EVALUATION OF THE SUSTAINABILITY IN HIGH-RISE BUILDINGS

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EVALUATION OF THE SUSTAINABILITY IN HIGH-RISE BUILDINGS

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ABSTRACT

EVALUATION OF THE SUSTAINABILITY IN HIGH-RISE BUILDINGS

With the increasing population, there is a shortage of natural resources and space in the world. Considering today, where problems such as scarcity of vacant lands, increase in carbon footprint, global warming danger and drought make themselves felt, it is almost inevitable that high-rise buildings will increase in the future. Since high buildings take up less space, it is possible to obtain a more organized city and less costly infrastructure (transportation, electricity, communication, water-wastewater, natural gas, etc.) with high-rise buildings. This reduces the carbon footprint and turns the world into a livable place. On the contrary, it can also harm the plants and animals living in nature, affect the transportation and psychology of the people living in that area, disrupt the fabric of the city, and even be nothing more than a pile of concrete and iron. In this respect, many assessment tools have been developed for the evaluation of high-rise buildings and for guiding the future. LEED, BREEAM, GREENSTAR, CASBEE, HK BEAM, DGNB, BEAT and ATHENA are some of these assessment tools. The most used and best five of these tools made in our thesis is to collect them under common topics. According to the evaluation scores and credits given to these subject titles, the importance levels of the main titles of the evaluation tool in the thesis were determined, and a score distribution was made accordingly. Although the evaluation questions in the thesis are unique in some places, they are generally based on the evaluation questions of these five tools. Unlike other tools, thanks to this tool, which is based on sustainability while constructing high-rise buildings regardless of location and region, where everyone can answer with more understandable and simple questions and evaluate their own building, meeting on a common denominator between countries, high-rise buildings to be constructed in accordance with this sustainability will guide the future. and to make the future more livable. Another aim is to turn these evaluation questions into a simple handbook and to be able to access and use them on the website or in the form of a booklet by local governments or municipalities. The tool created in the thesis was applied on the total of twelve high-rise buildings in Turkey. As a result, it is necessary to give more importance to the sustainability of high-rise buildings, and to carry out the necessary inspections and practices while constructing high-rise buildings.

ÖZET

YÜKSEK BİNALARDA SÜRDÜRÜLEBİLİRLİĞİN DEĞERLENDİRİLMESİ

Artan nüfusla birlikte dünyada doğal kaynak ve yer sıkıntısı çıkmaktadır. Boş arazilerin azlığı, karbon ayak izinin artması, küresel ısınma tehlikesi ve kuraklık gibi sorunların kendisini hissettirdiği günümüze bakarak, yüksek binaların gelecekte daha da artması nerdeyse kaçınılmazdır. Yüksek binalar daha az yer kapladığı için yüksek binalar ile daha düzenli bir şehir ve daha az maliyetli altyapı (ulaşım, elektrik, haberleşme, su-atıksu, doğalgaz, vb.) elde etmek mümkündür. Bu da baktığınızda karbon ayak izini azaltır ve dünyayı da yaşanılabilir bir yere çevirir. Bunun aksine aynı zamanda doğada yaşayan bitki ve hayvanlara zarar verebilir, o bölgede yaşayan insanların ulaşımını ve psikolojlerini etkileyebilir, şehrin dokusunu bozabilir, ve hatta beton ve demir yığınından başka bir şey olmayabilir. İşte bu bakımdan yüksek binaların değerlendirilmesi ve geleceğe dönük yol göstermesi için pekçok değerlendirme toolları geliştirilmiştir. LEED, BREEAM, GREENSTAR, CASBEE, HK BEAM, DGNB, BEAT ve ATHENA bu değerlendime toollarından bazılarıdır. Tezimizde yapılan bu toollardan en çok kullanılan ve en iyi beş tanesini seçip onları ortak konu başlıkları altında toplamaktır. Bu konu başlıklarına verilen değerlendirme puanlarına ve kredilere göre, tezde bulunan değerlendirme toolunun ana başlıklarının önem dereceleri belirlenmiş, ona göre bir puan dağılımı yapılmıştır. Tezdeki değerlendirme soruları yer yer kendine özgün olsa da genel olarak bu beş toolun değerlendirme soruları baz alınarak oluşturulmuştur. Diğer toollardan farklı olarak, daha anlaşılır ve basit sorular ile herkesin yanıtlayabileceği ve kendi binasını değerlendirebileceği, ülkeler arası ortak bir paydada buluşan, yer ve bölge farketmeksizin yüksek binalar yapılırken sürüdürülebilirliği esas alan bu oluşturulan tool sayesinde, bu sürdürülebiliğe uygun şekilde inşa edilecek yüksek binaların geleceğe yön vermesi ve geleceği daha yaşanılabilir kılması amaçlanmıştır. Bu değerlendirme soruları basit bir el kitapçığı haline getirilip internet sitesi üzerinden veya kitapçık halinde yerel yönetimlerce veya belediyelerce erişilebilmesi ve kullanabilmesi yine bir diğer amaçtır. Tezde oluşturulan tool Türkiye'de toplam on iki yüksek bina üzerinde uygulanmıştır. Bunun sonucunda yüksek binaların sürdürülebilirliği konusuna daha çok önem verilmesi, yüksek binalar yapılırken gerekli denetim ve uygulamaların yapılması gerekmektedir.

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LIST OF SYMBOLS/ABBREVIATIONS

L	The environmental loads of the building
LR	The environmental load reduction of the building
Q	The building quality and performance
D	Disaster
S	Social
EC	Economic
EN	Environment
DQ	Disaster question
SQ	Social question
ECQ	Economic question
ENQ	Environment question
BEE	The building environmental efficiency
C°	Centigrade
dB	Decibel
t	Time
m	Meter
n	The number of floors
CO_2	Carbon dioxide
CO	Carbon monoxide
Hz	Hertz
HCFC	Hydro chlorofluorocarbon
CFC	Chlorofluorocarbon
LEDs	Light-emitting diode in electronics
etc.	Et cetera
e.g.	For example
UK	United Kingdom
USA	United States of America
UAE	United Arab Emirates

CTBUH	The Council on Tall Buildings and Urban Habitat
BREEAM	The Building Research Institution Environmental Assessment Method
LEED	The Leadership in Energy and Environmental Design
CASBEE	The Comprehensive Assessment System for Building Environmental Efficiency
HK BEAM	The Hong Kong Building Environmental Assessment Method
BRE	The Building Research Institute
EPRI	The Electric Power Research Institute
BSL	The BEAM Society Limited
ASHRAE	The American Society of Heating and Air-Conditioning Engineers
LSURPD	The Lagos State Urban and Regional Planning Development
BIM	The Building Information Modeling
HVAC	The Heating, Ventilation, and Air-Conditioning
LCA	The Life Cycle Assessment
BEAT	The HELCOM Biodiversity Integrated Assessment Tool
EQUER	The French Evaluation Campaign of Question-Answering Systems
PAPOOSE	The Programming and Analysis of Works Projects and Operations Concerned with the Environment in French
TEAM	The Team Emergency Assessment Measure in French
ATHENA	The Sustainable Materials Institute in North America
LEGEP	The German Tool for Integrated Life-Cycle Analysis
CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
CEPAS	The Comprehensive Environmental Performance Assessment Scheme
DGNB	The German Sustainable Building Council
ESCALE	The Assessment Method of Buildings Environmental Performance
EEWH	The Taiwan Ecology, Energy Saving, Waste Reduction and Health Tool
GOBAS	The Green Olympic Building Assessment System
HQE	The High Environmental Quality
IDP	The Integrated Design Process

MSBG	The State of Minnesota Sustainable Building Guidelines
NABERS	The National Australian Built Environment Rating System
SBAT	The Sustainable Building Assessment Tool
TERI	The Energy and Resources Institute
TQ	The Total Quality Assessment
GBTool	The Green Building Assessment Tool in Canada
BEES	The Building for Environment and Economic Sustainability

1. INTRODUCTION

After the industrial revolution in the 19th century, scientific and technical developments had accelerated. Economic development and enrichment have become both cause and result of scientific development. During this period, there have been important developments in many sectors such as construction, machinery, technology, food, and textile, and the need for the employee in these fields has arisen as a result. Thus, more job opportunities in the cities were created and various positive changes were experienced in the structure of cities. So, cities have become more attractive to people and rapid migration from rural to urban has started. As a result of the rapid migration, more dense and irregular settlements have emerged. With the increasing population, large spaces were built in the city centers to meet the need of administrative, military, commercial, religious, and social institutions and communities. Due to these spaces requiring a very large area, inevitably, the city growth models have changed from horizontal spreading to vertical growth. These limited land resources increased the demand for tall buildings [1]. At first, the number of floors that a building could have was limited; however, the limits had begun to be enhanced in vertical with the developed technology. The high-rise buildings have continuously developed with the help of technological developments in many areas like the invention of the elevator and the booster, the use of steel in the carrier system, the fire safety system, lighting and ventilation systems, facade, floor, reinforced concrete, and foundation. At present, technology continues to push the boundaries and extend the limits of tall buildings [2]. High-rise buildings are used today as residences, hotels, offices, or both housing-office.

The definition of the ‘tall building’ has been made by many researchers and experts over time, but it has never had a certain definition and its definition has constantly varied according to the period and the country. So, defining the ‘tall building’ can be quite complicated. Even the term ‘high’ varies from person to person. For example, a person may be the tallest at school and the shortest next to basketball players. It is the same for the buildings. While a 5-storey building can be seen as high in the rural area, 45-storey buildings in cities may be considered as high buildings. If it is needed to define the “tall buildings”, the author can define as follows:

"High-rise buildings are the buildings that are at least 10-15 times higher than the average height of the buildings built in the same period of time."

Besides, each country has different standards for the definition and classification as mentioned above. In Germany, the criteria for high-rise buildings were identified as 22 meters in height, while this height threshold was determined as 10 stories in Turkey and 12 stories in the United States [2]. The terms 'tall building', 'high-rise building', 'skyscraper', 'supertall building', and 'megatall building' have been defined in many ways in the literature. These definitions can be seen in Table 1.1 with their classifications regarding their limits and countries/institutions.

Table 1.1. The definitions and criteria for the classifications of a tall building, high-rise building, skyscraper, supertall building, and megatall building with references [2]

Classifications	Definitions	According to	References
Tall Building	Height > 9 stories	The Town of Milton	(Obinna, 2020) [3]
	Height > 48m or 15 stories	-	(OPDC, 2018) [4]
	Height > 11 stories	The City of Burlington	(Obinna, 2020) [3]
	6 stories < Height < 35m	The article of (Church and Gale., 2000)	(Kunze, 2005) [5]
	Height > 91m	The ASHRAE Technical Committee	(Ross, 2004) [6]
High-rise Building	Height > 24m	China	(Shihong & Shuxian, 2007) [7]
	35m < Height < 100m	The Emporis Data Committee	(İlerisoy & Başgül, 2019) [8]
	Height > 23m	Life Safety Code, 2012 edition	(John R. Hall, 2013) [9]
	Height > 22m	The Germen standards (Aytis, 1991, p. 48)	(Bazzaz, 2013) [10]
	Height > 20 stories	-	(Yeşil, 1993) [11]
	Height > 22m	The German regulations	(Yeşil, 1993) [11]
	Height > 20 or 30 stories	(Canpolat, 1983)	(Ulutaş, 2018) [12]
	Height > 21m	The Massachusetts city laws	(Toprakal, 2008) [13]
	23m < Height < 150m	-	(Toprakal, 2008) [13]
	Height > 15m	The National Building Code of India	(Obinna, 2020) [3]
	Height > 12m	LSURPD	(Obinna, 2020) [3]

	Height > 25 stories	The book of (Yeşil, 1993, s. 7)	(Bal, 2003) [2]
	Height > 10 or 15 stories	-	(Bal, 2003) [2]
	Height > 10 stories	The Cork City Council 2004	(Ulutaş, 2018) [12]
	Height > 8 stories	-	(Kunze, 2005) [5]
Skyscraper	Height > 153m	In the United States	(Coşkun, 2006) [14]
	Height > 150m	B1M	(Cortese, 2018) [15]
	Height > 100m	Emporis Data Committee	(İlerisoy & Başgül, 2019) [8]
	Height > 100m		(Alkan & Altınışık, 2015) [16]
	Height > 150m	In USA	(Toprakal, 2008) [13]
	Height > 25 stories	The article of Öke (1991)	(Aydoğan, 2005) [17]
Supertall Building	Height > 100m	China	(Shihong & Shuxian, 2007) [7]
	Height > 305m	In the United States	(Coşkun, 2006) [15]
	Height > 75 stories	The article of Öke (1991)	(Aydoğan, 2005) [17]
	Height > 380m	The Skyscraper Museum	(Toprakal, 2008) [22]
	Height > 300m	CTBUH	(Obinna, 2020) [3]
	Height > 300m		(Cortese, 2018) [15]
	Height > 300m		(Rosenfield, 2012) [18]
	Height > 300m	HVAC Design Guide	(Simmonds, Fashrae, & Zhu, 2013) [19]
Megatall Building	Height > 600m	CTBUH	(Cortese, 2018) [15]
	Height > 600m		(Obinna, 2020) [3]
	Height > 600m		(Rosenfield, 2012) [18]
	Height > 600m	HVAC Design Guide	(Simmonds, Fashrae, & Zhu, 2013) [19]

As seen in the table, there are different definitions for the same terms. In addition to definitions given in Table 1.1, it was noticed that various definitions were also used over time. For instance, tall buildings were defined in the Great Larousse Dictionary and Encyclopedia as “*delicate buildings with a small base area, a height larger than their base size, and generally in the form of a tower”* [20]. In addition, according to Edwin R. Galea, the high building is “*a building that has passengers in a place where the ground recovery stairs cannot reach”* as unlined at the Tall Building Fire Safety Conference held in 2014.

In the book of Geoff Craighead's High-Rise Security and Fire Life Safety, it is defined as *"a tall building is a multi-story structure in which most occupants depend on elevators [lifts] to reach their destinations"* [21]. According to the Toronto City Council, tall buildings are generally defined as *"buildings with a height that is greater than the width of the adjacent street right-of-way or the wider of two streets if located at an intersection"* [22]. Finally, the definition of *"buildings that surpass other structures in the same part of the city in terms of height"* in the book "Tall Buildings in Urban Context" by Ackerknecht & Assaf can be given as an example [23]. Even though the meaning of the term high-rise building is close to a tall building, still different definitions have been published. At the International Conference on Fire Safety in High-Rise Buildings, a high-rise building is defined as *"any structure high enough to make evacuation seriously difficult"* [21]. The Council on Tall Buildings and Urban Habitat (CTBUH) defines a high-rise building as "*a building whose height creates different conditions in the design, construction, and use than those that exist in common buildings of a certain region and period"* [24]. When the word 'skyscraper' comes to the scene, the concept of the skyscraper first found its meaning in the 18th century as the highest mast of a ship in maritime and later it was used for tall buildings in the USA [25]. Alkan ve Altınışık explained the skyscrapers as follows: *"Skyscraper is a high-rise building; its height exceeds its other sizes, it is higher than its surrounding, it provides much more space and it has effects on the city because of its three dimensions and perceptual surfaces"* [16]. To name a building as a skyscraper, it must stand tall and firm without any support. Furthermore, the habitable area should cover at least 50% of the total height of the building and must be at least 150 meters high [15]. When Maitland's American Standard Dictionary was examined, it was found that it defines the skyscraper as "*a very tall building such as now are being built in Chicago"* [17]. In terms of 'Supertall' and 'Megatall', the definitions published by CTBUH can be taken as a basis. According to CTBUH, the building height is called *"supertall for those larger than 300 m and megatall for those larger than 600 m"*. In short, there is no exact definition of any height. Persons, countries, and cities have many definitions of this concept that can be also presented in a longer list. In this thesis, a high-rise building with eighteen floors and above is accepted.

2. SHORT HISTORY OF HIGH-RISE BUILDINGS

At the height of the building, the architectural height from the pedestrian entrance to the top of the building is important, neglecting the antenna and flag poles. As mentioned above, ‘high building’ or ‘skyscraper’ is difficult to define in terms of size because the concept of high building varies according to time and place. Today, there are many definitions of ‘multi-storey’, ‘tall building’, ‘high-rise’ or ‘skyscraper’. Most of them are similar, but no definitions are precise. For example, the word skyscraper was used for 12-storey buildings in Chicago in the 19th century for the first time, whereas today 12-storey buildings are seen as a normal apartment size [26]. Still, if we define these terms, a definition and classification can be made according to the number of floors and height. For a building to be defined as a tall building, it is sufficient that it is noticeably higher than the other buildings around it. High-rise buildings can be defined as buildings that are higher than 7-10 floors. A skyscraper must be more than 40 floors and at least 150 meters high [27]. Supertall buildings must be at least 300 meters high, and megatall buildings must be at least 600 meters high [18]. While the number of super buildings in the world was 34 at the end of 2007, this number reached 82 by the end of 2010 [28].

Looking into history, the desire to demonstrate power, wealth, and superiority is seen to be effective in the construction of high structures. Some of these include the pyramids built for Egyptian pharaohs or used as temples in Sumerian civilization. In the second half of the nineteenth century, when the western world began to witness the consequences of the Industrial Revolution in the architectural realm, the tallest building was the tower of the 133-meter-high Saint Martin Church in Germany [17]. If we put aside the historical high-rise buildings, with the industrial revolution, the construction of more modern and higher buildings first started in the United States in the late 19th century. New materials such as steel, iron, and pre-stressed concrete, which came with the industrial revolution, enabled a new era in construction. The criterion of being light was not so important to build a high building anymore, it was possible to make a very comfortable design with a steel frame building. Because iron allows large openings and large glass areas, which reduces mass. In addition to the material, another thing to consider is the elevator. Elisha Graves Otis developed a safe elevator in 1853 by adding brakes to the machine to prevent the elevator from hitting the ground. However, the first passenger elevator was used in real terms in 1857 at the Haughwout Department Store in New York

[17]. These developments increased the demand for tall building construction even more. In 1870, George B. Post designed the eight-story Home Insurance Building in New York, and it was the first office building to use an elevator. The Home Insurance Building, built for the first time in 1885 using a steel frame, was registered as the world's first tallest building by the Council on Tall Buildings and Urban Habitat (Chicago, architect William Le Baron Jenney) [29]. Thus, "Home Insurance" has become the representation of the modern skyscraper. Following Home Insurance, which gives the impression that two-three-storey buildings were built on top of each other, the construction of many skyscrapers began to rise rapidly all over the world. In turn, the 15-story Reliance Building (60 m) was built and the Eiffel Tower (300 m) became a new idol for the new altitude targets [26]. Around 1890, reinforced concrete began to be used as a building system material along with steel, and new designs were paved. The first reinforced concrete skeleton system was used in the Rue Franklin Apartment in Paris, France [30]. When we came to 1913, before the First World War, the 58-story Woolworth Building building, built in New York, had the title of the tallest and most important building in the world until 1930 [31]. The building, the first of a cathedral-style office building, featured steel columns and beams. Just after the Woolworth Building, the 40 Wall Street building, which was built at 283 meters in 1930, and the 319-meter-high Chrysler Building in 1931, could not hold the title of the world's tallest building for a very long time. The Chrysler Building was originally designed as 308 meters, but when Van Alen learned that his former assistant H. Craig Severence was designing another project with a height of 309 meters, he raised the Crysler Building to 319 meters with the addition of a tower [32]. This event reveals the dimensions of the height race of the period. The Empire State Building (381 m) which was built in New York in 1931-1932, held the record for being the tallest building for nearly 40 years [33].

While the building is rising, it has been observed that the increasing weight of the load-bearing system and the number of elevators increase the construction costs, and the rise of buildings has been found to negatively affect feasibility, as large elevators cause a decrease in areas. Due to the economic crisis arising from world wars in the aforementioned years, feasibility was the first factor in making decisions, and motifs and designs that were considered essential in terms of architecture were avoided. At this time, the search for functional high-rise buildings started [26]. In the following years, the quality of concrete was improved, heating, cooling, ventilation, and lighting systems were developed in buildings, and floor areas began to be used more efficiently. On the other hand, there have been changes in project design techniques, and great improvements have been made in carrier systems, construction methods, construction, and calculation methods. The first steps of computerized design have been taken. Limited buildable land resources have inevitably changed city growth patterns from horizontal outward spreading to vertical growth. All these things have accelerated the development of high-rise structures.

Empire State Building remained the tallest building in the world until the inauguration of the World Trade Center building in 1972 [33]. Willis Tower which was completed in 1973 in Chicago, even now it is the third tallest skyscraper in the USA, the twentieth tallest in the world [34]. After 24 years, Petronas Twin Towers construction has been completed. And then, this building took the title of the tallest building, from Willis Tower (442 m) which was built with an aluminum frame [35]. At the end of the 20th century, the construction of skyscrapers has also increased in the Far East and European countries, and the height race was carried out of America. Notably, Hong Kong, Japan, South Korea, Singapore, Malaysia, also Australia, Middle East countries participated in this race. The reason for this; dense urban life, protecting the countryside, saving time and money on travel, reducing infrastructure, letting people enjoy the vitality of city life. Hence, the need for high-density residential buildings has increased. Petronas Towers (452 m) wherein the capital city Kuala Lumpur of Malaysia, have been the tallest skyscrapers in the world from 1998 to 2004 [36]. At 150 meters in height, the buildings are interconnected by a steel bridge between the 41st and 42nd floors [37]. This building which was designed primarily as a business building lost the record for the highest skyscraper in the world with the completion of the Taipei 101 building in 2004. The Taipei 101 building (509 m) in Taiwan had both the world's second-fastest elevator and a mass damper tuned to protect it from earthquakes. Currently, Burj Khalifa (828 m), whose construction was completed in Dubai in 2010, is the tallest skyscraper in the world [26]. For the first time in the world, a skyscraper continued with steel construction on a reinforced concrete mass. It has an elevator with the longest travel distance in the world [38]. Besides, to minimize the wind loads on the facades of the building, none of the façades of the building are designed as flat and even the corners are circular [39].

Until this time, there were buildings that could not get the title of the tallest building, however left their mark in terms of both height and architecture. For example, an important structure that can be considered post-modern, in Sangay is Jin Mao Building

(421m). When the Join Mao Tower was built in 1998, it was the tallest building in China. As another example is Burj El Arab Building (321m) built-in 1991 that the most spectacular hotel in the world. It has become the symbol of Dubai [29]. The building was built on an artificial island. In addition to these examples, there is Abraj Al- Bait (Makkah Clock Royal Tower), located in the city of Mecca of Saudi Arabia. It has the world's largest clock dial and is the third tallest building in the world [40]. In the chart below, summary information and symbolic images of the world's highest and most important buildings are presented (Figure 2.1).

The Jeddah Tower (Burj Al Mamlahah) which is aimed to be the tallest building and currently under construction in Jeddah and, is planned to be completed in 2020. However, due to some disagreements, the construction has been put on hold. Although the goal of this building to be the first building to exceed 1000 meters in height is known, the full height of this building is still not declared because of the fear of a bad surprise by another project [41].

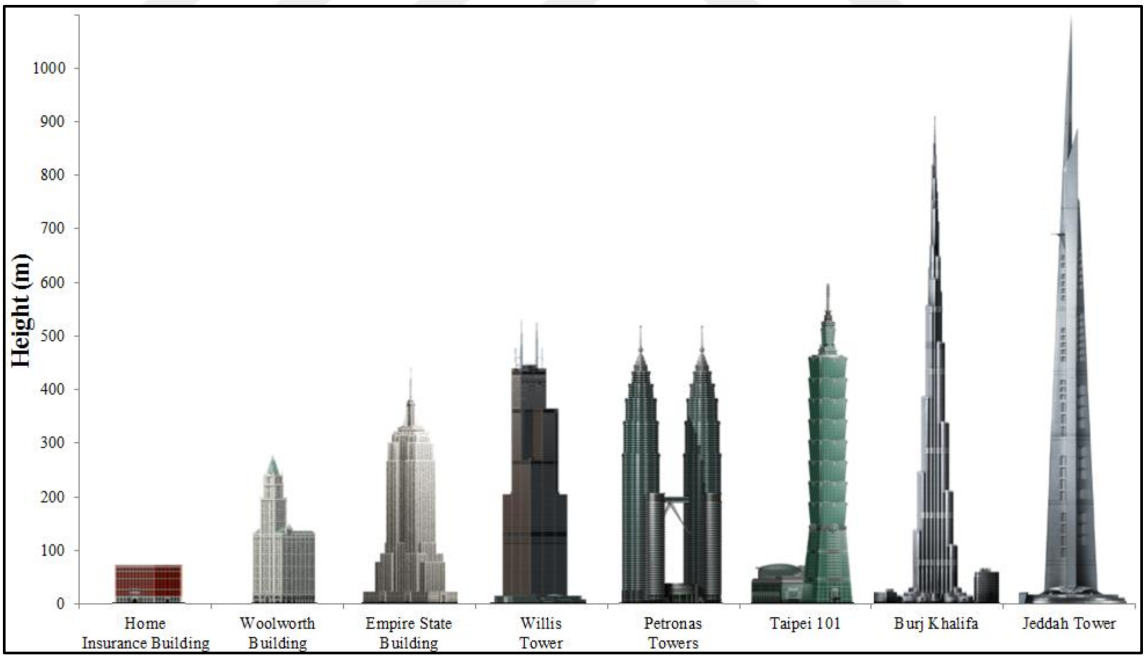

Figure 2.1. The ranking of important buildings that have made a name for themselves as tall buildings in the world (Illustrator Names of Diagrams: J. Eduardo Segundo Hernandez, Yusheng, James Raymond, Koops65, Steamboy and Joolet [34]).

High buildings in Turkey began in the 1950s [42]. At that time, there were only Ulus Commercial Building (13-storey) in Ankara, Hilton Hotel in Istanbul (12-storey), and Ephesus Hotel (9-storey) in Izmir as high-rise buildings. By the 1960s, buildings with over 20 floors were started to be built. The 24-storey Kızılay Emek Office Block (76m) was built in Ankara between 1959 and 1965 is considered the first high-rise building (skyscraper) in our country [13]. Subsequently, Hacı Omer Sabancı Girls' Dormitory (98.5m) was built again in Ankara in 1975, Mersin Trade Center-Mertim (176.8m) was built in Mersin in 1987, and Sabancı Towers (158m) was built in Istanbul in 1989-1993 and these are also important skyscrapers in the country [13]. When the construction of Mertim Building was completed, it was titled as the tallest building in Turkey and retained this title until 2000 [43]. Is Towers (181.2m), completed in 2000 in Istanbul and was announced as the tallest building and until 2011 [44]. Is Towers lost its first place with the construction of the Istanbul Sapphire building (235m) in 2011 [45]. Finally, Skyland Istanbul A-B Blocks (293m), which was built in 2017, received this title from Istanbul Sapphire and still holds it [46]. Besides, Ankara Central building (320 m) is nominated as the candidate for the tallest building in the country while its construction continues and the deadline for the construction is scheduled as 2020 [34]. The following chart is summarized the highest and most important buildings and symbolic images in Turkey (Figure 2.2).

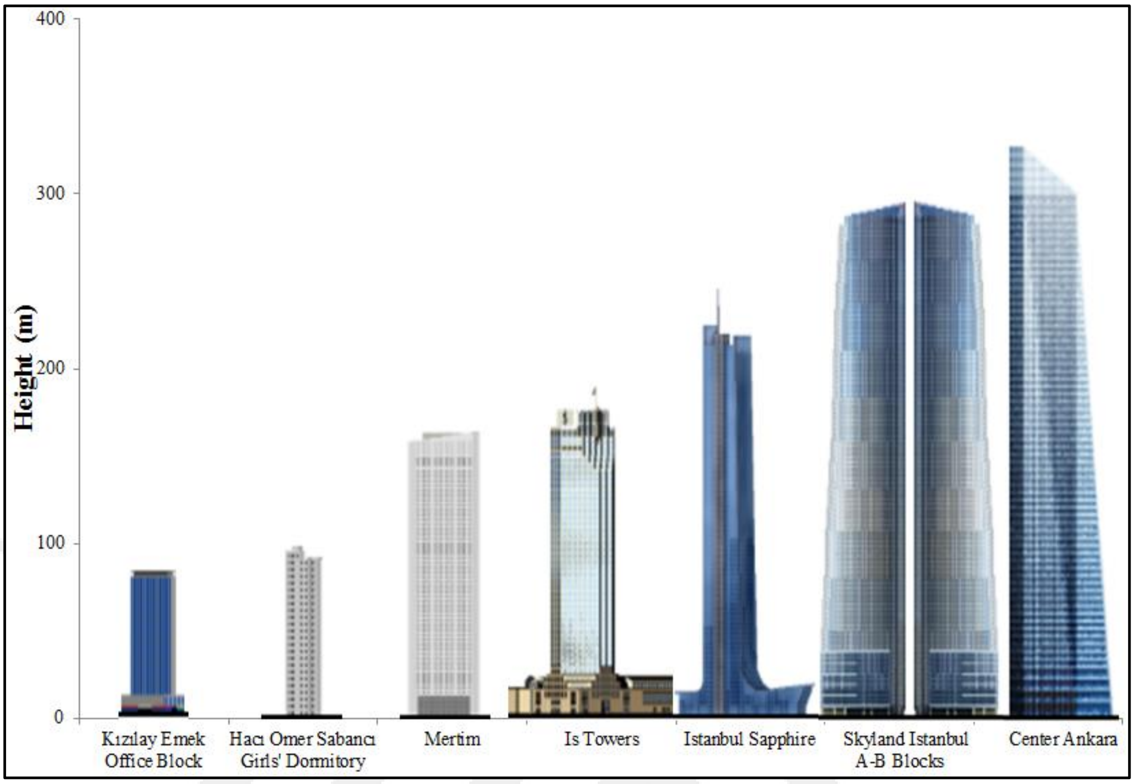

Figure 2.2. The ranking of important buildings that have made a name for themselves as tall buildings in Turkey (Names of Illustrators: Ertugrul, John Hinds, Matthew Dumont, Raptor, Diego Rocha and Koops65 [34]).

3. ADVANTAGES AND DISADVANTAGES IN HIGH-RISE BUILDIGNS

As time passed, problems like the increase in land costs and the inability to provide sufficient accommodation for the growing population, especially in urban cities, pushed people to the construction of tall buildings as a solution. However, high-rise buildings can result in positive or negative effects for the region where it is built and for the living creatures habituating in the area. Therefore, the possible effects and the harmony between the high building and its environment should be considered and discussed [47]. Many people have come up with different opinions on this subject. What matters is whether the advantages of tall buildings outweigh their disadvantages. Because no matter what, high-rise buildings will continue to be built unless an alternative solution is found for the increasing population density in cities. So, it is important to list the advantages and disadvantages of a high-rise building to investigate and pay attention to what should be considered in its construction.

3.1. ADVANTAGES OF HIGH-RISE BUILDINGS

High-rise buildings are usually called with their negative properties, but a well-planned and sustainable high-rise building can have several benefits.

The advantages of high-rise buildings can be listed as follows:

- Lower land consumption,
- Landscape,
- Energy-saving,
- Social facilities,
- Security,
- Urban transformation,
- Agglomeration,

- Transportation and infrastructure,
- City symbol,
- Technology development,
- Economy.

3.1.1. Land Consumption

Sustainability promotes dense urban living. According to the data provided by the Population Division of the United Nations Ministry of Economic and Social Affairs, 7.7 billion people live in the world as of 2020. Not much, 30 years from now, this number is estimated to reach 10 billion [48]. Therefore, the resources of the world will not be sufficient in the face of this rapidly growing population and at some point, dense life will be inevitable. The vegetation and water resources in the world would come to an end if we were to try to accommodate so many people with a horizontal spread. High-rise buildings protect the natural area and vegetation by placing many more people in a smaller area. Also, high-rise buildings enable vertical growth to overcome the problem of land and resource use in constantly growing and immigrant cities. Tall buildings maximize the building area with a minimum physical footprint [49]. For this reason, more skyscrapers are being built today, especially in growing and developing cities such as Hong Kong (1.648), New York (833), Shenzhen (572), Tokyo (567), and Singapore (516), which have population density and limited geographical area [50].

3.1.2. Landscape

The landscape is important. High-rise buildings can create wide openings inside the city because the interior of these buildings has such large areas in which more than one company can fit inside. These openings can accommodate all the community around. It also can create agricultural land for both the community and natural habitats for animals. It may provide a spacious movement area in the city center and that results in a higher quality of life. Super-tall buildings provide more vertical void for the entire city in the same floor space index when compared to the mid-rise buildings. So, there is more corridor for view and urban air circulating through the several wind routes [51]. Finally, high-rise buildings distract people from the city noise and offer them a pleasant panoramic view of the city.

3.1.3. Energy Saving

Energy is the other important parameter in today's world. The building roofs, besides the facade, are the points where the energy is highly losing in a building. For instance, while people share a roof in a high-rise building with a hundred flats in each story, and there would be a terrible loss of energy if there would be an individual roof for each flat. As a result, high-rise buildings consume less energy than low-rise buildings even though they seem to consume a high amount of energy [26]. Furthermore, the conservation of energy is not limited to this. High buildings are very suitable for sustainable energy management. For example, tall buildings are literally like lightning rods when it comes to taking advantage of daylight. In addition to generating energy from the exterior of the buildings with the photovoltaic system, flats can receive daylight throughout the day and this reduces the energy used for heating. Besides, wind energy can be also used efficiently via higher airflow around high-rise buildings. To sum up, it can be said that it is possible to build more energy-friendly tall buildings compared to old buildings employing smart systems and developing technological materials.

3.1.4. Social Opportunities

Since high buildings are generally located in the city center, the location is very advantageous. They are generally close to many services and present several transportation options to the community. It is always easy to satisfy a need regardless of the time of day. One of the reasons why people migrate from rural to urban areas is unemployment. The communication and connection between the people may provide job-seekers with more business opportunities. Also, schools, shopping malls, hospitals, concerts, theaters, entertainment venues, and sports arenas like pools, tennis courts, basketball, etc. have always attracted people to city centers over the years. High-rise buildings offer all of these to people with the comfort of urban life.

3.1.5. Security

In the city centers that a lot of buildings are located in, it is necessary to provide more open space to improve the urban environment. The super tall building has a positive effect in securing such as; creating open spaces and protecting the environment [51]. It can serve as an observation tower in the area. It provides a comfortable and clear view of what is happening in the area. It minimizes the need for personnel to ensure the site and building security. It is more proper for security cameras and sensors to access and easier control every point because the number of entrance doors is limited regardless of the number of apartments and offices. Besides, there are some extra security measures for intruders such as doors or building security codes in high buildings. Even this can sometimes be sufficient. Injuries from animals (bee bites, snakebites, etc.) are also almost non-existent in high buildings because they are too high for animals to access. But if you live in a one-story detached house, there would be multiple access points inside the house for both thieves and any animal, which would mean you are not safe.

3.1.6. Urban Transformation

Many city centers in developed countries that suffered from the migration of their population to the suburbs in the ’70s-’90s have witnessed a major return to their centers in recent years [26]. During this period, urbanization, especially in our country, was not a healthy and planned urbanization. It had the characteristic of irregular urbanization. As a result, cities are surrounded by buildings that are called unlawful, unhealthy, slums without any infrastructure [52]. Since immigration to the big cities has been recently abundant, land that was previously empty and worthless is now invaluable and scarcely. Urban transformation becomes significant in this regard. The lack of sufficient land in the city makes it difficult to build new buildings. Therefore, projects on urban transformation can be considered as a new solution. In the context of urban transformation, it is more proper to build technological, sustainable, and less space-consuming high-rise buildings instead of conventional and low-rise buildings. Urban transformation can create more space, reduces energy loss, and reduces carbon emission, and as a result, it offers a new and healthy building. Also, the need for extra infrastructure and transportation costs for urban transformation because it uses the existing infrastructure more efficiently. Therefore, the negative impacts of rapid urbanization can be prevented via intense immigration in legal, economic, social, and cultural areas.

3.1.7. Agglomeration

The gathering of people and companies in one place pushes them to be the best and different from the others. As a result, the presence of a large number of companies offering similar products in the same region promotes competition, innovation, and efficiency. While people buy the products they need with a more affordable budget, companies will constantly strive for self-improvement. This creates knowledge dissemination leading to increased innovation between firms in the same industry and across industries [26]. In this respect, agglomeration supports production and improves the economy of the region. Besides, agglomeration makes sharing of the produced product or information faster, and employees work more harmoniously and efficiently. If buildings are too high in an area, it means too much work and people crowding. Therefore, high-rise buildings provide this agglomeration and contribute to the economy efficiently with agglomeration.

3.1.8. Transportation and Infrastructure

The cost to provide and maintain public infrastructure and services for a given community in new sprawling development is higher than to service the same community in a “smart growth” or infill development [26]. As in the example given before, for a 100-apartment high-rise building, you create once the main lines of electricity, clean and wastewater, natural gas, and telecom infrastructure, but you need to create 100 lines for each infrastructure unit in 100 single-storey houses. Also, not only infrastructure but if you try to build 100 single-storey houses instead of high buildings, it will be more costly due to pedestrian sidewalks, traffic roads, lighting and signs, fire hydrants, sewer pits, and repair costs for them, etc. In addition to these negativities, the horizontal expansion of cities towards the suburbs causes an increase in CO_2 emissions due to travel time, energy used, and naturally exhaust gases. However, if we collect low-rise houses in a region in high buildings, people will be able to reach the places they need in a shorter time, perhaps without even driving. This means that tall buildings reduce carbon emissions as they shorten the travel distance. For these reasons, tall buildings are a rare opportunity to build compact cities. Because high-rise buildings bring many features such as shorter travel distance, less pollution, fewer CO_2 emissions, lower cost, less energy consumption, which are necessary for being a compact city [53]. When it is a compact city, time-consuming work such as going to the workplace, shopping stores, bank, hospital, school, hairdresser, butcher or town hall will be reduced to the minimum possible since they are in the same place. By doing this, people maximize the efficiency of their travels. In summary, the rise of buildings and vertical growth provide more efficient and more economical infrastructure and transportation in the city.

3.1.9. City Symbol

Since ancient times, the passion, curiosity, and admiration of people for heights continue. Over time, the race to prove that countries or cities are economically, culturally, socially, and technologically better and stronger has never ended. One of the most defining criteria of this race was high buildings. For example, the sultans built larger palaces for their magnificence, and the Egyptian pharaohs built their tombs in huge pyramids. Also, structures such as the Eiffel Tower in Paris, the Taj Mahal in India, the Christ the Redeemer statue in Brazil, the Big Ben clock tower in the United Kingdom, the Statue of Liberty, and the Golden Gate bridge in America made their marks in history and these are just a few of the buildings that remain in mind. These places have become symbols of the place where they were built, and these places are still frequented by tourists today. With the advancing technology over time, skyscrapers have also become a source of pride and symbol of people in the city. High buildings offer a unique view at unimaginable heights and give a feeling of being in the sky. So they can reflect a sense of socio-economic power and promote the city as a pioneering and modern business center [26]. Dubai city in the United Arab Emirates can be taken as an example. Dubai, which was only a small fishing and port town before the 1960s, has continuously developed after the 1960s with the discovery of oil and natural gas [54]. The UAE administration has invested a lot in the construction, tourism, and service sector so that the economy does not depend on natural gas and oil, and now the city of Dubai is talking about itself with its buildings and structures rather than oil [55]. Burj Khalifa, the world's largest building, Burj Al-Arab, the world's only 7-star hotel of its time [56], Miracle Garden, the largest flower garden and Palm Islands, the enchanting beauty of the engineering wonder, are just a few of the important symbols of Dubai [57,58]. Considering these developments, it is true that tall buildings are interesting and play an important role as the promotional face of the city. The tallest building is an advertisement for the city. People talk about it all the time, want to see it, want to have it, and it's the most popular. That's why tall buildings are symbols of the city.

3.1.10. Technological Development

After the industrial revolution, the construction industry has continuously improved itself and created a competitive environment between cities. In this competitive environment, each building has aimed to be higher, higher quality, and more innovative. As a result, architects and firms began to design different buildings that push the boundaries of technology to increase their reputation and make a name for themself. More technology was used each time, more aesthetic and eye-catching buildings were built. This attracted people's attention and increased the demand for high modern buildings. The demand for modern high-rise buildings has forced technology to evolve in many areas. In this way, progress has been made in many areas such as mechanical, electrical, computer, glass, building and facade engineering, sustainable materials, water, ventilation, and lighting systems [26].

3.1.11. Economic Development and Costs

The economy is shown as the most important advantage of tall buildings. Because it both adds economic power to the region where it is located and provides a financial savings. For example, in infrastructure and transportation, gathering everyone in high buildings significantly reduces the costs of road, metro, energy, telecommunication, natural gas, water, and wastewater. In the case of agglomeration, for example, traveling from home to work takes less distance, as tall buildings stop horizontal expansion and gather people in one place. This means fewer cars and less oil use. In terms of security, it saves the economy with fewer security personals and security systems. Since the tall buildings are the symbol of the city, they attract the attention of tourists and thus bring money from outside. Regarding energy-saving, tall buildings are more economical as they prevent heat loss of houses and are more efficient in terms of sustainable energy. In urban transformations, new and high-rise buildings provide people with a better quality of life without extra expense, as they use the existing infrastructure. Also, since high buildings use the land most efficiently, they are beneficial for the economy even at high land prices.

As tall buildings use less space and protect nature, it reduces infrastructure costs such as water filter facilities and sewerage built to prevent floods, because areas with natural ground cover do not have runoff problems [26]. Besides, a large number of public or private investments is another issue that contributes to the economy. Various brands from the clothing and food industry in the world have always found a place under tall buildings.

3.2. DISADVANTAGES OF HIGH-RISE BUILDINGS

The main disadvantages of high-rise buildings are not that different from their advantages. In other words, tall buildings bring advantages along with disadvantages.

The disadvantages to being considered in high-rise buildings can be listed as follows:

- Human relationships and psychology,
- Energy consumption,
- Maintenance and repair,
- Urban transformation,
- Density and congestion,
- Safety,
- Environmental damage,
- Economy.

3.2.1. Human Relationships and Psychology

High buildings can have many adverse effects on human relationships. According to many psychologists and sociologists, the impact of tall buildings on people is alarming. For instance, a person from the countryside or living in a detached house may not be able to adapt to living in high-rise buildings. Besides, there is no healthy environment for children. Children live in a restricted and isolated environment in many areas such as the playground, open space, and neighborhood friendliness. As a result, introverted and asocial people may grow. It also affects people badly in matters such as human relations, benevolence, and neighborhood, turning them into selfish people. The concept of privacy is almost nonexistent because your neighbors are next to you. To get along with them, you must be tolerant and follow certain rules. Likewise, there is always the possibility that they may bother you, and you have to live with it. As another example, you may not be able to sit on the balcony because of extreme wind or rain. Finally, it may not be allowed on the site to have a pet [59]. All of these limit freedom and result in a feeling of imprisonment. Besides, tall buildings can create a feeling of loneliness and height-related phobias in people.

3.2.2. Energy Consumption

Although high-rise buildings provide energy savings in terms of energy consumption, it can also bring too much trouble in the future if it is not well planned and necessary infrastructure systems are not provided. High-rise buildings will add burden to the existing electricity network, telecommunication line, water supply, and sewerage systems in that region [26]. Also, it consumes a significant amount of energy due to elevator and extra water pressure, lighting, and security systems related to having too many flats. This overload can disrupt the municipal services. Because of this reason, today most of the high-rise buildings have a generator against power outages and failures, but even this may not be the solution sometimes. In such a case, you may need to climb the stairs with your feet.

3.2.3. Maintenance and Repair

A tall building usually has a smooth and flat exterior for a more elegant appearance. This results in challenges in installing air conditioners, wiping windows, painting walls, maintaining air conditioners, replacing a leaking pipeline, repairing insulation, etc.. To solve such problems, technicians and plumbers have to build scaffolding, work at that height, and risk their lives. Besides, since there is more floor space to be maintained, the maintenance of high-rise buildings is difficult and expensive. Elevators break down often.

The elevators create a flow of air as they move up and down space. As a result of this airflow, when there is a bad odor from kitchens, soot, or smoke in the lower floors, it will be inhaled from the upper floors [7]. If there is a problem with one of the infrastructures of any of the apartments, such as electrical, mechanical, and telecommunication, it can be complicated and difficult to solve. For example, there are a lot of internet and TV dishes on the roof of a tall building. If these are placed irregularly, it may take a long time to solve the problem of that apartment [59].

3.2.4. Urban Transformation

Urban transformation is another factor that needs attention. Because when constructing new and high-rise buildings, the budget, infrastructure, transportation, and conditions of the region should be taken into consideration, especially not to leave the people in that region uncovered. If the poor or middle-class settlements are subjected to an urban transformation and are sold to the rich, this will not be an urban transformation. Likewise, urban transformation is not possible by building a high building in an area where transportation and infrastructure are already congested. All of these should be planned considering the finest details. Otherwise, the neighborhood structure deteriorates, economic class differences, groupings, and dissatisfaction may occur in the community.

3.2.5. Density and Congestion

Density and congestion are almost inevitable where tall buildings are. Because even when it is imagined that thousands of people come, use the same road and try to enter the same building, it is obvious how difficult it will be. High buildings can compactly provide efficient work, but this overcrowding can become even more unbearable, especially during business hours. This reduces the efficient use of time and financial gain. Waiting in line all the time in any place (in traffic, dining hall, elevator, restaurant, subway, etc.) takes away people's lives every day.

3.2.6. Safety

Elevation also poses potential safety hazards. First, tall buildings can cause ground subsidence. The main reason for ground subsidence is that many high-rise buildings disrupt the natural ground layer and put pressure on the soil with the increasing population. Besides, lighting should be placed on the face of the building to make it appear in the dark. The possibility of a possible aircraft, helicopter, or jet colliding with the building should be considered. Also, high-rise buildings are much more affected by security problems such as fire and natural disasters. For example, in an earthquake, high-rise buildings oscillate and displace more than normal buildings. This means that in the event of an earthquake, the general structure of the building, people, or objects in the apartment will be damaged more. If it collapses in an earthquake, this time it may collapse on the undamaged low-rise buildings or people around it.

Fire is another important safety problem in high-rise buildings. Because the elevator and shaft gaps in the building act as a chimney, the fire spreads rapidly with the wind in these gaps and can instantly envelop the whole building. Besides, high-rise buildings contain many flammable materials such as cables, wool, and household items. This speeds up the spread of flames. The worst part of the fire is that it makes human evacuation almost impossible because there is nowhere to escape in the horizontal direction. Fire spreads everywhere at once. To escape from the fire, you have to reach the ground floor or outside the fire escape. This is very difficult due to the density of people and the lack of elevators in the fire [7]. Finally, the possibility of dangerous situations such as falling from the building, jamming in the elevator, falling something from above, etc. is higher. For example, you should keep your children away from the window inside the house because the only thing that protects you from falling out of the building is glass. Again, hand, foot, or furniture jams in elevators can be fatal. While walking around the building terrace or ground floor, even the smallest thing that falls on you from above can cause serious damage.

3.2.7. Environmental Damage

High buildings affect the environment. The sunshine inside a space decreases the artificial light and heat energy demand and increases the quality of that space. But since tall buildings have a large volume, they shade adjacent properties, reducing the access of buildings and plants around them to the sun. Similarly, access to sunlight in open spaces is important and valuable for vegetation growth, quality of public space, and encouragement of social activities [60]. Also, since the exterior of tall buildings is full glass, it will reflect sunlight and increase the temperature around the building and create an island effect [7]. Another effect is that it prevents air circulation. Air circulation cannot be done properly in the city due to high buildings. Around the building, it creates strong winds that can disturb pedestrians. This may affect the regional climate. For example, the constant wind around the Istanbul Sapphire building. In addition, since high buildings accommodate a lot of people, air pollution is high due to the exhaust gas in that area. The important effect of tall buildings on the environment is that they disrupt the historical and urban silhouette of that region. As in urban transformation, the high building must be compatible with the region where it is built. Otherwise, it will lead to unplanned urbanization, social class differences will emerge and affect neighborhood life. Building design should be carried out without damaging the historical texture and disturbing the general appearance of the city. High-rise buildings should not be built in an area with low-rise buildings or on the coastline. One of the best examples of this is Süzer Plaza (Gökkafes). Many lawsuits have been filed against the Gökkafes building and are still being opened. It has been featured many times in the newspapers of the time for the reason that it spoils the city silhouette, destroys the site, and disregards the city’s morality. Again, many meetings and actions were held on this subject [61].

3.2.8. Economy

The most important element in the construction of high buildings is economic opportunities. Vertical growth is better for cities, but tall buildings are very expensive to build. Because there are too many cost items in a high-rise building. High-technique and high-quality materials must be used throughout the building for safety. For instance, it is necessary to calculate wind loads in addition to the earthquake and dead loads when carrying out the structural analysis of the building. Building high-rise buildings require a lot of construction workers, highly skilled engineers, and architects, thus the total cost increases. High-rise buildings let efficient use of costly land; however, doing so causes land prices to increase. This results in the price of the land increasing even more after each tall building is completed. Also, elevators, teleportation, and security systems consume a lot of electrical energy. Building maintenance requires different equipment (e.g. scaffolding for wiping glass) and maintenance-repair work is expensive. The structural life of super-tall buildings is generally more than 100 years. But many interior equipment systems only last more than ten years, are very difficult to repair and replace, and are very costly. Since the building itself is also consumable, it will wear out over time and its repair and maintenance will be very costly [7]. As another negative feature, the prices of the products in shops, markets, and stores are increasing as the high buildings change the economic level of the region in where they are built. Thus, life becomes more expensive for everybody. All show that high building construction has negative effects on the economy.

4. SUSTAINABILITY CONCEPT

After the urban life that emerged as a result of industrialization in the 19^{th} century and the world wars in the 20^{th} century, the increasing population increased the use of natural resources such as energy, water, air, trees, and oil. People need resources to survive. There are natural and artificial (man-made) resources in the world and these are divided into renewable and non-renewable resources (Table 4.1).

Table 4.1. A fourfold classification of natural and cultural resources [62].

	Non-renewable	Renewable
Natural	e.g., soil, biodiversity, fossil fuels	e.g., water, forest, clean air
Man-made	e.g., paintings, landscapes	capital

More natural resources are consumed to meet the demands of the ongoing increasing population, the world becomes even more polluted and nature is damaged irreversibly. This creates suspicion and anxiety about the future. This use of natural resources adversely affects us and the life of all living creatures that will live in the world after us. If precautions are not taken in this situation, the resources of the world will not be enough for people. When the water decreases, there will be famine and drought. Wastes will kill living plants and animals; gas emissions will pollute the atmosphere and further increase global warming. For this reason, it is an obligation to use not only natural resources but also artificial resources shortly and concisely. Consumption of resources in a planned and controlled manner enables people to leave a better world for future generations. Sustainability came into play at this very point. Many studies and discussions have been conducted for this purpose. With the developing technology, it has become possible to use resources such as water and electricity more efficiently and intelligently, to produce clean energy with sustainable energy systems, and to prefer environmentally friendly materials. Sustainability has therefore become very important for human health and the conservation of resources [63].

Nowadays, it is gradually better understood that sustainability has a significant impact on the construction industry as well. The construction industry in particular has a significant impact on the sustainable actions of our society as large amounts of energy are consumed. What's more, building materials and buildings are extremely durable and therefore affect our environment and society for a long time. Building construction accounts for about 40% of the energy consumption, and around 36% of greenhouse gas emissions worldwide come from the production and use of buildings [64]. Therefore, building owners and residents are now paying more attention to sustainability aspects in building construction or building renovation. The use of sustainable, technological, and environmentally friendly products in the construction industry will not only reduce CO_2 emissions but also reduce the operating cost of the building over the entire life cycle [65]. Various innovative ideas are generated on the topic of sustainability and used in all areas of daily life.

4.1. THE TERM OF ‘SUSTAINABILITY’

Although the word ‘Sustainable’ is generally perceived as a concept used by environmentalists and associated with nature, it means continuing, continuity, repeating as its name suggests. In other words, it can be said that things that do not deteriorate over time, that can remain the same over time, have continuity, are sustainable. Sustainability is a concept with many variables. Everyone can look for different criteria for something to be sustainable. According to some, a thing that stays the same for 100 years is sustainable, for some, 50 years is enough for sustainability. Although how sustainable something is measured over time, it would also be utopian and absurd to think of a time far ahead. Because no matter how sustainable someone does something, they will eventually lose their sustainability and function at some point.

The first known European use of the word sustainability (*German: Nachhaltigkeit*) occurred in 1713 by German forester and scientist Hans Carl von Carlowitz in his book Sylvicultura Oeconomica. Later, French and British foresters adopted tree planting as a route to 'Sustainable Productive Forestry'. This term was used extensively after 1987 of the Brundtland Report of the United Nations World Commission on Environment and Development [66]. ‘Sustainable Development’, which came to the agenda in the Common Future Report published by the World Environment and Development Commission in 1987, was defined for the first time as “*the development that allows meeting the needs of future generations while meeting today's requirements”* and became the most famous definition of sustainable development [67]. Although the idea seemed simple, its task was important. A popular concept of sustainable development together with environmental, economic, and social terms than it was in many developments. Countries have begun to reduce their energy problems, become more sensitive to their environment, and protect nature. Initiatives have started to reduce carbon emissions for cleaner air. New energy resources have begun to be searched and there have been developments in the energy policies of many countries to benefit effectively from renewable energy resources [68].

Sustainability means meeting today's needs without undermining the needs of the future. Sustainability is about time and the impact today's decisions will have tomorrow [69]. Marco Keiner wants each generation to *'leave less burden'* than they inherit, increasing the quantity and quality of ecological, human, and man-made resources for sustainability [70]. According to Mani Monto and et al., interpreted the concept of 'sustainability' as known to all, extremely vague, and difficult to make operational [71].

In May 1999, the UK Government published “A better quality of life: sustainable development strategy for the UK", setting four simultaneous goals to achieve sustainable development [72]. According to this strategy; first, social progress must be achieved. Everyone should be sharing, sensitive to the environment, and respectful to each other. States should work harder to solve problems that disturb society, such as aggression, poverty, exclusion, unemployment, pollution, unfairness, and crime. The second strategy is environmental protection. The use of all kinds of waste and toxic chemicals that adversely affect human health and can cause climate changes and global warming should be reduced, and air and water should be less polluted. Another strategy is to use natural resources sparingly. This is not to deny the use of non-renewable resources such as oil and gas, but it is an obligation to be sure that use them is efficient and alternatives must be developed as soon as possible to replace them. Important resources such as water and energy should be used sparingly without wasting them. The last strategy is to maintain economic growth. So, everyone can share high living standards and greater job opportunities. Businesses must produce the high-quality goods and services that consumers around the world want, at prices they are ready to pay. To achieve this, a workforce equipped with education and skills is needed [73].

At the first International Sustainable Construction Conference held in Tampa in 1994, sustainable construction was defined as *'the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles'* [74].

This is a very broad definition, but the foundations for linking construction and sustainability were thus laid. Many people say that sustainable development can only be possible with the interaction and coexistence of economic, ecological, and social structures. Therefore, in terms of ecological sustainability, the protection of resources and ecosystem, long-term use of resources for economic sustainability and minimization of usage costs, and human health and comfort for social and cultural sustainability, protection of social and cultural values are very important [75]. With ecology, that is environmental sustainability, the continuation of natural diversity is ensured, waste management is created, toxic substances are destroyed and recyclable materials are used. The world can become greener. With social sustainability, the cultural structure develops, the quality of life increases, healthier individuals are raised, life becomes easier, objectivity and justice are formed. When economic sustainability is achieved, development, development, efficiency in production, continuous cycle, and smart energy use environments occur [76].

The construction of buildings both affects and is influenced by these three main sustainability issues. Buildings destroy a significant portion of land and raw materials, constantly generate greenhouse gases and waste, consume a significant amount of energy, and maintenance and construction costs are very high. In this respect, it affects sustainability. Besides, a building with a sustainable certification, that is, taking into account environmental, economic, and social aspects, is easier to market, less maintenance, and generally more savings. Therefore, constructors may want to construct more sustainable buildings in the future. Due to recent earthquakes in the country, it was considered that it is appropriate to add vulnerability to a natural disaster regarding a sustainability issue in addition to these three sustainability issues in this study. Because earthquakes have a lot of impact on both buildings and sustainability. For example, the demolition of a building brings economic damage, human psychology in the social sense, and damage to nature in the environmental sense. To assess the sustainability of a building, it is not enough to consider environmental impact alone. Social, economic, environmental and disaster effects should also be taken into account to make sustainable construction. As you can see in Figure 4.1, the environment results in “sustainable” at the intersection of four policy areas: economic, disaster, social, and environment.

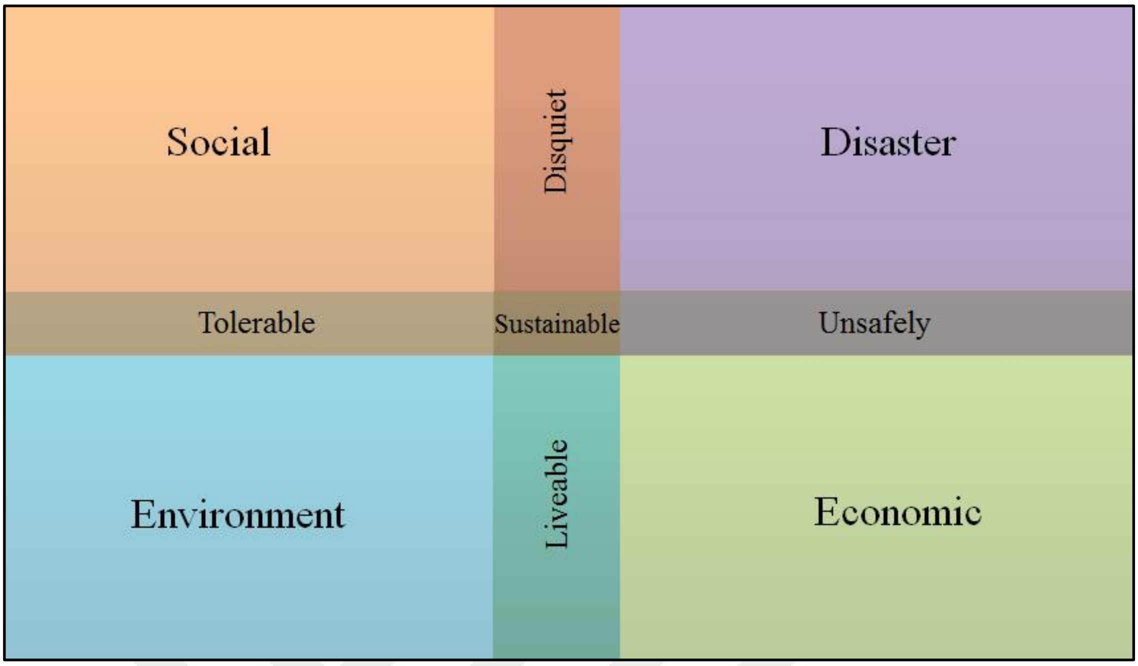

Figure 4.1. Scheme of sustainable development: at the confluence of four constituent parts.

This scheme has been modified by adding the fourth segment on schematic representation of Bob and et. al. [77].

4.2. CERTIFICATES ON GREEN BUILDINGS

Today, the negative effects of "non-green", in other words, classical buildings, on the environment are extremely high. In the world, the building industry consumes 70 percent of energy and materials, 17 percent of water, and 25 percent of forests; they also cause 33 percent of CO_2 emissions [78]. The approaches to reducing these environmental impacts are of great importance for the planet. The concept of ‘Green Building Sustainability’ has emerged with a focus on buildings in the construction sector. In simple terms, the green building consists of sustainable (less harmful to the environment) building materials, water, and energy efficiency must be high in these buildings. In the design phase, building design is of great importance to minimize energy losses. Green buildings can be defined as structures that are evaluated within the framework of the life cycle starting from the selection of the land, designed with a holistic understanding of social and environmental responsibility, suitable for climate data and conditions specific to that location, consuming as much as needed, encouraging the use of renewable energy resources, and sensitive to ecosystems where natural and non-waste-producing materials are used [63].

Firstly, the concept of green building emerged in developed countries. The construction of the buildings built in an environmentally friendly manner with minimal damage to nature has been encouraged. However, since the development level and geographical conditions of the countries are different, each country has its priorities. For example, while the most important criterion for arid countries is the efficient use of water, the most important criterion for countries dependent on foreign energy is energy efficiency. Besides, great importance is attached to the effective and efficient use of materials (recycling, reuse of materials) in developed countries. Also, since developed countries have high transportation facilities, it is estimated that green buildings in these countries will not have problems with access to urban equipment.

In short, green buildings are sustainable properties and sustainability is required for buildings. Nowadays, there is not much trend towards green buildings, as the sustainable equipment of green buildings requires additional fees. In Figure 4.2, you can see how sustainability affects the decision to purchase a property today and in the future. A sustainable building can close this demand gap with sustainability certificates, even if it drives housing sales prices up. A building with a sustainable certification is easier to market. However, surveys show that in the future, people will be willing to pay higher prices for certified buildings [65].

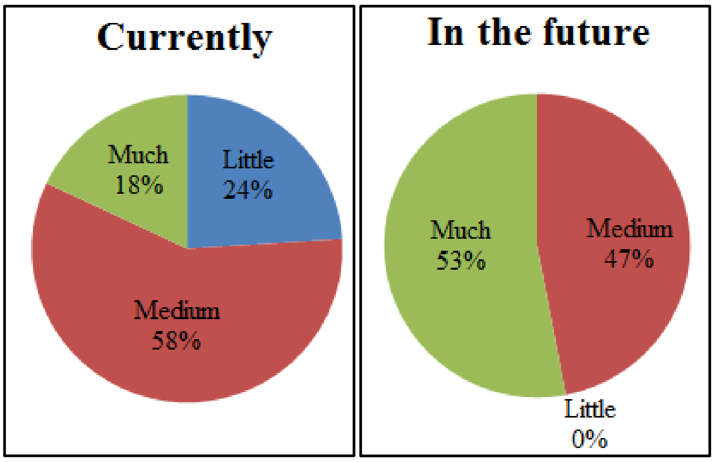

Figure 4.2. Influence of Aspects of Sustainability on Decisions about Acquiring Real Estate [65]

Green Buildings is a sustainability project in itself and different certification bodies have established standards in this area in the international arena. This certificate is called as 'Green building certificate'. The certificate degree to be obtained varies according to the performance of the building. Projects evaluated under categories such as an increase in energy efficiency, location of the project, and transportation earn a degree per the certification criteria.

5. GREEN-BUILDING CERTIFICATES

5.1. DEFINITION AND HISTORY

Green building certificates are assessment reports that are given as proof of how sustainable a building is. This evaluation document includes all of the sustainable criteria that must be met and possessed for many titles such as new buildings, existing buildings, urban transformation projects, municipal infrastructure, and transportation works. Each criterion has scores that vary according to the characteristics of the building, environmental factors, and its location in the world. Evaluation is in the form of a detailed examination of the building according to each criterion and scoring as a result of this examination. The building is given a certificate showing how green it is, according to the certificate grade corresponding to the total score obtained as a result of the evaluation [79].

The goals of certification systems can be summarized as follows;

To compare structures by creating a measurement standard accepted by everyone,

To develop a method that examines the building from all aspects,

To be a guiding guide for the future in the building industry,

To encourage green building competition,

To inform people about the benefits of green building,

To leave a livable world to the next generation by increasing resource savings.

In line with these purposes, many countries in the world adopt the green building concept and adopt it. These countries have established their own building assessment certificates or adapted any existing green building certificates [68].

Green building certificates first emerged in England in 1990 under the name of Breeam (Building Research Establishment Environmental Assessment Method) and continued with the LEED (Leadership In Energy and Environmental Design) green building system in America in 1998. After LEED, developed countries came together on sustainable and green buildings and decided to review the green building certification process and criteria and established IISBE (International Initiative For Sustainable Built environment). Afterward, green building certification systems were established in many different countries, the criteria were evaluated and their validity was widely accepted and used widely. You can see the timeline for some of the green building certificates generated in this process in Figure 5.1 [80].

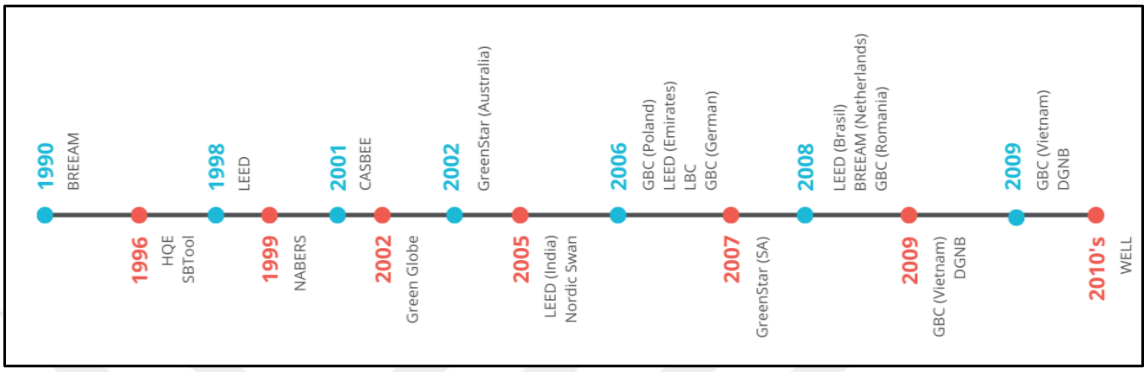

Figure 5.1. Timeline of the development of green-building tools in different countries

Sustainability rating systems are complex and difficult to develop. This is why so many rating systems come out. It is almost impossible for the rating system to remain generic and original because rating systems have to keep up with the advancing technology over time. In addition, the environmental conditions, building regulations, and standards of the countries are very different. This has caused each country to develop its rating systems. Although there are certification systems with so many different names, they also have common features. For example, like based on volunteering, not for money, is based on criteria and points, is based on numerical results, drawing attention to the importance of globalization and resource use, being environmentally friendly, and supporting the integrated project process can be given common features in general (Integrated Project Delivery) [68].

5.2. CLASSIFICATION

Green building certificates play an important role in examining and evaluating the buildings with concrete data to be sustainable and environmentally friendly. Green building assessment systems are divided into two groups: life cycle assessment (LCA) methods and criteria-based certification programs [81]. LCA methods are generally used in the project phase of the buildings to evaluate the material and product quality or options such as electronic, mechanical, and transportation service systems of the building. LCA is a method that evaluates the environmental performance of products and services from start to finish. Tools such as Bees (USA), BEAT 2002 (Denmark), EQUER, PAPOOSE and TEAM (France), EcoQuantum (Netherlands), ATHENA (Canada), Envest 2 (UK), and LEGEP (Germany) are examples for LCA. In certificate programs based on criteria, structures are examined and evaluated in more detail, and approval is obtained by third parties. It has become more prominent and widespread than LCA in terms of its easier application and clearer results [81].

As we mentioned before, these certification systems are the Building Research Institution Environmental Assessment Method (BREEAM) first introduced in 1990 by the Building Research Institute (BRE) in England. LEED greenhouse certificates, which emerged in the USA after BREEAM and BREEAM, served as the main framework for other developed countries. Later, most countries created their certification systems by making additions and changes on these systems. Table 5.1 shows the alphabetical list of 24 applicable tools and where they are based. There are six systems whose sources cannot be determined.

Table 5.1. Green Building Rating Systems and Main Sources [82]

Tools	Main Sources
BREEAM (Building Research Establishment's Environmental Assessment Method)	Original
CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	Original
CEEQUAL (UK)	Original
CEPAS (Comprehensive Environmental Performance Assessment Scheme)	LEED, BREEAM, HK-BEAM, IBI
DGNB (German Sustainable Building Council)	LEED, BREAAM, CASBEE, HQE, GREEN STAR
Earth Advantage Commercial Buildings (Oregon)	Undisclosed
EEWH (Taiwan)	LEED
EkoProfile (Norway)	Undisclosed
ESCALE	Undisclosed
GBTool	Original
GOBAS (Green Olympic Building Assessment System)	CASBEE, LEED
Green Building Rating System – Korea	BREEAM, LEED, BEPAC
Green Leaf Eco-Rating Program	Original
Green Star Australia	BREEAM, LEED
HK BEAM (Hong Kong Building Environmental Assessment Method)	BREEAM
HQE (High Environmental Quality)	Undisclosed
iDP (Integrated Design Process)	Original
LEED (Leadership in Energy and Environmental Design)	Original
MSBG (The State of Minnesota Sustainable Building Guidelines)	LEED, BREEAM
NABERS (National Australian Built Environment Rating System)	Undisclosed
SBAT (Sustainable Buildings Assessment Tool)	Original
Scottsdale's Green Building Program	Undisclosed
TERI Green Rating for Integrated Habitat Assessment (India)	Original
TQ Building Assessment System (Total Quality Building Assessment System)	Original

In addition to Table 5.1, there are many different green buildings tools available, but there is no need to extend the table as we cannot examine all of them. The reason there are so many different rating systems is that it is almost impossible to compare the sustainability of different buildings. For example, the highest BREEAM rating (Excellent) does not equal the highest grade of GreenStar (Six Stars). Since the environmental conditions and building codes of each country are very different, it is normal for such diversity.

Among these assessment systems, the most advanced ones have been used since 1990 and have been used in 89 countries with 2,313,475 registered buildings so far, BREEAM (Building Research Establishment Environmental Assessment Method) started to be used in 1998, and more than 69,000 registered in the USA alone. certified LEED (Leadership in Energy and Environmental Design) [83,84].

Assessment systems are usually created by people from different specialties related to the building sector, such as architects, civil and environmental engineers, geologists, and real estate investors. Thanks to these evaluation systems, buildings are subjected to constant evaluation by third parties or institutions. As a result of the evaluation, it is documented how sustainable the building is. All buildings are examined in the same way, the same criteria are evaluated in the same way. As such, the system is internally consistent and allows comparison with concrete data about buildings.

Although the criteria in the evaluation are expressed with different names in different systems, the main headings in general are; the choice of the land, the ecosystem, its relationship with the social environment of the building, the CO2 emission of the building, the building's electrical-mechanical-transportation infrastructures, heat and sound insulation, water consumption, operating and maintenance-repair conditions, materials used in the building, etc. various topics.

Binh Nguyen Khanh (2012) selected the 202 grading system with the method of elimination and scoring among the top 5 at Developing A Framework For Accessing Sustainability of Tall-Building Projects. It was examined and scored under 10 main titles (Popularity and Influence, Availability, Methodology, Applicability, Data Collecting, Accuracy and Verification, User Friendliness, Development, Results Presentation, and Innovation) to determine the first 5 out of 29 applicable systems. After an intensive review and rating process, the top five systems are: - BREEAM (UK); - LEED (USA); - CASBEE

(Japan); - HK-BEAM (Hong Kong); - Green Star (Australia) [73]. To avoid much confusion in this thesis, we will consider this top five rating system.

5.2.1. BREEAM

BREEAM (The Building Research Establishment's Environmental Assessment Method) certification system is the world's first green building assessment method. BREEAM assessment method, which was first developed in England in 1990 by BRE (Building Research Establishment), serves more than 50 countries worldwide [85]. There are more than 2 million buildings registered in this assessment system and more than 590,000 BREEAM certificates have been issued [84]. Since its inception, it has laid the foundations for and guided many rating systems.

There are 5 different BREEAM assessment areas for Communities, Infrastructure, New Construction, In-Use, and Refurbishment & Fit-Out [86]. If we classify only the building projects that BREEAM evaluates:

• Commercial Buildings (offices, shopping malls, restaurants, parquet units)

• Public Buildings (schools, universities, municipalities, hospitals, museums, libraries, courts)

• Multi-residential Buildings (nursing homes, dormitories, military barracks, hotels)

can be listed as [87].

BREEAM aims to reduce the effects of buildings on nature and living things, to spread the concept of green building, to ensure the harmony of the design-operation-management of the building with the environment, to create awareness about the effects of buildings on the environment, and to be a reliable evaluation label by everyone.

It addresses ten main issues while examining the BREEAM evaluation criteria. These are Energy, Health and Wellbeing, Innovation, Land Use, Materials, Management, Pollution, Transport, Waste, and Water [73].

As a result of the points collected by evaluating each criterion, according to the overall building performance percentage;

• Outstanding: % 85

• Excellent: % 70

• Very Good: % 55

• Good: 45 %

• Passed: % 30

• Not classified: <% 30

It is awarded one of 6 certificate degrees. You can see an example BREEAM score in Table 5.2 below [88].

Table 5.2. An example BREEAM rating score for a building

BREEAM section	Credits achieved	Credits available	% of Credits achieved	Section weighting (fully fitted)	Section score
Management	10	20	50.00%	0.12	6.00%
Health and wellbeing	17	21	80.95%	0.14	11.33%
Hazards	1	1	100.00%	0.01	1.00%
Energy	16	34	47.05%	0.19	8.94%
Transport	5	11	45.45%	0.08	3.63%
Water	5	9	55.56%	0.06	3.33%
Materials	10	14	71.43%	0.125	8.92%
Waste	3	13	23.07%	0.075	1.73%
Land Use and Ecology	5	5	100.00%	0.10	10.00%
Pollution	5	7	71.42%	0.065	4.64%
Surface Water Run-off	4	5	80.00%	0.035	2.80%
Innovation	2	10	20.00%	0.10	2.00%
Final BREEAM score				64.32%	
BREEAM Rating				VERY GOOD	

The BREEAM assessment uses recognized performance metrics to evaluate a building's characteristics, design, construction, and use, set according to country standards and regulations.

For the BREEAM certification process, construction and material records, interior-exterior architectural drawings, engineering calculations, mechanical infrastructure information, energy model report, written explanations and contracts about the project, and finally filled BREEAM documents are needed [81].

The way to follow in obtaining BREEAM certification is;

The registration of the building or building is in the form of assessment of the building by the BREEAM assessor, collection of assessment reports, review of assessment reports, and certification [89].

5.2.2. LEED

The US Green Building Council established LEED in 1998, when it received the pilot version 1.0, to evaluate the way structures were designed, built, and operated. After various and detailed revisions made by the Council, the LEED building rating system was released as version 2.0 in 2000, v2.1 in 2002, and v2.2 in 2005 [90]. As a result of the revisions made to date, different LEED evaluation categories have been developed and LEED v4.1 BD + C is currently used for buildings [91].

LEED Certificate is divided into different classes according to the needs. The names and the areas where they are used are as follows;

- LEED (BD&C) for New Building Design and Construction: Development of projects such as buildings larger than 93 m2, rough construction of buildings, schools, stores, data centers, warehouse and distribution centers, dormitories, and hospitals
- LEED for Indoor and Construction (ID&C): All interior spaces, shops, and accommodation facilities larger than 22 m2
- LEED for Existing Buildings (EB&OM): Operations and maintenance of existing buildings larger than 93 m2, such as shops, schools, accommodation facilities, data centers, and warehouse and distribution centers
- Neighborhood LEED (ND): Residential areas smaller than 1500 acres with at least 2 residences

- LEED for Residences (Homes): Buildings that can be defined as a "Housing Unit" or that contain more than one house together
- LEED for Cities and Communities (Cities): Examining the compliance of a city with its sub-units, its operation, and infrastructure criteria such as water-electricity-natural gas-transportation [92].

In addition to these, there are two additional assessment categories currently under development, health services and laboratories [91].

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System, developed by the US Green Building Council (USGBC), aims to increase the use of natural and renewable resources, support material recycling and repair, and minimize the negative effects on the environment and creatures by innovative and technological products. and aims to increase indoor comfort and air quality [93].

It addresses seven main issues while examining the LEED evaluation criteria. These are sustainable areas (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR), indoor environmental quality (IEQ), innovation in design (ID), and regional priority (RP) [94].

For LEED, the evaluation process includes building registration, design presentation, design review, construction presentation, construction review, and subsequent certification [89].

The total score is obtained by adding the points earned from the criteria under each main heading. The maximum total score is 110 for projects and 136 for homes. It is awarded one of four certification levels depending on the project type and the score collected [95].

These four levels are as follows;

• Platinum: 80 points and above

• Gold: 60--79 points

• Silver: 50--59 points

• Certified: 40-49 points.

You can see an example evaluation form in Table 5.3 [95].

Table 5.3. An example LEED v4 for BD+C: New Construction and Major Renovation [96]

Y	?	N			
			Credit	Integrative Process	1
0	0	0		**Location and Transportation**	**16**
			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
			Credit	Surrounding Density and Diverse Uses	5
			Credit	Access to Quality Transit	5
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1
0	0	0		**Sustainable Sites**	**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Site Assessment	1
			Credit	Site Development - Protect or Restore Habitat	2
			Credit	Open Space	1
			Credit	Rainwater Management	3
			Credit	Heat Island Reduction	2
			Credit	Light Pollution Reduction	1
0	0	0		**Water Efficiency**	**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction	2
			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
			Credit	Water Metering	1
0	0	0		**Energy and Atmosphere**	**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2
0	0	0		**Materials and Resources**	**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2
0	0	0		**Indoor Environmental Quality**	**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	1
0	0	0		**Innovation**	**6**
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1
0	0	0		**Regional Priority**	**4**
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
0	0	0		**TOTALS** Possible Points:	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

This system is a non-profit, voluntary, consensual, marketing, and brand-oriented system. Leadership in Energy and Environmental Design (LEED) standards have been widely adopted, particularly in the North American market.

5.2.3. CASBEE

CASBEE (Comprehensive Assessment System for Building Environmental) is a comprehensive assessment system for the environmental efficiency of buildings. CASBEE was implemented in 2004 by the Japanese Sustainable Building Consortium [79]. Addressing the sustainability issues specific to Japan and Asia, this system first aimed to improve indoor air quality by paying attention to indoor conditions. However, when the issue of air pollution in Tokyo gained importance, it was effective in establishing evaluation systems related to the outside of the building and its environment [89]. Finally, a detailed evaluation system has been formed that examines the harmony and effects of the building with the interior and exterior environment. CASBEE research and development have been with the support of the Ministry of Soil, Infrastructure and Transport of Japan. In addition, the system, which statesmen and academic people support by working together, is constantly improved and renewed. The CASBEE evaluation system started to issue certificates in 2005 [81].

This system is handled as 3 different groups adapted for places in different populations. We can list these from small to large as construction (houses and buildings), urban (town development) and city management [68]. 4 different CASBEE assessment tools are used for new preliminary designs, new buildings, existing structures, and residential renovations and renovations. Two systems have also been developed for temporary structures and exhibition areas (CASBEE for Temporary Construction) and detached houses (CASBEE for Detached House). Their general name is called the CASBEE family [97].

CASBEE examines and scores under main headings such as energy, resources and materials, offsite environment, noise and acoustics, thermal comfort, lighting, air quality, flexibility and adaptability, protection and creation of biotope, city view, and landscape. The system is a bit complicated. Each criterion is subjected to a score between 1 and 5, but the contribution of each category to the overall score is different because the percentage of each main head to the total score is different.

CASBEE's evaluation system consists of six categories divided under two main headings. The first of these main headings is building quality and performance (Q), and the other is the environmental loads of the building (L).

CASBEE evaluation results are determined according to Building Environmental Efficiency (BEE) value. Building Environmental Efficiency (BEE) is obtained by dividing the building performance quality expressed in Q by the building environmental loads expressed in L [98].

BEE = Q / L

Sub-categories can be briefly explained as Q1: Features of the indoor environment, Q2: Service quality, Q3: External environment of the building within the boundaries of the land, L1: Energy, L2: Resources and materials, L3: Non-land environment. You can see the rating system in Figure 5.2 [99].

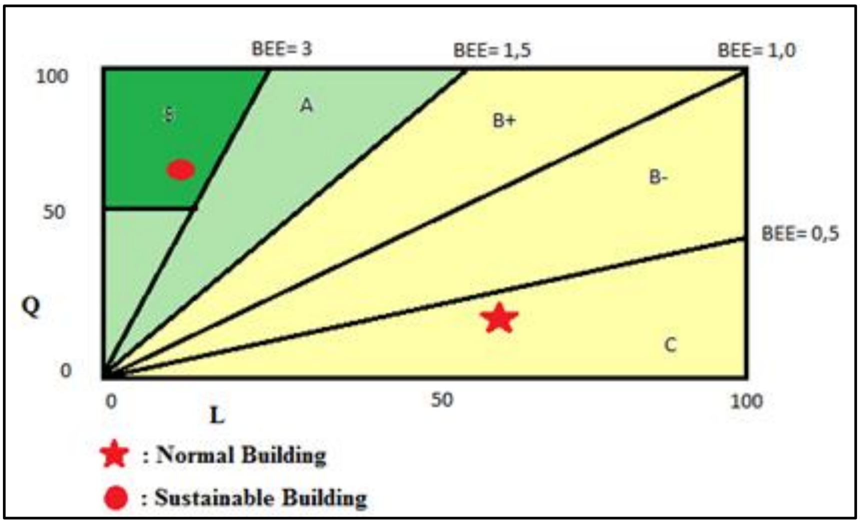

Figure 5.2. CASBEE Rating system

It is awarded a sustainability certificate degree in the form of C (Weak), B- (Slightly Weak), B + (Good), A (Very Good), S (Excellent) according to the BEE value of the evaluated building [100].

5.2.4. HK-BEAM

HK-BEAM aimed to encourage voluntary initiatives to improve the quality of buildings, increase the demand for sustainable buildings, minimize misinformation, reduce the environmental impact of buildings, and improve environmental sustainability performance from the beginning of the Project [101]. In 1996, two different evaluation methods were prepared for new and old office buildings. Office versions were upgraded in 1999 and a completely new evaluation method was published. Later, version updates were made several more times. Finally, BEAM Plus New Buildings Version 2.0 was published in 2019. It is run by a Hong Kong-based nonprofit and self-funded organization called BEAM Society Limited (BSL) [102].

According to BEAM Plus v2.0 for existing and new buildings, HK-BEAM certificates serve major areas such as office and residential buildings, shopping malls, hotels, schools and libraries, hospitals, building design and services, dining halls and dormitories, industrial buildings, and industries.

HK-BEAM assessment uses a range of good practices in building planning, design, construction, management, operation, and maintenance. It complies with local regulations, standards, and codes of practice. HK-BEAM has been specially produced for high-rise buildings and structures with high human density, taking into account the effect of the subtropical climate in Hong Kong [103].

In BEAM Plus NB v2.0, loans are grouped into seven main categories. These are Integrated Design and Construction Management (IDCM), Sustainable Sites (SS), Materials and Waste (MW), Energy Use (EU), Water Use (WU), Health and Wellbeing (HWB), and Innovations and Additions (IA). The number of credits and weight of each category are different, you can see this in Table 5.4.

Table 5.4. The weighting of categories in HK-BEAM [104]

Category	Weighting
IDCM	18%
SS	15%
MW	9%
EU	29%
WU	7%
HWB	22%

The overall rating depends on the percentage (%) of credits earned. Also, to obtain an HK-BEAM certification degree, they must collect at least 20% credit from each category. The degree award given according to the total score is given in Table 5.5.

Table 5.5. The effect of collecting each category in HK-BEAM [104]

Grade	Minimum Percentage for Each Category	Total Score
Platinum	20%	≥ 75%
Gold	20%	≥ 65%
Silver	20%	≥ 55%
Bronze	20%	≥ 40%

There are currently 1,673 projects registered in the HK-BEAM system, and it is a heavily used green building certification system, especially in Hong Kong [105]. The certification process takes the form of registration, submission, assessment, certification, and appeal [106].

5.2.5. GREEN STAR

Green Star, which was developed by the Australian Green Building Council (GBCA) in 2003, aimed to evaluate the long-term effects of buildings on the environment, to raise awareness about green building, and to a common measurement standard. It is highly supported by both industry and governments across the country. Green Star considers issues such as sustainability, human health, innovation, productivity, cost, and resource savings in building applications. In the Green Star certification system, which was developed for offices in the first stage, office designs, existing office buildings and office interiors are evaluated. Later, shopping centers and educational buildings were added to these spaces [100]. Green Star is a comprehensive and voluntary environmental rating system for buildings in Australia and has had a positive impact on the real estate and construction industry.

As given in Table 5.6, 9 main categories such as management, indoor quality, energy, transportation, water, material, land use and ecology, emissions, innovation have been determined for evaluation, similar to other certification systems [89]. Individual credits are awarded for each of these categories. It is multiplied by the weight coefficient determined by taking into account the geographical conditions and climate of the area where the building is located, then the innovation score is added and an evaluation result is determined by the number of stars according to the total score [107].

Table 5.6. The weighting of categories in Green Star [89]

CREDIT	POINTS AVAILABLE
MANAGEMENT	
Green Star Accredited Professional	1
Commissioning and Tuning	4
Adaptation and Resilience	2
Building Information	1
Commitment to Performance	2
Metering and Monitoring	1
Responsible Construction Practices	2
Operational Waste	1
INDOOR ENVIRONMENT QUALITY	
Indoor Air Quality	4
Acoustic Comfort	3
Lighting Comfort	3
Visual Comfort	3
Indoor Pollutants	2
Thermal Comfort	2
ENERGY	
Greenhouse Gas Emissions	20
Peak Electricity Demand Reduction	2
TRANSPORT	
Sustainable Transport	10
WATER	
Potable Water	12
MATERIALS	
Life Cycle Impacts	7
Responsible Building Materials	3
Sustainable Products	3
Construction and Demolition Waste	1
LAND USE & ECOLOGY	
Ecological Value	3
Sustainable Sites	2
Heat Island Effect	1
EMISSIONS	
Stormwater	2
Light Pollution	1
Microbial Control	1
Refrigerant Impacts	1
INNOVATION	
Innovation	10

Green Star gives points for obtaining specific credits in each rating category. Each category score will be calculated and multiplied by the regional weight coefficient of that category. Innovation scores are added on top of all scores and a total score table is created at the end of the assessment. It is checked in what range the overall total score is in the Green Star rating and accordingly, it gains a star.

According to the Green Star evaluation system;

One Star: 10 - 19 pts

Two Star: 20 - 29 pts

Three Star: 30 - 44 pts

Four Star: 45 - 59 pts (Best Practice)

Five Star: 60 - 74 pts (Australian Excellence)

Six Star: 75+ pts (World Leader)[108].

In Table 5.7, you can find the criteria for these five evaluation reports collectively.

Table 5.7. The Comparison of the best five systems by criteria [100]

Criteria(s)	BREAM	LEED	CASBEE	HK-BEAM	GREEN STAR
Sustainability	×	×	×	×	×
Water Efficiency	×	×	×	×	×
Energy	×	×	×	×	×
The atmosphere and CO_2 emissions	×	×	×	×	
Material Quality	×	×	×	×	×
Resource Usage		×	×	×	×
Economy					
Indoor Quality	×	×	×	×	×
Design and planning	×	×	×	×	×
Transportation	×	×		×	×
Waste	×			×	
Ecology and Environment	×	×	×	×	×
Innovation	×	×		×	×
Land Use	×	×			×
Management	×		×	×	×
Pollution	×	×	×	×	×
Human health and peace	×		×		

These top five measurement tools will be the backbone of our evaluation report and they will be used in preparing our evaluation report. So for a more comprehensive tall building assessment report, it'll be first compared these top five measurement tools against our criteria. As it is mentioned in Figure 4.1, it will be examined the sustainability of buildings under four main topics. These topics were economic, disaster, social, and environment. In this section, it will be prepared a simple and understandable report where we can see the sub-topics of the four main evaluation headings we have determined and their impact on the overall score. First of all, let's determine the evaluation criteria suitable for these four main subjects. While selecting these criteria, existing measurement tools were used. Most of the criteria names, in which each tool has a different name, mean almost the same thing. To avoid confusion with different names and to gather the main topics of all tools in a commonplace, these criteria have been gathered in the same group as possible by making these criteria the simplest and plainest. First, these five different measurement tools will be compared under six topics: Management and Innovation (purple), Health and Living Quality (yellow), Pollution and Ecology (red), Energy and Transport (green), Land Use and Sustainable Cities (brown), and Water-Waste-Materials (blue). The coloring of topics is indicated in parentheses. While giving color to these six topics, they are colored related to four main headings. For example, Economic (green), which is one of the four main headings, is colored green because it is mostly related to energy. Likewise, the subject of Environment (red), which is another of the four main titles, is colored red because it is more related to pollution and ecology. After that, these six topics will be organized under four main thesis topics. Each sub-title will be examined and distributed to the topics accordingly, so different values have been taken from all of them, but the same color has been tried to be chosen to be related to each other.

When making comparisons, the effect of these measurement tools on the average will be calculated depending on how much they value these topics and the scoring will be made accordingly. To give a simple example, if the pollution issue, which has a 20% effect for BEAM, is 15% for another measurement tool, LEED, the score of BEAM will be 4, while the score of LEED will be 3. In other words, even if the sum of the generally available credits for BREEAM is 132 credits, the percentage of importance of the criteria is calculated to be 100%. You can find calculation examples for each tool in the following tables (Table 5.8, Table 5.9, Table 5.10, and Table 5.11). The aim here is to gather each topic in a common denominator and to modify the percentage of importance according to a constant of 100 points.

Table 5.8. The calculation importance of criteria for BREEAM [109]

BREEAM		
	Credits Available	Importance of Criteria (%)
Management	20	13,33
Health and Wellbeing	21	14,00
Energy	34	22,67
Transport	11	7,33
Water	9	6,00
Materials	14	9,33
Waste	13	8,67
Land Use and Ecology	5	3,33
Pollution	7	4,67
Surface Water Run-off	5	3,33
Innovation	10	6,67
Hazards	1	0,67
TOTAL	**150**	**100**

Table 5.9. The calculation importance of criteria for LEED [110]

LEED		
	Credits Available	Importance of Criteria (%)
Integrative Process	1	0,91
Location and Transport	16	14,55
Sustainable Cities	10	9,09
Water Efficiency	11	10,00
Energy and Atmosphere	33	30,00
Materials and Resources	13	11,82
Indoor Environmental Quality	16	14,55
Innovation	6	5,45
Regional Priority	4	3,64
TOTAL	**110**	**100**

Table 5.10. The weight and importance of criteria for HK BEAM [111]

HK BEAM		
	Weight of Criteria (%)	Importance of Criteria (%)
Integrated Design & Construction Management	18	16,36
Sustainable Cities	15	13,64
Materials and Waste	9	8,18
Energy Use	29	26,36
Water Use	7	6,36
Health and Wellbeing	22	20,00
Innovation and Additions	10	9,09
TOTAL	**110**	**100**

Table 5.11. The calculation importance of criteria for Green Star [112]

GREEN STAR		
	Credits Available	Importance of Criteria (%)
Management	14	12,73
Indoor Environmental Quality	17	15,45
Energy	22	20,00
Transport	10	9,09
Water	12	10,91
Materials	14	12,73
Land Use and Ecology	6	5,45
Emissions	5	4,55
Innovation	10	9,09
TOTAL	**110**	**100**

The number of credits given for each criterion has been taken from the original evaluation forms, and since the same name is not expressed in all of them, assumptions have been made in some places. Although these tools are often expressed as credits and percentages, it was difficult to include CASBEE in this comparison and generalization as its assessment was unique. In CASBEE, which has a rather complicated system, it was tried to make it suitable for the simple criterion scoring table by using the coefficient values they used in the original tool. You can find these ratios and distributions in Table 5.12.

Table 5.12. The assumption and calculation of effect on overall avarage for CASBEE [113]

	Coefficient	Environmental Quality of the building	Effect on Overal Avarage		Environmental Load Reduction of the building	Coefficient	
Q (WEIGHTING %50)	**0,40**	**Indoor Environment**	**20**	**20**	**Energy**	**0,40**	LR (WEIGHTING %50)
	0,15	**Noise & Acoustics**	**3**	**4**	**Building Thermal Load**	**0,2**	
	0,4	Noise	1,2	**2**	**Natural Energy Utilization**	**0,1**	
	0,4	Sound Insulation	1,2	**10**	**Efficiency in Building Service System**	**0,5**	
	0,2	Sound Absorption	0,6	**4**	**Efficient Operation**	**0,2**	
	0,35	**Thermal Comfort**	**7**	4	Other than apartments	1	
	0,5	Room Temperature Control	3,5		Apartments		
	0,3	Humidity Control	2,1	**15**	**Resources & Materials**	**0,30**	
	0,2	Type of Air Conditioning System	1,4	**3**	**Water Resources**	**0,2**	
	0,25	**Lighting & Illumination**	**5**	1,2	Water Saving	0,4	
	0,3	Daylighting	1,5	1,8	Rainwater & Gray Water	0,6	
	0,3	Anti-glare Measures	1,5	**9**	**Reducing Usage of Non-renewable Resources**	**0,6**	
	0,15	Illuminance Level	0,75	0,9	Reducing Usage of Materials	0,1	
	0,25	Lighting Controllability	1,25	1,8	Continuing Use of Existing Building Skeleton etc	0,2	
	0,25	**Air Quality**	**5**	1,8	Use of Recycled Materials as Structural Frame Materials	0,2	
	0,5	Source Control	2,5	1,8	Use of Recycled Materials as Non-structural Materials	0,2	
	0,3	Ventilation	1,5	0,9	Timber from Sustainable Forestry	0,1	
	0,2	Operation Plan	1	1,8	Reusability of Components and Materials	0,2	
	0,30	**Quality of Service**	**15**	**3**	**Avoiding the Use of Materials with Pollutant Content**	**0,2**	
	0,40	**Service Ability**	**6**	0,9	Use of Materials without Harmful Substances	0,3	
	0,4	Functionality & Usability	2,4	2,1	Avoidance of CFCs and Halons	0,7	
	0,3	Amenity	1,8	**15**	**Off-site Environment**	**0,30**	
	0,3	Maintenance Management	1,8	**5**	**Consideration of Global Warming**	**0,33**	
	0,30	**Durability & Reliability**	**4,5**	**5**	**Consideration of Local Environment**	**0,33**	
	0,5	Earthquake Resistance	2,25	1,25	Air Pollution	0,25	
	0,3	Service Life of Components	1,35	2,50	Heat Island Effect	0,5	
	0,2	Reliability	0,90	1,25	Load on Local Infrastructure	0,25	
	0,30	**Flexibility & Adaptability**	**4,5**	**5**	**Consideration of Surrounding Environment**	**0,33**	
	0,3	Spatial Margin	1,35	2	Noise, Vibration & Odor	0,4	
	0,3	Floor Load Margin	1,35	2	Wind Damage & Sunlight Obstruction	0,4	
	0,4	Adaptability of Facilities	1,8	1	Light Pollution	0,2	
	0,30	**Outdoor Environment on Site**	**15**				
	0,3	**Preservation & Creation of Biotope**	**4,5**				
	0,4	**Townscape & Landscape**	**6**				
	0,3	**Local Characteristics & Outdoor Amenity**	**4,5**				
	0,5	Attention to Local Charcter & Improvement of Comfort	2,25				
	0,5	Improvement of the Thermal Environment on Site	2,25				

In CASBEE, they adjusted the coefficient value of the top evaluation title of the evaluation criteria to be 1 in total. If we look at Table 5.12, there are gray subtitles for LR (Environmental Load Reduction of the Building) on the right and Q (Environmental Quality of the Building) on the left and their coefficient values. There is a second subheading in cream color under the gray subheadings. You can see that the cream-colored secondary subtitles also have a white-colored third subtitle and their coefficient values. For example, under the Q main heading, you can see that the first subheadings with 3 grays are Indoor Environment (0.40) + Quality of Service Outdoor (0.30) + Environment on Site (0.30), the sum of which is 1. Again, to give an example, the first sub-title of LR is Energy, which is Building Thermal Load (0.2) + Natural Energy Utilization (0.1) + Efficiency in Building Service System (0.1) + Efficient Operation (0, 2) You can see that the coefficient totals make 1. Based on these coefficients, CASBEE normally has its evaluation algorithm and a complex scoring system. However, in this confusion, we had to adapt the criteria to similar islands and determine the criteria scores. Therefore, the two main determinants of CASBEE, Environmental Quality of the Building (Q) and Environmental Load Reduction of the Building (LR), were assumed to have an impact weight of 50%+50%=100% on the overall score. As a result of this assumption, the various criteria in Q and LR were allocated from 50% according to coefficient ratios. Each sub-title has a share of 50% according to the coefficient ratio and you can see the values of each criterion in the section that says the effect on the overall average. For example, if we consider the "quality of service" criterion on the Q side, it is calculated as 50%*(0,30) = 15% effect weight. Likewise, on the LR side, the impact weight was determined according to the "water resources" criterion as "water-saving" 3%*(0.4) = 1.2%, one of the third sub-criteria.

After being shared in Table 5.12, they were gathered under the common topics for other tools, and the necessary modifications were made and colored to be grouped as in Table 5.13. Again, these topics are not the same as the ones above, and an assumption has been made while grouping them. For Management, the impact weight, which is the sum of the criteria "Durability & Reliability", "Spatial Margin", "Floor Load Margin" and "Service Ability", was determined as 13.2%. For Indoor environmental quality, 20% points from the main criteria “Indoor environment” and 20% points from the “Energy” criteria for Energy where deemed appropriate. For Transport, the sub-criteria “Attention to Local Character & Improvement of Comfort” with a score of 2.25% and “Load on Local Infrastructure” with a score of 1.25% were selected and the total impact weight was deemed appropriate by 3.5%. 3% points from the “Water resources” sub-criteria for Water and 1.8% points for “Adaptability of Facilities” were deemed appropriate for innovation. For Materials and resources, the total impact weight of the criteria of “Reducing Usage of Non-renewable Resources” and “Avoiding the Use of Materials with Pollutant Content” was found suitable by 12%. For Land use and ecology, the effect weight, which is the sum of “Preservation & Creation of Biotope”, “Townscape & Landscape” and “Consideration of Surrounding Environment”, was deemed appropriate with a score of 15.5%. For Emission, the effect weight, which is the sum of the criteria of “Consideration of Global Warming” “Air Pollution” “Heat Island Effect” and “Improvement of the Thermal Environment on Site”, was determined by us as 11% points. Thus, CASBEE had similar names and similar voting scores.

In Table 5.13, you can see the percentile importance weights and similar titles and similar coloring with other tools.

Table 5.13. Calculation importance of criteria for CASBEE

CASBEE	
	Criteria (%)
Management	13,2
Indoor Environmental Quality	20
Energy	20
Transport	3,5
Water	3
Materials and Resources	12
Land Use and Ecology	15,5
Emissions	11
Innovation	1,8
Total Credits	100

After proportionally expressing CASBEE, let's compare these top five tools first as six topics. You can see six topics in different colors in Table 5.14. While choosing these titles, common or similar criteria names of five different evaluation tools were chosen as much as possible and gathered under the same title. Here, instead of going into details, it is aimed to see only the rough approximate scores and to prepare the ground for scoring the four main titles of our thesis.

Table 5.14 allows us to easily compare and see all the colored criteria for these five tools. You can easily see where the points come from, as they are colored with the same colors in the previous tables. However, while half of the score of a title such as "land use and ecology" was included in the title of "Land use and sustainable cities", the other half was added to "Pollution and ecology". The aim here was to try to gather the criteria names used in each certification system in a common-place and to compare them in a simple form in a table.

Table 5.14. The comparison in six common titles for five tools

	BREEAM	LEED	HK BEAM	GREEN STAR	CASBEE
Management and Innovation	20	6,36	25,45	21,82	15
Health and Living Quality	14	14,55	20	15,45	20
Pollution and Ecology	6,33	18,64	9,09	7,27	18,75
Energy and Transport	30	29,55	26,36	29,09	23,50
Land Use and Sustainable Cities	5,67	9,09	13,64	2,73	7,75
Water and Waste and Materials	24	21,82	14,55	23,64	15

After examining in detail the selected criteria titles for these top five tools and distributing credits and rates, they will be modified for use in this thesis. Since this thesis aims to obtain a simpler, clearer, more common, and practical tool, these titles will be modified according to the four main titles of our thesis. For example, for economic, which is one of the four main titles, we will examine the credit titles related to the economy such as management, innovation, and energy and try to find the place of economy in the total percentage. To give another example, health and living quality headings for social, which is one of the main headings of the thesis, were examined and the data percentages were arranged accordingly. Like these examples given, the credits of the five evaluation criteria under four main headings were divided and their importance percentages were calculated one by one. In Table 5.15, you can see the importance percentages for BREEAM.

Table 5.15. The BREEAM organized according to four main criteria

BREEAM		
	Credits Available	Importance of Criteria (%)
Disaster	8	6,20
Social	29	22,48
Economic	52	40,31
Environment	40	31,01
Total	129	100

If we explain in detail where these credits come from;

Disaster (8 credits) = Project brief and design (1 credit) + Life cycle cost and service life planning (1 credit) + Responsible construction practices (1 credit) + Commissioning and handover (1 credit) + Aftercare (1 credit) + Natural hazards (1 credit)+ Site selection (1 credit) + Designing for robustness (1 credit)

Social (29 credits) = Project brief and design (1 credit) + Life cycle cost and service life planning (1 credit) + Responsible construction practices (1 credit) + Visual comfort (3 credits) + Indoor air quality (4 credits) + Thermal comfort (2 credits) + Microbial contamination (1 credit) + Acoustic performance (2 credits) + Safe access (1 credit) + Moisture protection (2 credits) + Energy efficiency (2 credits) +Energy performance of building structure and installations (1 credit) + Public transport accessibility (2 credits) + Proximity to amenities (1 credit) + Alternative modes of transport (2 credits) + Maximum car parking capacity (1 credit) + Travel plan (1 credit) + Reduction of noise pollution (1 credit)

Economic (52 credits) = Project brief and design (1 credit) + Life cycle cost and service life planning (2 credit) + Responsible construction practices (4 credits) + Commissioning and handover (2 credit) + Aftercare (2 credits) + Visual comfort (1 credit) + Indoor air quality (1 credit) + Safe access (1 credit) + Moisture protection (1 credit) + Energy efficiency (8 credits) + Energy monitoring (3 credits) + External lighting (1 credit) + Low and zero carbon technologies (1 credit) + Energy efficient equipment (2 credits) + Energy performance of building structure and installations (1 credit) + Public transport accessibility (1 credit) + Maximum car parking capacity (1 credit) + Water consumption (1 credit) + Water monitoring (1 credit) + Water leak detection (1 credit) + Life cycle impact (1 credit) + Responsible sourcing of materials (2 credits) +Impact of refrigerants (1 credit) + NOxemissions (1 credit) + All innovations (10 credits) + Speculative floor and ceiling finishes (1 credit)

Environment (40 credits) = Project brief and design (1 credit) + Energy efficiency (2 credits) + Low and zero carbon technologies (1 credit) + Water consumption (4 credits) + Water leak detection (1 credit) + Life cycle impact (6 credits) + Responsible sourcing of materials (1 credit) + construction waste management (3 credits) + Recycle daggregates (1 credit) + Operational waste (1 credit) + Site selection (2 credits) + Ecological value of site and protection (2 credits) + Enhancing site cology (3 credits) + Long term impact on biodiversity (2 credits) + Impact of refrigerants (2 credit) + NOxemissions (2 credit) + Surface water run off (5 credits) + Reduction of night time light pollution (1 credit)

It has been deemed appropriate to distribute it to our criteria as above. It was published on 13.11.2019 under the name of "pre-assessment estimator 2016 version 1.08" for building performance based on BREEAM. There are more recent estimators and distributions, but since this is the only available detail, it has been allocated accordingly. You can see where the details selected above were taken from in Table 5.16.

Table 5.16. The BREEAM-NOR 2016 New construction pre-assessment estimator and credits [114]

BREEAM-NOR 2016 Issue	Available credits	Credits
MANAGEMENT		
Man 01 Project brief and design	4	
Man 02 Life cycle cost and service life planning	4	
Man 03 Responsible construction practices	6	
Man 04 Commissioning and handover	3	
Man 05 Aftercare	3	
Total performance management	**20**	

BREEAM-NOR 2016 Issue	Available credits	Credits
HEALTH & WELLBEING		
Hea 01 Visual comfort	4	
Hea 01 Visual comfort - Criteria 1	Yes/No	
Hea 02 Indoor air quality	5	
Hea 03 Thermal comfort	2	
Hea 04 Microbial contamination	1	
Hea 05 Acoustic performance	2	
Hea 06 Safe access	2	
Hea 07 Natural Hazards	1	
Hea 08 Private space	0	
Hea 09 Moisture protection	3	
Total performance health & wellbeing	**20**	

BREEAM-NOR 2016 Issue	Available credits	Credits
WATER		
Wat 01 Water consumption	5	
Wat 02 Water monitoring	1	
Wat 03 Water leak detection and prevention	2	
Wat 04 Water efficient equipment	0	
Total performance water	**8**	

BREEAM-NOR 2016 Issue	Available credits	Credits
MATERIALS		
Mat 01 Life cycle impacts	7	
Mat 01 Life cycle impacts - Criteria 1	Yes/No	
Mat 03 Responsible sourcing of materials	3	
Mat 03 Responsible sourcing of mat. - Crit 1.	Yes/No	
Mat 05 Designing for robustness	1	
Total performance materials	**11**	

BREEAM-NOR 2016 Issue	Available credits	Credits
WASTE		
Wst 01 Construction waste management	3	
Wst 02 Recycled aggregates	1	
Wst 03 Operational waste	1	
Wst 04 Speculative floor and ceiling finishes	1	
Total performance waste	**6**	

BREEAM-NOR 2016 Issue	Available credits	Credits
ENERGY		
Ene 01 Energy efficiency	12	
Ene 02 Energy monitoring	3	
Ene 03 External lighting	1	
Ene 04 Low and zero carbon technologies	2	
Ene 05 Energy efficient cold storage	0	
Ene 06 Energy efficient transportation systems	0	
Ene 07 Energy Efficient Laboratory Systems	0	
Ene 08 Energy efficient equipment	2	
Ene 09 Drying space	0	
Ene 23 Energy performance of building structure and installations	2	
Total performance energy	**22**	

BREEAM-NOR 2016 Issue	Available credits	Credits
TRANSPORT		
Tra 01 Public transport accessibility	3	
Tra 02 Proximity to amenities	1	
Tra 03 Alternative modes of transport	2	
Tra 04 Maximum car parking capacity	2	
Tra 05 Travel plan	1	
Tra 06 Home office	0	
Total performance transport	**9**	

BREEAM-NOR 2016 Issue	Available credits	Credits
LAND USE & ECOLOGY		
LE 01 Site selection	3	
LE 02 Ecological value of site and protection of ecological features	2	
LE 04 Enhancing site ecology	3	
LE 05 Long term impact on biodiversity	2	
LE 06 Building footprint	0	
Total performance land use and ecology	**10**	

POLLUTION		
POL 01 Impacts of refrigerants	3	
POL 02 NOx emissions	3	
POL 03 Surface water run-off	5	
POL 04 Reduction of night time light pollution	1	
POL 05 Noise attenuation	1	
Total performance pollution	**13**	

EXEMPLARY LEVEL AND INNOVATION (max 10 credits)		
Inn 01 - Man 05 Aftercare	1	
Inn 02 - Hea 02 Indoor air quality	1	
Inn 03 - Tra 03 Alternative modes of transport	1	
Inn 04 - Wat 01 Water consumption	1	
Inn 05 - Mat 01 Life cycle impacts	2	
Inn 06 - Mat 03 Responsible sourcing of materials	1	
Inn 07 - Wst 01 Construction site waste man.	1	
Inn 08 - Wst 02 Recycled aggregates	1	
Inn 09 - Approved innovation credits	10	
Total indicative environmental section performance	**10**	

In Table 5.17, the importance percentages for LEED can be seen.

Table 5.17. The LEED organized according to four main criteria

LEED		
	Credits Available	Importance of Criteria (%)
Disaster	5	4,55
Social	24	21,82
Economic	45	40,91
Environment	36	32,73
Total	110	100

If we explain in detail where these credits come from;

Disaster (5 credits) = Building Life-Cycle Impact Reduction (1 credit) + Environmental Product Declarations (1 credit) + Sourcing of Raw Materials (1 credit) + Material Ingredients (1 credit) + Regional Priority: Specific Credit (1 credit)

Social (24 credits) = High Priority Site (1 credit) + Access to Quality Transit (3 credits) + Bicycle Facilities (1 credit) + Open Space (1 credit) + Enhanced Commissioning (1 credit) + Optimize Energy Performance (2 credits) + Demand Response (2 credits) + Building Life-Cycle Impact Reduction (1 credit) + Enhanced Indoor Air Quality Strategies (2 credits) + Low-Emitting Materials (1 credit) + Indoor Air Quality Assessment (2 credits) + Thermal Comfort (1 credit) + Interior Lighting (1 credit) + Daylight (2 credits) + Quality Views (1 credit) + Acoustic Performance (1 credit) + Regional Priority: Specific Credit (1 credit)

Economic (45 credits) = Integrative Process (1 credit) + Access to Quality Transit (2 credits) + Rainwater Management (1 credit) + Outdoor Water Use Reduction (1 credit) + Indoor Water Use Reduction (2 credit) + Cooling Tower Water Use (1 credit) + Water Metering (1 credit) + Enhanced Commissioning (5 credits) + Optimize Energy Performance (14 credits) + Advanced Energy Metering (1 credit) + Enhanced Refrigerant Management (1 credit) + Bina Yaşam Döngüsü Etki Azaltma (2 credits) + Sourcing of Raw Materials (1 credit) + Construction and Demolition Waste Management (2 credits) + Construction Indoor Air Quality Management Plan (1 credit) + Interior Lighting (1 credit)

+ Daylight (1 credits) + Innovation (5 credits) + LEED Accredited Professional (1 credit) + Regional Priority: Specific Credit (1 credit)

Environment (36 credits) = Sensitive Land Protection (1 credit) + High Priority Site (1 credit) + Surrounding Density and Diverse Uses (5 credits) + Reduced Parking Footprint (1 credit) + Green Vehicles (1 credit) + Site Assessment (1 credit) + Protect or Restore Habitat (2 credits) + Rainwater Management (2 credits) + Heat Island Reduction (2 credits) + Light Pollution Reduction (1 credit) + Outdoor Water Use Reduction (1 credit) + Indoor Water Use Reduction (4 credits) + Cooling Tower Water Use (1 credit) + Optimize Energy Performance (2 credits) + Renewable Energy Production (3 credits) + Green Power and Carbon Offsets (2 credits) + Building Life-Cycle Impact Reduction (1 credit) + Environmental Product Declarations (1 credit) + Material Ingredients (1 credit) + Low-Emitting Materials (2 credits) + Regional Priority: Specific Credit (1 credit)

It has been deemed appropriate to distribute it to our criteria as above. You can see the "LEED v4 for BD+C: New Construction and Major Renovation" evaluation form based on LEED in Table 5.18.

Table 5.18. The LEED v4 for BD+C: New Construction and Major Renovation and credits [115]

			Credit	Integrative Process	1
0	0	0		**Location and Transportation**	**16**
			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
			Credit	Surrounding Density and Diverse Uses	5
			Credit	Access to Quality Transit	5
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1
0	0	0		**Sustainable Sites**	**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Site Assessment	1
			Credit	Site Development - Protect or Restore Habitat	2
			Credit	Open Space	1
			Credit	Rainwater Management	3
			Credit	Heat Island Reduction	2
			Credit	Light Pollution Reduction	1
0	0	0		**Water Efficiency**	**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction	2
			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
			Credit	Water Metering	1
0	0	0		**Energy and Atmosphere**	**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2
0	0	0		**Materials and Resources**	**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2
0	0	0		**Indoor Environmental Quality**	**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	1
0	0	0		**Innovation**	**6**
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1
0	0	0		**Regional Priority**	**4**
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
0	0	0		**TOTALS**	**Possible Points: 110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

In Table 5.19, you can see the importance percentages for HK BEAM.

Table 5.19. The HK BEAM organized according to four main criteria

HK BEAM		
	Credits of Criteria	Importance of Criteria (%)
Disaster	5	2,36
Social	44	20,75
Economic	74	34,91
Environment	89	41,98
Total	212	100

If we explain in detail where these credits come from;

Disaster (5 credits) = Integrated Design Process (1 credit) + Design for Climate Change Adaptation (1 credit) + Design for Durability and Resilience (3 credits)

Social (44 credits) = Measures to Reduce Site Emissions (1 credits) + Considerate Construction (1 credit) + Building Management Manual (1 credit) + Operator Training plus Chemical Storage Room (1 credit) + Occupant Engagement Platform (1 credit) + BIM Integration (1 credit) + Pedestrian oriented and Low Carbon Transport (4 credits) + Neighbourhood Amenities (2 credits) + Building Design for Sustainable Urbanism (1 credit) + Neighbourhood Daylight Access (1 credit) + Noise Control for Building Equipment (1 credit) + Light Pollution Control (1 credit) + Immediate Neighbourhood Wind Environment (1 credit) + Outdoor Thermal Comfort (2 credits) + Reduction of CO2 Emissions (2 credits) + Peak Electricity Demand Reduction (1 credit) + Air conditioning Units (1 credit) + Clothes Drying Facilities (1 credit) + Healthy and Active Living (1 credit) + Biophilic Design (1 credit) + Enhanced Ventilation (3 credits) + Waste Odour Control (1 credit) + Acoustic and Noise (5 credits) + Indoor Vibration (1 credit) + IAQ Monitoring (2 credits) + Thermal Comfort (3 credits) + Artificial Lighting (2 credits) + Daylight (1 credit)

Economic (74 credits) = Sustainability Champions Design (2 credits) + Complimentary Certification (3 credits) + Integrated Design Process (3 credits) + Life Cycle Costing (1 credit) + Commissioning (4 credits) + Sustainability Champions Construction (1 credit) + Construction and Demolition Waste Recycling (3 credits) + Construction IAQ Management (1 credit) + Digital Facility Management Interface (1 credit) + Document Management System (2 credits) + BIM Integration (3 credits) + Design for Engagement and Education on Green Buildings (1 credit) + Pedestrian oriented and Low Carbon Transport (1 credit) + Urban Heat Island Mitigation (1 credit) + Stormwater Management (2 credit) + Design for Climate Change Adaptation (1 credit) + Building Re-use (3 credits) + Modular and Standardised Design (2 credits) + Prefabrication (4 credits) + Recycled Materials (1 credit) + Regional Materials (1 credit) + Life Cycle Assessment (1 credit) + Adaptability and Deconstruction (2 credits) + Enhanced Waste Handling Facilities (2 credits) + Peak Electricity Demand Reduction (2 credits) + Metering and Monitoring (2 credits) + Renewable and Alternative Energy Systems (2 credits) + Air-conditioning Units (1 credit) + Clothes Drying Facilities (1 credit) + Energy Efficient Appliances (1 credit) + Annual Water Use (2 credits) + Water Efficient Irrigation (2 credits) + Water Efficient Appliances (1 credit) + Water Leakage Detection (1 credit) + Twin Tank System (1 credit)

+ Cooling Tower Water (1 credit) + Daylight (1 credit) + Innovations and Additions (10 credits)

Environment (89 credits) = Measures to Reduce Site Emissions (3 credits) + Construction and Demolition Waste Recycling (3 credits) + Design for Engagement and Education on Green Buildings (1 credit) + Building Design for Sustainable Urbanism (3 credits) + Light Pollution Control (1 credit) + Biodiversity Enhancement (6 credits) + Urban Heat Island Mitigation (10 credits) + Stormwater Management (1 credit) + Sustainable Forest Products (2 credits) + Recycled Materials (2 credits) + Ozone Depleting Substances (2 credits) + Regional Materials (2 credits) + Use of Green Products (6 credits) + Enhanced Waste Handling Facilities (2 credits) + Low Carbon Passive Design (6 credits) + Reduction of CO2 Emissions (13 credits) + Metering and Monitoring (1 credit) + Renewable and Alternative Energy Systems (9 credits) + Energy Efficient Appliances (1 credit) + Annual Water Use (2 credits) + Water Efficient Irrigation (1 credit) + Effluent Discharge to Foul Sewers (1 credit) + Water Harvesting and Recycling (3 credits) + Biophilic Design (1 credit) + Inclusive Design (2 credits) + Enhanced Ventilation (1 credit) + IAQ Monitoring (3 credits) + Biological Contamination (1 credit)

It has been deemed appropriate to distribute it to our criteria as above. You can see the "BEAM Plus New Buildings V2.0" main categories based on HK BEAM in Table 5.20. Since each title is very detailed and long, you can find the details and contents of these categories in BEAM Society Limited’s web site .

Table 5.20. The BEAM plus New Buildings V2.0 and credits [116]

Category	Applicable Credits (A)	Achieved Credits (B)
Integrated Design & Construction Management (IDCM)	25	25+14B
Sustainable Site (SS)	21	21+19B
Materials and Waste (MW)	14	14+21B
Energy Use (EU)	31	31+13B
Water Use (WU)	12	12+3B
Health and Wellbeing (HWB)	19	19+10B
Innovations and Additions (IA)		10

In Table 5.21, you can see the importance percentages for Green Star.

Table 5.21. The Green Star organized according to four main criteria

GREEN STAR		
	Credits Available	Importance of Criteria (%)
Disaster	7	6,36
Social	24	21,82
Economic	35	31,82
Environment	44	40
Total	110	100

If we explain in detail where these loans come from;

Disaster (7 credits) = Adaptation and Resilience (1 credit) + Commissioning and Tuning (2 credits) + Building Information (1 credit) + Responsible Building Materials (1 credit) + Potable Water (1 credit) + Sustainable Sites (1 credit)

Social (24 credits) = Responsible Construction Practices (1 credit) + Indoor Air Quality (3 credits) + Acoustic Comfort (3 credits) + Lighting Comfort (3 credits) + Visual Comfort (3 credits) + Indoor Pollutants (1 credit) + Thermal Comfort (2 credits) + Greenhouse Gas Emissions (2 credits) + Sustainable Transport (4 credits) + Potable Water (1 credit) + Microbial Control (1 credit)

Economic (35 credits) = Green Star Accredited Professional (1 credit) + Commissioning and Tuning (1 credit) + Commitment to Performance (1 credit) + Metering and Monitoring (1 credit) + Responsible Construction Practices (1 credit) + Operational Waste (1 credit) + Greenhouse Gas Emissions (8 credits) + Peak Electricity Demand Reduction (2 credits) + Sustainable Transport (2 credits) + Potable Water (5 credits) + Responsible Building Materials (1 credit) + Construction and Demolition Waste (1 credit) + Innovation (10 credits)

Environment (44 credits) = Commissioning and Tuning (1 credit) + Adaptation and Resilience (1 credit) + Commitment to Performance (1 credit) + Indoor Air Quality (1 credit) + Indoor Pollutants (1 credit) + Greenhouse Gas Emissions (10 credits) + Sustainable Transport (4 credits) + Potable Water (5 credits) + Life Cycle Impacts (7 credits) + Responsible Building Materials (1 credit) + Sustainable Products (3 credits) +

Ecological Value (3 credits) + Sustainable Sites (1 credit) + Heat Island Effect (1 credit) + Stormwater (2 credits) + Light Pollution (1 credit) + Refrigerant Impacts (1 credit)

It has been deemed appropriate to distribute it to our criteria as above. For Green Star, the criteria in the "Green Star Design & As Built v1.2 Submission Guidelines" are based. You can see the criteria scores in Table 5.22. Sub-titles of the titles appearing in Table 5.22 are detailed in the Submission Guidelines.

Table 5.22. The GreenStar Design & As Built v1.2 Submission Guidelines and credits [117]

INDEX	CREDIT	POINTS AVAILABLE
	MANAGEMENT	
1	Green Star Accredited Professional	1
2	Commissioning and Tuning	4
3	Adaptation and Resilience	2
4	Building Information	1
5	Commitment to Performance	2
6	Metering and Monitoring	1
7	Responsible Construction Practices	2
8	Operational Waste	1
	INDOOR ENVIRONMENT QUALITY	
9	Indoor Air Quality	4
10	Acoustic Comfort	3
11	Lighting Comfort	3
12	Visual Comfort	3
13	Indoor Pollutants	2
14	Thermal Comfort	2
	ENERGY	
15	Greenhouse Gas Emissions	20
16	Peak Electricity Demand Reduction	2
	TRANSPORT	
17	Sustainable Transport	10
	WATER	
18	Potable Water	12
	MATERIALS	
19	Life Cycle Impacts	7
20	Responsible Building Materials	3
21	Sustainable Products	3
22	Construction and Demolition Waste	1
	LAND USE & ECOLOGY	
23	Ecological Value	3
24	Sustainable Sites	2
25	Heat Island Effect	1
	EMISSIONS	
26	Stormwater	2
27	Light Pollution	1
28	Microbial Control	1
29	Refrigerant Impacts	1
	INNOVATION	
30	Innovation	10

Since the sub-evaluation subjects and details of the titles in Table 5.22 are long for each score, we can summarize their contents as follows;

1) Green Star Accredited Professional (1 point): Accredited Professional

2) Commissioning and Tuning (4 points): Environmental Performance Targets, Services and Maintainability Review, Building Commissioning, Building Systems Tunin, Independent Commissioning Agent

3) Adaptation and Resilience (2 points): Implementation of a Climate Adaptation Plan

4) Building Information (1 point): Building Information

5) Commitment to Performance (2 points): Environmental Building Performance, End of Life Waste Performance

6) Metering and Monitoring (1 point): Monitoring Systems

7) Responsible Construction Practices (2 points): Environmental Management System, High-Quality Staff Support

8) Operational Waste (1 point): Performance Pathway Specialist Plan-Facilities

9) Indoor Air Quality (4 points): Ventilation System Attributes, Provision of Outdoor Air, Exhaust or Elimination of Pollutants

10) Acoustic Comfort (3 points): Internal Noise Levels, Reverberation, Acoustic Separation

11) Lighting Comfort (3 points): General Illuminance and Glare Reduction, Surface Illuminance, Localised Lighting Control

12) Visual Comfort (3 points): Daylight, Views,

13) Indoor Pollutants (2 points): Paints, Adhesives, Sealants and Carpets, Engineered Wood Products

14) Thermal Comfort (2 points): Thermal Comfort, Advanced Thermal Comfort

15) Greenhouse Gas Emissions (20 points): Building envelope, Glazing, Lighting, Ventilation and airconditioning, Domestic hot water systems, Energy Intensity Reduction, Appliances and equipment, Accredited GreenPower® products

16) Peak Electricity Demand Reduction (2 points): Prescriptive Pathway On-site Energy Generation, Modelled Performance Pathway Reference Building

17) Sustainable Transport (10 points): Access by Public Transport, Reduced Car Parking Provision, Low Emission Vehicle Infrastructure, Active Transport Facilities, Walkable Neighbourhoods

18) Potable Water (12 points): Sanitary Fixture Efficiency, Rainwater Reuse, Heat Rejection, Landscape Irrigation, Fire System Test Water

19) Life Cycle Impacts (7 points): Portland Cement Reduction, Water Reduction, Aggregates Reduction

20) Responsible Building Materials (3 points): Structural and Reinforcing Steel, Timber, Permanent Formwork, Pipes, Flooring, Blinds, and Cables

21) Sustainable Products (3 points): Product Transparency and Sustainability

22) Construction and Demolition Waste (1 point): Reporting Accuracy, Fixed Benchmark, Percentage Benchmark

23) Ecological Value (3 points): Endangered, Threatened or Vulnerable Species and Communities, Ecological Value

24) Sustainable Sites (2 points): Conditional Requirement, Reuse of Land, Contamination and Hazardous Materials

25) Heat Island Effect (1 point): Heat Island Effect Reduction

26) Stormwater (2 points): Stormwater Peak Discharge, Stormwater Pollution Targets

27) Light Pollution (1 point): Light Pollution to Neighbouring Bodies, Light Pollution to Night Sky

28) Microbial Control (1 point): Legionella Impacts from Cooling Systems

29) Refrigerant Impacts (1 point): Refrigerant Impacts

30) Innovation (10 points): Innovative Technology or Process, Market Transformation, Improving on Green Star benchmarks, Innovation Challenge, Global Sustainability

You can find all these details in Green Star Design & As Built v1.2 Submission Guidelines.

In Table 5.23, you can see the importance percentages for CASBEE.

Table 5.23. The CASBEE organized according to four main criteria

CASBEE	
	Criteria (%)
Disaster	9
Social	20
Economic	33,5
Environment	37,5
Total	100

If we explain in detail where these loans come from;

Disaster (9%) = Durability & Reliability (4,5%) + Flexibility & Adaptability (4,5%)

Social (20%) = Noise & Acoustics (3%) + Thermal Comfort (7%) + Lighting & Illumination (5%) + Air Quality (5%)

Economic (33,5%) = Service Ability (6%) + Building Thermal Load (4%) + Natural Energy Utilization(2%) + Efficiency in Building Service System (10%) + Efficient Operation (4%) + Water saving (1,2%) + Reducing Usage of Materials (0,9%) + Continuing Use of Existing Building Skeleton etc (1,8%) + Use of Recycled Materials as Non-structural Materials (1,8%) + Reusability of Components and Materials (1,8%)

Environment (37,5%) = Preservation & Creation of Biotope (4,5%) + Townscape & Landscape (6%) + Local Characteristics & Outdoor Amenity (4,5%) + Rainwater & Gray Water (1,8%) + Use of Recycled Materials as Structural Frame Materials (1,8%) + Timber from Sustainable Forestry (0,9%) + Avoiding the Use of Materials with Pollutant Content

(3%) + Consideration of Global Warming (5%) + Consideration of Local Environment (5%) + Consideration of Surrounding Environment (5%)

It was deemed appropriate to distribute the percentages as above to our four main criteria headings. These percentages are the criteria of the “CASBEE for Building (New Construction) Assessment Software 2014 v.2.1” evaluation report, in which we have previously assumed and divided the percentages according to the coefficient values. You can see the modified version of the report again in Table 5.24.

Table 5.24. The CASBEE for Building (New Construction) Assesment Software 2014 v.2.1 modified version [96]

	Coefficient	Environmental Quality of the building	Effect on Overal Avarage		Environmental Load Reduction of the building	Coefficient	
Q (WEIGHTING %50)	0,40	Indoor Environment	20	20	Energy	0,40	LR (WEIGHTING %50)
	0,15	Noise & Acoustics	3	4	Building Thermal Load	0,2	
	0,4	Noise	1,2	2	Natural Energy Utilization	0,1	
	0,4	Sound Insulation	1,2	10	Efficiency in Building Service System	0,5	
	0,2	Sound Absorption	0,6	4	Efficient Operation	0,2	
	0,35	Thermal Comfort	7	4	Other than apartments	1	
	0,5	Room Temperature Control	3,5		Apartments		
	0,3	Humidity Control	2,1	15	Resources & Materials	0,30	
	0,2	Type of Air Conditioning System	1,4	3	Water Resources	0,2	
	0,25	Lighting & Illumination	5	1,2	Water Saving	0,4	
	0,3	Daylighting	1,5	1,8	Rainwater & Gray Water	0,6	
	0,3	Anti-glare Measures	1,5	9	Reducing Usage of Non-renewable Resources	0,6	
	0,15	Illuminance Level	0,75	0,9	Reducing Usage of Materials	0,1	
	0,25	Lighting Controllability	1,25	1,8	Continuing Use of Existing Building Skeleton etc	0,2	
	0,25	Air Quality	5	1,8	Use of Recycled Materials as Structural Frame Materials	0,2	
	0,5	Source Control	2,5	1,8	Use of Recycled Materials as Non-structural Materials	0,2	
	0,3	Ventilation	1,5	0,9	Timber from Sustainable Forestry	0,1	
	0,2	Operation Plan	1	1,8	Reusability of Components and Materials	0,2	
	0,30	Quality of Service	15	3	Avoiding the Use of Materials with Pollutant Content	0,2	
	0,40	Service Ability	6	0,9	Use of Materials without Harmful Substances	0,3	
	0,4	Functionality & Usability	2,4	2,1	Avoidance of CFCs and Halons	0,7	
	0,3	Amenity	1,8	15	Off-site Environment	0,30	
	0,3	Maintenance Management	1,8	5	Consideration of Global Warming	0,33	
	0,30	Durability & Reliability	4,5	5	Consideration of Local Environment	0,33	
	0,5	Earthquake Resistance	2,25	1,25	Air Pollution	0,25	
	0,3	Service Life of Components	1,35	2,50	Heat Island Effect	0,5	
	0,2	Reliability	0,90	1,25	Load on Local Infrastructure	0,25	
	0,30	Flexibility & Adaptability	4,5	5	Consideration of Surrounding Environment	0,33	
	0,3	Spatial Margin	1,35	2	Noise, Vibration & Odor	0,4	
	0,3	Floor Load Margin	1,35	2	Wind Damage & Sunlight Obstruction	0,4	
	0,4	Adaptability of Facilities	1,8	1	Light Pollution	0,2	
	0,30	Outdoor Environment on Site	15				
	0,3	Preservation & Creation of Biotope	4,5				
	0,4	Townscape & Landscape	6				
	0,3	Local Characteristics & Outdoor Amenity	4,5				
	0,5	Attention to Local Charcter & Improvement of Comfort	2,25				
	0,5	Improvement of the Thermal Environment on Site	2,25				

Thus, criteria and credit analyzes were made for all evaluation systems and distributed according to the four main topics of our thesis. A general comparison is made in Table 5.25.

Table 5.25. The comparison according to four main criteria

	BREEAM	LEED	HK BEAM	GREEN STAR	CASBEE
Disaster	6,20	4,55	2,36	6,36	9,00
Social	22,48	21,82	20,75	21,82	20,00
Economic	40,31	40,91	34,91	31,82	33,50
Environment	31,01	32,73	41,98	40,00	37,50

According to the comparison, CASBEE on “Disaster”, BREEAM on “Social”, LEED on “Economic” and HK BEAM on “Environment” showed the highest importance. These top considerations can be looked at when creating our importance percentages and choosing our evaluation criteria. For example, while determining the names of criteria for “Social”, the BREEAM evaluation report will be based on and will form the basis of several sub-topics. Before determining our number of criteria and names, we will first determine the percentages of the main topics. These values obtained in Table 5.25. are a guide for determining our importance percentages. After taking the average of the percentages given for the 5 tools, let's find the percentage values for our criteria that are suitable for the average. You can see our importance percentages and average in Table 5.26 and Figure 5.3.

Table 5.26. The resulted importance percentages for four main topics

	BREEAM	LEED	HK BEAM	GREEN STAR	CASBEE	Average	The Goal
Disaster	6,20	4,55	2,36	6,36	9,00	5,69	8
Social	22,48	21,82	20,75	21,82	20,00	21,37	22
Economic	40,31	40,91	34,91	31,82	33,50	36,29	35
Environment	31,01	32,73	41,98	40,00	37,50	36,64	35
					Total Percentage	100	100

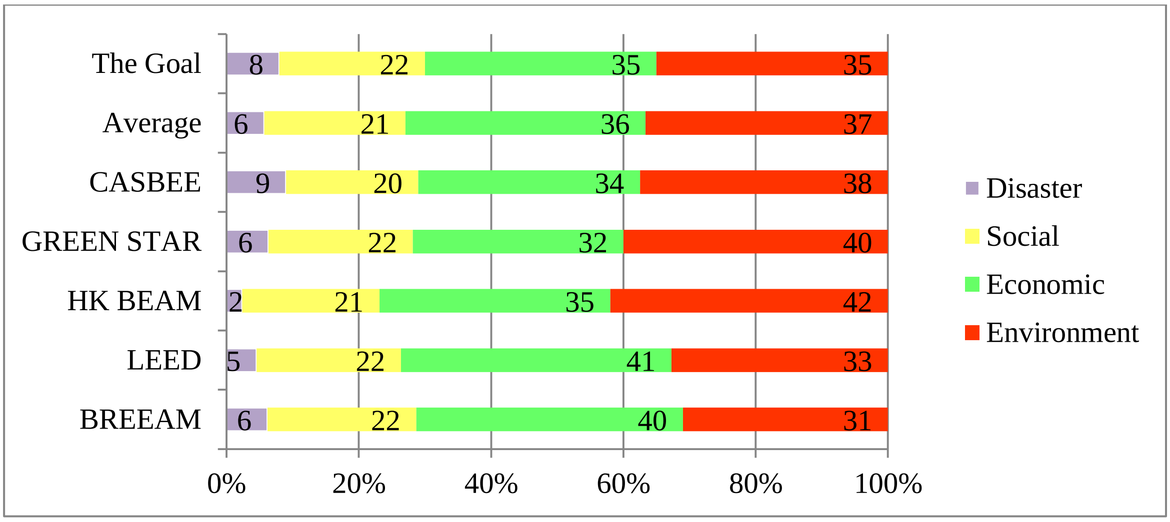

Figure 5.3. The comparison of our importance percentages with other rating systems

Values as close to the average as possible were accepted here, but since we believe that disaster issues should be considered more, it was decided to share the ratios in this way.

6. SUSTAINABILITY OF HIGH-RISE BUILDINGS

In the face of the rapidly increasing population in the world, the increasing demand for high-rise buildings has become inevitable. The reduction of vacant land has resulted in higher land prices and the clearing of forests to make room. With the increasing population in the areas reserved for agriculture, more buildings started to be built. Tall buildings serve many people. This is very important in terms of its relationship with the environment. Existing transportation, sewerage, and electricity infrastructure have to be strong in this sense, and it is. The strength of these infrastructures also provides an advantage in terms of sustainability in high-rise buildings. High-rise buildings have the opportunity to save huge amounts of money in many areas, especially in wind energy, solar energy, and natural ventilation. It can also provide advantages in terms of reducing the used space and carbon footprint, reducing transportation and carbon dioxide emissions, and healthy air quality.

6.1. DISASTER

In the subject of ‘Disaster’, issues such as the safety of the building, the measures were taken against natural disasters, especially earthquakes, human health, the age of the building, the region of the building, the building material and system, the building maintenance and repair works, and the building infrastructure features will be discussed.

6.1.1. Building Construction Material and System

If we first consider the building materials and systems of the building, it can be said that after steel and reinforced concrete systems, composite systems are generally more successful by using the good aspects of these two systems. According to their behavior against horizontal loads, we can group steel, reinforced concrete, and composite carrier systems as follows;

- Rigid frame systems

- Beamless slab/floor systems

- Core systems
- Curtain wall systems
- Cut-frame systems
- Mega column systems
- Mega core systems
- External-supported frame systems
- Tube systems [118].

Among these, rigid frame systems, tube systems, and curtain wall systems are generally used below 40 floors, while shear-frame systems, mega column and core systems, and tube systems are used on more than 40 floors. In Table 6.1, the construction materials of all systems and the height values in the most appropriate way for use are given [119]. While taking these floor numbers, based on Özcan and et al. studies (2019), but the coefficients corresponding to the levels were determined by me. For example, since it is said that horizontal curtained frame systems are suitable for use for 55 floors and above, it gives the most appropriate and highest score to 55 floors and above, besides that since tube systems are common for 100 floors and above, 100 floors were chosen as the limit and it was accepted as the worst value. The best and worst values were determined and assumptions were made in the intermediate values of the horizontal curtain frame system. While choosing these intermediate values, level rankings were made by increasing the number of floors by 15 each. The most suitable and usable is called level 4, while the least preferred corresponds to level 1. To give another example, since core systems can reach up to 20 floors, 20 floors and above are in the risky group. Therefore, values exceeding 20 floors correspond to the lowest level, while the highest level is accepted from 1 floor. Thus, for level 2 and level 3 in between, 1 to 20 floors are reasonably divided by 7 floors each. In the Frame system, which is another example, it is said that it is generally built up to 30 floors, but it can also be found 40-50 floors. Considering this, buildings with less than 30 floors have a higher level, while level 1, which is the worst level for over 50 floors, was deemed appropriate. While taking level 2 between 40 and 50, the number of floors of the building is 30 floors or less for the best level. In addition, since it is said to be made up to 20-25 floors for Beamless tiled, the lowest level after 25 floors was counted, and by reducing 5 floors, level grouping was made and 15 floors and below were deemed appropriate for the highest level, level 4. In the tube system, it is said to be advantageous for 45 layers and above, and it is also said that it is frequently applied over 100 layers. Therefore, while 45 floors and below are considered the best level, level 4 is accepted, while the level up to 110 floors is accepted as level 3. Although it is suitable for over 100 floors, the limit is assumed to be 150 floors. After 150 floors, it is grouped as level 1, which is the riskiest and worst level. Since it is common to use 50 floors or more for mega column and mega core, 50 floors below is accepted as the most robust and reliable, and level 4, which is 50 floors below the highest level, was deemed appropriate. Since these two systems can be used up to 100 floors, the level grouping has been made by increasing 25 floors between 50 and 100 floors. In this way, assumptions were made for the others based on the studies of Özcan and et al. As can be seen from the table, three simple questions will be asked here for easy scoring. The first question is "what is the building material?", the second question is "how many floors does your building have?" and the last question is “what is your building structure system?”. At the end of these three questions, one point will be taken. To transfer these questions to the points system, we need to gather them under a single roof, so the DQ1 (Disaster Question 1) question we will ask about disaster can be as follows;

DQ1: In Table 6.1, "what is the building material?", "how many floors does your building have?" and “what is your building structure system?” What is the level of your building according to the answers to the questions?

Table 6.1. Building systems, building material, and number of floors classification

System	**Material(s)**	**level 4**	**level 3**	**level 2**	**level 1**
Frame	Steel and reinforced concrete	n < 30	n < 40	n < 50	n > 50
Core	Reinforced concrete	n < 7	n< 14	n < 20	n > 20
Core and lateral roller	Steel and reinforced concrete	n < 20	n < 30	n < 40	n > 40
Beamless tiled	Reinforced concrete	n < 15	n < 20	n < 25	n > 25
With curtain wall	Reinforced concrete	n < 25	n < 35	n < 45	n > 45
Lattice curtain frame	Steel, reinforced concrete or composite	n < 40	n > 40	n > 60	n > 80
Curtain wall frame	Steel, reinforced concrete or composite	n < 40	n > 40	n > 60	n > 80
Mega column	Reinforced concrete and composite	n < 50	n > 50	n > 75	n > 100
Mega core	Reinforced concrete and composite	n < 50	n > 50	n > 75	n > 100
Horizontal curtain frame	Steel, reinforced concrete and composite	n < 55	n > 55	n > 80	n > 105
Tube systems	Steel, reinforced concrete and composite	n < 45	n > 45	n > 110	n > 150
		n= Number of floors			

6.1.2. The Project Area of the Building

The area where the building is located is important for the "Disaster" rating because the more favorable a ground is, the stronger the structure. In addition, questions will be asked about the wind loads, rain and humidity rates of the region, being in a landslide, tsunami or volcanic region, what degree of the fault line that region is, and scoring will be made accordingly. The questions here might be:

-DQ2: What is the fault line degree of your region?

It is considered to be in Zone 1 (level 1), Zone 2 (level 2), Zone 3 (level 3), Zone 4 (level 4), and Zone 5 (level 5).

-DQ3: Do storms and hurricanes happen a lot in your area? Are you anywhere near the risk of tsunami and volcano eruption?

If near a tsunami or active volcano, level 1,

If hurricanes or storms happen frequently, level 2,

If strong winds are rare, level 3,

If nothing extreme happens, level 4.

-DQ4: What type of soil is your building located on? Is there a risk of landslides or landslides?

If the building is on soft clay, sand or silty soil and on a slope with high landslide risk, it is level 1,

If the building is on soft clay, sand or silty soil and on flat ground, it is level 2,

If the building is on small rock particles, gravel and stony soil and on a slope with high landslide risk, it is level 3,

If the building is on small rock particles, gravel or stony soil and on a flat place, it is level 4,

If the building is on the hard rock or large rocks and on a slope with a high risk of landslide, it is level 5, If the building is on solid rock or large boulders and on flat ground, it is level 6

will be accepted and scored accordingly.

6.1.3. Human Health and Precautions in the Building

Nobody wants to live in a building that negatively affects human health, which reduces the life of the building. Dust, mold, bacteria, etc. in the building. Microorganisms that may be harmful to humans can cause permanent and serious diseases on humans. For a building to be sustainable, the people living in that building must feel that they live in a healthy and sheltered way. In this context, the building should be prepared in case of a possible earthquake, fire or danger. The questions on these issues are as follows;

-DQ5: Are the area and indoor health services of your building sufficient?

If the air quality of the area where your building is located is good and no mold or bacterial environment has occurred in the building, level 5,

If the air quality of the area where your building is located is moderate and no mold or bacterial environment has occurred in the building, level 4,

If the air quality of the area where your building is located is moderate, and if there is a mold fungus or bacterial environment in the building, level 3,

If the air quality of the area where your building is located is bad and mold fungus or bacterial environment has formed in the building, level 2,

If the air quality of the area where your building is located is bad and there is a permanent mold or bacterial environment in the building, level 1.

-DQ6: Is the building ready for a possible fire, earthquake or any bad situation?

If the indoor fire extinguishing systems are very good and applied to all areas of the building where fire may occur, if the first aid tools are in certain locations, if there are plans before and after the earthquake and if the necessary training is made in this regard, level 6, If the indoor fire extinguishing systems are good and applied to the common areas of the building and the basement parking areas if the first aid equipment is located in certain locations, if there are plans before and after the earthquake and if the necessary training is made in this regard, level 5,

If the indoor fire extinguishing systems are good and applied to the common areas of the building and the basement parking areas if the first aid tools are located in certain locations if there are plans before and after the earthquake, but if the necessary training is not provided, level 4,

If the indoor fire extinguishing systems are only applied to the basement parking areas, if the first aid tools are in certain locations if there are plans before and after the earthquake, but if the necessary training is not given, level 3,

If the indoor fire extinguishing systems are only applied to the basement parking areas, if the first aid tools are not available in certain locations if there are no plans before and after the earthquake and if the necessary training is not provided, level 2,

If there are no indoor fire extinguishing systems, first aid equipment is not available in certain locations if you do not have pre-earthquake and post-earthquake plans, and if the necessary training is not provided, level 1,

If you say you have no idea about it, level 0,

It will be accepted and scored accordingly.

Since high buildings are very high, they attract lightning like a lightning rod in adverse weather conditions. Therefore, the lightning rod grounding system of your building should be very good. Lightning rod systems can be of different types. Lightning rods are used considering factors such as the structure of the building, the environmental factor, the length or width of the building. For this reason, the building where the lightning rod system will be installed must first be examined by experts [120].

-DQ7: Does your building have a lightning rod system? Is it considered sufficient by experts?

If there is a lightning rod system and it is found sufficient by experts, level 3, There is a lightning rod system, but if you have no idea whether it is sufficient by experts, level 2,

If there is no lightning rod system and experts have never been called, level 1.

6.1.4. Building Maintenance and Repair

Precautions may have been taken against a possible earthquake or fire in the buildings, but your building will still be affected by these situations, depending on the severity of the fire and earthquake. This activation status also varies according to the age of the building. That's why we'll take them into account when asking questions. We can list the questions to be asked for building maintenance and repair as follows;

-DQ8: What is your building age? Have you had a strong earthquake or fire before?

If the building age is less than 50 and has not survived any earthquake or fire, level 5,

If the building age is less than 50 but has suffered a slight earthquake or fire hazard, level 4,

If the building is less than 50 years old but has experienced a severe earthquake or fire hazard at least once or if you don't know this, level 3,

If the building age is more than 50 but has not survived any earthquake or fire hazard, level 2,

If the age of the building is more than 50 but has survived any earthquake or fire hazard at least once or if you don't know about this, level 1[121].

-DQ9: Is there a document that includes the basic and structural system features of the building before any possible earthquake, fire or tsunami?

If it is available, level 2,

If it is not, level 1,

If you say you have no idea about it, level 0.

-DQ10: Is a specialist engineer called to the building and damage assessment is carried out, after any possible disaster such as earthquake, fire or tsunami?

If it is done,level 2,

If it is not, level 1,

If you say you have no idea about it, level 0.

-DQ11: After the damage assessment, if your building is slightly damaged or moderately damaged, is the building repaired?

If repairing all visible or invisible damages inside and outside the building, carrier systems, level 5,

If the damage to the column, beam, floor and main carrier systems is repaired, but the wall cracks inside or the damage outside the building are not done, level 4,

If only column and beam damage is repaired, level 3,

If only exterior or only cracks are repaired and shown visually intact, level 2,

If no repairs are made, level 1,

If you say you have no idea about it, level 0.

-DQ12: Is it regularly maintained after the building is repaired?

If it is maintained again in two years, level 5,

If it is maintained within five years, level 4,

If it is maintained again in seven years, level 3,

If it is maintained again in ten years, level 2,

If it is not maintained at all, level 1 [121].

If you say you have no idea about it, level 0.

6.1.5. Building Infrastructure

Building infrastructure is important in disasters such as a possible earthquake, fire and tsunami. Infrastructure systems must operate safely without or with minimal damage. In addition to electricity, water and natural gas infrastructures, transportation, communication and communication infrastructures are also extremely important. As a result of a possible earthquake, problems may arise in telephone lines and networks. In this context, we can list the questions related to the building infrastructure as follows;

-DQ13: Are the building's electricity, water and natural gas infrastructures safely maintained for a possible earthquake, tsunami and fire?

If all are safe, level 5,

If electricity is safe (Considering all devices (control panels, data cabinets, lighting fixtures, uninterruptible power supplies and battery packs, generators, main panels, compensation tables, MCC, medium voltage cells, and transformers, etc.) in the electrical installation in the building and the components of these devices, their seismic must have endurance) [122], natural gas is safe (During the earthquake, the building gives a warning by beeping in the form of a siren and shuts the gas inlet of the building by giving a command to the solenoid valve at the entrance of the building) [123], water is not safe, level 4,

If electricity is not safe, natural gas is safe, water is safe, level 3,

If electricity is safe, natural gas is not safe, water is safe, level 2,

If none is safe, level 1,

If you say you have no idea about it, level 0.

-DQ14: Is there any extra work done for communication and communication during or after the earthquake-fire-tsunami? (For example, installing a fixed wifi system outside the building or a communication tool that can still work in the wreckage in case of a possible collapse)

If there is still a working wifi system outside in a stable safe place or even when it is in a wreck, and if the building has an automatic SOS call facility, such as sending a call or message requesting assistance to the nearest ambulance and fire department in the event of an earthquake-fire-tsunami, level 3,

If there is no wifi system still working even when it is in a stable safe place or in wreckage outside, and if the building has an automatic SOS call facility, such as sending a call or message requesting assistance to the nearest ambulance and fire department in the event of an earthquake-fire-tsunami, level 2,

If no work has been done, level 1

If you say you have no idea about it, level 0.

-DQ15: How good are the ways of evacuating people from the building during or after a possible earthquake-fire-tsunami?

If the evacuation routes are always open and easily accessible, if the building can be evacuated in a short time (t < 15-20 min.), if the emergency exit stairs are wide enough (width>1.28 m), level 5,

If the evacuation routes are always open and easily accessible, if the building can be evacuated in an average time (t = 15-20 min.), if the emergency exit stairs are wide enough (width>1.28 m), level 4,

If the evacuation routes are always open and easily accessible, if the building can be evacuated in an average time (t = 15-20 min.), if the emergency exit stairs are not wide enough (width<1.28 m), level 3,

If the evacuation routes are always open and easily accessible, if the building can be evacuated in a little more than an average time (t > 15-20 min.), if the emergency exit stairs are not wide enough (width<1.28 m), level 2,

If the evacuation routes are always closed and completely regulated, the building can be evacuated in a little more than an average time (t > 15-20 min.), the emergency exit stairs are not wide enough (width<1.28 m), level 1 [124,125].

It can be considered.

You can find the distribution of scoring and the effects of the questions in the Table 6.2.

Table 6.2. Evaluation criteria and distribution of points on "Disaster" for the goal

		WEIGHTING	Qestion No	SCORE DISTRIBUTION					
				LEVEL 0-1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
DISASTER (8 POINTS)	**Building Construction Material and System**	**1,4**	DQ1	0,35	0,7	1,05	1,4	-	-
	The Project Area of the Building	**0,5**	DQ2	0,1	0,2	0,3	0,4	0,5	-
		0,2	DQ3	0,05	0,1	0,15	0,2	-	-
		0,3	DQ4	0,05	0,1	0,15	0,20	0,25	0,3
	Human Health and Precautions in the Building	**0,2**	DQ5	0,04	0,08	0,12	0,16	0,2	-
		0,4	DQ6	0,07	0,13	0,2	0,27	0,33	0,4
		0,2	DQ7	0,06	0,12	0,2	-	-	-
	Building Maintenance and Repair	**1,4**	DQ8	0,28	0,56	0,84	1,12	1,4	-
		0,2	DQ9	0,10	0,2	-	-	-	-
		0,5	DQ10	0,12 5	0,5	-	-	-	-
		0,5	DQ11	0,1	0,2	0,3	0,4	0,5	-
		0,4	DQ12	0,08	0,16	0,24	0,32	0,4	-
	Building Infrastructure	**0,3**	DQ13	0,06	0,12	0,18	0,24	0,3	-
		1	DQ14	0,3	0,6	1	-	-	-
		0,5	DQ15	0,1	0,2	0,3	0,4	0,5	

6.2. SOCIAL

The main topics of questions to be asked about Social will be accessibility, indoor and outdoor comfort, building life cycle planning, the area of the building, security, open space and parking lots, the efficiency of the infrastructure, site management, and privacy.

6.2.1. Accessibility

Transport access is very important to people. Especially in big cities, there are problems with transportation due to the crowd and a lot of time is wasted on the road. The time lost on the roads can be counted as a loss of human life in a sense. According to a study conducted in 2005, the average duration of vehicle journeys in Istanbul, which is one of the metropolitan cities, is 39 minutes [126]. This period has been extended with the increasing population until today. In 2019, the average commute time for people living in the EU was 25 minutes, compared to 27.6 minutes in the US [127,128]. The longest average travel time is said to be in London with 81 minutes [129]. Of course, this period varies according to the density of the city, but still, a ranking can be made according to the data at hand. Considering these;

-SQ1: How long does it take from home to work?

If comute time < 28 min., level 4,

If 28 min.< commute time < 40 min., level 3,

If 40 min.< commute time < 80 min., level 2,

If commute time > 80 min., level 1,

will be scored.

In some literature, there is consensus that the maximum walking distance to a bus, train, or tram stop is 400 meters and 800 meters. Also, according to the Spatial Development Institute, people are told that there should be public transport stops within 500 meters [130]. According to these;

-SQ2: How far is it from the public transport stop near or around the residential building?

If distance < 400 meters, level 4,

If 400 < distance < 500 meters, level 3,

If 500 < distance < 800 meters, level 2,

If distance > 800 meters, level 1,

will be scored.

-SQ3: Do the disabled have access to the parking lot or public transport stops without interruption or hindrance?

If there is, level 2,

If there is no, level 1, will be taken.

6.2.2. Indoor and Outdoor Comfort

Many indoor and outdoor factors affect human health. For example, if we consider noise pollution, it has performance effects as well as psychological, physiological, and physical effects on people. Effects such as decreased work efficiency, increased blood pressure, sleep disorders, behavioral disorders, insomnia, irritability, temporary or permanent hearing disorders, and anger can be given as examples [131]. For a better quality of life, indoor and outdoor factors should be given importance. The following questions can be asked about this subject;

-SQ4: How many dB is the indoor or outdoor sound level? (take the highest)

If 0-30 dB (rustling leaves, whispering, quiet talk, etc.), level 5,

If 30-65 dB (rain sound, dishwasher sound, hum, restaurant noises, normal tone speech, etc.), level 4,

If 65-90 dB (heavy traffic noise, traffic noises on the side of the highway, vacuum cleaner, hairdryer or washing machine sound, TV sound, alarm clock sound, subway and tram sound, factory noise, lawnmower sound, etc.), level 3, If 90-120 dB (garbage truck sound, kitchen blender sound, very heavy traffic noise, nightclub noises, industrial noise, horn sound, chainsaw sound, the sound of airplane taking off, etc.), level 2,

If 120 dB and above (penetrating hammer sound, rifle or gunshots, siren sounds, bomb explosions, etc.), level 1,

will be scored as this [131,132,133].

Another issue is thermal comfort. Uncomfortable temperature levels inside and outside the building reduce the quality of life. Excessive hot air, insomnia, fatigue, nervousness, decrease in working efficiency at work, etc. It has been proven to cause many causes. The temperature values that people can bear vary from person to person, but generalizations can still be made. According to Liu Yang and et al., they determined the lower limit of approximately 20 °C and the upper limit of 27 °C at 50% indoor relative humidity. However, it has been said that the comfort temperature can be as low as 17 °C and as high as 30 °C [134]. In addition, the presence of green space around the building; affects the outdoor air quality as it provides warmer air by cutting the wind in cold weather, and provides shade area in hot weather, and protects people from the sun. Considering these;

-SQ5: What is there to provide thermal comfort?

If the interior temperature is not always between 17-30 °C and there is no afforestation around the building, level 1,

If the interior temperature is not always between 17-30 °C and there is afforestation around the building, level 2,

If the interior temperature is always between 17-30 °C, but there is no afforestation around the building, level 3,

If the interior temperature is always between 17-30 °C and there is afforestation around the building, level 4,

If the interior temperature is always between 20-27 °C and there is no afforestation around the building, level 5, If the interior temperature is always between 20-27 °C and there is afforestation around the building, level 6,

can be scored like that.

Clean air is very important for people to live healthily. Indoor ventilation mold, fungus, harmful bacteria, etc. necessary for it to occur [135]. Air circulation inside the building and the amount of oxygen in the breath of people is another factor that affects the quality of life. Some air conditioners can cause negative effects on human health if the necessary periodic maintenance is not performed. Steam and puddles in cooling systems are perfect places for many fungi, bacteria, and harmful particles to multiply. That's why air conditioner maintenance is important. Daily, weekly, and seasonal transition maintenance should be done. Daily maintenance includes simple issues such as whether the device is working or not, whether it heats the environment or not. Weekly maintenance includes filter cleaning, air intake grilles, and remote control cleaning. Seasonal transition maintenance includes cleaning the indoor unit filter, disinfecting the indoor unit and outdoor unit coils with chemicals [136]. Here, afforestation and the location of the building, ventilation systems of the building and air conditioning maintenance will be considered as criteria. Therefore, there will be questions and scoring as follows;

-SQ6: How is the indoor air quality?

If there is a natural or mechanical ventilation system inside the building (uninterrupted fresh air entry and exit to the building), if there is no smell of food, oil smell, cigarette smell, etc. in the building, if there is no stain and mold formation on the walls, level 5,

If there is a natural or mechanical ventilation system inside the building (uninterrupted fresh air entry and exit to the building), if there are occasional odors such as food smell, oil smell, cigarette smell, etc. in the building, if there is no stain or mold formation on the walls, level 4,

If there is a natural or mechanical ventilation system inside the building (fresh air intake and exit to the building is uninterrupted), if there are occasional odors such as food smell, oil smell, cigarette smell, etc. in the building, if there is stain and mold formation on the walls, if it is maintained and cleaned, level 3, If there is no natural or mechanical ventilation system inside the building (uninterrupted fresh air entry and exit to the building), if there is stain and mold formation on the walls, if it is maintained and cleaned, level 2,

If there is no natural or mechanical ventilation system inside the building (uninterrupted fresh air entry and exit to the building), if there is stain and mold formation on the walls, if it is not cleaned, level 1,

can be scored like that.

-SQ7: Are periodic maintenances of your air conditioners performed every week and during seasonal transitions?

Yes if all is done on time, level 6

Even if it is not done every week, weekly maintenance (filter cleaning, air intake grille cleaning, and control cleaning) is carried out and if the maintenances carried out during seasonal transitions (indoor unit filter cleaning, disinfection of indoor unit and outdoor unit coils with chemicals) are on time, level 5,

If there are no weekly maintenances, but there are maintenances during the seasonal transitions, level 4,

They don't do maintenance during seasonal changes, but if weekly maintenance is done, level 3,

If there is no maintenance during seasonal changes and weekly maintenance is done for longer than 3-4 weeks, level 2,

If no maintenance is done, level 1,

If you have no idea about it, level 0,

It is said that the ideal oxygen level in the air is 21% and below 15%, life-threatening begins for people [137]. According to this;

-SQ8: How is the indoor and outdoor air quality?

If the outdoor green areas are abundant and the oxygen level is above 21%, level 4

If the green areas outside the building are normal and the oxygen level is below 21%, level 3,

If the green areas outside the building are low and the oxygen level is below 19%, level 2,

If the green areas outside the building are very few and the oxygen level is below 15%, level 1,

If you say you have no idea about it, level 0,

will be scored.

Since so many people live in high-rise buildings, there are some rules of life. For example, it is not allowed to cook food that produces intense steam during cooking, as it activates the smoke detection systems developed against the fire hazard and placed in the apartments. It has been observed that the use of balconies in high-rise buildings has almost completely disappeared due to the wind intensity, and no activities, including hanging laundry on the exterior of the building, can be done [138]. For some reasons like this, people can sometimes feel like they are living in high-rise buildings. In addition, Kenny Kwok, a professor at the University of Western Sydney in Australia and a world-class scientist on tall building vibrations, states that strong winds can make tall buildings vibrate at frequencies between 0.08-1 Hz and that these movements can cause Sopite Syndrome (a movement-related neurological disease) or Kinetosis. He said he could cause it to start [139]. Finally, the airflow around the load building can create cooler microclimates when it reaches street level. This affects people very negatively when entering and leaving the building. You can be suddenly exposed to cold and windy weather, and it can be even more effective in cold weather. Facial paralysis, frost and icing risks on stairs or roads, chilling, flying clothes and various objects with the effect of wind, dust and various particles getting into your eyes, etc. Many reasons make people feel uneasy.

-SQ9: Does the wind bother you when you enter the building?

If you're always uncomfortable, level 1,

If you're occasionally bothered, level 2,

If you're not bothered at all, level 3,

-SQ10: Can you do any activity such as sitting on the balcony of your building, chatting, or hanging laundry?

If you can't, level 1,

If you can do some things but not other things, level 2,

If you can do whatever you want, level 3.

6.2.3. Building Life Cycle Planning

Life cycle analysis covers the entire process of any product or material from raw material (cradle) to exhaustion (grave). The follow-up of the use of products or materials is very important for both human health and building safety. For example, the aging of plumbing and rusty water from sinks affect human health negatively. To give another example, the fact that the electrical infrastructure of the building is not sufficient for the building and continuous power cuts reduce the quality of life of people. At the same time, the carbon dioxide gas emitted by the building has negative effects on human health. Considering all this, life cycle planning should be done inside and outside the building, and the old and unhealthy things should be replaced or maintained when the time comes. Today, these life cycle analyzes are carried out by experts and many software programs for various purposes [140]. According to this;

-SQ11: Is life cycle analysis performed by experts or contractors in your building?

If it is done, it will be scored as level 2,

If life cycle analysis is not done, it will be scored as level 1,

If you say you have no idea about it, level 0.

6.2.4. Psychology

While the buildings are being built, they should be designed and planned according to the region in which they are located. While the building is being built, it should be constructed in a visually unobtrusive way, by the economic level of the region and the neighborhood structure. Otherwise, class differences between people may occur too much and people may feel uncomfortable with this situation. It is not pleasant to find an ordinary old apartment building among luxury skyscrapers. Or, on the contrary, a luxury skyscraper in a slum neighborhood should not be preferred both visually and because of economic class differences. Because when passing through those places, people can be uneasy and uncomfortable. In this case, it is necessary to minimize class differences as much as possible. Considering these;

-SQ12: Do you feel uncomfortable in the neighborhood where your building is located? Do you think your building is not suitable there? (≈ECQ10)

If the answer is yes, it will be scored as level 1,

If the answer is no, it will be scored as level 2.

While high-rise buildings increase the effect of urbanization and social effects are nervous, stress and tension in normal individuals, this effect can go much further in children. Therefore, the social effects of high-rise buildings are associated with children. Physical and mental underdevelopment and mental health disorders can be observed in children. According to Study Wridt, et al., (2015), it has been said that mothers living in high-rise buildings show much more aggressive and depressive behaviors than mothers living in normal houses [141].

-SQ13: Do you or your child feel irritable, uncomfortable or depressed in a tall building?

If the answer is yes, it will be scored as level 1,

If no, it will be scored as level 2.

6.2.5. Security

Site or apartment security is very important. In this section, unlike dangerous situations such as fire, security cameras, encrypted doors, security guards, etc. Scoring will be made for the measures that can be taken inside and outside the building. While these are not essential for buildings, they are important for people to live comfortably and peacefully. Security needs may increase or decrease depending on the region, city, and country. However, the scoring does not change according to the region or city, as people will feel more peaceful and safe where these security measures are in place. Considering these;

-SQ14: Are there camera systems outside and inside the building?

If there is a complete camera system around the building outside the building, and there is a camera system in the parking lots and common areas (stairs, elevators, and floor halls) inside the building, level 6,

If there is a complete camera system around the building outside the building, and there is a camera system in the parking lots, but there is no camera system in the common areas (stairs, elevators, or floor halls) inside the building, level 5,

If there is a camera system completely around the building outside the building, and there is no camera system in the parking lots, but there is a camera system in the common areas (stairs, elevators, or floor halls) inside the building, level 4,

If there is no camera system around the building outside the building, and there is a camera system in the parking lots and common areas (stairs, elevators, or floor halls) inside the building, level 3,

If there is no camera system completely around the building outside the building, and if there is a camera system in the car parks and there is no camera system in the common areas (stairs, elevators, or floor halls) inside the building, level 2,

If there is no camera system anywhere inside or outside the building, level 1,

will be scored.

-SQ15: Is the outer door of the building encrypted? Are parking entrances controlled?

If the building exterior door is entered with a password and the parking lot entrances are provided with a remote control system, level 4,

If the exterior door of the building is always open but the parking lot entrances are provided with a remote-controlled system, level 3, If the outside door of the building is entered with a password, but the parking lot is free for every one, level 2,

If the exterior door of the building is always open and the parking lot entrances are free for every one, level 1,

will be scored.

-SQ16: Is there a security guard at the entrance of the building? Is the building surrounded by wire fences or barbed wire?

If there is a security guard and the building is protected by wire fence or barbed wire, level 4,

There is a security guard, but if the building is not protected by wire fence or barbed wire, level 3,

There is no security guard, but if the building is protected by wire fence or barbed wire, level 2,

If there is no security guard and the building is not protected by wire fence or barbed wire, level 1,

will be scored.

6.2.6. Open Space and Parking Lots

Especially in big cities, people have to live very tight. As the population is high and there is not enough space, people cannot find greenery, park areas or open spaces for children to breathe a sigh of relief. In addition, with the increasing population, the number of cars is also increasing and it is getting harder to find a parking place day by day. These, in turn, cause distress, nerves, stress and restlessness on people. Therefore, our question will be as follows;

-SQ17: Does the building have its parking and open spaces?

If there are car parks and open parking lots or green areas, level 3, If there is only one of the car park or open parking spaces, level 2,

If there are no car parks and open parking lots or green spaces, level 1,

will be scored.

6.2.7. Efficiency of the Infrastructure

When building occupants cannot do what they have planned or wanted to do while carrying out their daily routines, they become restless. Everyone has a plan of their own, and no one wants this plan to be disrupted. At this point, they want their building and city infrastructures to work uninterruptedly and smoothly. For example, let's say you have to wash your laundry before going to work, but the water is out. This can put people in a state of great uneasiness and distress. To give another example, you need to train for a very important job on the computer, but suddenly the electricity is cut off and you cannot do it. Building and city infrastructures are important because such situations are not desired. Based on this, the following questions will be selective in scoring;

-SQ18: How long does an average power outage occur in your home per year?

According to EPRI's research, they examined the average number of power outages per year in the US by duration. Of these, 37% lasted less than 1 minute, 20% lasted 1-5 minutes, 23% lasted 5-60 minutes, 15% lasted 1-4 hours, and 5% lasted more than 4 hours [142].

Looking at these data, those with a downtime of less than 1 minute are level 5, those with a downtime of 1-5 minutes are level 4, those with a downtime of 5-60 minutes are level 3, those with a downtime of 1-4 hours are level 2, and those with a downtime of 4 hours and above will be scored as level 1.

Natural gas outages are not a very common occurrence, but they can still be interrupted in cases such as maintenance and repair. So we can accept this as once a year.

-SQ19: On average, how long does a gas outage occur in your home per year?

We can assume scoring as level 2 if it is once a year or less, and as level 1 if it is two or more per year.

For water cuts, Derya Çamur and et al. In his study on water management in municipalities in Turkey, it was stated that the frequency of water cuts was 8,4% every day, 18,1% several times a week, 31,1% several times a month, 44,4% several times a year [143].

According to these data;

-SQ20: How often do you have a water cut in your home?

It will be scored as level 1 if it happens every day, level 2 if it happens several times a week, level 3 if it happens several times a month, and level 4 if it happens several times a year.

Internet outages can be very critical for their time. It has been seen to be even more important especially during this corona pandemic period. In these periods, when processes such as work or school are monitored from home, many people have been victimized due to disconnections or interruptions on the internet. Internet interruptions should be as low as possible for these processes and similar situations.

-SQ21: How often do you have internet or telecom outages in your home?

It is appropriate to score as;

level 6 if it never happens during the day,

level 5 if it happens a few times a year,

level 4 if it happens a few times a month,

level 3 if it happens several times every two weeks,

level 2 if it happens several times a week,

level 1 if it happens several times every day.

6.2.8. Technical and Administrative Management

Technical and administrative management must be to quickly and effectively solve the demands or problems of the people in the building. Administrative management and apartment managers are elected annually. Re-meeting and voting can be held during the year, if necessary, in extraordinary circumstances [144]. People's habits and lifestyles can be very different. In high-rise buildings, with the increase in the number of people, the harmony of the people in that building becomes more difficult. Therefore, it is critical for site management to solve problems and for people to live harmoniously. Therefore;

-SQ22: Are there technical and administrative management? Does it meet at least once a year? Does the administrative management meet when people have a problem or request? (≈ECQ6)

If there are technical and/or administrative management, if it meets at least once a year and if it meets for human problems or demands, level 5,

If there are technical and/or administrative management, if it does not meet at least once a year and if it is gathered for human problems or demands, level 4,

If there are technical and/or administrative management, if it meets at least once a year and not for human problems or demands, level 3,

If there are technical and/or administrative management, if it does not meet at least once a year and if it does not meet for human problems or demands, level 2,

If there is no technical and/or administrative management, level 1,

If you have no idea, level 0,

will be scored.

6.2.9. Privacy

Privacy is very different from person to person. It is very important in our country, but of course, it varies from person to person. The proximity of buildings to each other is a situation that people generally do not want and they are uncomfortable with it. Many households today suffer from it. The following reasons can be given as examples of these difficulties;

-They have to close the curtains of the rooms,

-They want to ventilate the room, but they cannot ventilate,

-Sometimes they have to spend the day without even daylight entering the room.

At the same time, the sound insulation of the walls is very important. It is an undesirable situation to hear the topics discussed at home from another apartment. Because of this;

-SQ23: Is there anything in your flat that will restrict your private life?

If there is, it will be scored as level 1,

If there is not, it will be scored as level 2.

-SQ24: Do you hear the conversations from other flats in the flat you live in?

It will be scored as;

level 1 if heard,

level 2, if not heard.

You can see the weights and scoring distribution of the social topic questions in Table 6.3.

Table 6.3. Evaluation criteria and distribution of points on "Social" for the goal

		WEIGHTING	Qestion No	SCORE DISTRIBUTION					
				LEVEL 0-1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
SOCIAL (22 POINTS)	**Accessibility**	**1,8**	SQ1	0,45	0,9	1,35	1,8	-	-
		1	SQ2	0,25	0,5	0,75	1	-	-
		0,5	SQ3	0,25	0,5	-	-	-	-
	Indoor and Outdoor Comfort	**1**	SQ4	0,2	0	0,6	0,8	1	-
		1	SQ5	0,17	0,33	0,5	0,67	0,83	1
		0,6	SQ6	0	0	0,36	0,5	1	-
		0,6	SQ7	0	0	0,3	0,4	0	0,6
		0,6	SQ8	0,15	0,3	0,45	0,6	-	-
		0,6	SQ9	0,2	0,4	0,6	-	-	-
		0,6	SQ10	0,2	0,4	0,6	-	-	-
	Building Life Cycle Planning	**1**	SQ11	0,5	1	-	-	-	-
	Psychology	**0,5**	SQ12	0,25	0,5	-	-	-	-
		0,8	SQ13	0,40	0,8	-	-	-	-
	Security	**2**	SQ14	0,33	0,67	1	1,33	1,67	2
		1	SQ15	0,25	0,5	0,75	1	-	-
		1,5	SQ16	0,38	0,75	1,13	1,5	-	-
	Open Space and Parking Lots	**1,5**	SQ17	0,50	1,00	1,5	-	-	-
	Efficiency of the Infrastructure	**1**	SQ18	0,2	0,4	0,6	0,8	1	-
		0,4	SQ19	0,2	0,4	-	-	-	-
		1	SQ20	0,25	0,5	0,75	1	-	-
		1	SQ21	0,17	0,33	0,5	0,67	0,83	1
	Technical and Administrative Management	**1**	SQ22	0,2	0,4	0,6	0,8	1	-
	Privacy	**0,6**	SQ23	0,3	0,6	-	-	-	-
		0,4	SQ24	0,2	0,4	-	-	-	-

6.3. ECONOMIC

The economic costs of a tall building can be enormous. High-rise buildings, which affect both the economy of the city where they are located and the budgets of the building occupants, have to contribute to people economically. Otherwise, the investment made in the high-rise building will not pay off and the buildings will remain empty. The fact that the buildings are left empty causes even more economic loss for high-rise buildings, which already have very high economic costs. From this point of view, high-rise buildings were evaluated under the heading of economics. On the other hand, the economic topic has been examined in sub-headings such as accessibility, project management, appropriate building design, life cycle cost, waste management, renovation and commissioning, and innovation.

6.3.1. Accessibility

Efficiency in transportation is important economically as well as socially. Time lost on the road causes both late commuting and more fuel consumption. Since high-rise buildings are generally located in cities with high population, traffic jams in and around the high-rise building, waiting in line for the market or shopping, not being able to access the elevator when requested, hospital queues, not finding a parking lot, etc. many problems can be encountered. Problems like these can take up people's time and keep them from doing their other work. For example, a person may not be able to finish the job because he goes to work late in the morning and can be delayed to the next day, which reduces work efficiency and causes economic damage. To give another example, delaying the work of a factory that makes mass production even one hour can cause enormous economic losses.

Since the average patient waiting time, transportation infrastructure, and human densities of each country and city are different, it is almost impossible to make a measurement test based on these criteria. Therefore, scoring will be done with simple questions.

ECQ1: Can you get to work or somewhere on time?

If you're always on time, level 3,

If you're late occasionally, level 2,

If you're usually late, level 1.

Sometimes there is only one convenience store or department store in your area and this can lead to a lot of waiting lines.

ECQ2: Do you wait in line at the markets or shopping stores near your area?

It will be scored as;

level 1 if you are waiting in general,

level 2 if you are waiting occasionally,

level 3 if you are not waiting at all.

Nowadays, there is a requirement for buildings to have parking lots in most countries, newly constructed buildings comply with this rule, but sometimes there are parking lots. The reason is that it is planned to have 1 car or 2 cars per apartment in the planning, but some families can have 3 or 4 cars with their children. Yet another example is the number of the guest vehicle, and since too many people live in the high-rise building, the number of guests is also very high. It can be difficult to find a place in the parking lots for this.

ECQ3: Are you looking for a parking lot with your car? (If you don't have a car, think as you do)

If you can put it in the car park instantly every time you come, it will be scored as level 3,

If you have difficulty in finding a parking space from time to time, it will be level 2,

If you cannot find a parking lot every time you come and you are looking for a permanent place, it will be scored as level 1.

Large and large elevators with sufficient capacity are very important in high-rise buildings because the hours of going from home to work and coming home from work are usually the same or close to the elevators, so there is a waiting queue in the elevators. While it is a somewhat more bearable problem where you live, it becomes a more unbearable problem in your workplace. Because the work start time and end time are the same in workplaces.

ECQ4: Can you access the elevator in your building whenever you want?

If you come and get on the elevator every time you call the elevator, level 3,

It comes every time you call the elevator, but if the capacity of the elevator is full and you can't get on it sometimes, level 2,

If the passenger capacity in the elevator is always full and does not come immediately when you call the elevators, level 1,

6.3.2. Project Management

Project management covers the entire process starting from the high-rise building site. Issues such as planning site time and site costs, managing relationships between building occupants, recruiting appropriate personnel, evaluating and accepting proposals are costly.

Incorrect planning of the building construction phase and the prolongation of the time increase the construction cost. In addition, it also causes economic damage as it delays the functioning of the building. For example, if the building is to be used as an office, that office must be made operational as soon as possible.

ECQ5: Was the project completed and delivered on the promised date?

If yes, level 2,

If not, level 1,

If you have no idea, level 0.

Relationship between building occupants is more difficult due to a large number of people. Administrative and technical managers of the building should do the adaptation and coexistence in a way that everyone can have their problems. Harmony and coexistence also provide economic benefits. Being harmonious in the workplace can make things progress faster, and harmony between houses is also important in terms of heating, electricity, and water consumption of the building. In this respect, the administrative and technical managers of the building should have good communication with people. The problems of apartment residents or workplace employees should be listened to and resolved as soon as possible. In addition, the technical team often needs to raise the awareness of the building occupants on water, electricity, and heating issues. Technical personnel should be well-recruited. For example, the cleaning cost of a high-rise building is higher than other buildings. If a suitable cleaner is not found, this cost can be multiplied even more. Therefore, it is very important to recruit competent and affordable personnel.

ECQ6: Are there annual meetings with the administrative managers of your building?

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

ECQ7: Are information or conferences given in your building to raise awareness of people about the use of water, electricity, and natural gas? If so, what is the frequency?

If it is done every year, level 4,

If it is done every five years, level 3,

If it's done every ten years, level 2,

If not done at all, level 1,

If you have no idea, level 0.

ECQ8: Are you satisfied with the service received in return for the contribution or money you provide in your building?

If you are satisfied, level 3,

If you are mediocre, level 2,

If you are not satisfied, level 1.

Tall buildings are excellent places for advertising, news, or investment. Because high-rise buildings are considered as the symbol of that city in most cities and they can have remarkable, unique, and interesting features. That's why many people want to invest in tall buildings or want to advertise. It is up to the administrative managers to decide on the best and most appropriate of these offers. If the offers are evaluated well, very profitable deals can be achieved for both parties. With these agreements, you can receive low dues from the residents of the building, or you can meet the expenses of your building without reflecting it on the residents. The money received as a result of these agreements should be explained to the residents of the building and how they will use the money should be discussed.

ECQ9: Do you think that the administrative managers evaluate the incoming offers appropriately and clearly?

If they evaluate the incoming offers and the earnings appropriately and nicely, level 3,

If they evaluate the offers, but the residents do not benefit from the income, level 2,

If they reject the offers without any evaluation, level 1,

If you have no idea about it, level 0.

6.3.3. Appropriate Building Design

When designing a high-rise building, it should be designed according to the climatic conditions of the region and the structure of the neighborhood. If it is not designed according to the neighborhood structure, the houses or offices in the high-rise building may be empty. Because no matter how beautiful your building is, people will hesitate to invest as long as its surroundings consist of slums and old houses.

ECQ10: Do you think your building is suitable for the region it is located in?

If yes, level 2,

If not, level 1,

If you say you have no idea, level 0.

If the design is bad in terms of climate, it can lead to more heating, electricity and water costs. Although the climate of each region is different, the temperature felt inside the building should be such that it does not disturb people. Insulation and design should be made accordingly.

ECQ11: How do you feel in terms of thermal comfort inside the building, unless it's very cold or hot outside? Do you use air conditioning or heating systems a lot?

If thermal comfort is good and heaters or air conditioners are used during normal seasonal periods, level 3,

If the thermal comfort is moderately good and the heater or air conditioner is used outside of normal seasonal periods, level 2,

If the thermal comfort is not good and the heating or air conditioners are on throughout the year, level 1.

ECQ12: Are windows or doors fully insulated in your flat or office? So when you close the window, does water or air get in?

If properly insulated and if no water or air is getting inside, level 2,

If air or water are getting in, level 1,

If you say you have no idea, level 0.

ECQ13: Are the distribution and collection pipes and valves of the geothermal installation under the apartment insulated?

If available, level 2,

If not, level 1,

If you have no idea, level 0.

Thermostatic valves, with the sensitive thermostat group on them, adjust the flow of water passing through the radiator and ensure that the space is kept at the desired temperature. Thus, the temperature of each space can be adjusted to different degrees. If the room temperature is 23 °C and the energy consumption is 100; If the room temperature is 22 °C, the saving amount will be 6%, if the room temperature is 21 °C, the saving amount will be 12%, if the room temperature is 20 °C, the saving amount will be 18%. If the room temperature is 26 °C, the heating cost will increase by 52%, if the room temperature is 25 °C, the heating cost will increase by 32%, if the room temperature is 24 °C, the heating cost will increase by 15%.

ECQ14: Are thermostatic valves used in radiators?

If used, level 2,

If not used, level 1,

If you have no idea, level 0.

In addition, in our world where resources are less and less each day, the use of sustainable materials in building design and sustainable design becomes very important. Building designs that produce their energy and do not meet their own water needs have begun to emerge. Buildings that make maximum use of natural resources such as rainwater, daylight, and wind will relieve the occupants of the building in terms of cost. With a suitable building design, rainwater can be used for daily water needs, daylight can be used for heating and hot water, and wind can be used in ventilation and cooling systems. This saves a lot in a tall building because tall buildings have a lot of face area compared to other buildings. Since there is no obstacle preventing sunlight, wind and rainwater from coming to these surface areas, you can get the maximum efficiency from these sources.

ECQ15: Does your building generate electricity from solar energy with photovoltaic panels? (≈ENQ23)

If producing, level 2,

If not, level 1,

If you have no idea, level 0.

ECQ16: Is hot water obtained with the solar energy system in your building?

If obtained, level 2,

If not obtained, level 1,

If you have no idea, level 0.

ECQ17: Do you use wind energy in ventilation or cooling systems in your building? (≈ENQ24)

If you are using it, level 2,

If you are not using wind energy, level 1,

If you have no idea, level 0.

ECQ18: Does your building have a rainwater collection and storage system? (≈ENQ6)

If available, level 2,

If not, level 1,

If you have no idea, level 0.

ECQ19: Can you use rain water at home? (≈ENQ7)

If available, level 2,

If unavailable, level 1,

If you have no idea, level 0.

In addition, savings-oriented products that reduce electricity use, such as the use of photocell lamps in building floor halls or basements, also contribute greatly to the cost. To use such products in your building, the energy consumption of the building should be monitored and solutions should be found for the places that consume more energy.

ECQ20: Is energy monitoring done in your building? (≈ENQ27)

If it is done, level 2,

If it is not, level 1,

If you have no idea, level 0.

While water uses are more important environmentally, they are also important economically. Factors that reduce usage such as water aerators, water leak detection, rainwater collection, wastewater collection and recycling also contribute to the economy. These topics will also be scored separately under the environmental topic title. Since the number of apartments in high-rise buildings is high, it causes terrible water consumption. Water leak detection systems, which allow us to instantly find where the fault is in case of an excess of water pipes, support the economy. In addition, wastewater collection and recycling is also very beneficial in the long run, as it reduces water use. The condensers, on the other hand, reduce the amount of water flowing at the same time by mixing the water flowing from the normal faucet with the air.

ECQ21: Do you use a water aerator? (≈ENQ19)

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

ECQ22: Is there a wastewater collection and recycling system in the building? (≈ENQ28, ENQ29)

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

ECQ23: Does your building have a water leak detection system? (≈ENQ20)

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

6.3.4. Life Cycle Cost

The quality of the materials used in your building is very important. The materials used in high-rise buildings should be first-class materials. On the contrary, because too many people use the building, the building wears out more quickly. To give the simplest example, the continuous use of elevators in the building may cause some malfunctions. While such problems are included in the cost of the building's components, it is more important to determine the basic life cycle of the building, that is, the problems in the building's carrier systems. Examples of this are earthquakes, all kinds of damage and damage to carrier systems, fire, etc. In earthquakes, tall buildings may suffer more damage due to the height of the building and the load it carries. Basic life cycle cost calculation is important for the detection of such problems.

ECQ24: Is the basic life cycle cost calculation of your building done by experts?

Yes, if it is done and appropriate materials are used, level 3,

It is not done, but if you make your calculations and take the precautions yourself, level 2,

If nothing is being done and not cared about it, level 1,

If you have no idea about it, level 0.

ECQ25: Is the life cycle cost calculation of your building's components done by experts or contractors?

Yes, if it is done and appropriate materials are used, level 3,

It is not done, but if you make your calculations and take the precautions yourself, level 2,

If nothing is being done and not cared about level 1,

If you have no idea about it, level 0.

BIM integration helps a lot in this regard. BIM is based on the elements that define the structure and models the relations of the elements with each other [145]. Working on a database where project data is kept, BIM has started to take its place at the heart of the building production process due to the requirements for performance analysis, planning, programming, preparation of construction documents, time and cost, as well as design and visualization throughout the project life cycle.

ECQ26: Has your building BIM-based project management been created?

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

6.3.5. Waste Management

The issue of waste is also an issue that has economic effects as well as environmental. Consumption is also high in high-rise buildings where people are dense. When the residues and packages of the consumed products are collected properly, they can be recycled and reused, contributing to the national income. In addition, waste food can be collected and used as fertilizer or animal feed. For this, separate waste bins should be created and people should be made aware of this issue.

ECQ27: Are waste bins in separate groups such as glass, paper, plastic, food available in your building? (≈ENQ31)

Yes if available, level 2

If not available, level 1.

ECQ28: Are building occupants informed about the waste collection? (≈ENQ32)

Yes, if informed, level 2,

If not informed, level 1,

If you have no idea, level 0.

6.3.6. Renovation and Commissioning

It is designed to stay in that area for a long time in high-rise buildings. However, to keep up with today's technology, it is necessary to renew and maintain the systems in the building. To give the simplest example, there is a difference between the efficiency of a rusty wire and the efficiency of a new wire. To give another example, the electricity consumption differences between the previously used refrigerators and the new generation refrigerators are very high. For these reasons, it is necessary to replace aging devices or materials and to test how compatible it is with the building.

ECQ29: Is your building a technological and self-renewing building?

If yes, level 2,

If no, level 1,

If you have no idea, level 0.

ECQ30: When you replace an aging device or material in your building, is its compatibility with the building tested by experts or contractors? (≈ENQ22)

Yes, if it is tested by experts or contractors in the field, level 2,

No if not tested, level 1,

If you have no idea, level 0.

6.3.7. Innovation

Innovation is all the work used to produce solutions by combining existing problems with innovative ideas. Innovation is innovating, improving, changing and creating more efficient processes, products, or services. It aims to eliminate problems with the most effective solution methods by developing new applications for needs. It is an idea that enables the development and modification of an invented product, not like the invention of a product. In this context, every kind of innovation that can be in high-rise buildings will make a positive contribution to the economy of the building. This should be determined by experts.

ECQ31: Do you have any innovation work in your building? (≈ECQ27)

If available, level 2,

If unavailable, level 1,

If you have no idea, level 0.

Table 6.4. Evaluation criteria and distribution of points on "Economic" for the goal

		WEIGHTING	Qestion No	SCORE DISTRIBUTION			
				LEVEL 0-1	LEVEL 2	LEVEL 3	LEVEL 4
ECONOMIC (35 POINTS)	**Accessibility**	**1,5**	ECQ1	0,50	1,00	1,50	-
		0,5	ECQ2	0,17	0,33	0,50	-
		0,5	ECQ3	0,17	0,33	0,50	-
		0,8	ECQ4	0,27	0,53	0,80	-
	Project management	**0,5**	ECQ5	0,25	0,50	-	-
		0,3	ECQ6	0,15	0,30	-	-
		0,7	ECQ7	0,18	0,35	0,53	0,70
		1	ECQ8	0,33	0,67	1,00	-
		0,5	ECQ9	0,17	0,33	0,50	-
	Appropriate Building Design	**0,4**	ECQ10	0,20	0,40	-	-
		1,2	ECQ11	0,40	0,80	1,20	-
		1	ECQ12	0,50	1,00	-	-
		0,6	ECQ13	0,30	0,60	-	-
		0,6	ECQ14	0,30	0,60	-	-
		2	ECQ15	1,00	2,00	-	-
		1,8	ECQ16	0,90	1,80	-	-
		1,8	ECQ17	0,90	1,80	-	-
		1,8	ECQ18	0,90	1,80	-	-
		1,8	ECQ19	0,90	1,80	-	-
		1,8	ECQ20	0,90	1,80	-	-
		0,8	ECQ21	0,40	0,80	-	-
		1,8	ECQ22	0,90	1,80	-	-
		1,8	ECQ23	0,90	1,80	-	-
	Life Cycle Cost	**1,5**	ECQ24	0,50	1,00	1,50	-
		1,5	ECQ25	0,50	1,00	1,50	-
		2	ECQ26	1,00	2,00	-	-
	Waste Management	**1,5**	ECQ27	0,75	1,50	-	-
		0,5	ECQ28	0,25	0,50	-	-
	Renovation and Commissioning	**0,75**	ECQ29	0,38	0,75	-	-
		0,75	ECQ30	0,38	0,75	-	-
	Innovation	**1**	ECQ31	0,50	1,00	-	-

6.4. ENVIRONMENT

Considering these times when natural resources are rapidly depleted, it is inevitable for buildings to be designed as environmentally friendly and respectful to nature today and in the future. Now people are faced with many problems such as global warming, air and water pollution, thirst and drought, destruction of green areas, climate changes, and various diseases. The construction sector, on the other hand, plays a major role in the consumption of natural resources. In general, buildings in the construction sector consume 16% of the freshwater resources, 25% of the tree resources, 30% of the material resources, and 40% of the energy resources in the world during their construction and the life of that building. In addition, it accounts for 35% of CO_2 emissions [146]. For this reason, a high-rise building should be environmentally sustainable and with minimum damage to nature. For this, the fourth and last main title of our evaluation criteria, the sub-headings of the environment title, were chosen as air pollution, project plan and design, rainwater, environmental products, respect for nature, sustainable and renewable systems, wastewater, and waste management.

6.4.1. Air Pollution

Air pollution is very important for both human health and global warming. Increasing CO_2 emissions and the use of ozone-depleting substances (aerosols, solvents, refrigerator and air conditioning gases, plastic foams, exhaust gases, etc.) create a heat island and harm all living things in the world [147]. All country managers should provide the necessary information on this issue, but because too many people live in high-rise buildings, it is very important to raise the awareness of high-rise building residents on these issues. Therefore, people should be informed and warned about the use of substances that deplete the ozone layer, even if only occasionally. Also, due to the traffic and the number of cars around high-rise buildings, there is more CO_2 emission than other buildings. Therefore, to reduce this, more public transportation and bicycle transportation should be encouraged and people should be given opportunities and opportunities accordingly. Reducing the use of motor vehicles will increase air quality.

Secondly, the location of the building should be chosen carefully and in a planned manner. Constructing a high-rise building in a place where there is already traffic will increase the traffic there, so we waste more time on the road, and this means that cars emit CO for a longer period. For example, the skyscrapers stretching from Zincirlikuyu to Büyükdere Street, which is increasing in Istanbul, bring traffic to a standstill despite ten percent occupancy. Even if the majority of the skyscrapers built along Eskibuyukdere Street are not fully filled yet, the traffic becomes unbearable during the commute and return hours [148]. Therefore, it is extremely important that there are no other tall buildings around your tall building and that the traffic infrastructure is sufficient.

ENQ1: Are there traffic jams in or around your building?

If there is no heavy traffic, level 4,

If there is heavy traffic around the building very rarely, level 3,

If there is heavy traffic around the building from time to time, level 2,

If there is heavy traffic around the building in general, level 1.

Finally, as the altitude increases, both the CO concentration and the wind load increase. Increased wind load creates a top-down airflow in tall buildings. More CO decomposes around the tall building with a top-down wind flow, increasing air pollution [149]. With heavy traffic, the air quality around high-rise buildings deteriorates a lot. The questions and ratings to be asked here are as follows;

ENQ2: Are you warned or informed by the building management or construction company about reducing carbon emissions in the products you use in your building?

Yes, if it is done once a year, level 4,

If it is done every five years, level 3,

If it is done every ten years, level 2,

If it is not done at all, level 1.

ENQ3: Is sufficient public transport available to your building? How convenient do you find it to use public transport or cycling?

Yes, it is provided and if necessary, it is possible to reach by public transport or by bicycle, level 3,

If provided, but still not enough bicycle and public transport to go to work or elsewhere, level 2,

If you have to go by private vehicle because there are not enough opportunities, level 1.

6.4.2. Project Plan and Design

Buildings stay in the same places for years, unless there is a major earthquake or an extreme situation. Small buildings can be demolished and replaced with new ones, but the situation is more stable for tall buildings. Also, because too many people will live in high-rise buildings, the area needs to remove this population. Therefore, high-rise building projects should be well planned. It should be built in a place that is compatible with the environment, does not disturb the neighborhood structure and is the most suitable place. For example, building a tall building in nature and greenery means both killing nature and living things and making a very dysfunctional building. Instead, it makes more sense to build your tall building in an area that has little vegetation, is close to the city center and can support a high human population in terms of infrastructure. In addition, high-rise buildings emit more CO_2 than other buildings. Since the materials used in high-rise buildings are more than those used in other buildings, the carbon emissions of the materials are also higher than in other buildings. Therefore, choosing environmentally friendly materials is very important in high-rise buildings. Renewable environmentally friendly materials should be chosen in its design, it is necessary not to disturb the general neighborhood structure of the area where the building is located.

Natural materials cause less damage to the environment and require more labor than man-made materials. When low-energy natural materials are included in building products, the products are more environmentally friendly and emit less toxic substances. With the developing technology in recent years, many studies have been carried out on the reuse of concrete, timber and steel. Frequent use of fiber-reinforced concrete and steel in buildings are examples of these [150]. In addition, geosynthetic materials can be used for purposes such as insulation and surface protection in high-rise buildings, as they have been used in many areas in the construction industry in recent years, due to their ease of transport, low workmanship, long life, and environmental characteristics [151].

ENQ4: Do the building materials of your building consist of renewable environmentally friendly products? (steel, geosynthetic materials, fiber-reinforced concrete, etc.)

If yes, level 2,

If no, level 1,

If I have no idea, level 0.

ENQ5: Is the area where your building is located by the general neighborhood structure? Do you feel that the building you are in belongs to that region?

Yes, if you say there are such buildings around, level 2,

No, if you say that it does not fit the neighborhood structure in nature and aging or not between old buildings, level 1,

I have no idea or if you're stuck level 0.

6.4.3. Rainwater

Rainwater is also very important for the environment, as we have examined under the title of “appropriate building design” of the economy. The more natural resources are used, the better for our environment. High-rise buildings, on the other hand, have a serious rainwater collection potential. It was deemed appropriate to re-evaluate this water in terms of environment, but even some of the questions we asked would be the same. Because high-rise buildings accommodate more people in a small area, they actually provide more open space around the world, but generally, these open spaces are covered with asphalt and concrete instead of vegetation. This prevents rainwater from penetrating the ground. Around high-rise buildings, these areas have been used with concrete and asphalt instead of greenery. Parking lots or walking paths are the best examples of these. If there is no vegetation, the slope of the rainwater must be calculated correctly on the road or any opening and collected with drainage systems.

ENQ6: Does your building have rainwater storage and collection system? (≈ECQ18)

If available, level 2,

If not, level 1,

If you have no idea, level 0.

ENQ7: Can you reuse rainwater in your building? (≈ECQ19)

Yes, if used, level 2,

If not available, level 1,

If you have no idea level 0.

ENQ8: Is there more vegetation or asphalt or concrete in the open areas around your building? If asphalt and concrete are dominant, is rain water collected with the drainage system?

If vegetation is predominantly level 5,

If approximately half is vegetation, half is asphalt or concrete, and rainwater is collected by the drainage system, level 4,

Almost half of it is vegetation, half of it is asphalt or concrete and the drainage system does not collect rainwater, level 3,

If asphalt or concrete is weighted and rainwater is collected with the drainage system, level 2,

If asphalt or concrete is weighted and rainwater is not collected by the drainage system, level 1,

If I have no idea about asphalt or concrete weighted drainage system, level 0.

6.4.4. Environmental Products

Most of the time, the most affordable and durable materials are used in buildings without paying attention to carbon emissions, but today, attention should be paid to the damage they cause to the environment. Environmentally friendly products that do not affect human health should be used. Examples of environmentally friendly products include local materials, used materials, recycled materials, low-emission paint and insulation materials, wood, low-emission coatings and composite materials, renewable materials, and gases that do not harm the ozone layer [152]. For example, if the wood is generally used as a building material in a region, you should design a high-rise building in accordance with that region. The fact that the exterior of the building is wooden or the floor coverings are wooden reduces carbon emissions.

ENQ9: Has wood been used on the exterior or floor coverings of your building?

If both exterior and floor coverings are made of wood, level 4,

If only the exterior is wood, level 3,

If only the floor covering is wood, level 2,

If there is no wood veneer, level 1.

Since more materials are used in high-rise buildings than in normal buildings, the use of these environmental products is very important. All kinds of composite materials and cork made from bamboo, wool, cotton, linoleum, straw and wheat husk are examples of renewable products. These products are mostly used in flooring, fixed and mobile furniture, suspended ceilings and insulation materials [152].

ENQ10: Are any of the renewable products (bamboo, wool, cotton, linoleum, straw, cork, etc.) used in any part of your building?

If yes, level 2,

If not used, level 1,

If you have no idea, level 0.

Building occupants should be informed about products that damage the ozone layer. It has been understood that CFC (chlorofluorocarbon), HCFC (hydrochlorofluorocarbon), and halons, which are generally used as gases in building cooling and fire extinguishing systems, are very damaging to the ozone layer [153]. Therefore, the use of gases that have little effect on the ozone layer should be ensured and periodic maintenance of cooling and fire extinguishing gas pipes should be done.

ENQ11: Are the gases used in the cooling or fire extinguishing systems in your apartment one of the ones whose effect on the ozone layer is reduced?

If yes, level 2,

No if using CFC, HCFC, or halons, level 1,

If you have no idea about it, level 0.

ENQ12: Are information and warning meetings held in your building by building supervisors and/or managers or contractors about products that damage the ozone layer?

Yes, if information is given every five years, level 3,

Yes, if the information is provided every ten years, level 2,

If no the information is provided at all, level 1.

ENQ13: Is there periodic maintenance of the cooling and fire extinguishing gas pipes in your apartment?

If it is done, level 2,

If it is not, level 1,

If you have no idea about it, level 0.

6.4.5. Respect for Nature

A building must adapt to the natural life and ecology of that area. Tall buildings are not good at adapting to nature compared to detached houses. While detached houses have lower carbon emissions and can be made of wood, high-rise buildings contain high carbon emissions and cannot fully adapt to nature because they cannot be made from trees. In addition, because high-rise buildings affect more sunlight, rain, and wind than other buildings, they also affect the surrounding vegetation and ecology. It is known that the temperature values are higher in the regions where the skyscrapers are dense and the airflow changes. The use of the ones suitable for the roofs of the buildings as gardens and the greening of the roof with vegetation, and the covering of the unsuitable ones with light colors or reflective material also reduce the heat island effect. It has been calculated that the temperature will decrease by 0.8 degrees with the gardening of the roofs and terraces of the buildings in Tokyo [154]. In addition, it creates a negative effect on living things due to the light pollution in that region due to the light emitted from high buildings in the evenings. This light pollution usually makes itself felt more because glass is used on the exterior of high-rise buildings. Again, due to the large population living in high-rise buildings, the use of toxic cleaning materials, pesticides, and air pollutants create a negative effect on the living things living in that area.

ENQ14: Is there any planting work on the roof of your building, on the terrace, or the exterior of the building?

If there is greening work all around including the roof, terrace (or balcony), and exterior, level 5,

If there is greening work on any of these, including the roof, terrace (or balcony), and exterior, level 4,

If there is greening work in only one of them, including the roof, terrace (or balcony), and exterior, level 3,

There is no greening work anywhere, but if your roof is covered with light-colored paint or coating that acts as a reflector, level 2,

If there is no greening work anywhere and your roof is no covered with light-colored paint or coating, level 1.

There are differences between light plants and shade plants in many respects such as their photosynthetic capacity, sunlight saturation, leaf size, morphology, and chloroplast structure. The average light compensation of sun leaf and shade leaf are 500 lux and 200 lux respectively. Also, the light saturation of sun leaf and shade leaf are (20-35) lux and (6-15) respectively. Therefore, when plants will be used around the building, on the roof, or the terraces, the sunlight of the environment should be taken into consideration.

ENQ15: Do the plants around your high-rise building get enough daylight? If it does not take and dies, are shade-tolerant plants planted instead?

If yes and if they continue to grow healthily, level 3,

No, it is not getting enough daylight, but the plants are replaced with shade-tolerant ones, level 2,

No if it is not getting enough daylight and no greening work is done to replace dead plants, level 1.

Single-layer facades include simple facades that enable the shutters to be opened and closed with smart automation systems and curtain walls made of materials such as composite, terracotta, glasses with different properties, compact laminate, granite, and ceramic used on the exterior. Curtain facades can provide 70% energy savings in buildings. On double-layered facades, it provides natural ventilation and lighting by allowing air and light to enter the space between the outer layer and the building. Sunshades can be placed in this air gap. Double skin facades provide 30%-50% energy savings in the building [155].

ENQ16: Does the exterior of your high-rise building consist only of glass? Do they have a system to prevent light pollution in the evening?

If the outer surface consists of not only glass but other materials, and if there is a system such as curtains or blinds to prevent the light from spreading out in front of the windows in the evening, level 3,

If the outer surface consists of only glass, but if there is any system such as curtains or blinds to prevent the light from spreading out in front of the windows in the evening, level 2,

It consists of only glass and if you do not have a work that prevents light pollution in the evenings, level 1.

Lead is one of the most important metals causing air pollution. Insecticides used to control insects also contain lead [156]. Household cleaning materials contain many toxic chemicals. These chemicals create water and soil pollution through sewage and adversely affect the living life in the receiving water environment where they go [157].

ENQ17: Are residents ever informed about the use of toxic cleaning materials, pesticides, and air pollutants in your building by the building management or experts?

If informed every five years, level 3,

If informed once every ten years, level 2,

If not informed at all, level 1.

6.4.6. Sustainable and Renewable Systems

As we have examined under the title of "Appropriate Building Design" of Economics, some issues and questions will also be discussed under this title. Because the less energy your building consumes, the fewer resources it consumes. A more environmental world can be created with sustainable systems and renewable systems that save resources and get more efficient results with less use. Therefore, the use of sustainable products and the renewal of aging materials are very important.

High-rise buildings use a lot of water. Sanitary ware with sensors and tap head apparatus used to reduce this use can save water. In addition, it is very important to provide water leak detection in case of a possible leak or malfunction in the water pipes. Water consumption should be monitored and controlled.

ENQ18: Are sanitary wares with sensors used in your building?

If yes, level 2,

If no, level 1.

ENQ19: Are tap head apparatuses used in your building to save water? (≈ECQ21)

If yes, level 2,

If no, level 1.

ENQ20: Does your building have a water leak detection system? (≈ECQ23)

If yes, level 2,

If no, level 1.

If you have no idea, level 0.

ENQ21: Is water consumption monitored and controlled in your building?

If yes, level 2,

If no, level 1.

If you have no idea, level 0.

Technological products should be used for electricity use and periodic maintenance should be done. Those that are old or cannot function properly should be replaced. Sensor and LED lamps used for energy saving, monitoring of electricity consumption and use of technological products are important. All products, from indoor lamps to the refrigerator in your home, should be environmentally friendly products that consume less energy. Therefore, building occupants should be informed about this issue. In addition, buildings that produce their electricity from solar and wind energies are environmentally friendly buildings and high-rise buildings have the potential to use these two energies effectively. Wind energy can be effectively used not only as electricity but also in ventilation.

ENQ22: Are periodic maintenance of electrical cables, distribution boxes and electrical distribution elements carried out? Are old devices replaced with new ones? (≈ECQ30)

Yes if it is done and changed level 3,

Yes if it is done but not changed level 2,

If nothing is done level 1,

If you have no idea level 0.

ENQ23: Can your building generate energy with solar or wind energy?

If producing, level 2,

If not producing, level 1,

If you have no idea, level 0.

ENQ24: Is wind energy used effectively for the ventilation system in your building? (≈ECQ17)

Yes if used level 2,

If not used level 1,

If you have no idea level 0.

ENQ25: Are the lamps in your building with LEDs and sensors?

Yes, if it is led and sensor, it is level 4,

If it is not led but has a sensor, it is level 3,

If it is not a sensor but has a led is level 2,

If it is not a led or a sensor it is level 1.

Electronic devices have become indispensable today with the developing technology. As new products or devices are released, the old ones create a new type of garbage as e-waste, and these electronic products also harm the environment as they contain some harmful substances. For example, cathode ray tubes (CRT) contain high levels of heavy metals such as lead, barium, phosphorus, and these tubes are available in our monitors and televisions. Again, brominated flame retardants found in computer connectors, plastics, printed circuits, cables, and sponges are another substance that harms the environment. There are many harmful substances such as mercury found in cell phones, lamps, and batteries as a final example. Improper processing or direct disposal of such devices harms the environment [158]. As it has been said before, refrigerators and air conditioners should be chosen more sensitively because they contain harmful gases such as CFC (chlorofluorocarbon) and HCFC (hydrochlorofluorocarbon), and people should be informed about these issues by experts, building managers, or contractors.

ENQ26: Are building occupants informed about the electronic equipment used by experts, building managers or contractors?

If yes, level 2,

If no, level 1.

ENQ27: Is the electricity usage of the building occupants monitored? (≈ECQ20)

If yes, level 2,

If no, level 1,

If you have no idea level 0.

6.4.7. Wastewater

Since the issue of wastewater also affects the environment, it will also be evaluated under the title of environment. Due to the high population of people living in high-rise buildings, wastewater is also quite high. The reuse of this wastewater is very important in the environmental aspect. Separate collection of wastewater in buildings facilitates the recycling of water. For example, the pollution rate in the toilet and dishwashing expenses is not the same. Or, the level of pollution in the sink drain that we wash hands with and the drain of the washing machine is not the same. Therefore, the recovery difficulties of these waters are also different.

We can examine universal wastewater in three streams: gray water, brown water, and yellow water. Yellow water is the water containing urine and toilet water, and brown water is the water containing feces and toilet water. Gray water is wastewater other than toilet wastewater. For example tap water, bathwater, kitchen water, bleach [159]. The fact that there is only one drain pipe in the buildings mixes these waters together. Treatment of gray water is easier and faster. After the gray water is treated, it can be used in many areas such as reservoir feeding, garden irrigation, vehicle washing, rough cleaning, laundry, and ornamental pools.

ENQ28: Is gray water, brown water and yellow water collected separately in your building? (≈ECQ22)

Yes, if they are all separate, level 3,

If gray water is separate but yellow water and brown water are the same, level 2,

If they are all mixed in one pipe, level 1, If you have no idea about it, level 0.

ENQ29: Do you have a system that ensures the recovery of gray water in your building? (≈ECQ22)

If available, level 2,

If not, level 1,

If you have no idea about it level 0.

In addition, informing people about wastewater is important for the recycling of wastewater, because the wastewater can be more difficult to recover due to the materials thrown into the toilet drains. In addition, unnecessary water use also reduces the limited amount of freshwater resources available today.

ENQ30: Are people in the building informed and warned about wastewater and water use by experts, building managers, or contractors?

Yes, if it is informed every two years level 4,

If it is informed every five years level 3,

If it is informed every ten years level 2,

If it is not informed at all level 1.

6.4.8. Waste Management

The collection and recycling of waste materials are also indispensable for the economy as well as the environment. With the development of technology, artificial but more durable materials have been produced and their digestion time in nature has increased considerably. Because so many people live in high-rise buildings, the amount of waste can be incredible. In this respect, as in wastewater, separate collection of waste in waste management is very good both in terms of recovery speed and more efficient recycling. Therefore, plastics, glass, metals, cardboard and paper, biological waste (especially used oils), batteries, harmful or electronic waste should all be collected separately. In addition, people should be informed about this issue frequently, and those who do wrong should be warned.

ENQ31: Are waste materials collected separately in your building?

Yes, if they are all collected separately, level 3,

If they are collected partially separately and partially mixed level 2,

If they all go to the same trash level 1.

ENQ32: Are the people living in the building provided with necessary information about the collection of waste materials? (≈ECQ28)

Yes, if it is informed once a year, it is level 5,

If it is informed every two years, it is level 4,

If the information is given every five years, level 3,

If the information is provided every ten years, level 2,

If no information is provided at all, level 1.

Table 6.5. Evaluation criteria and distribution of points on "Environment" for the goal

		WEIGHTING	Qestion No	SCORE DISTRIBUTION				
				LEVEL 0-1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
ENVIRONMENT (35 POINTS)	**Air Pollution**	**0,5**	ENQ1	0,13	0,25	0,38	0,5	
		0,5	ENQ2	0,13	0,25	0,38	0,50	-
		0,5	ENQ3	0,17	0,33	0,50	-	-
	Project Plan and Design	**0,7**	ENQ4	0,35	0,70	-	-	-
		0,5	ENQ5	0,25	0,50	-	-	-
	Rainwater	**1,5**	ENQ6	0,75	1,50	-	-	-
		1,1	ENQ7	0,55	1,10	-	-	-
		1,2	ENQ8	0,24	0,48	0,72	0,96	1,20
	Environmental Products	**1,5**	ENQ9	0,38	0,75	1,13	1,50	-
		1	ENQ10	0,50	1,00	-	-	-
		1,2	ENQ11	0,60	1,20	-	-	-
		0,7	ENQ12	0,23	0,47	0,70	-	-
		0,7	ENQ13	0,35	0,70	-	-	-
	Respect for Nature	**1,5**	ENQ14	0,30	0,60	0,90	1,20	1,50
		1	ENQ15	0,33	0,67	1,00	-	-
		0,7	ENQ16	0,23	0,47	0,70	-	-
		0,5	ENQ17	0,17	0,33	0,50	-	-
	Sustainable and Renewable Systems	**1**	ENQ18	0,50	1,00	-	-	-
		1	ENQ19	0,50	1,00	-	-	-
		1	ENQ20	0,50	1,00	-	-	-
		1	ENQ21	0,50	1,00	-	-	-
		1	ENQ22	0,33	0,67	1,00	-	-
		2	ENQ23	1,00	2,00	-	-	-
		1	ENQ24	0,50	1,00	-	-	-
		1,5	ENQ25	0,38	0,75	1,13	1,50	-
		0,7	ENQ26	0,35	0,70	-	-	-
		0,7	ENQ27	0,35	0,70	-	-	-
	Wastewater	**2,4**	ENQ28	0,80	1,60	2,40	-	-
		2,4	ENQ29	1,20	2,40	-	-	-
		0,8	ENQ30	0,20	0,40	0,80	-	-
	Waste Management	**2,4**	ENQ31	0,80	1,60	2,40	-	-
		0,8	ENQ32	0,16	0,32	0,48	0,64	0,80

7. CASE STUDY

After the questions and score distributions created to evaluate high-rise buildings were determined in chapter 6, a survey study was conducted. Both the occupants of the building and the contractor or project manager responsible for the building's construction participated in this survey. After examining the buildings of four different contractors, responsible project managers or project management, the results of the occupants will be focused on in general.

7.1. CASE 1: “COMPANY A”

It consists of 7 blocks of residential and commercial offices. Located in Kartal-Istanbul, “COMPANY A” is a 40-floor high building.

In Figure 7.1 below prepared for “COMPANY A”, it is colored according to the degree of sustainability in terms of good-moderate-bad according to the question numbers under the main headings of disaster, social, economic and environment. The person answering the questions is the project management manager.

Figure 7.1. An overview of the “COMPANY A” high-rise building evaluation answers

According to these colorings, 1st, 2nd, and 12th questions in the Disaster section, 15th, 16th, 17th, 19th, 21st, and 26th questions in the Economic section, and 7th, 10th, 19th questions in the Environment section. , 23 and 24 received bad marks in questions. In this context, in order to eliminate the deficiencies of the building;

In the Disaster section: Before the building is built, you can look at the project plans and choose which system is more suitable and safe. Periodic maintenance of your building by damage assessment specialists is recommended at least once every ten years.

In the Economic part: Photovoltaic panels can be placed on the roof or side surfaces of the building, through which both hot water and electricity can be obtained. Before the building is built to use wind energy, necessary air corridors can be added inside the building in the project plans. At the project planning stage, a system that can be used in the toilets or balconies of the houses can be added by passing the collected rain water through a strainer. Faucet apparatus can be distributed to the residents of the building for their use of apparatus for saving water in faucets, these are apparatuses that are both economical and easy to use. BIM modeling, known as Building Information Modeling, is a system that continuously collects information and improves itself before the construction, construction process and post-construction of your buildings. It facilitates interdisciplinary harmony and enables the right decision to be made in these processes. Support can be obtained from companies or experts focusing on BIM when project planning is just beginning.

In the Environment part: At the project planning stage, a system that can be used in the toilets or balconies of the houses can be added by filtering the collected rain water. Worn out products/materials in an already constructed building can be replaced with renewable alternative products. For a building that is still at the project stage, using renewable and sustainable products should be a priority. Faucet apparatus can be distributed to the residents of the building so that they can use the apparatus for saving water in the faucets. Photovoltaic panels can be placed in your building and with appropriate air corridors, the interior of the building can be ventilated with fresh air.

You can see the distribution of questions and scores for the "COMPANY A" high-rise building. Detailed scoreboards can be found in Appendix A.

Table 7.1. Total score distribution of "COMPANY A" high-rise building

	Score	All-in	Percent
DISASTER	5,63	/8	70,375
SOCIAL	21,25	/22	96,59091
ECONOMIC	29,9	/35	85,42857
ENVIRONMENT	30,4	/35	86,85714
Overall:	**87,18**	/100	87,18

According to the results, the scores of the "COMPANY A" tall building under each main heading and the total score table are as above (Table 7.1). As can be seen from the spider diagram, the lowest score was for Disaster. The highest score was obtained from the Social section (Figure7.2).

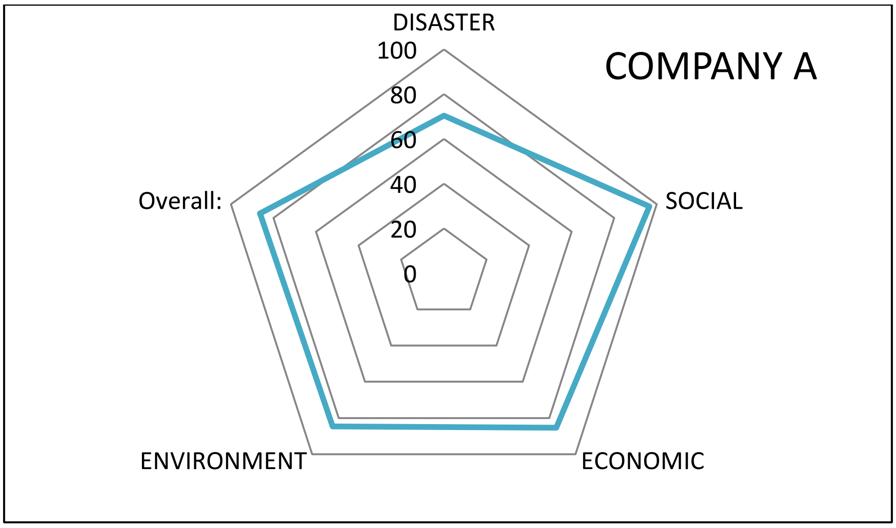

Figure 7.2. General distribution of “COMPANY A” high-rise building

7.2. CASE 2: “COMPANY B”

“COMPANY B”, which is planned as residential buildings, consists of 6 blocks and 19 floors. Its construction was completed in 2021.

In Figure 7.3 below prepared for “COMPANY B”, it is colored according to the degree of sustainability in terms of good-moderate-bad according to the question numbers under the main headings of disaster, social, economic and environment. The person who answers the evaluation questions is the project contractor.

Figure 7.3. An overview of “COMPANY B” high-rise building evaluation answers

According to these colorings, in the 10th question in the Disaster section, in the 13th and 24th questions in the Social section, in the Economic section 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd, 23rd, 24th, In questions 25, 26, 27, 28, 29, and 31, and in the Environment section, 6, 7, 10, 11, 12, 17, 18, 19, 20, It got bad marks in the 21st, 22nd, 23rd, 24th, 27th, 28th, 29th, 30th and 31st questions. In this context, in order to eliminate the deficiencies of the building;

In the Disaster section: After a natural disaster, expert engineers can be called and your building can be checked in order to determine the damage to the building.

In the Social section: Make sure that there is a place or an activity where people will be happy, drain their energy and mingle and socialize with each other. At the planning stage of your building, it should be ensured that open areas, parks and sports areas, open soil and plant areas are sufficient. In addition, after the building is built, many activities such as dance courses, fitness, sauna, pool, yoga, and far east martial arts can make people happier and more peaceful. When your building is at the project stage, products with good sound insulation can be used in the products used on the walls between apartments.

In the Economic section: Photovoltaic panels can be placed on the roof or side surfaces of the building, through which both hot water and electricity can be obtained. Before the building is built to use wind energy, necessary air corridors can be added inside the building in the project plans. At the project planning stage, the collected rain water can be collected in a tank. This collected rain water can be used in the toilets or balconies of the houses. Water saving devices can be distributed to the building occupants so that they can use water-saving devices at the taps. Support can be obtained from companies or engineers who are experts in BIM. In buildings, waste collection areas with different colors and functions can be separated for each floor, and people can be informed about waste collection. While the building is in the project phase, a system to detect water leakage can be installed. For the basic life cycle cost of the building, an expert can be called and calculated. Worn and inefficient building components can be replaced with new ones. Efficient and environmentally friendly products can be used by following the development of technology.

In the Environment section: In addition to the above about rain water, the stored rain water can be used for garden and park irrigation around the building. The fire extinguishing system can be renewed and systems that cause less damage to the ozone layer can be preferred. It is important that there is no leakage in these systems, so annual maintenance can be done. Building occupants can be informed about the harms of deodorant, cleaning materials and pesticides to the environment. The vitreous glasses can be replaced with the ones with sensors. A system can be installed to monitor the building's energy and water use, or simply, a person in the building management can make an energy and water use tracking table and create a monitoring chart for each flat or office. In this follow-up chart, flats or offices that use excessive energy and water can be warned. In this way, awareness can be raised and recommendations can be made about energy and water use. Periodic maintenance of all infrastructure systems and components of the building should be done, and the old or inefficient ones should be replaced. Solar panels can be placed on the roof for solar power. While your building is in the project phase, the waste water pipes can be designed separately, such as gray-yellow-brown. Building occupants can be informed about this wastewater use.

In Appendix A, you can see the distribution of questions and the scores for the "COMPANY B” high-rise building.

Table 7.2. Total score distribution of “COMPANY B” high-rise building

	Score	**All-in**	**Percent**
DISASTER	6,485	/8	81,0625
SOCIAL	18,75	/22	85,22727
ECONOMIC	22,26	/35	63,6
ENVIRONMENT	20,84	/35	59,54286
Overall:	**68,335**	/100	68,335

According to the results, the scores of the "COMPANY B" tall building under each main heading and the total score table are as above (Table 7.2). As can be seen from the spider diagram, the lowest score was for Environment. The highest score was obtained from the Social section (Figure 7.4).

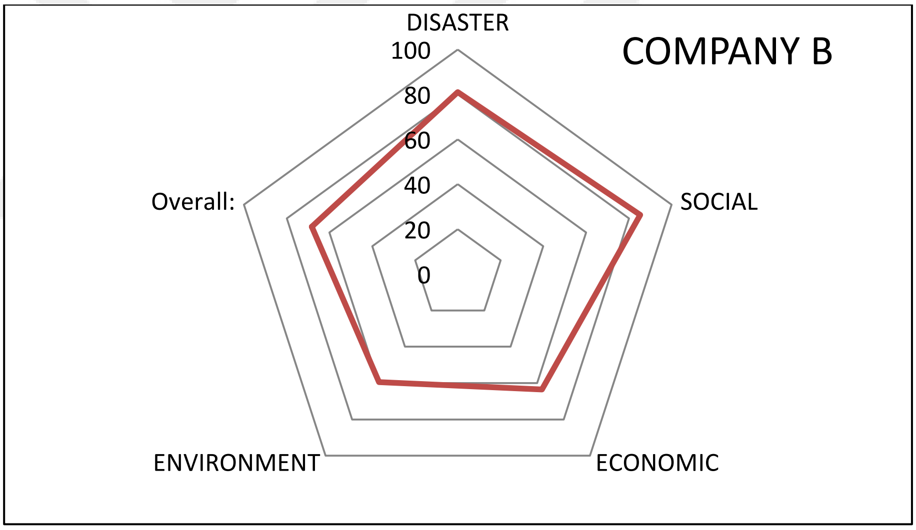

Figure 7.4. General distribution of “COMPANY B” high-rise building

7.3. CASE 3: “COMPANY C”

“COMPANY C” consists of 3 blocks used as residential or commercial offices. Its construction was completed in 2020. Located in Ankara, “COMPANY C” is a 42-floor and 210 m high building.

In the Figure 7.5 below prepared for the "COMPANY C", it is colored according to the degree of sustainability in terms of good-moderate-bad according to the question numbers under the main headings of disaster, social, economic and environment. The person who answers the evaluation questions is the project manager.

Figure 7.5. An overview of "COMPANY C" high-rise building evaluation responses

According to these colorings, in the Social part in the 11th question, in the Economic part in the 14th, 15th, 16th, 17th, 18th, 21st, 25th, 26th and 31st questions, and in the Environment part 9th, 10th, 11th. . got bad grades in questions 12, 20 and 23. In this context, in order to eliminate the deficiencies of the building;

In the Social section: Support can be obtained from expert engineers to calculate the building life cycle.

In the Economic section: Thermostatic valve can be used for radiators. Photovoltaic panels can be placed on the roof, balcony or side surfaces of the building. Both hot water and electricity can be obtained through them. Before the building is built to use wind energy, necessary air corridors can be added inside the building in the project plans. While the building is still in the project phase, a system that collects rain water and allows it to be used later should be added to the project. For BIM-based project management and building life cycle calculations, relevant or experts should be consulted. Innovation studies are innovative studies. To get innovative and developing ideas about service, production, building products, trade or building management, building occupants or expert civil engineers can be asked for help, good ideas will be.

In the Environment section: More environmentally friendly materials can be used during the building project phase. Cotton, fiber, cork, etc. for sound and heat insulation. products can be used. Wood can be used on the building surface and floor coverings. After the fire extinguishing systems are checked, more environmentally friendly gas and foam products should be used. Building managers can hold meetings and give warnings and information about products that are harmful to the ozone layer, at least once every ten years. While the building is in the project phase, a water leak detection system should be planned and infrastructure should be created accordingly.

In Appendix A, you can see the distribution of questions and the scores for the "COMPANY C" high-rise building.

Table 7.3. Total score distribution of "COMPANY C" high-rise building

	Score	**All-in**	**Percent**
DISASTER	7,4	/8	92,5
SOCIAL	19,98	/22	90,81818
ECONOMIC	27,93	/35	79,8
ENVIRONMENT	28,07	/35	80,2
Overall:	**83,38**	/100	83,38

According to the results, the scores of the "COMPANY C" tall building under each main heading and the total score table are as above (Table 7.3). As can be seen from the spider diagram, the lowest score was in Economics. The highest score was obtained from the Disaster section (Figure 7.6).

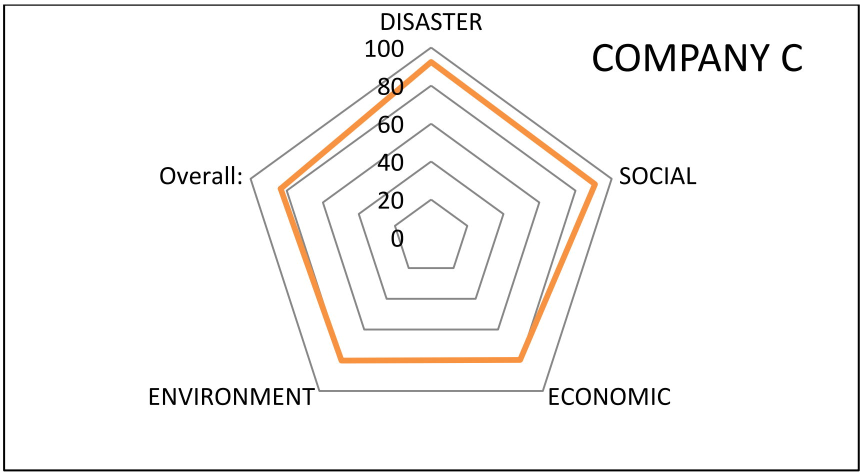

Figure 7.6. General distribution of "COMPANY C" high-rise building

7.4. CASE 4: "COMPANY D"

This high-rise building will be shared as "COMPANY D" as its name is requested to be kept confidential. The high-rise building, which is used as a residence or commercial office, has 28 floors and is located in Istanbul.

In the Figure 7.7 below, prepared for the "COMPANY D" high-rise building, it is colored according to the degree of sustainability in terms of good-moderate-bad according to the question numbers under the main headings of disaster, social, economic and environment. The person who answers the evaluation questions is the project contractor.

Figure 7.7. An overview of the “COMPANY D” high-rise building evaluation answers

According to these colorings, 2nd, 10th, 11th, 12th, 13th and 14th questions in the Disaster section, 2nd, 7th, 8th, 11th, 12th, 15th and 24th questions in the Social section, and in the Economic section 5th, 6th, 7th, 8th, 9th, 10th, 13th, 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd, 23rd, 24th. , 25th, 26th, 28th, 29th and 31st questions, and in the Environment section 2nd, 4th, 6th, 7th, 10th, 11th, 12th, 13th, 14th, 18th. , 19th, 20th, 21st, 22nd, 24th, 26th, 27th, 28th, 29th, 30th and 32nd questions got bad marks. In this context, in order to eliminate the deficiencies of the building;

In the Disaster section: After a natural disaster, expert engineers can be called and your building can be checked in order to determine the damage to the building. After the damage is determined, if it is damaged, necessary work should be done and it should be checked regularly. In a possible earthquake, a system that closes the power lines can be made. Likewise, a system that will secure the natural gas lines in a possible fire can be integrated into the building. While the building is in the project phase, the infrastructure pipes in the water and natural gas infrastructure can be selected from products that are resistant to possible earthquake damage. In the event of a disaster, any work can be done to prevent damage to communication lines (internet and telephone). In the event of a disaster, an automatic help call system can be used in the building.

In the Social section: The place where the building will be built should be chosen in close proximity to metro and bus stops. Your air conditioning and ventilation systems can be cleaned periodically. It can be greened by placing plants on the balcony, terrace, roof, building corridors and around the building. You can build your building in less dense areas instead of districts with high-rise buildings at the project stage. At the same time, before the building is built, places that will not disturb the general neighborhood structure of that high-rise building should be selected. You can put a password on your building's outer door and put padlocked barges in the parking lot.

In the Economics section: Extra workers or overtime may be required to complete the project on time. Administrative managers can be determined in the building and annual meetings can be held for these people to improve the building. At the same time, they can warn and inform occupants about resource consumption. In-building dues and building advertising revenues, etc. Ensure that the proceeds are properly used for the benefit of the building and its occupants. For this, building meetings should be held and the opinions of the building occupants should be taken. Insulation of natural gas and water installations under the building can be done during the project phase. Photovoltaic panels can be placed on building side surfaces, roofs or terraces and energy and hot water can be obtained from them. According to the annual wind data of the area where the building will be built, suitable wind corridors can be placed inside the building at the project stage in order to use wind energy efficiently. Thus, both fresh air will enter and your building will be less affected by the wind. A rain collection tank can be used in your building where you can reuse rain water. The energy usage in the building can be tracked from the invoices or the building can be provided with the energy tracking system. In this way, information can be given to the building occupants to make their energy use more efficient. You can use water saving apparatus in your building. Efforts for waste water collection and recycling can be carried out at the project stage. Again, at the project stage, the system to detect water leakage can be integrated into your building. Your building can be more economical by getting help from BIM experts. Different trash cans can be placed in your building for waste collection and the residents of the building can be informed about this. For the innovation work in your building, you can get ideas from engineers who are experts in high-rise buildings, academic lecturers and even building residents, and they will have good ideas.

In the Environment section: Building occupants can be informed about the use of deodorants, air fresheners, chemical pesticides and cleaning products. Environmentally friendly products such as fiber reinforced concrete, geosynthetic materials, wood products, bamboo, wool, cork and steel can be preferred during the building project phase. A system that you can collect and use rain water can be integrated into your building. Fire extinguishing systems can be controlled. If the systems are harmful to the environment, they should be replaced with environmentally friendly gases and foams. Fire extinguishing pipes should be checked periodically, and if there are leaks or malfunctions, they should be repaired. Sanitary ware can be replaced with sensored sanitary ware, and water-saving apparatuses can be used on taps. Planting works can be done on the terrace, roof, building corridors and around the building. Water and electricity consumption in your building should be checked on invoices, and the residents of the building with excessive use should be warned and informed about this. Periodic maintenance of indoor electrical panels and electrical distribution elements can be done. Energy and hot water can be obtained by placing photovoltaic panels on building surfaces and roofs. While the building is in the project phase, wastewater collections can be divided into gray water, yellow water or brown water. Building occupants can be informed about this system. Afterwards, a system to treat this collected wastewater can be established and these waters can be reused. As for the collection of waste materials, people should be informed and warned at least once every five years.

You can see the distribution of questions and scores for the "COMPANY D" high-rise building in Appendix A.

Table 7.4. Total score distribution of “COMPANY D” high-rise building

	Score	**All-in**	**Percent**
DISASTER	4,975	/8	62,1875
SOCIAL	15,57	/22	70,77273
ECONOMIC	19,76	/35	56,45714
ENVIRONMENT	20,98	/35	59,94286
Overall:	**61,285**	/100	61,285

According to the results, the scores of the “COMPANY D” tall building under each main title and the total score table are as above (Table 7.4). As can be seen from the spider diagram, the lowest score was in Economics. The highest score was obtained from the Disaster section (Figure 7.8).

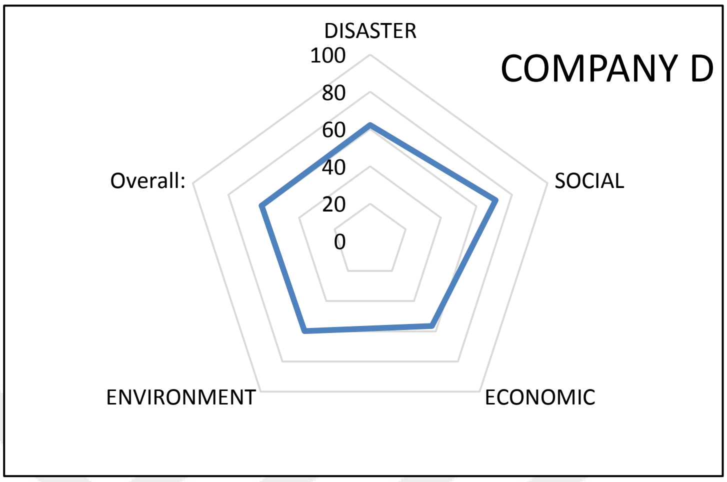

Figure 7.8. General distribution of “COMPANY D” high-rise building

7.5. CASE 5 : GENERAL FLAT RESIDENTS

In this section, the results of the general average scores of the evaluation forms filled by the residents of high-rise buildings in different provinces and districts will be given. The following data are obtained from the residents of 8 different buildings.

In this section, the level values corresponding to the answers given by the residents for each question are written one by one. For each of these questions, the average of the level values was taken separately. The values obtained in these average results have been converted to the nearest integer score. Thus, this integer score was accepted as the common level value of that question for eight different buildings. In Table 7.5, Table 7.6, Table 7.7 and Table 7.8, question-answer distributions are given for each topic (Disaster, Socail, Economic, Environment) without showing the building occupants and building names. You can see their average and accepted level points.

Table 7.5. Question-answer distribution and averages of eight buildings on “Disaster”

	DISASTER QUETION NO														
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Level	1	1	3	6	5	6	3	5	2	1	1	1	5	1	5
	2	2	3	5	5	5	2	3	1	2	5	1	5	1	4
	3	3	3	6	5	6	1	5	1	1	1	1	1	1	3
	2	1	3	6	5	5	2	5	1	1	1	1	5	1	5
	4	3	3	6	4	5	3	5	2	2	5	4	5	1	5
	2	2	3	4	4	3	1	5	1	1	1	1	1	1	3
	3	1	3	6	5	3	3	5	2	2	5	5	5	1	4
	2	3	4	4	5	6	2	5	2	2	5	5	5	3	4
Average	2,38	2	3,13	5,38	4,75	4,88	2,13	4,75	1,5	1,5	3	2,38	4	1,25	4,13
Accepted	**2**	**2**	**3**	**5**	**5**	**5**	**2**	**5**	**2**	**2**	**3**	**2**	**4**	**1**	**4**

Table 7.6. Question-answer distribution and averages of eight buildings on “Social”

	SOCIAL QUESTION NO																							
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Level	4	4	2	4	6	5	6	4	2	3	1	2	2	5	4	4	3	4	2	4	6	5	2	1
	4	4	2	5	6	5	4	3	2	3	2	2	2	6	4	4	3	5	2	4	3	5	2	2
	4	4	2	5	6	5	1	1	3	1	1	2	2	6	4	3	2	5	2	4	5	5	2	2
	4	4	2	4	4	5	1	4	2	3	1	2	2	6	4	4	3	5	2	4	6	5	2	2
	4	4	2	3	5	5	2	3	1	2	2	2	2	6	4	3	3	5	2	4	6	5	2	1
	3	4	2	4	4	3	1	3	2	2	1	2	2	4	4	2	3	1	2	4	5	5	2	1
	2	4	2	4	6	5	6	4	2	2	1	2	1	6	4	4	3	3	2	4	5	4	2	1
	3	3	2	4	6	5	5	3	2	3	1	2	2	4	4	4	2	3	2	3	5	4	2	2
Average	3,5	3,88	2	4,13	5,38	4,75	3,25	3,13	2	2,38	1,25	2	1,88	5,38	4	3,5	2,75	3,88	2	3,88	5,13	4,75	2	1,5
Accepted	**4**	**4**	**2**	**4**	**5**	**5**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**5**	**4**	**4**	**3**	**4**	**2**	**4**	**5**	**5**	**2**	**2**

Table 7.7. Question-answer distribution and averages of eight buildings on “Economic”

	ECONOMIC QUESTION NO																														
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31
Level	3	2	3	3	2	2	4	1	1	1	3	2	1	2	1	1	1	1	1	2	1	1	2	1	1	1	1	2	1	1	1
	3	2	3	3	2	2	4	2	2	2	3	2	2	2	1	1	1	1	1	2	1	2	2	3	3	1	1	1	1	2	1
	1	2	2	3	1	1	1	2	1	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	2	2	3	2	2	1	2	1	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
	2	3	3	3	1	2	1	1	2	2	3	1	2	2	1	1	1	2	1	2	1	2	2	3	3	2	2	2	2	2	2
	3	3	3	3	1	2	1	2	3	2	3	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1
	2	3	3	2	1	2	1	2	2	2	3	2	2	2	1	1	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
	3	3	3	3	2	2	3	2	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	1	2	1
Average	2,38	2,5	2,75	2,88	1,5	1,88	2	1,75	1,88	1,88	3	1,75	1,5	1,63	1,13	1,13	1,13	1,25	1,13	1,75	1,25	1,38	1,63	1,75	1,88	1,25	1,38	1,38	1,25	1,75	1,13
Accepted	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**

Table 7.8. Question-answer distribution and averages of eight buildings on “Environment”

	ENVIRONMENT QUESTION NO																															
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32
Level	4	1	3	1	1	1	1	4	1	1	1	1	1	4	3	2	1	1	1	2	2	3	1	1	3	1	2	1	1	1	2	5
	3	4	3	1	2	1	1	2	2	1	2	2	2	3	3	3	3	1	1	2	2	3	1	1	2	2	1	1	1	3	2	5
	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
	3	1	2	1	2	1	1	5	1	1	1	1	1	3	3	3	1	1	1	1	1	1	1	1	4	1	1	1	1	1	3	1
	2	1	3	1	2	2	2	2	1	1	1	1	2	5	3	1	1	1	1	2	2	3	1	1	4	1	2	3	1	1	3	1
	4	1	3	1	2	1	1	3	1	1	1	1	2	4	3	3	3	1	2	1	2	3	2	2	3	2	2	1	1	3	1	1
	3	1	1	1	2	1	1	3	1	1	1	1	2	3	3	1	1	1	2	2	1	3	1	1	4	1	2	2	1	1	1	1
	3	3	2	1	1	1	1	5	4	1	2	2	1	4	3	3	3	2	2	1	1	2	2	2	4	2	2	3	2	4	3	5
Average	3	1,63	2,3	1	1,63	1,13	1,13	3,13	1,5	1	1,25	1,25	1,5	3,38	2,88	2,38	1,75	1,13	1,38	1,5	1,5	2,38	1,25	1,25	3,13	1,38	1,63	1,63	1,13	1,88	2	2,75
Accepted	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**1**	**2**	**2**	**3**

As a result of this, in the Figure 7.9 below, prepared for the eight diffirent high-rise buildings, it is colored according to the degree of sustainability in terms of good-moderate-bad according to the question numbers under the main headings of disaster, social, economic and environment.

Figure 7.9. An overview of the eight high-rise buildings evaluation answers

Table 7.9. Total score distribution of eight high-rise buildings

	Score	All-in	Percent
DISASTER	5,35	/8	66,875
SOCIAL	18,97	/22	86,22727
ECONOMIC	23,41	/35	66,88571
ENVIRONMENT	22,14	/35	63,25714
Overall:	**69,87**	/100	69,87

According to the results, the scores of the eight high-rise buildings under each main title and the total score table are as above (Table 7.9). As can be seen from the spider diagram, the lowest score was in Environment. The highest score was obtained from the Social section (Figure 7.10).

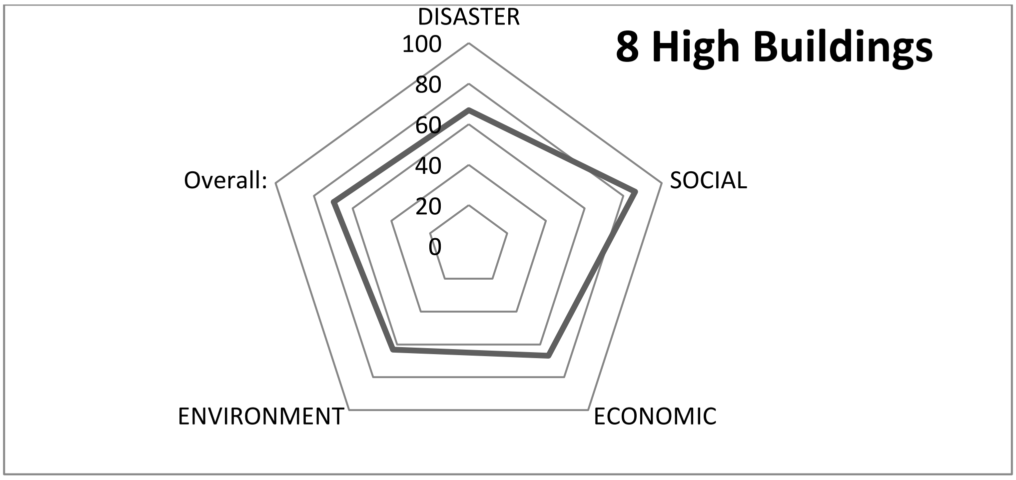

Figure 7.10. General distribution of eight high-rise buildings

In this section, the aim was to evaluate the general viewpoints of high-rise buildings from the perspective of building residents. This perspective gave us information about the sustainability of high-rise buildings in Turkey in general. The aim of the thesis was to create an evaluation tool where everyone can evaluate their own building. In this context, the results from eight different buildings and regions are examined in this section in order to bring together the residents, the contractors, the local government and the municipalities on a common ground.

8. RESULT

Although the results were different for five different cases, it was observed that the same scores were obtained from some questions. In the Table 8.1 below, you can see the badly scored question numbers for five different cases. The low-scoring questions taken in at least three of the five different cases are generally considered to be lack of high-rise buildings in Turkey.

Table 8.1. Detailed question distribution and common denominator of bad results for five cases

	CASE1	CASE2	CASE3	CASE4	CASE5	Defects
DQ	1,2,12	10	-	2,10,11,12,13,14	14	-
SQ	-	13,24	11	2,7,8,11,12,15,24	11	**11**
ECQ	15,16,17,19,21,26	15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,31	14,15,16,17,18,21,25,26,31	5,6,7,8,9,10,13,15,16,17,18,19,20,21,22,23,24,25,26,28,29,31	15,16,17,18,19,21,22,26,27,28, 29, 31	**15,16,17,18,19, 21,22,25,26,28, 29,31**
ENQ	7,10,19,23,24	6,7,10,11,12,17,18,19,20,21,22,23,24,27,28,29,30,31	9,10,11,12,20,23	2,4,6,7,10,11,12,13,14,18,19,20,21,22,24,26,27,28,29,30,32	4,6,7,10,11,12,18,19,23,24,26,29	**6,7,10,11,12,18, 19,20,23,24,29**

According to these results, it has been seen that newly constructed high-rise buildings in Turkey are successful in Disaster. It has been determined that the only missing thing in Social is that there is no study about how long the building has a lifespan and what the weak aspects of the building are. Although the most importance is given to the cost in Turkey, the worst result has been in Economics. The reason for this is the priority given to being more economical in the construction of buildings rather than longevity and sustainability in Turkey. When we look at the question numbers with bad results, you can see that there are no photovoltaic panels, rain water and wind energy are not used. These are features that will make your economy very comfortable in the long run. Apart from that, faucet apparatuses that make water use economical should become widespread. Separate wastewater collection systems for high-rise building infrastructures can be included in the projects. Another shortcoming is the lack of BIM-based project management. It has been observed that people are not informed about waste collection. Since there is no innovation work, it can be assumed that each building is almost a copy of each other. The environment part was unfortunately another issue that was not paid attention to. The reason for this is as seen in Table 8.1, wind energy, rain water collection and use, solar energy, use of renewable and biodegradable materials, waste separation and recycling, awareness about ozone layer and harmful gases, conscious use of water, water saving, It is a lack of issues such as wastewater recycling and not showing the necessary importance. Considering that all of the evaluated buildings are under the age of 50, it has been determined that the newly constructed buildings have very serious shortcomings in these matters. In the globalizing world, a structuring that is more oriented towards these issues should be entered into.

In Table 8.2, when these five cases are examined, Case 1 received the highest overall score, while Case 4 received the lowest overall score. Not surprisingly, the Case 5 “Occupant Evaluation” received an average value. Since this value is the average of different buildings, it would be more accurate to evaluate the success percentages of Case 5. For this reason, those below Case5 can be interpreted as a low score for Turkey in general. Case 3 got the highest score on the Disaster section, while Case 1 got the highest score on the Social, Economic and Environment section.

Table 8.2. Case comprasion chart

	Case 1	**Case 2**	**Case 3**	**Case 4**	**Case 5**
DISASTER	70,38	81,06	92,5	62,19	66,88
SOCIAL	96,59	85,23	90,82	70,77	86,23
ECONOMIC	85,43	63,6	79,8	56,46	66,89
ENVIRONMENT	86,86	59,54	80,2	59,94	63,26
OVERALL:	**87,18**	**68,335**	**83,38**	**61,285**	**69,87**

As a result of these case studies, the general average of all of them can be determined as the normal acceptable value for the evaluation tool created in our thesis and the handbook that may be issued in the future. In Table 8.3, the average of five cases was determined as

74.01. As a result, 74.01 points were taken as the basis to create my own evaluation scoring system ranges. The range of 80 and 70 points, where 74.01 is found in Table 8.4, is named "Normal" as rank. You can see other ranks and score ranges in the table.

Table 8.3. Average of five case overall scores

case 1	case 2	case 3	case 4	case 5	Average
87,18	68,335	83,38	61,285	69,87	**74,01**

Table 8.4. Rank and score ranges of my own evaluation tool

Points Intervals	Rank
100-90	Elite
90-80	Class
80-70 (74,01)	Normal
70-60	Casual
60-50	Lowlihood
<50	Inadmissible

Our own evaluation tool is named AV-SE (Average Value for Sustainable Environment). A web page will be opened for this evaluation tool and the service will be provided free of charge. This evaluation tool will be turned into a handbook and distributed to local governments and municipalities.

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APPENDIX A: DETAILS OF EVALUATION FORMS

Tablo A.1. Disaster question-point distributions details of COMPANY A

	1	2	3	4	5	6		
DQ1	0,35	0	0	0			0,35	
DQ2	0,1	0	0	0	0		0,1	
DQ3	0	0	0,15	0			0,15	
DQ4	0	0	0	0	0	0,25	0,25	
DQ5	0	0	0	0	0,2		0,2	
DQ6	0	0	0	0	0	0,4	0,4	
DQ7	0	0	0,1				0,1	
DQ8	0	0	0	0	1,4		1,4	
DQ9	0	0,1					0,1	
DQ10	0	0,5					0,5	
DQ11	0	0,2	0	0	0		0,2	
DQ12	0,08	0	0	0	0		0,08	
DQ13	0	0	0	0	0,3		0,3	
DQ14	0	0	1				1	
DQ15	0	0	0	0	0,5		0,5	
					DISASTER		**5,63**	/8

Table A.2. Social question-point distributions details of COMPANY A

	1	2	3	4	5	6	
SQ1	0	0	0	1,4			1,4
SQ2	0	0	0	1			1
SQ3	0	0,35					0,35
SQ4	0	0	0	0,8	0		0,8
SQ5	0	0	0	0	0	1	1
SQ6	0	0	0	0	0,6		0,6
SQ7	0	0	0	0	0	0,6	0,6
SQ8	0	0	0	0,6			0,6
SQ9	0	0	0,6				0,6

SQ10	0	0	0,6				0,6	
SQ11	0	1					1	
SQ12	0	0,5					0,5	
SQ13	0	0,8					0,8	
SQ14	0	0	0	0	0	2	2	
SQ15	0	0	0	1			1	
SQ16	0	0	0	1,5			1,5	
SQ17	0	0	1,5				1,5	
SQ18	0	0	0	0	1		1	
SQ19	0	0,4					0,4	
SQ20	0	0	0	1			1	
SQ21	0	0	0	0	0	1	1	
SQ22	0	0	0	0	1		1	
SQ23	0	0,6					0,6	
SQ24	0	0,4					0,4	
					SOCIAL		21,25	/22

Table A.3. Economic question-point distributions details of COMPANY A

	1	2	3	4	5	6	
ECQ1	0	0	1,2				1,2
ECQ2	0	0	0,5				0,5
ECQ3	0	0	0,5				0,5
ECQ4	0	0	0,8				0,8
ECQ5	0	0,5					0,5
ECQ6	0	0,3					0,3
ECQ7	0	0	0	0,7			0,7
ECQ8	0	0	1,5				1,5
ECQ9	0	0	0,5				0,5
ECQ10	0	0,4					0,4
ECQ11	0	0	1,2				1,2
ECQ12	0	0,8					0,8
ECQ13	0	0,6					0,6

ECQ14	0	0,6					0,6	
ECQ15	1	0					1	
ECQ16	0,9	0					0,9	
ECQ17	0,9	0					0,9	
ECQ18	0	1,8					1,8	
ECQ19	0,9	0					0,9	
ECQ20	0	1,8					1,8	
ECQ21	0,4	0					0,4	
ECQ22	0	1,8					1,8	
ECQ23	0	1,8					1,8	
ECQ24	0	0	1,5				1,5	
ECQ25	0	0	1,5				1,5	
ECQ26	1	0					1	
ECQ27	0	1,5					1,5	
ECQ28	0	0,5					0,5	
ECQ29	0	0,75					0,75	
ECQ30	0	0,75					0,75	
ECQ31	0	1					1	
					ECONOMIC		29,9	/35

Table A.4. Environment question-point distributions details of COMPANY A

	1	2	3	4	5	6	
ENQ1	0	0	0,38	0			0,38
ENQ2	0	0	0	0,5			0,5
ENQ3	0	0	0,5				0,5
ENQ4	0	0,7					0,7
ENQ5	0	0,5					0,5
ENQ6	0	1,5					1,5
ENQ7	0,55	0					0,55
ENQ8	0	0	0	0,96	0		0,96
ENQ9	0	0,75	0	0			0,75
ENQ10	0,5	0					0,5

ENQ11	0	1,2					1,2	
ENQ12	0	0	0,7				0,7	
ENQ13	0	0,7					0,7	
ENQ14	0	0	0	1,2	0		1,2	
ENQ15	0	0,76	0				0,76	
ENQ16	0	0	0,7				0,7	
ENQ17	0	0	0,5				0,5	
ENQ18	0	1					1	
ENQ19	0,5	0					0,5	
ENQ20	0	1					1	
ENQ21	0	0,1					0,1	
ENQ22	0	0	1				1	
ENQ23	1	0					1	
ENQ24	0,5	1					1,5	
ENQ25	0	0	0	1,5			1,5	
ENQ26	0	0,7					0,7	
ENQ27	0	0,7					0,7	
ENQ28	0	0	2,4				2,4	
ENQ29	0	2,4					2,4	
ENQ30	0	0	0,8				0,8	
ENQ31	0	0	2,4				2,4	
ENQ32	0	0	0	0	0,8		0,8	
					ENVIRONMENT		30,4	/35

Table A.5. Disaster question-point distributions details of COMPANY B

	lwl 1	lwl 2	lwl 3	lwl 4	lwl 5	lwl 6	
DQ1	0	0	1,05	0			1,05
DQ2	0	0	0	0,4	0		0,4
DQ3	0	0	0	0,2			0,2
DQ4	0	0	0	0	0	0,25	0,25
DQ5	0	0	0	0,16	0		0,16

DQ6	0	0	0	0	0	0,4	0,4	
DQ7	0	0	0,1				0,1	
DQ8	0	0	0	0	1,4		1,4	
DQ9	0	0,1					0,1	
DQ10	0,125	0					0,125	
DQ11	0	0	0	0	0,5		0,5	
DQ12	0	0	0	0	0,4		0,4	
DQ13	0	0	0	0	0,3		0,3	
DQ14	0	0,6	0				0,6	
DQ15	0	0	0	0	0,5		0,5	
					DISASTER		**6,485**	/8

Table A.6. Social question-point distributions details of COMPANY B

	lwl 1	lwl 2	lwl 3	lwl 4	lwl 5	lwl 6	
SQ1	0	0	0	1,4			1,4
SQ2	0	0	0,5	0			0,5
SQ3	0	0,35					0,35
SQ4	0	0	0	0,8	0		0,8
SQ5	0	0	0	0	0	1	1
SQ6	0	0	0	0	0,6		0,6
SQ7	0	0	0	0,4	0	0	0,4
SQ8	0	0	0	0,6			0,6
SQ9	0	0,34	0				0,34
SQ10	0	0,4	0				0,4
SQ11	0	1					1
SQ12	0	0,5					0,5
SQ13	0,4	0					0,4
SQ14	0	0	0	0	0	2	2
SQ15	0	0	0	1			1
SQ16	0	0	1,13	0			1,13
SQ17	0	0	1,5				1,5

SQ18	0	0	0	0,8	0		0,8	
SQ19	0	0,4					0,4	
SQ20	0	0	0	1			1	
SQ21	0	0	0	0	0,83	0	0,83	
SQ22	0	0	0	0	1		1	
SQ23	0	0,6					0,6	
SQ24	0,2	0					0,2	
					SOCIAL		**18,75**	/22

Table A.7. Economic question-point distributions details of COMPANY B

	lwl 1	lwl 2	lwl 3	lwl 4	lwl 5	lwl 6	
ECQ1	0	0	1,2				1,2
ECQ2	0	0	0,5				0,5
ECQ3	0	0	0,5				0,5
ECQ4	0	0	0,8				0,8
ECQ5	0	0,5					0,5
ECQ6	0	0,3					0,3
ECQ7	0	0	0,53	0			0,53
ECQ8	0	0	1,5				1,5
ECQ9	0	0	0,5				0,5
ECQ10	0	0,4					0,4
ECQ11	0	0	1,2				1,2
ECQ12	0	0,8					0,8
ECQ13	0	0,6					0,6
ECQ14	0	0,6					0,6
ECQ15	1	0					1
ECQ16	0,9	0					0,9
ECQ17	0,9	0					0,9
ECQ18	0,9	0					0,9
ECQ19	0,9	0					0,9
ECQ20	0,9	0					0,9

ECQ21	0,4	0					0,4	
ECQ22	0,9	0					0,9	
ECQ23	0,9	0					0,9	
ECQ24	0,5	0	0				0,5	
ECQ25	0,5	0	0				0,5	
ECQ26	1	0					1	
ECQ27	0,75	0					0,75	
ECQ28	0,25	0					0,25	
ECQ29	0,38	0					0,38	
ECQ30	0	0,75					0,75	
ECQ31	0,5	0					0,5	
					ECONOMIC		**22,26**	/35

Table A.8. Environment question-point distributions details of COMPANY B

	lwl 1	lwl 2	lwl 3	lwl 4	lwl 5	lwl 6	
ENQ1	0	0	0,38	0			0,38
ENQ2	0	0	0,38	0			0,38
ENQ3	0	0	0,5				0,5
ENQ4	0	0,7					0,7
ENQ5	0	0,5					0,5
ENQ6	0,75	0					0,75
ENQ7	0,55	0					0,55
ENQ8	0	0	0,72	0	0		0,72
ENQ9	0	0,75	0	0			0,75
ENQ10	0,5	0					0,5
ENQ11	0,6	0					0,6
ENQ12	0,23	0	0				0,23
ENQ13	0	0,7					0,7
ENQ14	0	0	0,9	0	0		0,9
ENQ15	0	0	1				1
ENQ16	0	0	0,7				0,7

ENQ17	0,17	0	0				0,17	
ENQ18	0,5	0					0,5	
ENQ19	0,5	0					0,5	
ENQ20	0,5	0					0,5	
ENQ21	0,5	0					0,5	
ENQ22	0,33	0	0				0,33	
ENQ23	1	0					1	
ENQ24	0,5	1					1,5	
ENQ25	0	0	1,13	0			1,13	
ENQ26	0	0,7					0,7	
ENQ27	0,35	0					0,35	
ENQ28	0,8	0	0				0,8	
ENQ29	1,2	0					1,2	
ENQ30	0,2	0	0				0,2	
ENQ31	0,8	0	0				0,8	
ENQ32	0	0	0	0	0,8		0,8	
				ENVIRONMENT			**20,84**	/35

Table A.9. Disaster question-point distributions details of COMPANY C

	1	2	3	4	5	6	
DQ1	0	0	0	1,4			1,4
DQ2	0	0	0,3	0	0		0,3
DQ3	0	0	0	0,2			0,2
DQ4	0	0,1	0	0	0	0	0,1
DQ5	0	0	0	0	0,2		0,2
DQ6	0	0	0	0	0	0,4	0,4
DQ7	0	0	0,1				0,1
DQ8	0	0	0	0	1,4		1,4
DQ9	0	0,1					0,1
DQ10	0	0,5					0,5

	1	2	3	4	5	6		
DQ11	0	0	0	0	0,5		0,5	
DQ12	0	0	0	0	0,4		0,4	
DQ13	0	0	0	0	0,3		0,3	
DQ14	0	0	1				1	
DQ15	0	0	0	0	0,5		0,5	
					DISASTER		**7,4**	/8

Table A.10. Social question-point distributions details of COMPANY C

	1	2	3	4	5	6	
SQ1	0	0	0	1,4			1,4
SQ2	0	0	0	1			1
SQ3	0	0,35					0,35
SQ4	0	0	0	0	1		1
SQ5	0	0	0	0	0	1	1
SQ6	0	0	0	0	0,6		0,6
SQ7	0	0	0	0	0	0,6	0,6
SQ8	0	0	0	0,6			0,6
SQ9	0	0	0,6				0,6
SQ10	0	0,4	0				0,4
SQ11	0,5	0					0,5
SQ12	0	0,5					0,5
SQ13	0	0,8					0,8
SQ14	0	0	0	0	0	2	2
SQ15	0	0	0	1			1
SQ16	0	0	0	1,5			1,5
SQ17	0	0	1,5				1,5
SQ18	0	0,4	0	0	0		0,4
SQ19	0	0,4					0,4
SQ20	0	0	0	1			1
SQ21	0	0	0	0	0,83	0	0,83
SQ22	0	0	0	0	1		1

SQ23	0	0,6					0,6	
SQ24	0	0,4					0,4	
					SOCIAL		19,98	/22

Table A.11. Economic question-point distributions details of COMPANY C

	1	2	3	4	5	6	
ECQ1	0	0	1,2				1,2
ECQ2	0	0,33	0				0,33
ECQ3	0	0	0,5				0,5
ECQ4	0	0	0,8				0,8
ECQ5	0	0,5					0,5
ECQ6	0	0,3					0,3
ECQ7	0	0	0	0,7			0,7
ECQ8	0	0	1,5				1,5
ECQ9	0	0	0,5				0,5
ECQ10	0	0,4					0,4
ECQ11	0	0	1,2				1,2
ECQ12	0	0,8					0,8
ECQ13	0	0,6					0,6
ECQ14	0,3	0					0,3
ECQ15	1	0					1
ECQ16	0,9	0					0,9
ECQ17	0,9	0					0,9
ECQ18	0,9	0					0,9
ECQ19	0	1,8					1,8
ECQ20	0	1,8					1,8
ECQ21	0,4	0					0,4
ECQ22	0	1,8					1,8
ECQ23	0	1,8					1,8
ECQ24	0	0	1,5				1,5
ECQ25	0,5	0	0				0,5

	1	2	3	4	5	6		
ECQ26	1	0					1	
ECQ27	0	1,5					1,5	
ECQ28	0	0,5					0,5	
ECQ29	0	0,75					0,75	
ECQ30	0	0,75					0,75	
ECQ31	0,5	0					0,5	
					ECONOMIC		27,93	/35

Table A.12. Environment question-point distributions details of COMPANY C

	1	2	3	4	5	6	
ENQ1	0	0	0	0,5			0,5
ENQ2	0	0	0,38	0			0,38
ENQ3	0	0	0,5				0,5
ENQ4	0	0,7					0,7
ENQ5	0	0,5					0,5
ENQ6	0	1,5					1,5
ENQ7	0	1,1					1,1
ENQ8	0	0,48	0	0	0		0,48
ENQ9	0,38	0	0	0			0,38
ENQ10	0,5	0					0,5
ENQ11	0,6	0					0,6
ENQ12	0,23	0	0				0,23
ENQ13	0	0,7					0,7
ENQ14	0	0	0	0	1,5		1,5
ENQ15	0	0	1				1
ENQ16	0	0	0,7				0,7
ENQ17	0	0	0,5				0,5
ENQ18	0	1					1
ENQ19	0	1					1
ENQ20	0,5	0					0,5
ENQ21	0	0,1					0,1

ENQ22	0	0	1				1	
ENQ23	1	0					1	
ENQ24	0	0					0	
ENQ25	0	0	0	1,5			1,5	
ENQ26	0	0,7					0,7	
ENQ27	0	0,7					0,7	
ENQ28	0	0	2,4				2,4	
ENQ29	0	2,4					2,4	
ENQ30	0	0	0,8				0,8	
ENQ31	0	0	2,4				2,4	
ENQ32	0	0	0	0	0,8		0,8	
				ENVIRONMENT			28,07	/35

Table A.13. Disaster question-point distributions details of COMPANY D

	1	2	3	4	5	6		
DQ1	0	0	0	1,4			1,4	
DQ2	0,1	0	0	0	0		0,1	
DQ3	0	0	0,15	0			0,15	
DQ4	0	0	0,15	0	0	0	0,15	
DQ5	0	0	0	0,16	0		0,16	
DQ6	0	0	0	0	0,33	0	0,33	
DQ7	0	0,12	0				0,12	
DQ8	0	0	0	0	1,4		1,4	
DQ9	0	0,1					0,1	
DQ10	0,125	0					0,125	
DQ11	0,1	0	0	0	0		0,1	
DQ12	0,08	0	0	0	0		0,08	
DQ13	0,06	0	0	0	0		0,06	
DQ14	0,3	0	0				0,3	
DQ15	0	0	0	0,4	0		0,4	
					DISASTER		**4,975**	/8

Table A.14. Social question-point distributions details of COMPANY D

	1	2	3	4	5	6		
SQ1	0	0	1,05	0			1,05	
SQ2	0,35	0	0	0			0,35	
SQ3	0	0,35					0,35	
SQ4	0	0	0	0,8	0		0,8	
SQ5	0	0	0,5	0	0	0	0,5	
SQ6	0	0	0	0	0,6		0,6	
SQ7	0,1	0	0	0	0	0	0,1	
SQ8	0,15	0	0	0			0,15	
SQ9	0	0,34	0				0,34	
SQ10	0	0,4	0				0,4	
SQ11	0,5	0					0,5	
SQ12	0,25	0					0,25	
SQ13	0	0,8					0,8	
SQ14	0	0	0	1,33	0	0	1,33	
SQ15	0,25	0	0	0			0,25	
SQ16	0	0	0	1,5			1,5	
SQ17	0	0	1,5				1,5	
SQ18	0	0	0,6	0	0		0,6	
SQ19	0	0,4					0,4	
SQ20	0	0	0	1			1	
SQ21	0	0	0	0	0	1	1	
SQ22	0	0	0	0	1		1	
SQ23	0	0,6					0,6	
SQ24	0,2	0					0,2	
					SOCIAL		15,57	/22

Table A.15. Economic question-point distributions details of COMPANY D

	1	2	3	4	5	6	
ECQ1	0	0,8	0				0,8
ECQ2	0	0	0,5				0,5
ECQ3	0	0	0,5				0,5
ECQ4	0	0,53	0				0,53
ECQ5	0,25	0					0,25
ECQ6	0,15	0					0,15
ECQ7	0,18	0	0	0			0,18
ECQ8	0,5	0	0				0,5
ECQ9	0,17	0	0				0,17
ECQ10	0,2	0					0,2
ECQ11	0	0	1,2				1,2
ECQ12	0	0,8					0,8
ECQ13	0,3	0					0,3
ECQ14	0	0,6					0,6
ECQ15	1	0					1
ECQ16	0,9	0					0,9
ECQ17	0,9	0					0,9
ECQ18	0,9	0					0,9
ECQ19	0,9	0					0,9
ECQ20	0,9	0					0,9
ECQ21	0,4	0					0,4
ECQ22	0,9	0					0,9
ECQ23	0,9	0					0,9
ECQ24	0,5	0	0				0,5
ECQ25	0,5	0	0				0,5
ECQ26	1	0					1
ECQ27	0	1,5					1,5
ECQ28	0,25	0					0,25
ECQ29	0,38	0					0,38
ECQ30	0	0,75					0,75
ECQ31	0,5	0					0,5

ECONOMIC	19,76	/35

Table A.16. Environment question-point distributions details of COMPANY D

	1	2	3	4	5	6	
ENQ1	0	0	0	0,5			0,5
ENQ2	0,13	0	0	0			0,13
ENQ3	0	0,33	0				0,33
ENQ4	0,35	0					0,35
ENQ5	0	0,5					0,5
ENQ6	0,75	0					0,75
ENQ7	0,55	0					0,55
ENQ8	0	0,48	0	0	0		0,48
ENQ9	0	0,75	0	0			0,75
ENQ10	0,5	0					0,5
ENQ11	0,6	0					0,6
ENQ12	0,23	0	0				0,23
ENQ13	0,35	0					0,35
ENQ14	0,3	0	0	0	0		0,3
ENQ15	0	0	1				1
ENQ16	0	0	0,7				0,7
ENQ17	0	0,33	0				0,33
ENQ18	0,5	0					0,5
ENQ19	0,5	0					0,5
ENQ20	0,5	0					0,5
ENQ21	0,5	0					0,5
ENQ22	0,33	0	0				0,33
ENQ23	0	2					2
ENQ24	0,5	1					1,5
ENQ25	0	0	0	1,5			1,5
ENQ26	0,35	0					0,35
ENQ27	0,35	0					0,35

ENQ28	0,8	0	0				0,8	
ENQ29	1,2	0					1,2	
ENQ30	0,2	0	0				0,2	
ENQ31	0	1,6	0				1,6	
ENQ32	0,16	0	0	0,64	0		0,8	
				ENVIRONMENT			20,98	/35