) It uses recyclable and reused material selection.							
2) It provides waste minimization.							
3) It uses natural materials with low chemical content.							

4) It provides simplicity and source reduction.							
5) It uses long-lasting material with high strength.							
6) It uses local resources to reduce transport energy.							
7) It is easy to produce using minimum energy consumption.							
8) It provides easy assembly and disassembly.							
9) It consists of small parts and can be packaged with less material.							
10) It is easily repairable.							

In Table 28 and Table 29, cafe furniture with the same criteria is painted in the color determined for that criterion, and comparisons are made. The first point that stands out in this overall assessment is that recyclable materials have been used in chair and table designs in all cafes. This is because the main materials used for furniture in such spaces are wood and metal. Because today, with the development of technology, many materials have become recyclable.

It provides waste minimization: When furniture designs in cafes are examined in terms of this criterion, it is seen that no design meets this criterion. Solid waste reduction is a principle that aims to minimize the damage to the environment by creating a reuse or recycling plan, especially for furniture that occurs during the production phase and then ends its useful life.

It uses natural materials with low chemical content: This criterion is limited to the application of only two chairs and one table. When raw materials are obtained from trees that grow in sustainable forests and overgrow, environmental damage is minimized.

It provides simplicity and source reduction: When cafe furniture is evaluated, it is seen that four of the seven chairs and tables meet this criterion. The use of simple and fewer materials is a principle that positively affects nature in terms of providing less resource consumption in terms of environmental sustainability. waste.sustainability.

It uses long-lasting material with high strength: The second most applied criterion for chair and table designs is the use of long-lasting materials. In this criterion, durable furniture is preferred not only by considering environmental conditions but also by considering economic conditions.

It uses local resources to reduce transport energy: It is seen that the criterion of local resource use is applied in three chair designs and two table designs. The use of local resources positively affects the environment by reducing the energy consumed in transportation.

It is easy to produce using minimum energy consumption: When the furniture designs on the heads are examined in terms of the criterion of being easy to produce with low energy use, it is seen that only two chair designs and one table design meet this criterion. The fact that a design is easy to produce and the low energy consumed during production is essential in environmental sustainability.

It provides easy assembly and disassembly: When the easy assembly and disassembly criteria are examined, it is seen that three different chair and table designs provide this feature. In particular, chairs and tables with metal frames prefer to use the welding method. However, this situation harms the environment by causing high energy use and increasing the material required for packaging.

It consists of small parts and can be packaged with less material: When furniture designs are evaluated in terms of material reduction criteria during packaging by consisting of small parts, it is seen that only the chair design in Lodos Kafe meets this criterion. Unfortunately, many designers and manufacturers do not tend to reduce materials such as plastic, paper, and cardboard that will be spent in the packaging phase when creating furniture design.

It is easily repairable: When the easily repairable criterion is examined, it is seen that three different chair and table designs meet this feature. If a design can be easily repaired, in case of damage, it will be reused instead of throwing it away and creating environmental pollution, preventing unnecessary material waste.

When the analysis is made in general, when the chair and table selections in cafes are carefully examined, it is seen that furniture designed with environmental concerns is

few. Apart from the chair and table choices in Lodos cafe and Bigfoot cafe, it is seen that there is much less sensitivity to environmental sustainability in other cafes. As a result, it can be said that aesthetic and economic concerns take precedence over environmental concerns. In the next section, the criteria of cafe furniture in terms of social sustainability are examined.

5.4.2 Evaluation in terms of Social Sustainability

In order to create a sustainable design, environmental conditions are essential as well as a fundamental issue that should be taken into account in social situations. The concept of social sustainability is the basic building block of creating a balanced society character based on the principle of recognizing and respecting the rights of all individuals, especially sensitive groups such as children, the elderly, and the disabled, without discrimination among people. The need for an inclusive design approach is increasing in public spaces used jointly by the individuals in the society, with the prolongation of life expectancy and the increase in the number of disabled individuals in the increasing population with the developing technology in the world. The social sustainability problem has a vast literature, including development-oriented, environment-oriented, human-oriented, and culture-oriented. Architects and interior designers have a direct role in society with the human factors impact. Designers have important social sustainability responsibilities through values, social rights, and social relations. This study focuses on the human-oriented social sustainability approach in responsible furniture design. It evaluates the furniture in cafe spaces through basic concepts such as the inclusivity of the furniture in society and its contribution to socialization. Tables 30 and 31 show the comparison of chairs and table designs in the seven cafes studied in terms of social sustainability criteria.

Table 30: Evaluation of the Social Sustainability Furniture criteria checklist among cafes (Chair-Bench).

Social Sustainability Furniture Criteria (Chair-Bench)	**Lodos Café**	**Fiyaka Cafe**	**Özsüt**	**Hangover Cafe**	**Leon Cafe**	**Bigfoot Cafe**	**Duvar dibi**
1) It provides equitable use.							
2) It provides flexible use.							
3) It provides tolerance for error.							
4) It requires low physical effort.							
5) It provides size and space for approach and use.							
6) It provides users with social communication area.							
7) It provides aesthetic harmony with the local atmosphere.							
8) It provides community outreach and involvement.							
9) It does not adversely affect human spine health by providing the correct posture.							

10) It helps to construct social relations with people with various physical characteristics.							

Table 31: Evaluation of the Social Sustainability Furniture criteria checklist among cafes (Table).

Social Sustainability Furniture Criteria (Table)	**Lodos Café**	**Fiyaka Cafe**	**Özsüt**	**Hangover Cafe**	**Leon Cafe**	**Bigfoot Cafe**	**Duvar dibi**
1) It provides equitable use.							
2) It provides flexible use.							
3) It provides tolerance for error.							
4) It requires low physical effort.							
5) It provides size and space for approach and use.							
6) It provides users with social communication area.							
7) It provides aesthetic harmony with the local atmosphere.							
8) It provides community outreach and involvement.							

9) It does not adversely affect human spine health by providing the correct posture.							
10) It helps to construct social relations with people with various physical characteristics.							

It provides equitable use: When the furniture designs in the cafe areas are evaluated with the criteria of equitable use, it is seen that four furniture designs for chair designs and 3 furniture designs for table designs provide this factor. The principle of equitable use includes meeting the furniture needs of individuals with different physical characteristics in a fairway. The critical point in this principle is to prevent exclusion from society by increasing the inclusiveness of the designed furniture. For example, the height of the table design in Lodos cafe is 77 cm, and it also provides the 60 cm space required for the approach of a wheelchair user. Thus, while a wheelchair user is socializing in the Lodos cafe, they can meet their sitting area needs without the help of someone else, and fair use is achieved.

It provides flexible use: With the principle of flexible use, furniture changes shape according to the needs of different users, creating an inclusive design feature. In the case studies, no cafe furniture is suitable for flexible use. Flexible use is also a principle that contributes to environmental sustainability by providing more functions with less material. The bar table in the Leon Cafe example is a design with the potential for flexible use. If a height-adjustable rail system was used on the bar table, it could turn

into a design that could help individuals with different physical characteristics meet their needs when they come to the cafe.

It provides tolerance for error: Humans are one of the most prone to make mistakes. Especially, children or elderly individuals are more prone to make mistakes while using furniture due to decreased physical abilities. In cafe furniture, only three different chair designs can meet the fault tolerance criteria.

It requires low physical effort: Low physical effort criterion is one of the essential factors to ensure fair furniture use. For example, high-weight chair designs can create significant problems for people from different segments of society, such as disabled individuals, children, and elderly users. Despite this fact, only one chair and table design meet this feature in the furniture designs in the selected cafe areas.

It provides size and space for approach and use: The concept of the approach area, determined by anthropometric measurements, is of great importance, especially for wheelchair users to benefit from furniture designs fairly. In addition, the principle of size and approach area plays a critical role in individuals with different physical characteristics. According to the case study studies, two different chair and table designs can meet this principle.

It provides users with social communication area: It is the only criterion that is met in all of the furniture in the cafe areas. The factor of providing a social communication space is that they are designs that enable people to communicate comfortably, especially when they go to these cafes. For example, if there was an extremely long

table design, the people sitting at the table might have difficulty communicating with each other.

It provides aesthetic harmony with the local atmosphere: Furniture designs interacting with the local atmosphere create harmony by harmonizing with the whole city. For example, Çanakkale is one of the cities rich in forest assets. Primarily, forest villages provide their livelihood from wood and wood products and contribute to wooden furniture production. In addition, the fact that the Trojan horse, which has become the symbol of the city of Çanakkale, is made of wood encourages the furniture in the cafes to be wooden design. In addition, the local material to be used to provide the local atmosphere also contributes to environmental sustainability. Three chair and table furniture designs from the sample cafe spaces meet this criterion.

It provides community outreach and involvement: The criterion of access and participation in society is of great importance for the concept of human-oriented social sustainability. Because the equal and fair use of public spaces by all individuals in the society is of great importance for ensuring social sustainability. Cafe spaces are also places that must be designed with an objective use for individuals with different characteristics from all segments of society. In particular, furniture designs are a factor that will help individuals with different characteristics people to come to cafe places and mingle with society, and socialize. Because many disabled individuals think that people will get lost in stereotyped socialization norms, they withdraw into their own individual shells and isolate themselves from society.

It does not adversely affect human spine health by providing the correct posture: Various standards have been developed according to anthropometric measures in

furniture design. For example, in order to provide a correct posture, the back angle of the chairs should be 105 °, and the height from the ground is 45 cm. The dimensions are calculated for the most suitable position by researching the human anatomy. These dimensions are of great importance for the health of the spine, especially in furniture design. Only one of the chair designs and three table designs in the examined cafe areas have this feature.

It helps to construct social relations with people with various physical characteristics: The number of individuals with different physical characteristics in the world is increasing day by day. It is one of these individuals' most fundamental rights and freedoms to establish social relations with all other people in public spaces. Individuals with different characteristics can be divided into two general definitions as physical and mental characteristics. In this study, the problems of individuals with physical differences are mainly discussed. This is because a more comprehensive literature study and in-depth research that should be done for individuals with different mental characteristics can create more substantial effects. For example, individuals with autism may have some desires such as hypersensitivity to environmental stimuli (light, noise, etc.), the desire to turn to and touch objects with specific characteristics (for example, bright objects). Individuals with mental characteristics who have problems with socialization can be examined in future studies with more comprehensive research. In the case study examined, none of the chair designs can fully meet this feature. In addition, only two different table designs can meet this criterion.

As shown in Tables 30 and 31, furniture designs in cafe areas, unfortunately, do not perform sufficiently in terms of social sustainability. In the case study, the concept of

social communication, which is the functional focus of cafes, is only met by every piece of furniture. However, if other social sustainability criteria are not applied, it is impossible to obtain designs that appeal to all segments of society and create inclusiveness by providing fair use. This study shows that table and chair furniture used in cafe areas have different characteristics in terms of environmental and social factors. In the study, environmental and social sustainability factors were obtained by using the systems developed by various organizations. The aim here is to transform the complex scoring systems of these certification systems into simple checklists to encourage designers for sustainable design in the first phase of design. According to the examinations made in seven different cafe places, most of the furniture used is insufficient for sustainable design. This research shows that designers need to be more conscious and take action for sustainable design. design.

Chapter 6

CONCLUSION

The primary purpose of this research is to raise awareness among architects, interior designers, and all furniture designers by discussing the factors that furniture design needs in terms of environmental and social sustainability in responsible furniture design. Today, energy resources are decreasing day by day, and with the effects of global warming, some consequences can endanger living life in the world.

Roy T. Bennett has an excellent quote about change; “It is only after you have stepped outside your comfort zone that you begin to change, grow, and transform” (cited in “The Light in the Heart” book, 2016). As it can be understood from this statement, the moment architects and interior designers begin to step out of their comfort zones, they will begin to grow and transform in their designs. When furniture designs in the current system were examined, designers such as Gunnar Aagaard Andersen and Peter Murdoch in the early 1950s succeeded in taking the first bold steps of change in the name of sustainable furniture design (Yararel & Sever, 2019). In the following years, it started to be discussed in the Stockholm Conference held in the 1970s that sustainability is more of a requirement design than an alternative design. Although the concept of sustainability is discussed for larger-scale designs such as the sustainability of buildings in general, thanks to these discussions, the importance of the user profile in buildings and product design on sustainable design have begun to be understood. Life-long assessment and design concepts such as cradle to cradle have demonstrated

that sustainable design cannot be achieved with a linear approach but should be seen as a circular concept that all steps interact with each other. In particular, it is aimed to reduce environmental damage to zero with the concept of recycling and re-use at the end of good sustainable design life.

Sustainability criteria in furniture design began to be established according to ISO standards. Later, independent organizations established their own green furniture certification systems and determined various sustainability criteria. These criteria served as a data collection tool in the thesis study and helped shape the checklist created at the end of the research. In this study, the checklist criteria were developed by considering the common items of these systems by using LCA standards, Level Certification, FSC certification, and Universal Design Principles while creating the checklist. The standards preferred in this study are the most known and preferred certificates in the evaluation of furniture design in terms of sustainability. The Life Cycle Assessment (LCA) standard, which was created specially based on ISO criteria, has been taken as the basis for the general outlines of the basic items of the checklist since it has titles and contents such as resources, material processing, distribution, use and end of life.

When the sustainable furniture criteria are examined, it is seen that the score allocated to environmental sustainability is higher, while social sustainability has less impact. Of course, the reliability of these green furniture certification systems, which emerged as a result of long and arduous research, cannot be disputed. However, since the existing certification systems include scoring criteria with a complex structure, they create problems in terms of traceability. According to the research, it has been concluded that the checklist tool is more useful and applicable to make an evaluation

in the comparison between the evaluation tools of sustainable designs. For this reason, in this study, the sustainability problems of furniture are discussed from environmental and social aspects by using the checklist tool. While designing furniture, designers need to be sensitive to human-centered, socially sustainable design as well as to the environment. Therefore, this thesis aims to develop a checklist in which both factors have equal influence. Thus, socially sustainable design is also inspired by universal design principles, in which all users in society can be accepted as participants. In this way, a socially sustainable design should appeal to users with all physical characteristics in society. For example, instead of making separate designs for right-handed and left-handed users, designing furniture that can be used flexibly both creates social cohesion and creates environmental sustainability and social sustainability. The studies conducted in the literature study concluded that the concept of social sustainability includes many approaches. While examining the concept of social sustainability, the researcher put forward the idea that adopting a human-oriented approach in furniture design may be more beneficial for this study. One of the reasons for this is that furniture design and the human factor are directly related to design stages, such as anthropometric measures, egalitarian approaches, and inclusiveness. Considering these conditions, the criteria created for the concept of social sustainability have been shaped.

Cafe spaces were chosen for the case analysis study because they are among the most popular public spaces where society goes to socialize as a shared space. One of the main purposes of this research is to convey the awareness that social sustainability is as important as environmental sustainability for sustainable design. In addition, research has shown that designers have difficulty using and following complex green

furniture certification criteria. In order to encourage designers to design sustainable furniture in the initial phase of design, this checklist, which is easier to follow according to the green furniture certification systems, was created.

In conclusion, when the furniture in the cafe spaces in Çanakkale is examined, it is observed that some of them have done positive works in environmental sustainability. However, when the furniture used in cafe areas is examined in terms of social sustainability, it is evident that this furniture needs greater improvement. The biggest reason for this is that the concept of social sustainability is not given as much importance as environmental sustainability. The owners of the place give more importance to the aesthetic dimension of the furniture due to economic concerns instead of the ergonomic and functional dimensions of the furniture. However, it should not be forgotten that all individuals living in society have equal rights. They have the right to use the socialization places at the most optimal level. Also, every healthy individual in society is a candidate to lose various physical characteristics in the future. Therefore, if designers give critical importance to environmental sustainability and social sustainability, especially in furniture designs, it may result in more positive results.

In this study, an evaluation list was created by considering sustainable furniture design's environmental and social aspects. However, both the concept of social sustainability and environmental sustainability are concepts with broad research topics integrated with many different disciplines. This study aims to start with baby steps for sustainable design. In future research, issues such as employee rights, working conditions, and the contribution of local economic employment to sustainable furniture design can be discussed under the title of social sustainability. Thus, this checklist,

prepared as an initial stage for designers, can be renewed and improved to reach more comprehensive results. From a different point of view, in this study, the checklist criteria that evaluate furniture designs in terms of social sustainability are mainly based on examples of individuals with different physical characteristics. In future studies, it will be helpful to determine the needs of individuals with mental characteristics through a more exhaustive literature review and contribute to the development of checklist criteria. In this thesis, furniture designs are discussed regarding environmental and social responsibilities that designers have more authority over and can directly affect. As a suggestion for further research the checklist, can be evolved considering the economical sustainability factors related to the user, manufacturer, and designers.

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APPENDIX

Checklist Chart

Sustainable Furniture Design Checklist						
Furniture Group Photo				**Place Name:**		
				Types of Furniture:		
				Furniture Materials:		
Top View	Front View			3D Modeling		
Environmental Sustainability Criteria				Social Sustainability Criteria		
1) It uses recyclable and reused material selection.				1) It provides equitable use.		
2) It provides waste minimization.				2) It provides flexible use.		
3) It uses natural materials with low chemical content.				3) It provides tolerance for error.		
4) It provides simplicity and source reduction.				4) It requires low physical effort.		
5) It uses long-lasting material with high strength.				5) It provides size and space for approach and use.		
6) It uses local resources to reduce transport energy.				6) It provides users with social communication area.		
7) It is easy to produce using minimum energy consumption.				7) It provides aesthetic harmony with the local atmosphere.		
8) It provides easy assembly and disassembly.				8) It provides community outreach and involvement.		
9) It consists of small parts and can be packaged with less material.				9) It does not adversely affect human spine health by providing the correct posture.		
10) It is easily repairable.				10) It helps to construct social relations with people with various physical characteristics.		
Evaluation Comment						