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Determination of Criteria and Importance Levels for Prioritization of Protected Areas

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Abstract

Protected areas form the basis of the most effective operational tools of national and international conservation strategies to protect and sustain natural and cultural resource values. This study aimed to score the essential criteria and sub-criteria according to the importance of identifying and prioritizing new protected areas. For this purpose, a 5 Likert scoring technique was applied to 30 experts. As a result, seven essential criteria and 37 sub-criteria that can be used in the prioritization process of protected areas according to their weight scores were determined. The main criteria are listed as natural values (0.32), social and cultural values (0.26), spatial values (0.11), negative criteria (pressures and threats) (0.09), legal, administrative and political situation (0.07), economic values (0.06), research and development potential (0.06). With the seven essential criteria and 37 sub-criteria developed in this study, a decision support tool based on a straightforward, fast, and scientific approach that can mainly serve planners, practitioners, and decision-makers according to the importance levels of protected areas has been created.

Keywords: *Protected areas, assessment criteria, importance levels, nature conservation, biodiversity.*

Korunan Alanların Önceliklendirilmesinde Kullanılabilecek Ölçütler ve Önemlilik Düzeylerinin Belirlenmesi

Öz

Korunan alanlar, doğal ve kültürel kaynak değerlerinin korunması ve sürdürülebilirliğine yönelik ulusal ve uluslararası koruma stratejilerin en etkili eylemini oluşturur. Bu çalışmada yeni korunan alanların belirlenmesi ve önceliklendirilmesi için temel ölçüt ve alt ölçütlerin önemlilik düzeyine göre puanlandırılması amaçlanmıştır. Bu amaçla 30 uzman kişiye 5'li likert puanlama tekniği ile uygulanmıştır. Sonuç olarak; Korunan alanların önceliklendirme sürecinde ağırlık puanlarına göre kullanılabilecek 7 temel ölçüt ve 37 alt ölçüt belirlenmiştir. Temel ölçütler ağırlık puanlarına göre doğal değerler (0,32), sosyal ve kültürel değerler (0,26), mekânsal değerler (0,11), olumsuz ölçütler (baskı ve tehditler) (0,09), yasal, yönetsel ve politik durum (0,07), ekonomik değerler (0.06), araştırma ve geliştirme potansiyeli (0,06) şeklinde sıralanmıştır. Bu çalışma ile geliştirilen 7 temel ölçüt ve 37 alt ölçüt ile korunan alanların önemlilik düzeylerine göre özellikle plancılara, uygulayıcılara ve karar vericilere hizmet edebilecek kolay, hızlı ve bilimsel bir yaklaşıma dayalı bir karar destek aracı oluşturulmuştur.

Anahtar Kelimeler: *Korunan alanlar, değerlendirme ölçütleri, önemlilik düzeyleri, doğa koruma, biyoçeşitlilik.*

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1. Introduction

Human beings have directly and indirectly interacted with nature according to the value judgments, perceptions, perspectives, Degree of importance, and prioritization levels of the individual and society since its existence. As a result of this association, human beings have constantly and unilaterally destroyed, exploited, changed, and shaped nature in line with their needs and demands. Humankind's tendency to dominate nature and consume it at the maximum level has led to its irreversible negative impact (Gül & Kurdoğlu, 2021). Human beings, who have damaged nature by intervening in the physical dimension until today, have been working to change the natural system's content, genetics, magnetics, and frequency, especially in recent years. Although it is not yet clear what the effects will be on nature and human life, it is thought to bring serious vital problems (Gül, Dinç & Gül, 2021).

Nature conservation is the work carried out to protect all living and non-living beings from all kinds of adverse effects, pressures, and destruction of people and to secure them for the future, to maintain ecosystem services such as ecological-environmental, socioeconomic and cultural ecosystem services of natural systems (Gül & Kurdoğlu, 2021). Nature conservation reflects the sense of protection in the human spirit or existence. It can be considered an internal orientation towards guaranteeing one's existence and natural life by worrying about the future. In this context, nature and environmental protection efforts cover the natural and cultural spaces where people live and interact (Gül & Türker, 2014). In the nature conservation approach, the fact that the one who damages or destroys nature and the one who tries to protect nature are human beings in the position of a single subject brings along a philosophical paradox. In this context, the nature conservation approach prioritizes the protection of nature from human activities or limiting its use (Gül & Kurdoğlu, 2021).

The International Union for Conservation of Nature's (IUCN) definition of a protected area is a clearly defined geographical area recognized, allocated, and managed by legal or other effective means to ensure the long-term conservation of nature, together with associated ecosystem services and cultural values (Dudley, 2008). Most protected areas are located in natural or near-natural ecosystems, but they are also integrated with historical, archaeological, and cultural areas due to human activities.

Protected areas offer essential opportunities not only for the protection of biodiversity (protection of species and ecosystems) but also for essential ecological, social, and economical services such as clean water, carbon storage, genetic reservoirs, disaster mitigation and soil stabilization, conducting scientific research, providing education, awareness and consciousness-raising, contributing to the social and economic development of the region and protecting our cultural heritage (Gül & Türker, 2014; Gül, Dinç & Gül, 2021). For this reason, protected areas are key in protecting and sustaining natural ecosystems and biodiversity. It is recognized that they are the only way to stop the extinction of many endangered, threatened, or endemic species. The main reason for the emergence of the protected area approach is to protect the natural and cultural values of protected areas in their current state, to limit human activities that may pose a threat, and to prevent undesirable changes (Gül & Metin, 2021).

Protected areas are increasing in number on a global scale and constitute the most critical component and action of global conservation strategies and in situ conservation (Gaines et al., 2010; Game et al., 2009; Gray, 2010; Lester et al., 2009; Lubchenco et al., 2003; Pimm et al., 2001).

According to the World Database on Protected Areas (WDPA), 2024, the number of protected areas is 293,696 (number of protected areas on land and inland waters: 275496 + number of marine protected areas: 18200) and covers 244 countries and territories. The ratio of protected areas to the world area is 16.1% (The World Database on Protected Areas (WDPA), 2024; protectedplanet, 2024).

In Türkiye, the ratio of terrestrial protected areas to the country's surface area is approximately 14.9 percent.

The amount of protected areas under the responsibility of the Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks is approximately 3 739 459 hectares. Protected areas and their numbers are National Park (48) Nature Park (266), Nature Monument (110), Nature Conservation Area (31), Wildlife Conservation Area (85), Wetlands (106), Ramsar Areas (14),

Protection Forests (55), Gene Conservation forests (353), Seed Stands (311), Seed Orchard (212) and Forest Parks (133) (Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks, 2024).

The total area of protected areas under the responsibility of the Ministry of Environment, Urbanisation, and Climate Change is 7,883,511 hectares. These areas and their numbers are Special Environmental Protection Areas (SEPA) (19) and Natural Protected Areas (3,834) (Ministry of Environment, Urbanisation and Climate Change, 2024).

The total number of protected areas under the General Directorate of Cultural Assets and Museums of the Ministry of Culture and Tourism is 24786. They are Archaeological Protected Areas (24031), Urban Protected Areas (361), Historical Protected Areas (230), Urban Archaeological Protected Areas (36), and Mixed Protected Areas (128) (General Directorate of Cultural Assets and Museums, 2024).

In 2006, Doğa Derneği, in its book 'Türkiye's Important Nature Areas,' identified 305 Important Nature Areas (IBAs) in Türkiye that should be protected according to scientific criteria and where endangered species or critical habitats should be considered during the planning of activities within their borders. The total area of these areas is 20 million 280 thousand 149 hectares. This area constitutes 26 percent of Turkey's surface area (Eken et al., 2006).

Natural systems and protected areas around the world are under serious human threats, including misuse and change, urbanization, mining and quarrying, excavation, environmental pollution, harvesting, hunting, and climate change, leading to their increasing fragmentation and isolation (Brandon et al., 1998; Oates. 1999; Sala et al., 2000; Bruner et al., 2001). With continued economic growth, pressure on natural systems will likely increase further.

Climate change and biodiversity loss are our two most significant environmental challenges. The 2015 Paris climate agreement and agreements such as COPE envisage limiting global warming to an increase of less than 2°C above pre-industrial levels to avoid the most significant impacts of climate change. Nature conservation is perhaps the only way to curb carbon emissions and ensure the proper functioning of ecosystem services (Dudley et al., 2009). In particular, it is envisaged as a target to increase the number and amount of protected natural areas to limit carbon emissions and sustain and protect ecosystem services and biodiversity.

Since the existence of human beings, it has emerged that nature should be protected holistically and that humans should adopt a lifestyle in harmony with nature. The idea of securing at least half of the world by 2050 to protect nature is becoming increasingly widespread (Wilson, 2016). However, many people question whether it is possible to realize this goal (Dinerstein et al., 2017; Watson & Venter, 2017) because it is predicted that it will not be possible to discover the protection of even 30% of all terrestrial and marine ecosystems rather than 50% of the world in economic, ecological, and managerial dimensions.

According to Watson & Venter (2017), to make conserving 50% of the Earth a reality, Watson & Venter (2017) suggest that it should be centered around three key questions.

- Which places are the most important to conserve?

- What is the extent, severity, and trajectory of threats to local biodiversity, and what processes sustain them?

- For areas prioritized for intervention, what measures will be needed to ensure they retain their natural integrity?

It is necessary to determine the general management objectives, status, methods, programs, and principles for protecting protected areas in natural ecosystems and to develop nature conservation policies considering each country's conditions. Selecting and prioritizing natural areas using qualitative and quantitative criteria according to protection status and management objectives is essential. However, the determination of protected areas is generally based on some ecological indicators. Socioeconomic aspects are only considered in the management stages of these areas (Smith & Theberge, 1986). The reasons for nature conservation are accepted as aesthetic, psychological and

medical, ecological and vital, scientific, pedagogical, economic, and ethical reasons (Gül & Türker, 2014).

Although the criteria and indicators used in the identification and planning of protected areas have been given more importance, they have not yet been brought to a scientific standard because they belong to different purposes and categories (quantitative/qualitative, species/habitat) and are often duplicated and sometimes not applicable. In our country, criteria or indicators for identifying or evaluating candidate areas for protected areas have not yet been established. In particular, only limited criteria, such as ecological, biological diversity, and social values, were used to create a simple checklist for evaluating candidate areas.

Today, it is essential to determine the priority areas according to the criteria/sub-criteria, importance levels, and indicators in scientific and technical dimensions according to the protection status of protected areas, which are increasing in quality and quantity. To prioritize protected areas according to the criteria and sub-criteria to be determined, as well as their weight levels, and to select candidate areas easily and quickly, an approach should be put forward according to scientific and technical standards. Thus, it will be of great benefit in terms of more effective protection of the protected areas to be prioritized in terms of quality and quantity, planning/designing according to the purpose of protection, and ensuring sustainable, economical, and rational management.

This study aims to determine the basic/sub-criteria that will include scientific and technical standards in the prioritization and selection of protected areas and to choose the weight scores, including the level of importance of these criteria. Thus, the candidate areas to be protected will be determined according to the sum of the indicator scores proposed for each sub-criteria. The selection of protected areas will promote the country's network of protected areas and allow it to make the best choices from different natural ecosystems.

2. Material and Method

This study was carried out in two stages.

In the first stage, the primary/sub-criteria and indicators used and their significance levels were determined by reviewing the relevant written sources to identify and evaluate protected areas. In this context, a base proposal for basic/sub-criteria was developed.

Second stage: Determination of Significance Levels of Basic and Subcriteria: In determining the relevant candidate protected areas, weight scores were obtained according to the significance levels of the basic/sub-criteria developed by asking the appropriate experts and indicators were proposed according to the sub-criteria.

For this purpose, to determine the criterion/sub-criteria and importance levels, experts were asked to use a 5-point Likert scoring technique (Very unimportant: 1 point, Unimportant: 3, Undecided: 5 points, Important: 7 points, Very important: 9 points). The criteria/sub-criteria and the level of importance were applied to a total of 30 experts including Landscape Architects (n: 5), Building Architects (n: 5), Urban Planners (n: 5), Forest Engineers (n: 5), Agricultural Engineers (n: 5), Biologists (n: 5). Thus, a multidimensional and rapid evaluation guide of priority areas or candidate areas for all protected areas at scientific level has been created.

As a result of the literature review, 6 of the seven essential criteria (Natural values, Spatial values, Social and cultural values, Economic status, Legal, administrative and political status, Research and development capacity status) were determined as positively scored essential criteria and 1 of them was determined as negatively scored negative criteria (pressures and threats).

The sum of the scores given by each expert group to the proposed positive six essential criteria was calculated as the percentage ratio with the score of all crucial criteria. Thus, weight scores showing the level of importance of each essential criterion were obtained. After the weight score of each essential criterion was determined, the percentage ratio of the total score of each expert group was calculated by scoring the sub-criteria belonging to the essential criteria by the experts. Thus, the weight scores showing the importance levels of the sub-criteria were determined. In addition, negative weight scores

were determined by performing the same procedures for the negative scored basic and sub-criteria. Thus, the protected area with the highest total score obtained by subtracting the total score of 6 positive basic/sub-criteria indicators from the total score of negative sub-criteria indicators with negative scores will be determined as a priority area. Thus, deciding on priority protected areas with multi-criteria, scientific, and rapid evaluation has become possible.

3. Results and Discussion

3.1. Determination of Basic/Subcriteria and Importance Levels for the Selection of Natural Protected Areas

For this purpose, many sources have been analyzed to determine the criteria.

According to the UNEP Caribbean Environment Programme (1996), when designating a new protected area, the conservation objectives should be clear, and the area should contain species and/or habitats important for natural (or cultural) conservation and social and cultural sustainability. The main criteria for the designation and selection of protected areas are;

- Ecological diversity and integrity (the area should include specific habitats or species that are rare or endangered, or a variety of different habitats that allow for the occurrence of rare or endangered species, or feeding, breeding, or resting areas for endangered species);
- Presence of rare species or habitats;
- The Degree of naturalness of the area;
- The need to secure the habitat of species in danger of being harmed
- It is the community's willingness to preserve and maintain traditional uses and spiritual links with the past and to ensure the integrity of the relationship with conventional beliefs and ways of life.

The most important factors to be used in the assessment/identification of protected areas by UNEP (1996) are Importance (Degree of uniqueness, naturalness, diversity, ecological integrity, opportunities for sustainable development and scientific values), representativeness (differences or similarities in the character, quality, quantity or combination of resources of the area), feasibility (size, isolation, configuration, accessibility, land ownership and ancestral rights, population density, acquisition costs, economic interests in the region, environmental impacts and staffing or development requirements), priority status (presence of endangered and endemic species, unique or rare landscapes, special areas for migratory species, areas of high biodiversity, areas of high economic and social value, presence of rare species) (UNEP Caribbean Environment Programme, 1996).

According to Kelleher & Kenchington (1992), the general criteria for deciding whether an area should be protected are naturalness, biogeographical, ecological, economic, social, scientific, international, national, and feasibility.

Sharifi et al. (2011) proposed to evaluate protected areas according to 5 criteria. 1) Habitat criterion (sub-criteria are landscape, representativeness, uniqueness, habitat importance, fragility, and water resources), (2) Species criterion (sub-criteria are species diversity, population, conservation level, and damage), (3) Social criterion (sub-criteria are cultural and historical importance and Compatibility), (4) Economic criterion (sub-criteria are dependence on local economy and cultural and historical importance and Compatibility), (4) Economic criterion (sub-criteria; dependency on local economy and importance for national economy), (5) Management criterion (sub-criteria; research and monitoring, education, threat factors and legal support).

According to Rita et al. (2017), a. Ecological factors (Diversity (species and habitats), modifiability/non-modifiability, rarity (species and habitats), endemism, size (area), typicality, representativeness, uniqueness, naturalness, location in ecological/geographical unit (spatial location), spatial connectivity, rarity or irreplaceability (species and/or habitat). b. Socioeconomic Indicators (Threat of human disturbance, recorded history, ecological fragility, vulnerability, economic value, educational value, amenity value, scientific value, availability, ease of acquisition, cost of new establishment,

reserve, accessibility, management considerations, legal context for conservation, habitat representation/addition, spatial connectivity, functional integrity, regional dynamic or evolutionary trend, external human threats, economic value of the site (use or non-use value), financial and land use/ownership constraints, legislation/level of national legal involvement.

Margules & Usher (1981) suggested criteria for assessing conservation potential and ecological value: diversity (including species richness and habitat diversity), rarity, naturalness, number of biological interactions (e.g. predation, competition), area, threat of human interference, typicality, representativeness, educational value, environmental value, recorded history, scientific value, uniqueness, wildlife reservoir potential, ecological fragility, location in ecological/geographical unit, potential value, availability, modifiability, ease of acquisition and management considerations.

Rarity, uniqueness of the area, species richness (diversity), size, naturalness of the area, fragility, representativeness, spatial connectivity, typicality, vegetation structure, fragility, number of plant communities, plant structural formations, fragility, irreplaceability and endemism have been proposed in many sources to evaluate protected areas and biodiversity status (Tubbs & Blackwood, 1971; Tans, 1974; Gehlbach, 1975; Goldsmith, 1975; Wright, 1977; Van der Ploeg & Vlijm, 1978; Smith & Theberge, 1986).

In Europe, the Natura 2000 network is a network of protected areas distributed throughout the European Union, consisting of Special Protection Areas designated under the Habitats Directive and the Birds Directive, respectively, covering both land and marine areas. Within Natura 2000, criteria include species and habitat characteristics such as 'representativeness, conservation status, functions (resting, breeding, feeding, wintering or summering), habitat size, population density of target species, spatial connectivity and sensitivity of species' (WWF, 1998). The International Union for Conservation of Nature (IUCN) has also used ecological selection criteria such as naturalness, representativeness, size, and conservation status to define protected area categories (Dudley, 2008).

Ecological indicators for conservation priorities and protected area designation include site heterogeneity (Lindenmayer et al., 2000), site uniqueness, and natural character (Gubbay, 1995).

In the study by Edward & Porter-Bolland (2008), five essential criteria and 18 sub-criteria were determined according to the level of importance in selecting protected areas in the forest ecosystem. Accordingly, the main criteria are (1) Habitat, (2) Species, (3) Social, (4) Economic, and (5) Management criteria. Sub-criteria are habitat uniqueness, species diversity, habitat sensitivity, habitat representative, legal support, species protection level, habitat importance, threat factors, dependence on the local economy, research and monitoring, education, Compatibility, cultural and historical significance, landscape, water resources, importance in the national economy, damage and population, etc.

In addition to analyzing many foreign literatures, the existing legislation in our country was also examined. In this context, within the scope of the 'Regulation on the Procedures and Principles Regarding the Determination, Registration, and Approval of Protected Areas' (Official Gazette dated July 19, 2012, and numbered 28358), the principles and criteria for the determination of natural sites are defined in Article 6. According to this,

> ***Article 6:*** *a) Of sufficient size to sustain ecosystem functions, b) Having significant biodiversity values in terms of species, genetic, habitat and ecosystem diversity, c) Containing narrowly distributed or endemic species whose extinction is threatened or endangered on a regional, national or world scale, or containing habitats where these species spend a certain period of their lives, ç) Having the ability to represent these species in terms of the protection of threatened ecosystems or species in danger of extinction, d) Has social, cultural and recreational value that provides resource and landscape integrity, e) Can maintain its natural structure without human intervention or with limited intervention, f) Typical, natural, rare, g) The species or habitats it contains are more interesting than other species or habitats, ğ) It has surface and underground water resources of ecological importance in terms of hydrological-hydrogeological aspects, h) It represents a habitat of migratory bird species, ı) Can be regained through ecological*

rehabilitation or ecological restoration works and breeding methods to include existing and potential habitat types, i) Preserves natural processes and species that will ensure the long-term continuity of biological diversity.

3.2. Determination of Basic Criteria and Importance Levels for Prioritisation in Protected Areas

Due to the increase and diversification of protected areas, it is necessary to reconsider and prioritize the evaluation criteria and indicators. On a global scale, various criteria and data have been used to identify areas that may be particularly important for the long-term conservation of biodiversity.

Table 1. Weight scores of the main criteria according to their importance according to the experts

	Natural Values	Social and Cultural Values	Spatial Values	Legal, Administrative, and Political Values	Economic Values	Research and Development Potential	Negative (Pressure and Threats) Criteria	Total Weight Scores and Importance Value
Forest Engineer	45,00	35,00	15,00	13,00	13,00	11,00	13,00	145
	0,31	0,24	0,10	0,09	0,09	0,08	0,09	1,00
Landscape Architect	45,00	39,00	17,00	11,00	11,00	9,00	13,00	145
	0,31	0,27	0,12	0,08	0,08	0,06	0,09	1,00
City Planner	43,00	41,00	17,00	13,00	11,00	7,00	11,00	143
	0,30	0,29	0,12	0,09	0,08	0,05	0,08	1,00
Architect	43	41	17	11	11	7	11	141
	0,30	0,29	0,12	0,08	0,08	0,05	0,08	1,00
Agricultural Engineer	45,00	27,00	13,00	9,00	7,00	7,00	9,00	117
	0,38	0,23	0,11	0,08	0,06	0,06	0,08	1,00
Biologist	45,00	29,00	11,00	11,00	7,00	11,00	15,00	129
	0,35	0,22	0,09	0,09	0,05	0,09	0,12	1,00
Total Score	**266**	**212**	**90**	**68**	**60**	**52**	72	**820**
Significance Score	**0,32**	**0,26**	**0,11**	**0,08**	**0,07**	**0,06**	0,09	**1,00**

In this study, the weight scores of the essential criteria that can be used in the determination and preference of protected areas according to their importance in line with the scores given are listed as natural values (0.32), social and cultural values (0.26), spatial values (0.11), negative criteria (pressure and threats) (0.09), legal, administrative and political status (0.07), economic values (0.06), research and development potential (0.06). It is seen that there is a statistically consistent scoring among the experts.

In the study conducted by Edward & Porter-Bolland (2008), the priorities of the main criteria were determined as habitat, species, social aspects, management aspects, and economic aspects. Factors to be considered in determining the importance of a natural area include the Degree of uniqueness, naturalness, diversity, ecological integrity, sustainable development opportunities, and scientific value. Culturally and historically significant sites may include regions, areas, natural features, structures, or objects that are indicative of a country's heritage and values and have a high level of integrity of location, design, setting, materials, artistry, feeling, and association (UNEP Caribbean Environment Programme, 1996).

According to the UNEP Caribbean Environment Programme (1996), the highest priority areas may have the following characteristics: (UNEP Caribbean Environment Programme, 1996).

- Presence of endangered and locally endemic species;
- The presence of unique or rare national, regional, or international landscapes or ecosystems
- Special areas of high importance for the maintenance of nesting, feeding, wintering, and breeding of migratory species;

- Areas of high biodiversity of special importance for genetic evolution and conservation of resources within each biogeographical region;
- Areas with biological or geographical features that enable and sustain genetic evolution and areas of high economic and social value, in particular, those critical for ensuring the long-term survival and well-being of the population;
- The existence of populations of locally rare species.

3.3. Determination of Sub-criteria and Importance Levels for Prioritisation in Protected Areas

The sub-criteria that may be related to the main criteria and their weight scores were determined as follows.

3.3.1. Natural Values

The most important prioritized essential criterion in the determination of protected areas was determined as natural values. The weight scores of the sub-criteria according to their importance in the natural values criterion are as follows; Biodiversity value (0,15), Endangered, sensitive and rare species (0,15), Representativeness (Uniqueness and Typicality) (0,14), Naturalness (Hemerobi Degree) (0,13), Endemic status (0,13), Presence of water resources (0,12), Self-renewal ability (0,10), Stability status (0,07). The determined sub-criteria will be essential in determining the protected areas regarding natural values. In this context, each sub-criterion can be scored using measurable indicators (Table 2).

Table 2. Importance status and weight scores of sub-criteria for natural values criterion according to experts

	Natural Values								
Experts	**Biodiversity status**	**Endangered, vulnerable, and rare species**	**Representativeness (Uniqueness and Typicality)**	**Naturalness (Hemerobi Degree)**	**Endemic status**	**Presence of water resources**	**Self-renewal ability**	**Stability status**	**Total Score**
Forest Engineer	45	45	45	43	41	41	29	27	316
	0,14	0,14	0,14	0,14	0,13	0,13	0,09	0,09	1,00
Landscape Architect	45	45	45	43	41	37	33	25	314
	0,14	0,14	0,14	0,14	0,13	0,12	0,11	0,08	1,00
City Planner	45	43	41	35	37	31	31	21	284
	0,16	0,15	0,14	0,12	0,13	0,11	0,11	0,07	1,00
Architect	45	45	39	37	35	25	25	15	266
	0,17	0,17	0,15	0,14	0,13	0,09	0,09	0,06	1,00
Agricultural Engineer	45	45	39	41	37	37	29	19	292
	0,15	0,15	0,13	0,14	0,13	0,13	0,10	0,07	1,00
Biologist	45	45	43	43	41	41	39	25	322
	0,14	0,14	0,13	0,13	0,13	0,13	0,12	0,08	1,00
Total score	**270**	**268**	**252**	**242**	**232**	**212**	**186**	**132**	**1794**
Significance Score		**0,15**	**0,14**	**0,13**	**0,13**	**0,12**	**0,10**	**0,07**	**1,00**

a. Biodiversity Status

Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems (Convention on Biological Diversity (CBD), 1992).

In this case, biodiversity consists of four essential components (Zeydanlı et al., 2017).

- Ecosystem (or habitat) diversity,
- Species diversity,
- Genetic diversity,
- Process (ecological events and functions) diversity.

Biodiversity is defined as the multiplicity and diversity of the elements and structures of a system. Biodiversity is generally formulated as biodiversity = richness + diversity. In the biodiversity criterion, separate measurable indicators can be defined and scored for four components. For example;

- Potential species diversity (relative frequency and number of different species within a particular area): 5 points can be given if there is at least five species diversity, and 1 point can be given if there is less.
- Genetic diversity (hereditary variation within and between species and populations). If there is at least five genetic diversity, 5 points can be awarded; if there is less, 1 point can be awarded.
- Habitat (ecosystem=biotope) diversity (diversity in habitats within or part of the landscape), 5 points if there is at least five ecosystem diversity, 1 point if there is less.
- In terms of process diversity, if there are at least five process diversity, 5 points can be awarded; if less, 1 point can be awarded.

b. Presence of Endangered, Sensitive, and Rare Species

Founded in 1964, the World Conservation Union's (IUCN) 'International Union for Conservation of Nature's Red List of Threatened Species' has become the world's most comprehensive source of information on the global conservation status of animal, fungal, and plant species. The IUCN Red List is a critical indicator of the health of the world's biodiversity. Much more than a list of species and their status, it is a powerful tool for action on biodiversity conservation and policy change that is critical for protecting the natural resources needed for Survival. It is one of the most decisive criteria, especially in identifying and prioritizing protected areas.

The IUCN Red List Categories and Criteria aim to be an easy and widely understood system for classifying species at high risk of extinction on a global scale. According to IUCN, the Red List is divided into nine categories. Not Assessed, Data Insufficient, Least Concerned, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct' (IUCN, 2024).

In protected areas, if a plant or animal species is classified as 'CR - Near Extinct' or 'EN - Endangered' according to IUCN criteria, all areas where they live should be given priority for protection as they are among the rarest species in the world. No threshold value should be used.

However, if the status of a species is relatively better, i.e., 'VU - Vulnerable, DD - Insufficient Data or NT - Near Endangered' categories are still priority areas for protected areas. However, the species' population size, distribution, breeding pattern vulnerability, etc., should be considered. Numerical thresholds can be used for these species.

In this context, the indicators for plant and animal species are proposed as follows.

- 5 points for at least one species or ecosystem entity that is thought to be extinct or extinct, or 1 point if there are no such species in the area
- Presence of at least one endangered species, 5 points, 1 point can be given if there are no such species in the area
- Presence of at least one sensitive or endangered species, 5 points, 1 point can be given if there are no such species in the area
- Presence of at least one rare or uncommon species, 5 points, 1 point can be given if there are no such species in the area

c. Representativeness (Uniqueness=Uniqueness and Typicality)

Representativeness refers to the Degree to which an area is unique and typologically representative of the biodiversity, species, ecosystem, ecological process, biological community, geographical or physical characteristic of a particular region. Preference should be given to areas representing some species and ecosystems, especially in large areas. While these typical areas have similar characteristics, they may also have a unique, rare and unique character (Levin et al., 2013; Zeydanlı et al., 2017).

Uniqueness can be explained by the fact that the area's resource values (species or habitat) have different characteristics from the surrounding geography on an international or national scale and often manifest themselves with distinct natural boundaries. The rarity of the area's resource values is the most important priority of nature conservation. It is sufficient for any resource values (species, ecosystems, climate, soil, water resources, etc.) to be unique and unparalleled (Levin et al., 2013; Zeydanlı et al., 2017).

Representativeness is usually selected from the following groups: Distribution, coexistence, environmental variables, rare species or threatened species, and unique living communities can be considered (Levin et al., 2013; Zeydanlı et al., 2017).

In this context, it has been proposed as an indicator;

- Very high representativeness of the resource values of the area compared to other areas can be given 5 points, and 1 point can be given if the representativeness is low.
- Being unique on an international scale can be given 5 points, being unique on a national and local scale can be given 3 points, and not being unique can be given 1 point.

d. Degree of Naturalness (Hemerobi degree):

Natural ecosystems are an indicator of ecological integrity if they have intact natural biological components (plants, animals, and other organisms), abiotic components (such as geology and water), and processes (such as reproductive population growth). In this context, the Degree of naturalness of the natural ecosystem can be explained as the level of influence of human activities. In defining the concept of nature conservation, the Degree of closeness and naturalness to nature (hemerobi) is another important concept. Hemerobi is explained as the level of influence of human activities on nature (Çolak, 2001).

The word ‘hemerobi’ is formed from the Greek words ‘hemeros’ = cultivated and ‘bios’ = life and refers to the historical and current state of human impact on an ecosystem (Steinhardt et al., 1999). The historical state considers the past: the previous state without the influence of culture. The current state is a specific self-regulating state based on the potential of the growing environment. With the potential primordial state, the Degree of naturalness can be revealed. Thus, the anthropogenic change of the potential of the growing environment is less than the naturalness because this shows a departure from the primordial state.

For example, the presence of beech forests instead of oak or hornbeam forests near the river in an arid place is caused by human influence, and therefore, the Degree of naturalness is low here. In some cases, however, when the growing environment has undergone irreversible human-induced changes or when a new species has been established there for a very long time (e.g., species that have been present for 500 years), these species are called ‘Neophytes.' This can also be characterized as natural vegetation.

In order to analyze the cultural impact of man on the natural system, hemerobi cascades have been established. Kowarik (1999) defined hemerobia as ‘a measure of human cultural influence on the ecosystem'. It is predicted that no ecosystems are left in the world that have not been directly or indirectly affected by anthropogenic impacts that have continued for centuries. Therefore, ‘potential natural vegetation’ is significant in determining the Degree of naturalness.

According to Çolak et al. (2003), the hemerobi approach can be used in vegetation research, ecosystem analyses, nature conservation, and forest management assessment. Four fundamental indicators can

be taken into account for the Degree of hemerobia: the proportion of neophytes (species that, although not naturalized in a place, seem to have been introduced by man, mostly 400-500 years ago, and naturalized there), soil characteristics, indicator species, and the proportion of therophytes (annual plants) (Çolak et al., 2003).

Sukopp (1972) made hemerobia steps:

- Ahemerob = No or very insignificant cultural effect (Natural)
- Oligohemerobes= Minimal impact; primitive vegetation can be visible (close to nature)
- Mesohemerob = with a pronounced and periodic cultural influence (moderately altered):
- Euhemerob = Under very marked influence (Strongly altered):
- Polyhemerobes = Changes in the growing environment and the emergence of new plant combinations (Artificial):
- Metahemerob = Very significant impact, extinction tendency, and artificial condition.

In this context, as an indicator suggestion that can be used for the sub-criterion of naturalness, natural and near-natural areas can be given 5 points, and areas that have been moderately and strongly changed by human impact can be given 1 point.

e. Endemic Status

Endemic species include flora and fauna species whose distribution is limited to a particular geographical area or whose natural habitat consists of a limited geographical area (Korunan Alanların Tespit, Tescil ve Onayına İlişkin Usul ve Esaslara Dair Yönetmelik, (2012). Endemic species may show characteristics such as having a narrow distribution area, being found only in one or very few unique biotopes, and having small populations.

An important indicator is the number, percentage, density, and distribution of endemic species at international, national, regional, and local scales regarding plant or animal species in protected areas. In this context, indicators for endemic sub-criteria are as follows.

- A high number of endemic plant species at the international level can be given 5 points, 3 points for being at the national and local level, and 1 point for not being at the international level.
- Having a high number of endemic animal species at the international level can be given 5 points, being at the national and local level can be given 3 points, and not being at the national and local level can be given 1 point.
- If the density and distribution of endemic plant species at the international level is more than 10% of the area, 5 points; if it is at the national and local level, 3 points; if not, 1 point can be given.
- The density and distribution of endemic animal species internationally is more than 10% of the area. There are 5 points: 3 points for being at the national and local level, and 1 for not being at the international level.

f. Presence of Water Resources

Potable water resources (river, spring, eye, lake, sea, dam, etc.) in the area represent a biotic and abiotic vital value. However, as important as the type and quantity of water resources in the area, the high potable quality of the water should also be considered as an important indicator. Indicators for this sub-criterion;

- If the number of water resource types in the area is 3< or more, 5 points can be given; if not, 1 point can be given.
- If the area's total percentage of water resources is more than 10%, 5 points can be given; if it is less than 10%, 1 point can be given.

- If the potable quality of water resources in the area is high, 5 points can be given; if it is low, 1 point can be given.

g. Self-Renewal Capability,

Natural systems can be negatively affected by natural factors and human activities. Protecting species or ecosystems that are impossible for nature to create on its own or to be created by humans makes it a priority. As a result of negative impacts, natural systems that can renew themselves rapidly are more potent and can create a priority situation compared to other areas due to their sustainable ecological processes. In this context, indicators for sub-criteria;

- If the area's self-renewal capacity of the target plant species is high, 5 points can be given; if not, 1 point can be given.
- The area's high self-renewal capacity of target animal species can be given 5 points; if not, 1 point can be given.
- High self-renewal capacity of abiotic factors (soil, water, and air) can be given 5 points; if not, 1 point can be given.

h. Stability Status:

The ecosystems of protected areas must live with various natural stressors such as storms, snow, insects, and drought. These factors continuously test the vitality of ecosystems and contribute to their stability. DARWIN calls this phenomenon ‘ Survival of the fittest, - 'Survival of the fittest.' The concept of stability has many different meanings.

- ‘Durability’ against unfavourable factors.
- ‘Elasticity is the speed of return to its former value (equilibrium) after an unfavorable factor.
- ‘Stagnation,' which preserves its value against specific changes until a certain time.
- Relative temporal ‘Immutability-Constancy.'
- It can be summarized as the state of reacting against destruction.

Indicators according to the stability sub-criterion of the site can be suggested as follows;

- If the ‘Durability’ of the site against negative factors is high, 5 points can be given; if not, 1 point can be given.
- If the ‘Elasticity’ of the site against adverse factors is high, 5 points can be given; if not, 1 point can be given.
- If the area's 'Relative temporal invariance' against unfavorable factors is high, 5 points can be given; if not, 1 point can be given.
- If the area has a high reaction to adverse factors, 5 points can be

3.3.2. Social and Cultural Values

In protected areas, the conservation of historical and archaeological heritage values that have survived from the past to the present, together with natural values, is accepted as the primary conservation objective. For this reason, cultural heritage values within natural systems, living human communities, local identities, traditions and customs, lifestyles, and approaches of local communities towards conservation should be considered important sub-criteria in the prioritization, planning, and managing of protected areas.

The experts evaluated four sub-criteria within the scope of the leading social and cultural values criterion. The weighted scoring was as follows: Cultural, historical, or archaeological heritage value and presence (0,36), Degree of local community support for conservation (0,25), Local social and political acceptability (0,21), Compatibility with existing land uses of local people (0,19) (Table 3).

Table 3. Importance status and weight scores of sub-criteria for social and cultural values criterion according to experts

	Social and Cultural Values				
Experts	**Cultural, historical, or archaeological heritage value and presence**	**Local community support for conservation**	**Local social and political acceptability**	**Compatibility with existing land uses of the local community**	**Total Score**
Forest Engineer	43	31	27	25	126
	0,34	0,25	0,21	0,20	1,00
Landscape Architect	43	27	25	23	118
	0,36	0,23	0,21	0,19	1,00
City Planner	43	31	25	19	118
	0,36	0,26	0,21	0,16	1,00
Architect	43	29	21	21	114
	0,38	0,25	0,18	0,18	1,00
Agricultural Engineer	37	29	25	23	114
	0,32	0,25	0,22	0,20	1,00
Biologist	41	27	23	21	112
	0,37	0,24	0,21	0,19	1,00
Total score	250	174	146	132	702
Significance Score	0,36	0,25	0,21	0,19	1,00

a.Cultural, Historical, or Archaeological Heritage Value and Presence: The presence of historical and archaeological values in the area and their integrity with natural values will increase the heritage value and ecosystem services of protected areas. Thus, protecting natural and cultural values and ensuring holistic sustainability will be possible. For this reason, protecting historical and archaeological values with natural values should be considered an important priority.

Different indicators can be used for this sub-criterion. For example

- - If there are internationally important heritage values, 5 points can be given; if at the national level, 3 points can be given; if not, 1 point can be given.
- - If the cultural values in the area represent 100 years ago, 5 points; if not, 1 point.
- - If the area has different cultural stratification heritage values, 5 points; otherwise, 1 point.
- - If the site represents historical objects and events at international and national levels, 5 points; otherwise, 1 point
- - If there is diversity in the area's unique cultural landscape values, 5 points can be given. Otherwise, 1 point can be given, etc.

b. Local Community's Support for Conservation: Local people living in and around protected areas play an important role in protecting natural and cultural resource values. To the saying 'the closest to the problem is the closest to the solution,' local people in and around the protected areas are more effective in solving the problems related to protected areas. Especially when local people have high demands and tendencies towards conservation, the conservation and sustainability of natural and cultural resource values in the area can be easier and more effective. For this reason, it is preferable that the local community support conservation.

Different indicators can be used for this sub-criterion.

- - If the local community has high conservation awareness, it is 5 points; if not, it is 1 point.
- - If the local community has very few harmful activities towards the area, 5 points; if not, 1 point.
- - Local community taking actions to protect the resource values can be counted as 5 points, otherwise 1 point.

c. Local Social and Political Acceptability: The Compatibility of local people, administrators, decision-makers, and political approaches with the conservation objectives where protected areas are located is an excellent opportunity for the conservation, management, and sustainability of resource values. For this reason, it is directly related to the social and political acceptability of the area with conservation objectives.

The indicators of this sub-criterion can be suggested as follows;

- 5 points if the level of community acceptance of the conservation and utilization objectives of the site is high, 1 point if not.
- If the level of acceptance of conservation policies and actions by the local community is high, it can be counted as 5 points; if not, it can be counted as 1 point.

d. Level of Compatibility with Existing Land Uses of Local People: The land use activities (agricultural activities, animal husbandry, settlement, etc.) of local people in and around the area must be compatible with the conservation objectives of natural and cultural resource values. The indicator for this sub-criterion can be given as 5 points if the land use activities in and around the area are compatible with the conservation objectives and 1 point if not.

3.3.3. Spatial Values

Spatial values within the area can be important in prioritizing protected areas. In this context, the weight scores of the experts according to the importance of spatial values sub-criteria are as follows: Area size (0,18), spatial connection (0,17), current settlement and construction status (0,16), ownership status (0,16), presence of existing agricultural areas (0,13), accessibility (accessibility) status (0,12), current infrastructure status (0,09) (Table 4).

Table 4. According to the experts, the importance status and weight scores of the sub-criteria for the spatial values criterion

Spatial Values								
Experts	**Size of the Area**	**Spatial connection**	**Existing Settlement and Structuring**	**Status Property**	**Status Existence of Existing Agricultural Areas**	**Accessibility to the Area**	**Existing Infrastructure Status**	**Total Score**
Forest Engineer	33	31	27	29	25	21	13	179
	0,18	0,17	0,15	0,16	0,14	0,12	0,07	1,00
Landscape Architect	35	33	29	31	25	23	15	191
	0,18	0,17	0,15	0,16	0,13	0,12	0,08	1,00
City Planner	31	29	31	29	23	21	17	181
	0,17	0,16	0,17	0,16	0,13	0,12	0,09	1,00
Architect	33	31	29	31	23	23	21	191
	0,17	0,16	0,15	0,16	0,12	0,12	0,11	1,00
Agricultural Engineer	31	29	39	29	21	23	19	191
	0,16	0,15	0,20	0,15	0,11	0,12	0,10	1,00
Biologist	35	31	27	27	23	21	13	177
	0,20	0,18	0,15	0,15	0,13	0,12	0,07	1,00
Total score	**198**	**184**	**182**	**176**	**140**	**132**	**98**	**1110**
Significance Score	**0,18**	**0,17**	**0,16**	**0,16**	**0,13**	**0,12**	**0,09**	**1,00**

a. Area Size:

The size of the protected area is determined according to conservation objectives and priorities. The nature conservation approach is generally fulfilled by in-situ protection at a particular spatial scale, considering the environmental relationship rather than the species or object scale. The natural process can only be secured in large and unaffected areas. Small protection areas may be unable to protect habitats long term.

Numerous studies suggest that larger protected areas are more desirable for long-term conservation of species and maintenance of ecological and evolutionary processes (Cowling et al., 1999; Bierregaard et al., 2001). Other research suggests that small reserves are sufficient for some species and are almost always better than no reserves or management in an area (Turner & Corlett, 1996).

The size of the protected area can vary from 1m2 for the protection of a species to hundreds of hectares for ecosystem or process protection. For example, an area of several decares may be protected to protect a group of trees (a small stand). Alternatively, 'process protection' close to nature may require more than 10,000 ha. The International Nature Conservation Organisation IUCN recommends at least 1,000 ha for national and international nature reserves (wilderness areas, national parks, protected landscapes). For 'zoological species conservation,' large areas are generally required. Depending on the species, this can range from a few m2 to 1 million hectares.

Only in large protected areas can populations adequately maintain their communities for a long time against risks and additional fluctuations in environmental conditions. Indeed, there is a minimum population size for each species. Small populations are likely to die out earlier than large populations. Large populations can only best buffer fluctuations in the stand. For this reason, environmental conditional effects are only rarely practical in large areas. Large protected areas are secured by viable, i.e., sufficiently large, population stands. This requires hundreds of hectares. It is generally recognized that large areas are necessary for the conservation of zoological species or species since wild animals consist of a habitat, a staging area, a mating area, and a feeding area.

The literature often debates whether a large protected area is better than many small protected areas in the same area. For example, some studies in practice show that in terms of habitat, many small islands have more species than large areas. However, it is also recognized that the fragmentation of forests in the form of habitat islands may adversely affect fauna.

As a result, there is no standard for area size in protected areas. Therefore, the area size should be determined according to the target species and ecosystem character. In this context, some indicators can be used for area size. For example

- For target wild animal species (sheltering, feeding, etc.), 5 points for having a suitable size for vital activities, 1 point if not.
- The suitable size for vital activities for target plant species is 5 points, if not 1 point.
- If the habitat areas have a holistic protection size, 5 points; if not, 1 point.
- Abiotic (soil, water, air, etc.) can be suggested as 5 points if it has sufficient size for conservation purposes, 1 point if not.

b. Spatial connection

The geographical location of the candidate area and the existing utilization areas around it may affect the resource values. For this reason, it refers to the organic connection of the area with other natural ecosystems in its surroundings and the fact that it is in a holistic rather than fragmented position. For this reason, having natural systems around the candidate area and having an organic connection should be preferred. Indicators for this sub-criterion can be suggested as follows;

- If there are natural systems (forest ecosystem, lake ecosystem, other protected areas, etc.) near the site, 5 points; if not, 1 point
- If the area is far away (more than 20 km) from the settlement, industry, etc. near the area, it can be recommended as 5 points; if not, 1 point.

c. Existing Settlement and Structuring Status

The area's settlement and construction tendencies may negatively impact resource values, pressure, and threats. For this reason, it should be preferred that there are no settlements in the area. Indicators for this sub-criterion;

- 5 points if there is no settlement in the area, 1 point if not
- If there is no building tendency (accommodation buildings, recreational facilities, agricultural facilities, structures, etc.) in the area, 5 points; if not, 1 point, etc., can be recommended.

d. Presence of Agricultural Areas

The presence of agricultural activities in the area, especially the use of pesticides, irrigation, etc., may adversely affect resource values. For this reason, it should be preferred not to have agricultural areas or agricultural activities in the area. Indicators for this sub-criterion;

- Absence of agricultural activities in the area 5 points, if not, 1 point,
- There should be 5 points if there are no agricultural facilities in the area, 1 point if there are none, etc.

e. Accessibility Status

Existing and possible access roads in the area may facilitate protecting and managing resource values.

Indicators for this sub-criterion;

- If there are existing car roads in the area, 5 points; if not, 1 point, etc., can be suggested.

f. Ownership Status:

The protection and institutional management may be more effective if the area is a forest or treasury land. In particular, it should be preferred that there are no private lands within the area.

Indicators for this sub-criterion;

- If the entire area is under treasury or forest ownership, 5 points; if not, 1 point, etc., can be suggested.

g. Existing Infrastructure Status:

Infrastructure systems such as electricity, water, and sewerage within the area may provide some advantages in managing the protected area. Therefore, having infrastructure systems is an advantage.

Indicators for this sub-criterion;

- - It can be suggested that there be 5 points if there are existing infrastructure systems in the area or 1 point if there are none.

3.3.4. Legal, Administrative and Political Situation

The identification of protected areas, granting protection status, planning/design, implementation, and administrative processes are carried out and organized within the framework of international and national legislation and the scope of the authority and responsibilities of the relevant official institutions. For this reason, the existing legislation, administrative structure and organization, and the protection policies of the state and the public play an important role in prioritizing protected areas.

In this context, the legal, administrative, and political situation was evaluated as an important criterion by the experts, and the weight scores of the sub-criteria according to their importance were as follows: Institutional and management organization capacity (0,26), compliance with the current national legislation (0,24), availability of areal inventory data (0,22), the existence of existing protection statuses in the area (0,15), the existence of NGOs related to the area (0,14) (Table 5).

Table 5. Importance status and weight scores of sub-criteria for the legal, administrative, and political capacity criterion according to experts

	Legal, Administrative, and Political Situation					
Experts	**Institutional and Management Organisation Capacity**	**Status of Compliance with Existing International or National Legislation**	**Availability of Spatial Inventory Data**	**Existence of Existing Protection Statuses in the Area**	**Existence of NGOs Related to the Area**	**Total score**
Forest Engineer	41	37	33	23	21	155
	0,26	0,24	0,21	0,15	0,14	1,00
Landscape Architect	39	37	31	21	17	145
	0,27	0,26	0,21	0,14	0,12	1,00
City Planner	35	31	33	21	19	139
	0,25	0,22	0,24	0,15	0,14	1,00
Architect	37	31	33	19	21	141
	0,26	0,22	0,23	0,13	0,15	1,00
Agricultural Engineer	33	31	31	19	19	133
	0,25	0,23	0,23	0,14	0,14	1,00
Biologist	33	35	29	21	19	137
	0,24	0,26	0,21	0,15	0,14	1,00
Total score	**218**	**202**	**190**	**124**	**116**	**850**
Significance Score	**0,26**	**0,24**	**0,22**	**0,15**	**0,14**	**1,00**

a. Institutional and Management Organisation Capacity: The existence and organizational status of the institutions responsible and competent for protected areas will facilitate protecting and managing natural and cultural values. For this reason, the existing organizational structure of the institutions in charge and responsible for the firm and practical protection status may effectively prioritize the protected area.

In this context, some indicators can be used for this sub-criterion. For example;

- High institutional and organizational capacity related to protection status can be suggested as 5 points; if not, 1 point, etc.

b. Compliance with Existing International or National Legislation: Compliance of protected areas with existing legislation may facilitate the administrative and implementation process. For this reason, the Compatibility of the protected area with the statuses defined in the existing international or national legislation regarding resource values may facilitate the prioritization of the area.

In this context, some indicators can be used for this sub-criterion. For example

- - It can be suggested that 5 points be given if the protected area candidates comply with the legislation and 1 point if not.

c. Availability of Spatial Inventory Data: Existing scientific research or projects for protected areas (especially biodiversity inventory, natural plant species inventory, wild animals inventory, etc.) can provide an important advantage. Thus, obtaining up-to-date resource values will facilitate more effective planning and management of the protected area.

In this context, some indicators can be used for this sub-criterion. For example

- - If the availability of existing scientific data within the protected area candidates is high, 5 points can be suggested. Otherwise, 1 point can be suggested.

d. Existence of Existing Protection Statuses in the Area: The existence of different protection statuses (natural site, archaeological site, archaeological site, archaeological site, nature park, monumental tree, etc.) in and around the candidate protected areas may be beneficial for the holistic protection and sustainability of resource values.

In this context, some indicators can be used for this sub-criterion. For example;

- - In case of having different protection status within the protected area candidates, 5 points, otherwise 1 point, etc. can be suggested.

e. Presence of NGOs related to the area: Where candidate protected areas are located, the presence of non-governmental organizations (NGOs) operating in the area can make significant contributions to the protection and sustainability of the area.

In this context, some indicators can be used for this sub-criterion. For example

- - If at least 1 NGO is associated with the area, 5 points; if not, 1 point, etc., can be suggested.

3.3.5. Economic Values

The conservation, sustainability, planning, and management processes balance expenditure and income, and maintenance and repair of protected areas depend entirely on economic capacity. Therefore, the financial source of the area and the added value to be obtained from the area are the priority criteria for protected areas.

In this context, the economic situation was evaluated as an important criterion by the experts, and the weight scores of the sub-criteria according to their importance were as follows: Ecosystem service value (0,41), conservation status management cost (0,30), potential to receive international and national financial support (0,30) (Table 6).

Table 6. According to the experts, the importance status and weight scores of the sub-criteria for the Economic Status criterion

	Economic Situation			
Experts	**Ecosystem Service Value of the Area**	**Conservation Status Management Cost**	**Potential for International and National Financial Support**	**Total Score**
Forest Engineer	43	31	31	105
	0,41	0,30	0,30	1,00
Landscape Architect	43	31	31	105
	0,41	0,30	0,30	1,00
City Planner	41	31	31	103
	0,40	0,30	0,30	1,00
Architect	39	29	31	99
	0,39	0,29	0,31	1,00
Agricultural Engineer	39	29	29	97
	0,40	0,30	0,30	1,00
Biologist	41	29	27	97
	0,42	0,30	0,28	1,00
Total score	**246**	**180**	**180**	**606**
Significance Score	**0,41**	**0,30**	**0,30**	**1,00**

a. **Ecosystem Service Value;**

Human beings have benefited from the multifaceted services and contributions of natural ecosystems since their existence. Economic and market-based valuation of ecosystem services forms the basis of a conservation model that promotes development for local communities based on the utilization of ecosystem products and services. In this context, the economic value of biodiversity can be assessed by socioeconomic indicators related to the direct and indirect use value, option value, and existence value of a given ecosystem.

Protected areas, which are increasing globally, have a wide variety of purposes, resource values, functioning, administrative processes, etc. Protected areas have many services and functionalities that ensure the continuity of human life and other species and ecosystems. Ecosystem services and functions of protected areas are categorized under four headings (WWF, 2020).

- Supportive Services: Biodiversity protection, soil formation, nutrient cycle, seed dispersal, life cycle, etc.
- Supply Services: Water, food, medicinal and aromatic products, fungi, genetic resources, etc.
- Regulatory Services: Cleansing soil, water, and air; regulation and stabilization of climate; control of natural disaster risks; maintenance of surface and groundwater regulation; pollination of plants; carbon storage and sequestration, etc.
- Cultural Services: Tourism and recreation, health, education, research, aesthetics, tangible and intangible values, socialization, etc.

In this context, some indicators can be used for ecosystem service values, the area's most important economic capacity sub-criteria. For example

- - 5 points if Supporting Services is high; otherwise, 1 point.
- - 5 points if Supply Services are high; otherwise, 1 point,
- - 5 points if Regulatory Services are high; otherwise, 1 point,
- - If Cultural Services are high, it can be suggested as 5 points; if not, 1 point, etc.

b.Conservation Status Management Cost:

In granting protection status to the candidate area, protecting its natural and cultural values and the cost of the management process are important. Therefore, conservation activities' low cost can be considered a priority sub-criterion.

In this context, some indicators can be used for this sub-criterion. For example

- - If the total cost of conservation activities is low, 5 points; if not, 1 point.

c. Potential for International and National Financial Support:

Providing the financial support needed for the conservation and management of the natural and cultural values of the area will provide a great advantage. In this context, it will be possible to provide institutional or private financial resources at international and national scales, especially to make conservation more effective and sustainable with the financial resources the area can obtain from its own resources.

In this context, some sub-criteria indicators can be used, e.g.,

- High level of financial support at an international scale of 5 points, if not 1 point.
- High level of financial support (institutional and private) at a national scale of 5 points, if not 1 point.
- If the field's capacity to generate finance with resources is high, 5 points; if not, 1 point.

3.3.6. Research and Development Potential

Protected areas' natural and cultural resource values may contain many unknown information and secrets. At the same time, it could be a source of original inspiration and create added value. High capacity of research and development activities in the context of solving and discovering the secrets of protected areas and producing new scientific knowledge can provide an important priority. In addition, it can play an important role in transforming the information obtained into multifaceted added value, including social, cultural, technological, and economic.

In this context, research and development capacity was evaluated as an important criterion by the experts, and the weight scores of the sub-criteria according to their importance were listed as follows: Scientific research and development potential (0.51), value added (innovation) capacity (0.49) (Table 7).

Table 7. Importance status and weight scores of sub-criteria for research and development capacity criterion according to experts

	Research and Development Potential		
Experts	**Scientific Research and Development Potential**	**Capacity to create added value (innovation)**	**Total points**
Forest Engineer	33	31	64
	0,52	0,48	1,00
Landscape Architect	31	31	62
	0,50	0,50	1,00
City Planner	29	29	58
	0,50	0,50	1,00
Architect	27	27	54
	0,50	0,50	1,00
Agricultural Engineer	29	29	58
	0,50	0,50	1,00
Biologist	33	31	64
	0,52	0,48	1,00
Total score	**182**	**178**	**360**
Significance Score	**0,51**	**0,49**	**1,00**

a.Scientific Research and Development Potential:

The fact that candidate-protected areas offer opportunities for a wide range of scientific studies in terms of resource values and are attractive to researchers may create an important potential for increasing the scientific capacity of the area and for R&D.

In this context, some indicators can be used for this sub-criterion. For example, if the R&D potential of the area is high, 5 points, otherwise 1 point, etc., can be suggested.

b.**Capacity to Create Added Value (Innovation):**

Existing or potential R&D studies for candidate areas may increase the added value of the area in ecological, social, technological, and economic dimensions.

In this context, some indicators can be used for this sub-criterion. For example, 5 points if the area has high added value, 1 point if not, etc.

3.3.7. Negative (Pressures and Threats) Criteria

In protected areas, pressures and threats within or around the area may negatively affect natural and cultural resource values. Therefore, knowing the capacity and impact level of internal/external pressures and threats can be important in prioritizing protected areas, especially in the negative

direction. In this context, the experts evaluated internal/external pressures and threats as an important criterion in the negative direction. Negative weight scores were determined according to the importance of the sub-criteria. According to this, Pressure and threat of settlement or construction (-0,18), pressure and threat of highways in and around the area (-0,14), pressure and threat of mining and quarrying activities (-0,14), pressure and threat of environmental pollution (-0,14), pressure and threat of environmental pollution (-0,14), 13), pressure and threat of recreational activities (-0,12), pressure and threat of forest fire (-0,12), pressure and threat of energy production areas (-0,10), pressure and threat of natural disasters (-0,08). The negative total score of this criterion will be determined by multiplying the score of each sub-criterion by the weight score, and the negative total score will be obtained (Table 8).

Table 8. According to the experts, the importance status and weight scores of the sub-criteria for the negative (pressures and threats) criterion

	Negative (Pressure and Threats) Criteria								
Experts	**Pressure and Threat of Settlement or Construction**	**Pressure and Threat of Highways in and around the area**	**Pressure and Threat of Mining and Stone Activities**	**Pressure and Threat of Environmental Pollution**	**Pressure and Threat of Recreational Activities**	**Pressure and Threat of Forest Fire**	**EPressure and Threat of Energy Production Areas (HEPP, WPP, Solar Panels, etc.)**	**Pressure and Threat of Natural Disasters (Flood, earthquake, erosion, landslide, etc.)**	**Total Score ((Negative)**
Forest Engineer	-41	-31	-33	-31	-29	-29	-23	-19	-236
	-0,17	-0,13	-0,14	-0,13	-0,12	-0,12	-0,10	-0,08	-1,00
Landscape Architect	-43	-33	-33	-31	-29	-25	-29	-15	-238
	-0,18	-0,14	-0,14	-0,13	-0,12	-0,11	-0,12	-0,06	-1,00
City Planner	-39	-27	-29	-29	-23	-21	-23	-19	-210
	-0,19	-0,13	-0,14	-0,14	-0,11	-0,10	-0,11	-0,09	-1,00
Architect	-37	-29	-27	-29	-23	-23	-21	-13	-202
	-0,18	-0,14	-0,13	-0,14	-0,11	-0,11	-0,10	-0,06	-1,00
Agricultural Engineer	-35	-29	-29	-27	-27	-25	-21	-17	-210
	-0,17	-0,14	-0,14	-0,13	-0,13	-0,12	-0,10	-0,08	-1,00
Biologist	-41	-37	-33	-29	-27	-31	-21	-19	-238
	-0,17	-0,16	-0,14	-0,12	-0,11	-0,13	-0,09	-0,08	-1,00
Total score (Negative)	**-236**	**-186**	**-184**	**-176**	**-158**	**-154**	**-138**	**-102**	**-1334**
Significance Score (Negative)	**-0,18**	**-0,14**	**-0,14**	**-0,13**	**-0,12**	**-0,12**	**-0,10**	**-0,08**	**-1,00**

a. Pressure and Threat of Settlement or Construction: The presence of existing and potential settlements or construction tendencies within and near candidate protected areas is an important threat and pressure factor for natural resource values. For this reason, it should be preferred that there is no settlement or construction tendency in the area.

In this context, some indicators can be used for the negative sub-criterion.

For example, if the pressure and threat of settlement or construction in the area is high, -5 points, etc.

b. Pressure and Threat of Motorways in and around the Area: Existing and potential motorways in and around candidate protected areas may be an important threat and pressure factor regarding habitat fragmentation, noise, accidental deaths and injuries of wild animals, feeding, etc.

In this context, some indicators can be used for the negative sub-criterion, for example, -5 points if the pressure and threat of motorways in and around the area is high, etc.

c. Pressure and Threat of Mining and Quarrying Activities: Existing and potential mining and quarrying activities in or near the candidate protected area may be an important threat and pressure factor in terms of resource values, especially as a result of activities such as destruction of natural vegetation, noise, dust pollution, excessive use of water resources, etc.

In this context, some indicators can be used for the negative sub-criterion. For example, -5 points in case of high pressure and threat of mining and quarrying activities in the area, etc.

d. Environmental Pollution Pressure and Threat: Existing and potential water, soil, and air pollution due to human activities in or near the candidate protected area may be an important threat and pressure factor for resource values.

In this context, some indicators can be used for the negative sub-criterion. For example, if the pressure and threat of environmental pollution is high in the area, -5 points, etc.

e.Pressure and Threat of Recreational Activities: Existing and potential recreational facilities and activities (accommodation and service facilities, sports activities, hunting, picnicking, vehicle road construction, festivals, etc.) in or near the candidate protected area may be a significant threat and pressure factor for resource values.

In this context, some indicators can be used for the negative sub-criterion, for example, -5 points if the pressure and threat of recreational activities in the area is high, etc.

f. Forest Fire Pressure and Threat: Resource values may be adversely affected due to activities such as fire-sensitive species (e.g., red pine forest, etc.), picnic activities with barbecues, stubble burning in agricultural areas, etc., in or near the candidate protected area.

In this context, some indicators can be used for negative sub-criteria. For example, if the pressure and threat of forest fire are high in the area, -5 points can be suggested.

g.Pressure and Threat of Energy Production Areas: During the construction and operation process of Energy Production Areas (e.g., HEPP, WPP, Solar Panels, etc.) in or near the candidate protected area, resource values may be negatively affected as a result of activities such as destruction of natural vegetation, land noise, etc. In this context, some indicators can be used for negative sub-criteria. For example, if the pressure and threat of energy production areas in the area is high, -5 points, etc., can be suggested.

h. Natural Disaster Pressure and Threat: The possibility of natural disasters, such as floods, earthquakes, erosion, landslides, etc., in or near the candidate protected area may adversely affect the resource values in the area. In this context, some indicators can be used for the negative sub-criterion. For example, if the pressure and threat of natural disasters are high in the area, -5 points can be suggested.

4. Conclusion and Recommendations

Today, the harmony or incompatibility of natural (ecological) systems and the relations resulting from the multifaceted economic activities of humans determine and affect the future of both areas of existence. The global economy is shaped and evolving in line with the rules and interests of the global capital power that governs the system. At the last point, the blockage of production and consumption processes in the global economy, the deterioration of income distribution, the excessive depletion of natural systems and resources, the decrease in biodiversity, the food crisis, climate change, etc., have brought along complex problems. As a result, global collapse and chaos continue under the mask of development or economic growth. The minority with global economic power continues to use and exploit nature in line with their interests, seeing every way and method as a license to gain rent, more profit, and power. Natural resources are the habitat for humans and all living things and are the insurance of the future (Gül et al., 2023).

One of the most effective means of protecting natural and cultural resource values is 'in-situ conservation.' Protected areas are envisaged as the only way to sustain and conserve ecosystem services and biodiversity (Dudley et al., 2010). At the same time, in situ conservation must be supported by ex-situ conservation.

There are many reasons for establishing a protected area. Among these, the conservation of biodiversity components (ecosystem, genetic, species, and process diversity) and ensuring the continuity of outstanding landscapes come to the fore. Protected areas are becoming increasingly crucial in eliminating threats to sensitive landscapes, preventing biodiversity loss, ensuring food security, increasing ecosystem services, storing carbon, and providing social, cultural, and economic services and contributions. For this reason, protected areas should be handled multidimensionally, including their legal, ecological, social, cultural, political, and economic dimensions, and should be associated with strategic policies focusing on conservation.

Today, in mitigating and adapting to the negative impacts of climate change, increasing the number and amount of protected natural areas is envisaged as the most important strategic goal, especially for limiting carbon emissions and protecting biodiversity. In this context, identification, prioritization, conservation, planning/design, and management/governance of protected areas should be considered. Therefore, identifying and prioritizing new protected areas must be associated with scientific, ecological, social, economic, institutional, financial, and objective criteria.

This study developed a decision support tool based on seven essential criteria and 37 sub-criteria developed scientifically and objectively based on an easy and fast approach that can help planners, practitioners, and decision-makers according to their level of importance. This tool can prioritize the impact of multidimensional ecological, socio-cultural, economic, administrative, and political criteria to different degrees in determining the protected area.

Basic and sub-criteria that can be used in the prioritization process of protected areas;

- *Natural values (0,32): (Sub-criteria; Biodiversity value (0,15), presence of endangered, sensitive and rare species (0,15), representativeness (uniqueness and typicality) (0,14), naturalness (Degree of hemerobi) (0,13), endemic status (0,13), presence of water resources (0,12), self-renewal ability (0,10), Stability status (0,07)).*
- *Social and cultural values (0,26): (Sub-criteria; Cultural, historical or archaeological heritage value and presence (0,36), Degree of local community support for conservation (0,25), Local social and political acceptability (0,21), Compatibility with existing land uses of local people (0,19)).*
- *Spatial values (0,11): (Sub-criteria are as follows: Area size (0,18), spatial connectivity (0,17), existing settlement and construction status (0,16), ownership status (0,16), presence of existing agricultural areas (0,13), accessibility (accessibility) status (0,12), existing infrastructure status (0,09).*
- *Negative Criteria (Pressure and threats) (0,09): (Sub-criteria; Pressure and the threat of settlement or construction (-0,18), pressure and threat of motorways in and around the area (-0,14), pressure and threat of mining and quarrying activities (-0,14), pressure and threat of environmental pollution (-0,14), pressure and threat of environmental pollution (-0,14), 13), pressure and threat of recreational activities (-0,12), pressure and threat of forest fire (-0,12), pressure and threat of energy production areas (-0,10), pressure and threat of natural disasters (-0,08)).*
- *Legal, Administrative and Political Status (0,07): (Sub-criteria; Institutional and management organization capacity (0,26), compliance with existing national legislation (0,24), availability of areal inventory data (0,22), existence of existing protection statuses in the area (0,15), existence of NGOs in the area (0,14)).*

- Economic values (0.06): (Sub-criteria; value of ecosystem services (0.41), management cost of conservation status (0.30), potential for international and national financial support (0.30)).
- Research and Development Potential (0,06); (Sub-criteria; Scientific research and development potential (0,51), value added (innovation) capacity (0,49)).

With this study, the basic and sub-criteria determined in the prioritization process of protected areas will provide a quick and easy evaluation. However, the indicators proposed in the method can be changed and improved according to the characteristics of protected areas.

Identifying and prioritizing protected areas alone do not guarantee biodiversity protection and other natural and cultural resource values. The objectives of protected areas management include social and economic objectives and the conservation of biological diversity. However, scientific and purposeful planning/design and effective and participatory management/governance are determining factors in achieving conservation objectives.

The primary approach to protected areas should ensure the joint participation of all relevant stakeholders, including relevant institutions and organizations, landowners, managers and users, Indigenous peoples, local communities, and NGOs. Countries should guarantee the protection and sustainability of nature/environment through ecological state policies and legal regulations free from any rent system approach.

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Evaluation of Restoration Interventions in the Ancient Theater of Ephesus in Terms of National and International Conservation Principles

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Abstract

Theaters, which can be integrated into contemporary life without altering their original construction purposes, are cultural heritages of documentary nature. International platforms established rules for their use for events and conservation of cultural traces they possess. The preservation and restoration efforts in theaters, aimed at bringing them back into modern life, have evolved over time, reflecting shifts in techniques and approaches from past to present. The study aims to emphasize why and how changing restoration techniques have been used in the theaters' integration into contemporary life and to evaluate restoration works conducted over the years on these monuments in the context of national and international conservation legislation. The scope was determined as the Ancient Theater of Ephesus, where the first restoration works began with the Ephesus Festival organized in 1968, and continued subsequently for tourism-related events. A literature review covering the national and international statutes and laws was conducted to examine the changing restoration works over time, and findings from on-site observations were conveyed through plans and photographs.

Keywords: *Contemporary use, the ancient theater of Ephesus, conservation and restoration.*

Efes Antik Tiyatrosu'ndaki Restorasyon Müdahalelerinin Ulusal ve Uluslararası Koruma İlkeleri Bağlamında Değerlendirilmesi

Öz

Yapılış amacı değiştirilmeden çağdaş yaşama katılabilen tiyatrolar, taşıdıkları kültürel izlerle belgesel nitelikteki miraslardır. Tiyatroların etkinlikler için kullanımı ve taşıdıkları kültürel izlerin korunması için uluslararası platformlarda altı çizili kurallar belirlenmiştir. Çalışmanın amacı, antik alanlarda zaman içerisinde değişen restorasyon tekniklerinin tiyatroların çağdaş yaşama katılma süreçlerinde nedenli ve nasıl ele alındığını vurgulamaktır.Çalışmanın hedefi ise bu anıt eserlerde yıllara sâri yapılan restorasyon çalışmalarının ulusal ve uluslararası koruma mevzuatları bağlamında değerlendirilmesidir. Çalışmanın kapsamı, 1968'de düzenlenen Efes Festivali ile birlikte ilk restorasyon çalışmaları yapılan, sonraki yıllarda turizm amaçlı etkinlikler için tekrar restorasyon çalışmaları sürdürülen Efes Antik Tiyatro'su olarak belirlenmiştir. Zamanla değişen restorasyon çalışmalarını incelemek amacıyla ulusal ve uluslararası alanlardaki tüzükleri ve yasaları kapsayan literatür araştırması yapılmış, yerinde yapılan gözlemlerle edinilen bulgular planlar ve fotoğraflar üzerinden aktarılmıştır.

Anahtar kelimeler: *Çağdaş kullanım, Efes Antik Tiyatro, koruma ve onarım, restorasyon.*

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1. Introduction

As stated in the Charter on the Use of Ancient Places of Performance, issued as a result of the Conference of the Council of Europe held in Verona, theaters are among the very few monuments that can still serve their original purposes under particular circumstances. Together with the cultural traces they possess, they are living cultural heritages of artistic and documentary nature, covering a broad range of processes from the periods when they were built to the restorations they underwent and the alternative uses they served over time (Council of Europe [COE], 1997). While religious rituals, sacred ceremonies and parades were among the primary purposes of use of these heritages until today, it is seen that they began to serve social purposes over time due to changing socio-cultural factors (Çorbacı, 2007). The conservation and restoration works, carried out in the theaters that have been desired to be reintegrated into contemporary life, have continued from the past to the present with changing techniques and approaches.

In this study, the Ancient Theater of Ephesus was examined to compare the changes in conservation and restoration techniques that began seventeen years after its public opening for its use as an event venue and have continued over the years since then. The fact that the reflection of conservation and restoration works carried out in the theaterfor the same purpose in different periods on the national and international legislation are accessible, and that the continuity of the concept of conservation can be observed despite changing techniques played an important role in the selection of the theater, integrated into contemporary life as an event venue, as the subject of the study.

Within the scope of the study, the first comprehensive conservation and restoration works started in the Ephesus Archeological Site, which was opened in 1951, with the Ephesus Festival organized in 1968 and turned into an international event, and the more recent conservation and restoration works, carried out in 2018-2021 and completed with another event, were examined.

1.1. Historical Background of the Ancient City of Ephesus

Situated in the present-day Selçuk District, 79 km south of İzmir province and established in the Küçük Menderes delta, the Ancient City of Ephesus has been home to many different civilizations throughout the ages. Designated as a world heritage site in 2015, the first foundation of the city dates back to 7000 BC. The settlement and harbor area of the city has changed over historical processes due to historical events and geographical conditions (Türkoğlu, 2000). In the area covering approximately 585 hectares, traces of urbanization, architectural structures and layers of beliefs forming a wide spectrum from the Neolithic period to the Republican period are seen together (Table 1).

Table 1. Historical periods of Ephesus (Selcuk Municipality, 2022)

Historical Period	Settlement Area
Neolithic, Chalcolithic and Early Bronze Age	Çukuriçi Höyük (‘Çukuriçi Mound’)
Bronze Age and Iron Age	Ayasuluk Hilland Surroundings of the Temple of Artemis
Archaic and Classical Periods	Ayasuluk Hill, Artemis, Mt Pion (Panayır)
HellenisticPeriod	Ephesus, 4th century BC –31 BC
Roman Period	Ephesus, 31 BC –293 AD
Byzantine Period	Ephesus and Ayasuluk, 293 AD – 13th century
Principalities Period	Ayasuluk, 1304 – 1426
Ottoman Period	Ayasuluk, 1426 – 1923
Republican Period	Selçuk

Ephesus World Heritage Site can be expressed in four parts as important historical processes. Çukuriçi Höyük, the earliest Neolithic and Bronze Age settlement, was discovered during excavations in 1995. It is believed that the settlement here was abandoned in the early 3rd century BC with its destruction. It is mentioned in written sources that the settlement shifted to Ayasuluk region as of the mid-Bronze Age. Hittite records refer to the city of Apasa, the main settlement of the land of Arwaza, located in

the Ayasuluk region, addressing to the late 2000 BCE. It is thought that the name "Apasas" corresponds to "Ephesus" in Greek (Selcuk Municipality, 2022).

Greek culture increased in the ancient city of Ephesus, being dated back to 1000 BC.. The Temple of Artemis, one of the seven wonders of world today, is dated as a construction of this period (Selcuk Municipality, 2022). Known as the house of gods, the temple is the most important sacred place of the settlement. During this period, there was a harbor located to the north of the temple, near Ayasuluk Hill. Like many wars created turning points in history, the Persian and Spartan war continued until the siege by Alexander the Great. After Alexander's death in 300 BC, one of his generals, the Macedonian Commander Lysimachus founded Ephesus in its present location. Although the Ephesians were reluctant to leave their old settlement, the people were forced to settle in the Arsinoe region, named after the commander's wife. During this period, a new harbor and defensive walls were built in the city, which was established between Mt Pion and Mt Koressos. The city was designed in a grid plan (Ladstatter et al., 2016).

Few remains from the Hellenistic period survived in the city until today. The most magnificent structure belonging to this period is the Great Theater, exhibiting influences of the Hellenistic period, and the fountain to its west. After the death of the Macedonian commander, the city started to be called Ephesus again. After Ephesus became part of the Roman Empire in 133 BC, the city highly developed as the new capital of Anatolia (Selcuk Municipality, 2022).

The Ancient City of Ephesus experienced the period when important architectural structures came into prominence in the 2nd century. Many magnificent buildings were constructed thanks to the donations and supports of the leading families of the city. The Temples of Domitian and Hadrian, and the Library of Celsus are the notable buildings of this period. One of the turning points in the city was the closure of the Temple of Artemis in 381 and its use as a quarry with the spread of Christianity. Similarly, many similar buildings in the city were abandoned and churches were constructed. However, by the 9th century, the military and political power of Samos and Smyrna provinces increased, leading Ephesus to lose its importance, and the city was reconstructed around the old harbor area. Thus, from the 10th century onwards, urban textures emerged around Ayasuluk Hill (Selcuk Municipality, 2022).

With the Battle of Maznikert in 1071, Anatolian Turkish Principalities began to dominate the region. Aydinid dynasty (the Principality of Aydın) ruled the region, and the Ottoman Empire era started with the end of the period of principalities. From the late 17th century until the early 19th century, Selçuk suffered from epidemic diseases and as a result, the population density declined significantly and the city lost its vitality in social and economic terms. However, with the increase in the investment activities of the Ottoman Empire in the 19th century, the industrial sector developed in the city and commercial trade and social life started to revive. The construction of the İzmir-Aydın railway, the first railway in Anatolia, started in 1858. Although it reached Selçuk in 1862, it was completed in eight years after a challenging construction process, reaching its final destination, Aydın, in 1866 (Cobb, 2023).

Another aspect that makes the Ephesus cultural heritage site important is the belief in Christianity that after her death, the Virgin Mary ascends to heaven on August 15 each year (Assumption/Dormition). With this belief, Christians visit the church of the Virgin Mary on Mt Koressos every year. Visits for this purpose make Ephesus one of the key sites for religious tourism.

1.2. The Great Theater

Architect John Turtle Wood, who came to the city in 1863 to study the Temple of Artemis, received a decree from the Ottoman Government with the support of the British Museum authorities and started the first excavations in the area. He continued his excavation works until 1874 in the important structures in the city to provide financial support for his quest to find the Temple of Artemis (Ürüm, 2014). The most important of these significant monuments is the Great Theater of Ephesus. Following the works in 1800s, various excavations and archaeological studies have been conducted in the area by the Austrian Archaeological Institute, which still continue today.

With a capacity of 24,000 people, the Ancient Theater of Ephesus is one of the focal points of the city center, being the largest and most magnificent theater built by human in Anatolia. The construction of

the theater, part of which leans against the slope of Mt Pion and which is located at the intersection of Harbor (Arcadian) Street and Marble Road, commenced in the Hellenistic Period and the theater was expanded during the reign of Emperor Claudius between 41-54 AD during Roman Imperial Period. It was completed during the reign of Emperor Trajan between 97-117 AD (Anabolu, 2001).

The theater lost its Hellenistic characteristic in the Roman Period, enlarged with periodic interventions and its shape was constantly changed. Today, it is a mass slightly larger than a semicircle with a diameter of approximately 150 meters. The architectural layout of the structure in general consists of the stage building, caveas (seating area) and orchestra pit (Figure 1).

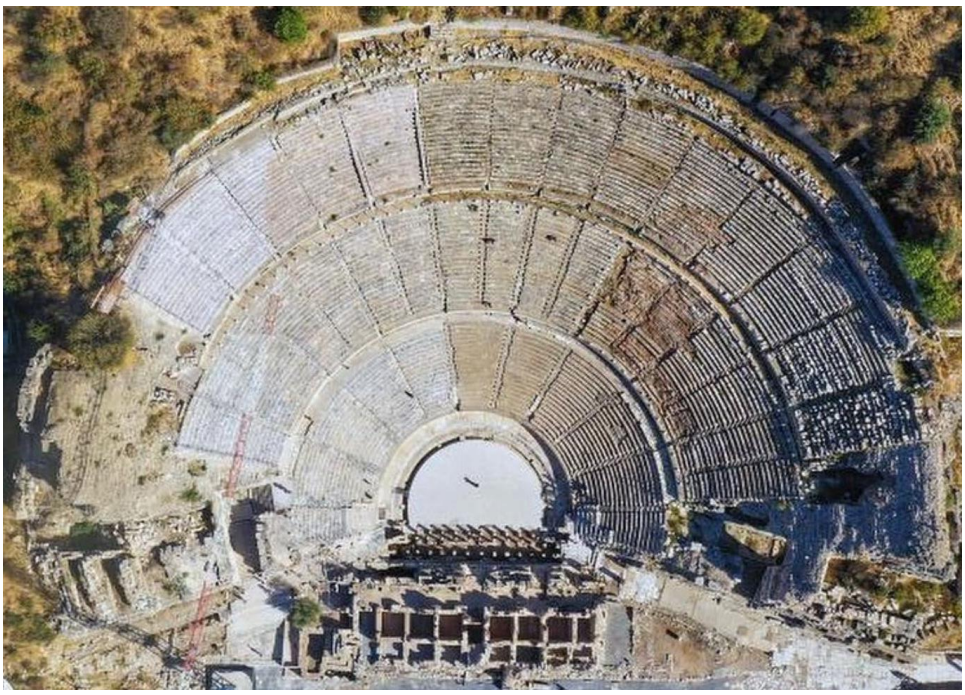

Figure 1. General view of the theater after conservation and restoration works carried out in 2018-2021 (Republic of Türkiye Ministry of Culture and Tourism, 2021)

The stage building originally had three stories, but only the basement and some remnants from upper-story survive today. The building is approximately 43 meters wide and 23 meters deep. The basement of the stage building comprises of 8 rooms aligned along an east-west axis, a corridor connecting these rooms and 4 support rows carrying the Roman Period stage. All facing stones of the building with closed arched entrances (parodoi) on the ground floor have been lost. In addition, the remains of the walls in the building, which was incorporated into the city walls during the Byzantine Period can be still seen.

The caveas of the theater, divided into three sections by two diazomata (walkways between seats), containing a total of 65 rows, the highest of which is 30 m above the orchestra floor, are visible even from a great distance when approaching from Kuşadası towards Selçuk. The first tier of seating areas is reached from the south by a sloping ramp, the other parts are reached from the north and again the south by vaulted passageways with stairs in the Analemmata (supporting walls). The auditorium, resembling a giant half funnel, has an incline of approximately 33 degrees. The orchestra pit, which is larger than a semicircle, and the surrounding active water channel, where we can observe traces of Hellenistic and Roman Period together, have survived to the present day in a well-preserved structural

2. Material and Method

In the article, the conservation status of the building, the interventions made for the problems in building stones, consideration of the aesthetic compatibility of the works and methods of indication within the context of conservation legislation are discussed. The interventions carried out in the theater over various periods were examined in more detail with the visual analysis technique and

literature review, and the conservation and restoration works conducted at different times with the same purpose were compared.

3. Findings and Discussion

The Ancient Theater of Ephesus is one of the rare cultural heritage sites included in the UNESCO World Heritage List among the theaters that can serve their original purpose by involving into contemporary life, albeit intermittently, from the 60s to the present day. The building shows construction phases from different periods, and these phases differ in terms of material, technique and design. In this context, although the comprehensive conservation and restoration works carried out in the monument, having the characteristic of a historical document, which is in a very good condition in terms of observability, serve the same purpose, they differ from each other in terms of approach, type of material used and stylistic aspects. The latest conservation and restoration works in the theater should serve as a model for ensuring that cultural heritages which are integrated into contemporary life are simultaneously carried to the future sturdily.

3.1. Comprehensive Conservation and Restoration Works in the Theater

Integration of archeological monuments into contemporary life by organizing cultural events such as exhibitions, concerts, operas and theaters there helps to make the site widely known, allows the local people to acquire awareness while familiarizing with art and culture and to actively participate in the conservation of the monuments and also provides funds for conservation works (Ahunbay, 2010). In the recent years, important monuments in the Ancient City of Ephesus such as the Bouleuterion, the Great Theater, Library of Celsus, Atrium Thermarum and Arcadian Street have been integrated into contemporary life by cultural activity organizations.

In the archeological site, which was officially opened to visit in1951, the Ephesus Festival was organized in 1962 with the participation of local community and under the organization of the local administration; and thus, the site began to be used as a festival venue (Aktüre, 2012). With the festival, excavation works and first comprehensive restoration efforts were carried out by the museum directorate in the 1960s and 70s to use the ancient theater as an active event venue. During these works, some parts of the caveas of the theater were repaired with original materials while some of the parts were completed using concrete materials (Hofbauer et al., 2017). In addition to the restoration works at caveas, the restorations started on the orchestra floor, south analemma wall and the Hellenistic Fountain of the theater and continued over time (Türkoğlu, 2000). Atalay, 1973) highlighted the extent of these interventions in the Annual of the Ruins and Museum of Ephesus, stating, “After the completion of the restoration of the Great Theater of Ephesus, its grandeur in ancient times reappeared and it became the only large structure visible when looking towards Ephesus from the shores of the city of Claros” (s.51).

By the early 90s, the impact of increasing modern use, as well as frequent winds in Ephesus, cold and rainy winter, hot and humid climatic conditions, especially the rapid drying in July and August, affected the ancient structure negatively (Hofbauer et al., 2017). The structure, showing signs of wear and tear, became unsafe for visitors. To reduce the impact of severe earthquakes on the large building blocks in the theater and ensure safety of the building and its construction elements, a joint damage assessment was conducted by the competent Turkish authorities in collaboration with the Austrian excavation site director St. Karwiese and Turkish architect İ. Ataç. Urgent measures to strengthen the theater were determined (Altıntaş, 2008). These efforts focused on the western sections, including the external walls of the auditorium. Within this context, additional excavation works were also carried out in the corridors providing access to the lower and middle diazomata (Hofbauer et al., 2017).

In 2012, during the tenure of Ertuğrul Günay, Minister of Culture and Tourism, the ancient theater served its original purpose once again and hosted the Berlin Philharmonic Orchestra. Before this cultural event, conservation and restoration works had been carried out for approximately four years starting in 2008 by the excavation site directorate and under the supervision of Ephesus Museum (Ladstatter, 2012).

The focus of these works was mainly on the reinforcement and strengthening of the monument. However, numerous previous conservation interventions, which were harmful to the building and partially impossible to be removed, complicated the works. Since the Summa Cavea section was closed to visit, only cleaning works were conducted there, and diazoma and entrance areas of the building were reinforced for directing the visitor circulation safely. In addition, reinforcement works were also carried out at the orchestra floor, the surrounding channel and orchestra stairs. Another focus of the works was the South Analemma wall in the southern part of the theater, which had been significantly affected by the earthquakes in the past and was statically unstable (Ladstatter, 2016).

Ladstatter (2016), the excavation site director at the time, stated the works conducted at that section in the article "Conservation Strategies in the Archeological Sites of Ephesus" as follows:

> *"The works at the South Analemma, which had lost its stability due to severe earthquake damage, were particularly challenging. It was necessary to install a steel construction to prevent a previously detached vault block from falling, to keep it in place and secure the chambers in the structure below. The modular steel structure was fully reversible and matches the protective roof of the Terrace House 2 visually. To reinforce the statically dangerous sections of the facade and cavea, telescopic poles that could be removed when desired were used. Controlled visitor access was provided by the consolidation of the entrances both in the orchestra and in the first diazoma. In the fall of 2012, the Great Theater of Ephesus was opened for cultural events under strict monument conservation rules, and the visitor capacity was restricted to 2,200 visitors" (p. 546).*

Maintenance and restoration works continued in the theater over the years. The density of events was reduced and the monument was completely closed for performances and concerts in 2018. The second comprehensive conservation and restoration work was started. When this work was completed, the theater reopened its doors for performances in 2021, hosting three international events within the festival (Erbalaban Yılmaz, 2021). The conservation and restoration works, which lasted for three years, were carried out under the supervision of the relevant ministry control office by a team consisting of the project owner, the Austrian Excavation Site Directorate, the Ephesus Museum Directorate, the science committee and the contractor. The northern parodos walls of the theater, a part of the northern section of caveas, the orchestra pit and the stage building were the main focuses within the scope of the works. During the works conducted, the building's cultural heritage status of documentary nature was approached sensitively, together with the late-period additions which were preserved in some parts. Reinforcement and strengthening works in the theater, which was located on the bedrock (conglomerate) in the south, but on vaults in the north, were carried out primarily at the northern section. The Media Cavea Wall, which was statically unstable and a late-period intervention, was dismantled and reconstructed by using materials and construction techniques in harmony with the original. Unqualified repairs were removed from the cavea sections, which had been reconstructed with concrete completions and repaired with cement mortars in 70s, and stone completions were performed following approach principles appropriate to the existing texture.

The northern parodos walls at the entrance of the theater on Harbor Street axis, which feature early examples of vandalism, having material losses and cracks in the building stones, were reinforced and completed with stone materials appropriate to the original. Conservation works were performed on the stage building, which has empty joints, micro-cracks in the building stones, structural cracks in the northern entrance lintel and the late-period concrete leveling floor covering. The late-period floor covering, which was partially reconstructed with reinforced concrete material, in the orchestra area, the center for events, was removed. The original floor paving stones, of which a very small part has been preserved to the present day, were protected and floor covering was constructed with stone slabs. Furthermore, in the orchestra area, imitation completions were made using hydraulic-lime-based mortar at the section between the profiled ground circle and orchestra retaining wall. Conservation works were carried out on the ous sectile remains that have survived to the present day in some sections.

3.2. Comparative Evaluation of the Works

3.2.1. Interventions in the cavea sections

The restorations dated to the 70s in the cavea sections exhibit rubble stone masonry and reinforced concrete completions with different textures and cement mortar repairs. In addition, the stairs, which are among the vertical circulation elements providing access to the cavea sections, were reconstructed in multi-part by use of rubble stone and cement mortar in some sections, while in other sections they were entirely rebuilt with monolithic concrete. When the northern cavea sections of the auditorium were examined, it was observed that in the Ima Cavea (First Cavea) section, the large gaps behind the thin pitch-faced stones were filled with cement mortar; in the Media Cavea (Second Cavea) section, the large gaps behind the pitch-faced stones were also mainly filled with cement mortar; in the Summa Cavea (Third Cavea) section, different rubble stone masonry and entirely reinforced concrete completions were performed in places where the density of pitch-faced stones was very low or non-existent (Figure 2).

a b

Figure 2.a. Repairs with cement-based mortar and concrete completions made in the 70s (Republic of Türkiye Ministry of Culture and Tourism, 2021), .**b.**The difference in texture of the completions with hydraulic-lime-based mortar and stones carried out during works between 2019-2021 and the parts with cement repairs made in the 70s (Yılmaz, 2019-2021)

In the latest restoration works carried out in the theater, the interventions in the cavea were categorized under three main titles, the first of which is rubble stone completion, the second is completion with hydraulic-lime-based mortar and the third is rubble stone completion with pitch-faced stones. If the common principles of the restoration works, which are seen together with all the interventions in the cross-section below, are discussed, it can be said that the gap behind the existing pitch-faced stone in the cavea served as a guide. While rubble stone completions were made where the gaps were approximately 30-40 cm, completions were made with hydraulic-lime-based mortar in places where the gaps behind the existing pitch-facing stones were less than 7-8 cm deep. In places where the original pitch-facing stones were entirely missing, completions were made with new pitch-facing stones, maintaining a minimum 40 cm and a maximum 70 cm width in the front part of the cavea seating units. The back parts of the placed pitch-facing stones were filled with new rubble stones, matching the color of the existing stones (Figure 3).

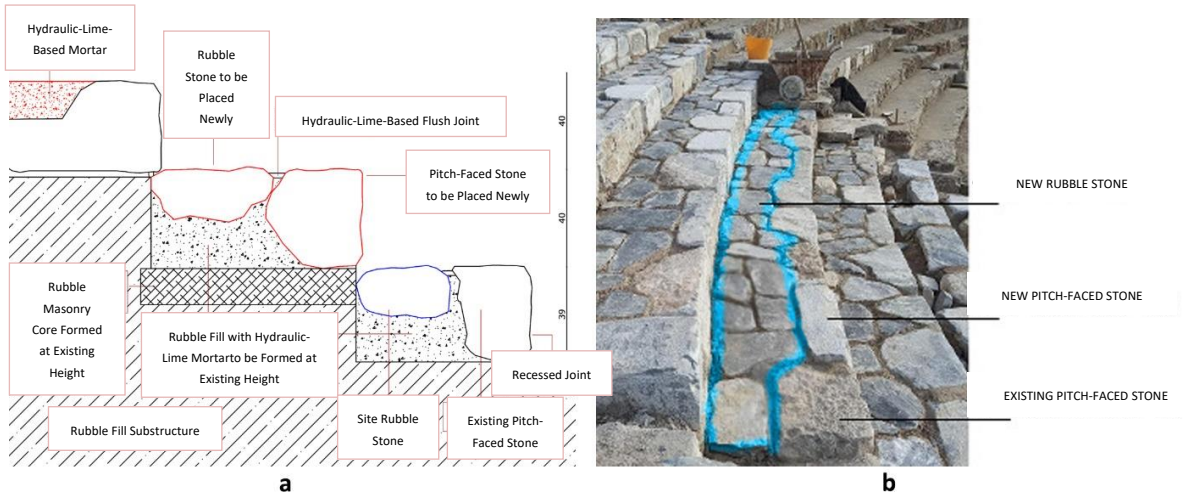

Figure 3.a. Detailed cross section of the cavea completions made between 2018-2021 (Republic of Türkiye Ministry of Culture and Tourism, 2021), **b.** Samplesof cavea completions made between 2018-2021 (Yılmaz, 2019-2021)

The cement inserts in the stairs were also removed during the cavea works. Instead of monolithic concrete steps, which were placed in a way to divide the height of each cavea seating unit in two steps, new stars made of stone material were built by preserving the end axes and heights of the cavea seating units. The stone stairsteps were formed using monolithic pitch-facing stones for smaller step parts and two pieces of pitch-facing stones for the larger steps below (Figure 4).

Figure 4.a. Concrete steps with cement repairs made in the 70s (Republic of Türkiye Ministry of Culture and Tourism, 2021), **b.** Steps formed with freestones during the works between 2018-2021 (Yılmaz, 2019-2021)

3.2.2. Interventions in the M4 Cavea Wall

The western parodos entrance, starting at the end of Harbor Street, leads visitors to the diazoma that divides the Media and Ima Cavea through a vaulted passage with rising stairs in the Roman Period Theater. However, some parts of the northern caveas, constructed on vaults, have not survived to the present day due to the impact of the major earthquake in the past. In the late period restorations, the substructure of the M4 Cavea was constructed with a sequential layering technique using rubble stones of different sizes with cement mortar in order to function as a retaining wall. Signs of static weakening and out-of-plane deformations were observed on this wall, which was a later-period addition (Figure 5).

Figure 5. Reinforcement works carried out on the M4 Cavea substructure in the 70s. (Republic of Türkiye Ministry of Culture and Tourism, 2021)

Within the scope of the latest conservation and restoration works in the theater, the retaining wall was constructed in two stages to provide sufficient static support to the caveas and to ensure the continuity of the appearance of cavea substructure. In the first stage, a wall where the cavea seating units leaned was constructed with large-sized pitch-facing stones using hydraulic-lime-based mortar, to serve as a retaining wall. In the second stage, a wall with a sloped and indented front facewas constructed in front of the pitch-facing stone wall, using small-sized rubble stones based on the restitutive information and referring to the cavea substructure rubble stone masonry. Thus, reinforcement was provided with a concealed retaining wall, indirectly suggesting the presence of the cavea sections that are no longer visible when visited today (Figure 6).

Figure 6. Reinforcement works between 2018-2021 (Republic of Türkiye Ministry of Culture and Tourism, 2021)

3.2.3. Interventions in the Parodos Walls

Parodos walls run along the Harbor Street and define the western entrance at the end of the street. It is one of the entrances frequently used in contemporary events. The walls border both sides of the stairs leading to the Media Cavea Diazoma. The walls, which still show examples of the first vandalism, were severely affected by past major earthquakes and statically weakened. Continuous maintenance and repair works were conducted in the past by the responsible authorized institutions, and the parts with deep openings and large-scale material losses posing risks were supported with metal poles for reinforcement.

Comprehensive interventions were carried out in the recent works to address the structural problems and building material problems of the parodos walls. The necessary conservation works were performed by reinforcing the cracks, gaps and broken pieces on the building blocks. In addition, the empty joints within the inner masonry were renewed, and medium-sized gaps were completed with rubble stones and mortar to prevent rainwater destruction. The free soil on top of both sections was capped so that the inner masonry was protected from rainwater destruction. In the inner masonry and external surface, where large material losses were seen, partial stone completion was carried out,

where needed, using textures and materials matching the original. In this way, the structure's load-bearing system was restored and the original masonry technique of the wall was made observable through the partial stone completions on the external surface (Figure 7).

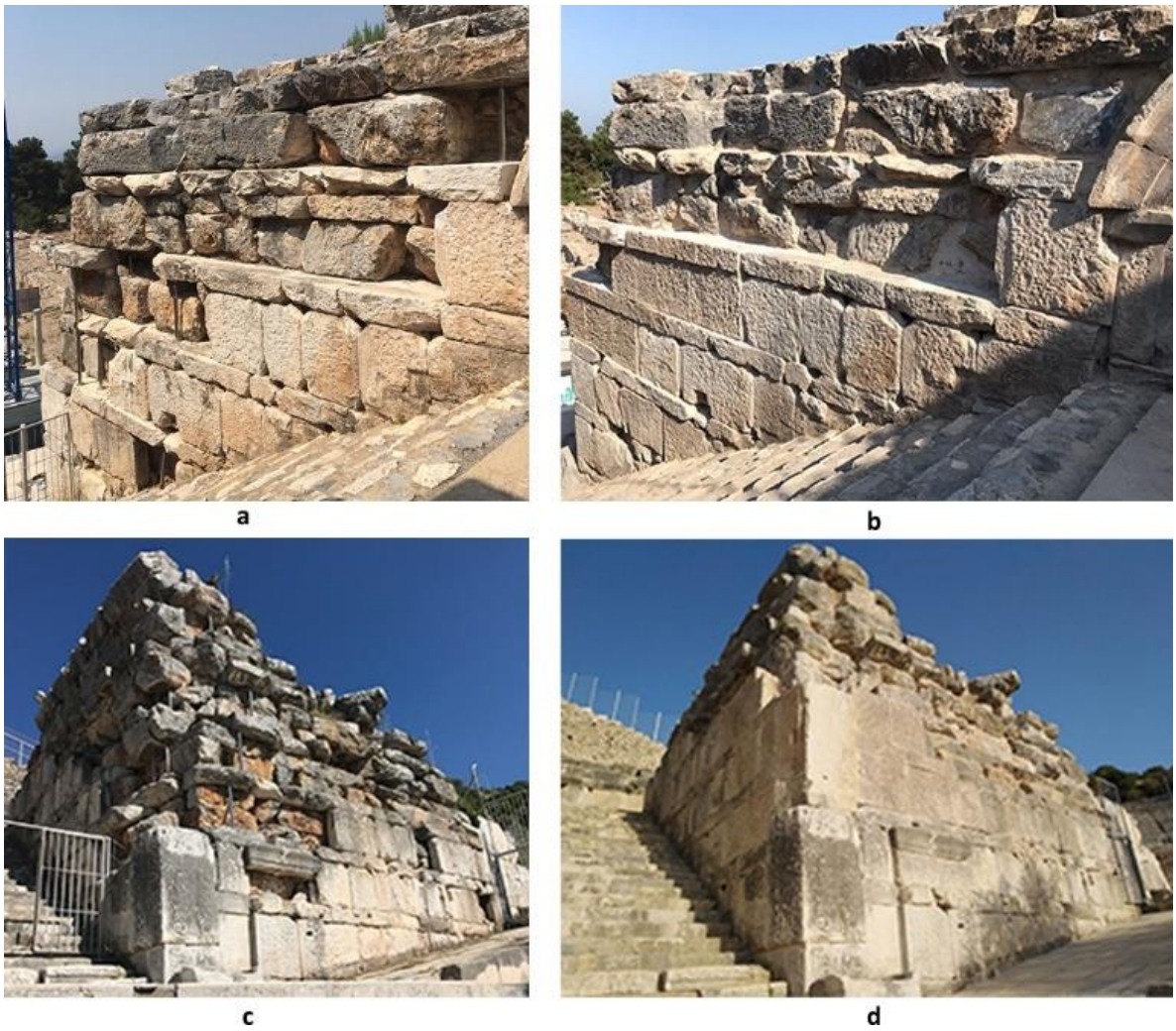

Figure 7.a. Sample of the reinforcement works on the Parodos walls, stones supported with metal poles (Yılmaz, 2019-2021). **b.**Partial stone completion during reinforcement and strengthening works between 2018-2021 (Yılmaz, 2019-2021). **c.**Wall stones supported with metal poles (Yılmaz, 2019-2021). **d.**Partial stone completion during reinforcement works between 2018-2021(Yılmaz, 2019-2021)

3.2.4. Interventions in the Orchestra Pit

Layers from ancient periods can be observed in the present orchestra of the theater. Structurally, the orchestra of the Hellenistic period was expanded and elevated during the Roman Empire period and took its present form. The Roman orchestra area consists of seven parts between the cavea and stage building, which can be named as follows:orchestra retaining (support) wall, epicycle gap, profiled ground circle, water channel, floor, stage border (logeion - proskenion) and stairs.

The stage building or orchestra areas are the units where circulation is highly active in terms of functional use in the ancient theaters that are integrated into contemporary life today. Most parts of the original marble floor covering of the theater, hosting festivals for many years, has been lost, with only a small part preserved until today (Figure 8).

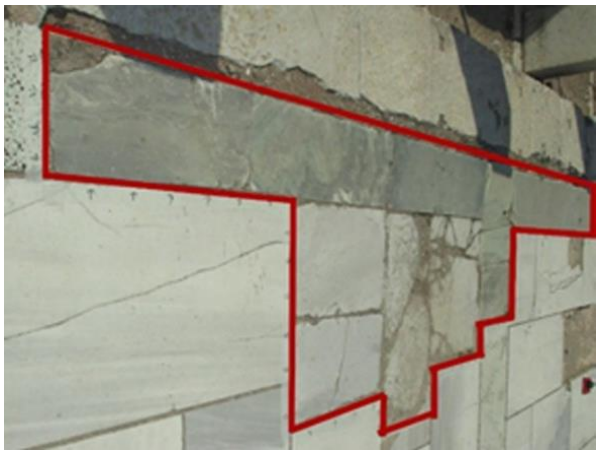

Figure 8. Original orchestra floor paving stones within the red frame (Republic of Türkiye Ministry of Culture and Tourism, 2021)

In the late period interventions made in order to prepare the orchestra for performances and events, the lost parts of the floor covering were partially completed with marble pieces of varying sized and colors, and mostly with concrete imitation coverings in different sizes in an alternating pattern. In these completions, the original flooring elevation was taken as a reference, but the concern of distinguishing between the original and the completed parts was not reflected in the works (Figure 9). In addition, the parts of the concrete wall were formed with repairs made using cement-based mortars and in-situ marble stones in some places in the approximately 1.70 meter high and 60-meter-longboundary retaining support wall of the orchestra pit.

Figure 9. Concrete imitation floor coverings made in the 70s (Republic of Türkiye Ministry of Culture and Tourism, 2021)

In the last restoration works carried out in the orchestra, the concrete imitations were removed and horizontal axis completed were made in the floor covering with light gray-white, honed natural stone slabs. The areas with original marble paving stones preserved until today were separated from the present-day completions by forming a boundary with hydraulic-lime-based contour mortar. Additionally, in the completion based on the original Roman Orchestra leveling, reference was made to the Roman Orchestra elevated after the Hellenistic Period and the texture of the orchestra substructure before floor covering. The Hellenistic Channel, which runs around the orchestra and still actively drains rainwater from south to north, was not covered as it was during the Roman Period, allowing visitors to explore both ancient periods (Figure 10).

a b

Figure 10. a. The orchestra after the completion of works between 2018-2021 (Yılmaz, 2021). **b.** Border mortar around the original paving stones (Yılmaz, 2019-2021)

In addition, as part of these works, only the joining parts of the in-situ marble stones and the imitation concrete stone plaster on the orchestra retaining wall were separated, bounded with hydraulic-lime-based mortar. Thus, the salinization effect of the cement was separated from the marble stones, while concrete-completed wall was preserved as a period restoration.

As a result, the effect of the cement's salting was kept apart from the marble stones, but the wall's completed concrete structure was kept intact as a historical restoration. The soil-covered outer circle gap served as one of the circulation areas in the past. To maintain flexibility and reversibility while incorporating ergonomics into modern usage, imitation flooring was completed using hydraulic lime-based mortar and the circle's required radial form (Figure 11).

a b

Figure 11. a. Restoration intervention on the orchestra retaining wall in the 70s (Republic of Türkiye Ministry of Culture and Tourism, 2021). **b.** The retaining wall and epicycle gap imitation with mortar after the works between 2018-2021 (Yılmaz, 2019-2021)

4. Conclusion and Recommendations

Throughout the history, there has been a desire to integrate the ancient buildings into contemporary life by organizing festivals, performances and various events at ancient sites. The underlying factors behind this desire are the wish to recognize or increase the recognition of these monuments, along with educating, teaching and raising awareness while human factors are in close interaction with culture and art. On the other hand, it should be noted that ancient monuments are extremely sensitive structures despite being educational and enlightening. Should a list of sensitivities be made, theaters would rank at top of this list, having a high risk of wear and tear. The increasing number of visitors especially during summer months and the frequency of the concerts and events with the participation of large crowds can be damaging particularly if measures are not taken. The Ancient Theater of Ephesus, which shows signs of wear and tear due to the effects of adverse natural events and the

increasing modern use since the date it hosted festivals until the 90s, can serve as an example of a site turning into an unsafe place for its guests to visit.

On the other hand, conservation and restoration works carried out in theaters, which are living historical documents of cultural, artistic and periodical changes, play a major role in their sound transmission to future generations. Within this context, the principles and rule set by certain authorities on national and international platforms form the basis of conservation and restoration principles and techniques, as well as the approaches in the process of integrating ancient buildings into contemporary life.

In the restoration works examined comparatively on the theater, it is seen that interventions in the 70s caused significant changes in the structure with reconstructions and led to differences in the perception of the monument. However, restoration is the practice of repair and improvement with the least intervention as a subheading of the concept of conservation. In this context, it is observed that in the recent conservation and restoration works, the existing monument and visitor safety have been prioritized, great importance has been given to the original architectural structure and traces of historical usage, the traces have been preserved in terms of periodical additions by avoiding non-essential interventions, and "reversible" interventions have been made in some areas. In addition, in the theater, which serves its original purpose of construction today, events and concerts are organized in a controlled manner, with no use of sound amplifiers, no large decoration installations, and the seating capacity of 24,000 people is limited to 2,500 people. These restrictive measures prevent the ancient building from wear and tear.

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Author Contribution and Conflict of Interest Declaration Information

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Akıllı Park Performans Ölçümüne Yönelik Model Girişimlerinin İrdelenmesi

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Öz

Bu çalışma, akıllı kent parklarının performansını değerlendirmek amacıyla geliştirilen model girişimlerini ele almaktadır. Akıllı parklar, teknolojinin yardımıyla şehirlerdeki yeşil alanların yönetimini ve kullanılabilirliğini optimize eden sistemlerdir. Ancak, bu parkların performanslarının nasıl ölçüleceği hala önemli bir sorundur. Bu makalede, daha önce yapılmış üç farklı model girişimi incelenmiş ve karşılaştırılmıştır. Her modelin güçlü ve zayıf yönleri değerlendirilmiş, performans ölçümünde kullanılan metrikler karşılaştırmalı analiz edilmiştir. Çalışmanın amacı, akıllı parkların performansının doğru ve sürdürülebilir bir şekilde ölçülmesine yönelik model önerileri geliştirmektir. Sonuçlar, gelecekteki çalışmalar için öneriler sunmaktadır.

Anahtar Kelimeler: *Akıllı park, performans ölçümü, akıllı park modeli.*

Examination of Model Initiatives for Smart Parking Performance Measurement

Abstract

This study addresses the model initiatives developed to evaluate the performance of smart urban parks. Smart parks are systems that optimize the management and usability of green spaces in cities with the help of technology. However, how the performance of these parks should be measured remains a significant issue. In this article, three different model initiatives previously conducted were examined and compared. The strengths and weaknesses of each model were evaluated, and the metrics used in performance measurement were analyzed. The aim of the study is to develop model proposals for accurately and sustainably measuring the performance of smart parks. The results provide suggestions for future studies.

Keywords: *Smart park, performance measurement, smart park model.*

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1. Giriş

Günümüzde şehirleşme ve nüfus artışının hız kazanmasıyla birlikte, yeşil alanlar ve parklar kentsel yaşamın vazgeçilmezleri haline gelmiştir. Bu alanlar, şehir sakinlerine doğayla iç içe olma fırsatı sunarak fiziksel ve zihinsel sağlığı desteklemekte, sosyal etkileşimi artırmakta ve yaşam kalitesini yükseltmektedir. Ancak kent parkları, kullanıcı ihtiyaçlarının tam anlamıyla karşılanamaması, ulaşım ve erişim sorunları, altyapının yetersizliği, güvenlik eksikliği, yetersiz bakım hizmetleri, bakımsız bırakılmış yeşil alanlar ve kaynak yetersizliği gibi ciddi sorunlarla karşı karşıya kalmaktadır (Radwan & Morsy, 2018). Bu sorunlar, parkların etkin kullanımını engellemekte ve kent sakinlerinin yaşam kalitesini olumsuz etkilemektedir.

Şehirlerin giderek artan ve çeşitlenen sorunları, geleneksel yöntemlerle çözülememektedir. Bu nedenle yenilikçi yaklaşımlara ihtiyaç duyulmaktadır. Özellikle peyzaj tasarımı ve yönetimi alanında, teknoloji tabanlı çözümlerin geliştirilmesi ve uygulanması gerekliliği vurgulanmaktadır (Lele & Lihua, 2017).

Teknolojinin hızlı ilerleyişi, kent parklarının tasarımından yönetimine kadar birçok alanda dönüşümü getirmektedir. Bu dönüşüm, parkların daha sürdürülebilir, verimli ve kullanıcı dostu hale gelmesini sağlamaktadır. Ekonomi, teknoloji, toplum ve iklim gibi çeşitli alanlardaki gelişmeler, şehirleri ve toplulukları "akıllı" şehirler olma yoluna teşvik etmektedir. Akıllı şehir kavramı, genel olarak şehir yönetiminde ve hizmetinde teknolojik çözümlerin entegrasyonu olarak ifade edilmektedir. Bu bağlamda, sürdürülebilir kentsel parklar da bu dönüşümün bir parçası olarak görülmektedir. Sürdürülebilir kentsel parklar, çevresel, dijital ve malzeme teknolojilerini kullanarak erişim, toplumsal uyum, sağlık, güvenlik, dayanıklılık, su, enerji, operasyon ve bakım süreçlerine olumlu yönde katkılar sağlamayı hedeflemektedir (Loukaitou-Sideris, 2018). Bu hedefler, hem bireysel kullanıcıların ihtiyaçlarının karşılayanmasına; hem de genel olarak şehirlerin sürdürülebilirlik hedeflerine ulaşmasında katkı sağlamaktadır.

Akıllı teknolojilerin kent parklarına entegrasyonu, park yönetimi ve kullanıcı deneyimi açısından önemli avantajlar sunmaktadır. Örneğin, ziyaretçilerin sayısı, kalış süresi ve konumlarına ilişkin verilerin toplanması ve analiz edilmesi, parkların daha verimli ve kullanıcı odaklı yönetilmesine olanak tanımaktadır. Bu veriler sayesinde, sağlık aktiviteleri ve sosyal etkinlikler için etkin program planlaması yapılabilmekte, böylece parkların toplumsal faydaları artırılmaktadır (Abdülhamid, 2019). Ayrıca, sensörler ve IoT cihazları gibi teknolojik yenilikler, parkların performansını optimize etmekte ve uzun vadeli işletme maliyetlerini düşürmektedir (SMART Parks, 2018). Örneğin, akıllı sulama sistemleri su tasarrufu sağlarken, enerji verimliliği sağlayan aydınlatma sistemleri enerji tüketimini azaltmaktadır.

Sürdürülebilir kentsel parklar, akıllı teknolojilerdeki gelişmelerden doğan yeni bir kavram olarak ortaya çıkmaktadır (Truch & Sutanto, 2018). Bu parklar, kullanıcıların ihtiyaçlarına daha hızlı cevap vermekte, çevresel sürdürülebilirliğe katkı sağlamakta ve şehirlerin genel yaşam kalitesini yükseltmektedir. Ancak, bu dönüşüm sürecinde parkların performansının nasıl ölçüleceği ve değerlendirileceği önemli bir konudur. Parkların performansını ölçmek, hem park yönetimi stratejilerinin etkinliğini değerlendirmek hem de kullanıcı deneyimini sürekli olarak iyileştirmek için büyük önem taşımaktadır.Ayrıca performans ölçümü, kaynakların optimal kullanımını sağlamak, kullanıcı memnuniyetini artırmak ve parkların uzun vadeli sürdürülebilirliği sağlamak için önemlidir.

Akıllı parklar, şehirlerdeki kentsel alanların daha etkin ve verimli kullanılmasını sağlarken, parkların performanslarının nasıl değerlendirileceği konusu önemli bir sorundur. Performans ölçümünde kullanılacak kriterler ve yöntemler, parkların sunduğu hizmetlerin kalitesini belirlemekte büyük öneme sahiptir. Aynı zamanda performans ölçümü, gelecekteki iyileştirme ve geliştirme çalışmalarına da yön vermektedir.

1.1 Akıllı Kent Parklarının Tanımı ve Önemi

Son yıllarda, akıllı park konseptinin kentsel parkları dijital teknolojilerle dönüştürme ve yeniden yapılandırma açısından etkili bir model olduğu bilimsel olarak kanıtlanmaktadır (Bogdanović Protić, Vasilevska & Ljubenović, 2022). Akıllı kent parkları, şehirlerin karşı karşıya kaldığı sosyal, çevresel ve ekonomik zorluklara yenilikçi çözümler sunarak kentsel yaşam kalitesini artırmada kritik bir rol oynamaktadır. Loukaitou-Sideris (2021), kent parklarını çeşitli kentsel sorunların çözümüne olanak

sağlayan alanlar olarak değerlendirirken, akıllı parkları en son teknolojileri kullanarak sosyal ve çevresel sorunlara çözüm sunabilen parklar olarak tanımlamaktadır.

Akıllı kent parkları sadece teknolojik yeniliklerin uygulanmasıyla sınırlı değildir. Aynı zamanda toplumsal ve çevresel faydaların en üst düzeye çıkarılmasıyla da ilişkilidir. Akıllı parklar, şehir sakinlerinin fiziksel ve zihinsel sağlığını desteklerken, sosyal etkileşimi ve toplumsal ilişkileri güçlendirmektedir. Bunların yanında kentsel ısı adası etkisinin azaltılması, hava kalitesinin iyileştirilmesi ve biyolojik çeşitliliğin korunması gibi çevresel katkılarda sağlamaktadır. Ancak, park performansının artırılması ve iyileştirilmesi için doğru ölçümlerin ve değerlendirme kriterlerinin geliştirilmesi önemlidir. Akıllı park performans göstergelerinin belirlenmesi, akıllı parkların etkinliğini ve sürdürülebilirliğini değerlendirmede kritik bir rol oynamaktadır.

Akıllı kent parkları, teknolojiyle birlikte kent yaşam kalitesini artırmada ve sürdürülebilir kentler inşa etmek için önemli bir araçtır. Bu parkların başarılı bir şekilde hayata geçirilmesi ve yönetilmesi, hem bireylerin hem de toplumun genel refahına katkıda bulunacaktır.

1.2. Performans Ölçümünde Kullanılan Teknikler ve Karşılaşılan Zorluklar

Akıllı kent parklarının performansını ölçmek, bu parkların etkinliğini değerlendirmek ve parkın gelişimi için önemlidir. Performans ölçümünde kullanılan teknikler, genellikle saha gözlemleri, uzman görüşmeleri ve teknolojik literatürün incelemesine dayanarak kameralar, sensörler, veri analizleri, kullanıcı memnuniyeti anketleri ve enerji-su tüketimi izleme sistemleri gibi çeşitli sistemleri içermektedir. Örneğin, park alanına yerleştirilen sensörler ile park yoğunluğu, ziyaretçi sayısı, kullanım süreleri ve kullanıcı davranışları gibi veriler gerçek zamanlı olarak toplanabilmektedir. Bu veriler, park yönetimine kullanıcı ihtiyaçları ve tercihleri hakkında bilgi sunarak hizmet ve altyapının optimize edilmesine olanak tanımaktadır. Aynı zamanda su yönetimi ve enerji verimliliği sürdürülebilirlik açısından performans ölçümünde önemli yer tutmaktadır. Akıllı aydınlatma sistemleri, hava durumuna ve canlı varlığına göre ayarlanabilirken; akıllı sulama sistemleri ise toprak nemine ve bitki ihtiyaçlarına göre su tüketimini optimize etmektedir. Bu sistemlerden elde edilen veriler, parkın çevresel kazanımlarına ve etkin kaynak kullanım yönetiminin sağlamasına katkıda bulunmaktadır. Ancak, bu sistemlerin uygulanması ve performans ölçüm süreci, çeşitli zorlukları içinde barındırmaktadır. Akıllı teknolojilerin kentin ana altyapısının bir parçası olan halka açık kent parklarına entegrasyonu, basit ve tek boyutlu bir müdahale değil, karmaşık ve çok boyutlu bir süreç gerektirir (Jun, 2023). Farklı teknolojik altyapılar ve veri toplama yöntemleri, sistemlerin birlikte çalışabilirliğini zorlaştırmakta ve performans ölçümünü karmaşık hale getirmektedir. Akıllı parkların temel performans kriterlerinin net bir şekilde tanımlanamaması, bu parkların etkinliğinin ve başarısının ölçülmesinde de zorluklara yol açmaktadır (Elsayed & Ashrry, 2020).

Akıllı parkların performansını ölçmek için kullanılan teknikler, parkların etkin yönetimi ve kullanıcı memnuniyetinin artırılması için önemlidir. Ancak bu teknolojilerin kullanımı ile açık rekreasyon alanlarının sunduğu faydalardan dengeli bir biçimde yararlanma arasındaki sağlıklı ilişkinin nasıl kurulabileceğinin incelenmesi gerekmektedir (Brandis, 2018).

2. Materyal ve Yöntem

Bu makalede, akıllı park performansını değerlendiren üç model incelenmiştir. Bu modeller, farklı performans kriterlerine dayanarak geliştirilmiştir ve her biri farklı veri toplama yöntemleri kullanmaktadır. Bu modeller, kullanıcı memnuniyeti, enerji kullanımı, çevresel sürdürülebilirlik gibi kriterlere dayanmaktadır. Her modelde kullanılan veriler, sensörler, mobil uygulamalar ve kullanıcı geri bildirimlerine dayanmaktadır. Bahsedilen modellerin etkinliği, bu verilerin analiz edilmesi yoluyla değerlendirilmektedir.

Bu makale, literatürdeki mevcut modelleri analiz ederek, her modelin veri toplama süreçlerini, analiz tekniklerini ve kullanılan teknolojileri karşılaştırmaktadır. İncelenen modellerin karşılaştırmalı verileri, amaç ve hedefleri, metodolojik yaklaşımları, uygulanabilirlikleri, performans ölçümleri, kullanıcı odaklılıkları, sürdürülebilirlikleri ve teknolojik entegrasyonları üzerine toplanan veriler kullanılarak, karşılaştırmalı değerlendirme analiz yöntemiyle elde edilmiştir.

Çalışmada değerlendirilen model yaklaşımları şu şekildedir:

Model 1: Tarihi Kent Parklarının Akıllı Teknolojiler Kullanılarak Canlandırılması Yaklaşımı.

Model 2: Akıllı Kamu Parklarının Performansını Ölçmeye Yönelik Önerilen Model Yaklaşımı.

Model 3: Busan Citizens Park'ın Akıllı Kentsel Parka Dönüşüm Yaklaşımı.

2.1. Model 1: Tarihi Kent Parklarının Akıllı Teknolojiler Kullanılarak Canlandırılması Yaklaşımı

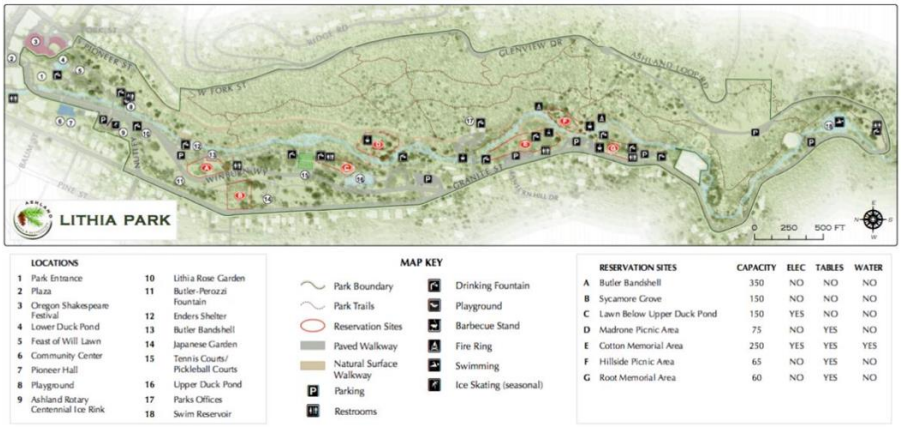
Çalışma, tarihi kentsel parkların yeniden canlandırılması üzerine odaklanmıştır. Özellikle, parkların akıllı şehir altyapısı ile uyumlu hale getirilmesi ve sürdürülebilir bir çevre yaratılması amaçlanmaktadır. Çalışma, geliştirilen bu akıllı yaklaşımın tarihi parkların etkin kullanımını artırabileceğini ve modern teknolojilerle desteklenmiş bir park yönetimi sağlayabileceğini savunmaktadır.

Çalışma, hem teorik inceleme hem de uluslararası örneklerin analizi yoluyla gerçekleştirilmiştir. İzlenen yöntemler şu şekilde açıklanabilir:

1. **Literatür İncelemesi:** Çalışmada, tarihi parklar ile akıllı park kavramının gelişimi ile ilgili geniş kapsamlı bir literatür incelemesi yapılmıştır. Özellikle, akıllı park yaklaşımının nasıl şekillendirileceğine dair teorik çerçeve oluşturulmuş ve bu çerçevede IoT (Nesnelerin İnterneti) teknolojilerinin kullanımından bahsedilmiştir. Aynı zamanda, şehir parklarının tarihsel evrimi ve kentsel peyzaj yönetimindeki akıllı teknolojiler incelenmiştir.
2. **Tarihi Parkların İncelenmesi:** Üç uluslararası tarihi park örneği analiz edilmiştir:
    - Tiergarten (Berlin, Almanya) (Şekil 1).
    - Boulognerskogen Park (Skövde, İsveç) (Şekil 2).
    - Lithia Park (Ashland, Oregon, ABD) (Şekil 3).

Şekil 1. Tiergarten parkı (Lenné, 1835; Abdülhamid, 2019).

Şekil 2. Boulognerskogen parkı'nın yenilenmesi için kazanan tasarım (Andersson ve diğerleri, 2015; Abdülhamid, 2019).



Şekil 3. Lithia Park Ashland haritası (City of Ashland, n.d.; Abdülhamid, 2019).

Bu parklar, tarihi dokularını korurken aynı zamanda modern teknoloji ile nasıl yeniden canlandırıldıklarına dair analiz edilmiştir. Her bir parkın erişilebilirlik, konfor, güvenlik, sosyal aktiviteler, kullanıcı beklentilerinin anlaşılması ve modern teknolojilerin uygulanması unsurları açısından karşılaştırılması yapılmıştır. Bu unsurlar, tarihi parkların nasıl yönetildiği, kullanıldığı ve halka sunduğu hizmetler açısından birbirleriyle karşılaştırılarak analiz edilmiştir.

3. **Akıllı Park Modelleri:** Çalışmada akıllı park konseptini tanımlamak için 10 temel unsur (cihazlar, veri toplama, bağlantı kanalları, IoT platformu, çözümler ve uygulamalar, analitik teknikler, algılama ve karar verme, örgütsel zeka, kullanıcı etkileşimi, enerji ve kaynak yönetimi) belirlenmiş ve bu unsurlar doğrultusunda parkların performansını ölçmek için bir model önerilmiştir. Öne çıkan teknolojiler şu şekildedir:

    - Akıllı sulama sistemleri
    - Yağmur suyu hasadı
    - Güneş enerjili çöpler
    - Hareket sensörlü aydınlatmalar
    - Akıllı banklar ve Wi-Fi bağlantı noktaları
    - Otomatik Çim Biçme Makineleri
    - Enerji Üreten Egzersiz Ekipmanları
    - Gün Işığını Depolayan Fluoresan Zemin Kaplamaları
    - Geçirgen Zemin Kaplamaları

- İnternet Bağlantılı Cihazlar ve Sensörler

4. **IoT (Nesnelerin İnterneti) Ekosistemi:** Akıllı parkların IoT teknolojileri ile nasıl entegre edileceği detaylı bir şekilde açıklanmıştır. Bu teknoloji, parklarda sensörler kullanarak hava durumu, su kalitesi, enerji kullanımı gibi verilerin toplanmasına olanak tanımakta ve park yönetimine anlık geri bildirimler sağlamaktadır.

Çalışma, akıllı park teknolojilerinin tarihi parkların yeniden canlandırılması için kritik bir rol oynadığını göstermektedir. Bu teknolojiler, parkların sürdürülebilirliğini artırarak hem hükümetin üzerindeki mali baskıyı hafifletmekte hem de park kullanıcılarının ihtiyaçlarını daha iyi karşılamaktadır. Çalışma sonuçları aşağıdaki gibidir:

- Tarihi parkların akıllı hale getirilmesi hem parkların sürdürülebilirliğini artıracak hem de gelecek nesillerin kullanımını teşvik edecektir.
- Stakeholder katılımı parkların yeniden canlandırılmasında önemlidir. Kullanıcı geri bildirimlerine dayalı esnek yönetim stratejileri geliştirilmelidir.
- Akıllı teknolojiler, kültürel mirasın saklanmasını ve parkların modern ihtiyaçlara göre güncellenmesine yardımcı olacaktır.

Çalışma, tarihi parkların modern teknoloji ile nasıl yeniden canlandırılabileceğine dair kapsamlı bir yöntem ve teorik modeller sunmaktadır.

2.2. Model 2: Akıllı Kamu Parklarının Performansını Ölçmeye Yönelik Önerilen Model Yaklaşımı

Bu araştırma, geleneksel parkları akıllı parklara çevirmek ve hali hazırdaki akıllı parkların performansını ölçmek için bir model geliştirmeyi amaçlamaktadır. Akıllı parklar enerji verimliliği, su yönetimi, kullanıcı etkileşimi ve güvenlik gibi çeşitli alanlarda teknolojik çözümleri entegre etmektedir. Çalışma, bu dönüşümün nasıl yapılabileceğini ve performansın nasıl değerlendirilebileceğini göstermek için Al-Azhar Parkı'na bir model uygulamıştır.

Araştırmada indüktif ve dedüktif yaklaşımlar benimsenmiştir:

- **İndüktif yaklaşım:** Geleneksel parklar ile akıllı parklar arasındaki farklar tanımlanmış, parkların tasarım ilkeleri ve akıllı parkların teorik temelleri belirlenmiştir.
- **Dedüktif yaklaşım:** Küresel ve bölgesel akıllı parkların (örneğin, Singapur'daki Gardens by the Bay, Çin'deki Haidian Park, Birleşik Arap Emirlikleri'ndeki Al Mamzar Park) performans kriterleri analiz edilerek bir model oluşturulmuştur. Bu model, parkların performansını ölçmek için gerekli kriter ve göstergeleri tanımlamaktadır.

Araştırmada önerilen model, 8 ana kriter, 25 alt kriter ve 84 anahtar performans göstergesi (KPI) içermektedir. Bu kriterler, parkların farklı yönlerini değerlendirerek performanslarını ölçmeyi hedeflemektedir. Ana kriterler, alt kriterler ve anahtar performans göstergeleri Çizelge 1'de verilmiştir.

Çizelge 1. Akıllı park performansını ölçme modeli şablonu

ANA KRİTERLER	ALT KRİTERLER	ANAHTAR PERFORMAS GÖSTERGESİ
Akıllı Tarım ve Peyzaj	**Peyzaj Yönetimi**	Otomatik çim biçme makineleri kullanımı
		Yakın kızılötesi fotoğrafçılık ile bitki sağlığı izleme
		Yeşil çatı ve duvarların kullanımı
		Hava akımı ile kök büyümesini teşvik eden saksı sistemleri
		Titreşimli tozlaşma araçları kullanımı
	Akıllı Sulama	Akıllı su denetleyicileri kullanımı
		Düşük basınçlı döner sulama sistemleri
		Yüzey altı damla sulama sistemleri
		Akıllı su ölçerler
		Gri su geri dönüşüm sistemleri
Akıllı Yönetim	**Dijitalleşme**	Wi-Fi erişimi sağlanması
		Coğrafi bilgi sistemleri (GIS) kullanımı
		Uygulama yazılımlarının kullanımı
		Dijital sensörlerin kullanımı
	Akıllı Kontrol	Yağmur suyu depolama havuzları
		Toprak programlama ve duyarlılık izleme
	Akıllı Yönetim Sistemleri	Akıllı rezervasyon sistemleri
		Elektronik ödeme sistemleri
		Akıllı yönetim sistemi
Akıllı Çevre	**Ziyaretçi Niteliği**	Temiz enerji üretimi
		Hava durumu tahmin sistemleri
		Karbon emisyonlarını kontrol etme
	Akıllı Aydınlatma	Hareketle etkinleşen ışıklar
		LED'ler ve fiber optikler ile sanat
		Şebekeden bağımsız ışık sistemleri
		LED'lere dijital eklemeler
		Işık kalkanları
	Ekolojik Kaynak Yönetimi	Su tüketimi ve GDP ilişkisi
		Elektrik tüketimi ve GDP ilişkisi
Akıllı İnsanlar	**Ziyaretçi Eğitimi**	Ziyaretçilerin eğitim düzeyi
		Dil becerileri
	Yaşam Boyu Öğrenme	Kültürel farkındalık
		Sürekli eğitim
	Etnik Çeşitlilik	Yabancı ziyaretçilerin oranı
		Yerli ziyaretçilerin oranı
	Açık Fikirli Olma	Yeni fikirlerin benimsenme oranı
		Gönüllü çalışmalara katkı
		Toplumsal katılım düzeyi
Akıllı Bakım	**Arızalar ve Risk Yönetimi**	Akıllı kontrol sistemleri
		Kriz ve afetlere müdahale sistemleri
		Yangın alarm sistemleri
	Verimliliği Artırma	Periyodik bakım sistemleri
		Ziyaretçi güvenliği sigortası
Akıllı Mobilite	**Özel İhtiyaçlar İçin Hizmetler**	Hareket kısıtlılığı olan bireyler için erişim
		İşitme kısıtlılığı olan bireyler için hizmetler
		Görme engelli bireyler için hizmetler
	Akıllı Yönlendirme	Ziyaretçiler için yönlendirme levhaları
	Akıllı Otopark	Akıllı park yerleri
		Ekonomik arabaların kullanımı
Akıllı Yaşam	**Akıllı Kentsel Mobilyalar**	Akıllı banklar
		Güneş enerjili gölgelikler
		Akıllı su çeşmeleri
		Dijital tabelalar
	Aktivite Alanları	Yüksek performanslı yürüyüş yolları
		Enerji üreten egzersiz ekipmanları
		Dış mekan DJ kabinleri
		Sert yüzey test ekipmanları
Kültürel ve Sivil Kimlik	**Kültürel Referanslar**	Tarihi ve işlevsel referanslar
		Politik/sosyal/ekonomik öneme sahip yapılar
	Zihinsel İmaj	Yönlendirme yolları
		Bölgesel özellikler
		İşaret ve sınırların korunması

Model Al-Azhar Parkı'nda uygulanmıştır. Parkın mevcut performansı değerlendirilmiş ve akıllı park kriterlerini karşılayıp karşılamadığı incelenmiştir. Bu çalışmada, model uygulanırken ağırlıklandırmalar "Anahtar Performans göstergesi" (KPI) üzerinden yapılmıştır. Ağırlıklandırma yöntemi şu adımlarla gerçekleştirilmiştir:

1. **Anahtar Performans Göstergelerinin Belirlenmesi:** Modelde her bir ana kriter ve alt kriter için performans göstergeleri belirlenmiş, bu göstergeler parklarda uygulanarak değerlendirilmiştir.
2. **Başarı Durumunun Değerlendirilmesi:** Her performans göstergesi için başarı durumu iki farklı değerle ölçülmüştür:
    - **0:** Göstergeye ilişkin kriterin parkta %50'den az gerçekleştirilmesi.
    - **1:** Göstergeye ilişkin kriterin parkta %50'den fazla gerçekleştirilmesi.
3. **Toplam Ağırlığın Hesaplanması:** Her KPI, ilgili parkta elde ettiği sonuçlara göre değerlendirilmiş ve tüm parklardaki sonuçlar birleştirilmiştir. Ağırlık oranı, KPI'ın tüm parklarda aldığı toplam puan ile hesaplanmıştır.
4. **Ağırlık Oranlarının Hesaplanması:** Her bir performans göstergesinin aldığı toplam puan, tüm KPI'ların toplam tekrarı üzerinden hesaplanarak ağırlık oranı oluşturulmuştur. Bu oran, ilgili performans göstergesinin toplam performans içindeki önem derecesini belirlemiştir.
5. **Uygulama:** Önerilen model Al-Azhar Parkı'na uygulanmış ve bu parkın performansı bu anahtar performans göstergelerine göre değerlendirilmiştir. Parkın mevcut durumu incelenerek eksiklikler tespit edilmiştir.

Bu ağırlıklandırma yöntemi, her bir kriterin ve performans göstergesinin parklarda ne kadar başarıyla uygulandığını değerlendirmek ve parklara uygulanabilir geliştirme stratejileri belirlemek için kullanılmıştır.

Al-Azhar Parkı'na uygulanan modelin sonuçlarına göre:

- Parkın akıllı park kriterlerinin yalnızca %50'sini karşıladığı bulunmuştur.
- Parkın özellikle su yönetimi, enerji verimliliği ve güvenlik gibi alanlarda eksikleri olduğu saptanmıştır. Örneğin, suyun daha verimli kullanımı için akıllı sulama sistemleri ve gri su geri dönüşüm sistemleri önerilmiştir.

Al-Azhar Parkı'nın akıllı bir parka dönüştürülmesi için şu adımlar önerilmiştir:

- **Akıllı Su Yönetimi:** Parka yağmur suyu toplama ve geri dönüşüm sistemleri gibi su verimliliği çözümleri eklenmelidir.
- **Enerji Verimliliği:** Güneş enerjisi ile çalışan sistemler, enerji tasarrufu sağlamak için parka entegre edilmelidir.
- **Güvenlik:** Park içinde hareket sensörlü aydınlatmalar ve güvenlik kameraları gibi güvenlik teknolojilerinin kullanılması önerilmiştir.
- **Dijital Entegrasyon:** Ziyaretçi etkileşimini artırmak için Wi-Fi noktaları, akıllı banklar ve dijital sensörler eklenebilir.

Araştırma sonucunda, Al-Azhar Parkı'nın akıllı park olma potansiyelinin olduğu, ancak mevcut durumda akıllı park kriterlerinin yarısını karşıladığı sonucuna varılmıştır. Bu parkın, çevre dostu teknolojiler ve akıllı yönetim sistemleri ile donatılarak bir akıllı parka dönüşebileceği belirtilmiştir. Model, bu süreci ölçmek ve yönetmek için gerekli performans kriterlerini sağlamaktadır.

2.3. Model 3: Busan Citizens Park'ın Akıllı Kentsel Parka Dönüşüm Yaklaşımı

Bu çalışmada, Busan Citizens Park örneği üzerinden akıllı park teknolojilerinin uygulanabilirliği incelenmiş ve parkın yönetiminde kullanılan teknolojilerin etkinliği değerlendirilmiştir. Çalışmadaki amaç, Busan Citizens Park'ı temel alarak akıllı park sistemlerinin performansını ölçmeye yönelik model girişimleri sunmak olmuştur.

Çalışma saha gözlemleri, uzman görüşmeleri ve teknolojik literatürün incelemesine dayanarak parkın akıllı bir şehir altyapısına nasıl entegre edilebileceği konusunda kapsamlı bir metodoloji kullanmıştır.

Çalışmada saha araştırmaları oldukça önemli bir yer tutmaktadır. Bu saha çalışmaları, Busan Citizens Park'taki mevcut kullanım yoğunluğunu ve parkın farklı alanlarındaki kullanıcı davranışlarını anlamayı amaçlamaktadır. Ayrıca, gözlem ve anketler**,** alan çalışması dört farklı zaman diliminde (hafta içi/hafta sonu, yaz ve bahar mevsimlerinde) yapılmış ve toplamda 36 farklı noktada kullanıcı yoğunluğu gözlemlenmiştir. Parkın hangi alanlarının en yoğun kullanıldığı, hangi bölgelerde daha az kullanım olduğu gibi bilgiler toplanmıştır. Bu gözlemler, parkın hangi kısımlarının daha fazla akıllı teknoloji ile donatılabileceğini belirlemeye yardımcı olmuştur.

Busan Citizens Park'ın yönetiminden sorumlu olan yetkililer ve park yönetim uzmanları ile toplamda 6 kişiyle görüşmeler yapılmıştır. Bu görüşmelerde yöneticilerden parkın mevcut durumu, akıllı park dönüşüm planları, yönetim sorunları ve parkın akıllı komuta merkezi gibi konular hakkında bilgi alınmıştır. Görüşme yapılanlar arasında park yöneticileri, altyapı şirketlerinden yetkililer ve akademik uzmanlar gibi farklı disiplinlerden uzmanlar olduğu belirtilmiştir.

Saha çalışmaları sırasında, parkın kullanıcılarının hangi alanları daha yoğun kullandıkları ve hangi alanların daha az tercih edildiği veri toplanarak analiz edilmiştir. Ayrıca, kullanıcıların park içindeki davranışları ve ihtiyaçları da gözlemlenmiştir. Bu veriler, parkta hangi akıllı çözümlerin daha verimli kullanılabileceği konusunda ipuçları vermiştir.

Busan Citizens Parkında hali hazırda var olan akıllı çözümler şu şekildedir:

- **Akıllı Banklar:** Parkta acil durum düğmeleri, sıcaklık ve nem sensörleri ile donatılmış banklar bulunmaktadır.
- **Güvenlik Sistemleri:** 42 adet hareket sensörlü akıllı güvenlik kamerası 24 saat boyunca parkı izlemektedir. Acil durumlarda polis veya itfaiye gibi birimlere hızlıca bildirim yapılmaktadır.
- **Yeşil Alan Yönetimi:** Ağaçlara yerleştirilen QR kodlar ile kullanıcılar, ağaç türleri hakkında bilgi alabilmektedir. Bazı önemli ağaçlar RFID (Radio Frequency Identification) teknolojisiyle izlenmekte ve sağlık durumu sürekli kontrol edilmektedir.
- **Wi-Fi:** Parkın belirli alanlarında ücretsiz Wi-Fi hizmeti sunulmaktadır, bu da park kullanıcılarının internet erişimini sağlamaktadır.
- **Su Yönetimi:** Yeşil alanlar için otomatik sulama sistemleri kullanılarak suyun daha verimli kullanımı sağlanmaktadır. Ayrıca, parkta biyolojik su yolları ile yağmur suyu yönetimi yapılmaktadır.

Çalışmada, farklı akıllı teknolojiler ve uygulamaların Busan Citizens Park'a nasıl entegre edilebileceği üzerine ayrıntılı bir inceleme yapılmıştır. Akıllı park teknolojilerinin uygulanabilirliği şu 5 ana kategoriye ayrılmıştır:

- **Tesisler ve Donanım**: Akıllı banklar, güneş enerjisiyle çalışan cihazlar, sensörlerle donatılmış oyun alanları gibi teknolojiler.
- **Su Yönetimi**: Akıllı su kontrol sistemleri, yağmur suyu hasadı, gri su geri dönüşüm sistemleri.
- **Yeşil Alan Yönetimi**: Dronlar ile bitki yönetimi, düşük bakım gerektiren bitkiler ve akıllı sulama sistemleri.
- **Yol ve Kaldırım Teknolojileri**: Piezoelektrik enerji hasadı ve geçirgen kaldırım taşları.
- **Kullanıcı Teknolojileri**: Kullanıcıların ihtiyaçlarını analiz etmek için büyük veri ve bulut bilişim, Wi-Fi, artırılmış gerçeklik (AR) ve sanal gerçeklik (VR) hizmetleri.

Elde edilen bilgiler ışığında Busan Citizens Park'ın mevcut durumu analiz edilmiş ve akıllı park teknolojilerinin hangi alanlarda nasıl uygulanabileceği konusunda öneriler geliştirilmiştir. Bu çalışma, parkın akıllı bir şehir altyapısına entegre edilmesi için gereken adımların atılmasındaki önemine dikkat çekmiştir. Ayrıca parkın mevcut yönetim yapısının akıllı teknolojilerle nasıl dönüştürülebileceği ve bu dönüşümün sürdürülebilir bir şekilde nasıl yönetileceği hakkında öneriler sunulmuştur.

3. Bulgular ve Tartışma

Makalenin bu bölümünde, incelenen modellerin performans sonuçları ve karşılaştırmaları sunulmuştur. Üç model, akıllı parkların tasarımı, dönüşümü ve yönetimi konusunda farklı ancak birbirini tamamlayan perspektifler sunmaktadır. Model 1, tarihi ve kültürel boyutları ön plana çıkarırken, Model 2 performans ölçümü ve dönüşüm sürecinin yönetimine odaklanmaktadır. Model 3 ise uygulamalar ve kullanıcı deneyimi üzerinden değerlendirme yapmaktadır. İncelenen modellerin karşılaştırmaları **amaç ve hedefler, metodolojik yaklaşım, uygulanabilirlik, performans ölçümü, kullanıcı odaklılık, sürdürülebilirlik ve teknolojik entegrasyon** üzerinden yapılmıştır. Karşılaştırma sonuçları Çizelge 2' de detaylandırılmıştır:

Çizelge 2. Modellerin performans sonuçları ve karşılaştırmaları

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1. Amaç ve Hedefler: Hangi model hangi sorunu çözmeyi amaçlamaktadır?

- **Model 1:**
  - **Amaç:** Tarihi kentsel parkların akıllı şehir altyapısı ile yeniden hayata geçirilmesi ve sürdürülebilir bir çevre yaratılmasıdır.
  - **Hedefler:** Tarihi parkların yenilikçi teknolojilerle etkin kullanımını artırmak, kültürel mirası korumak ve park yönetimini iyileştirmektir.
- **Model 2:**
  - **Amaç:** Geleneksel parkları akıllı parklara dönüştürmek ve mevcut akıllı parkların performansını ölçmek için bir model geliştirmektir.
  - **Hedefler:** Parkların enerji tasarrufu, çevreye duyarlılık ve kullanıcılarla etkileşim alanlarında teknolojik yeniliklerle donatılması ve bu değişimlerin somut olarak ölçülmesidir.
- **Model 3:**
  - **Amaç:** Busan Citizens Park örneği üzerinden akıllı park teknolojilerinin uygulanabilirliğini ve etkinliğini değerlendirmektedir.
  - **Hedefler:** Spesifik bir parkın akıllı şehir altyapısına dahil edilmesini sağlamak, kullanıcı ihtiyaçlarını analiz etmek ve park yönetiminde teknolojilerin etkinliğini artırmaktır.

2. Metodolojik Yaklaşım: Hangi yöntemlerle sonuca ulaşılmaktadır?

- **Model 1:**
  - **Literatür İncelemesi:** Tarihi parkların ve akıllı park kavramının teorik çerçevesi oluşturulmuştur.
  - **Uluslararası Örneklerin Analizi:** Üç tarihi park detaylı olarak incelenmiş ve karşılaştırılmıştır.
  - **Akıllı Park Modelleri:** 10 temel boyut belirlenerek performans ölçüm modeli önerilmektedir.
  - **IoT Entegrasyonu:** Nesnelerin İnterneti teknolojilerinin parklara entegrasyonu detaylandırılmaktadır.
- **Model 2:**
  - **İndüktif ve Dedüktif Yaklaşımlar:** Geleneksel ve akıllı parkların farkları tanımlanmakta, teorik temeller oluşturulmaktadır.
  - **Küresel Örneklerin Analizi:** Dünya genelindeki akıllı parklar incelenerek performans kriterleri belirlenmiştir.
  - **Model Geliştirme:** 8 ana kriter, 25 alt kriter ve 84 KPI içeren detaylı bir performans ölçüm modeli oluşturulmuştur.
  - **Model Uygulaması:** Al-Azhar Parkı'na model uygulanarak sonuçlar elde edimiştir.
- **Model 3:**
  - **Saha Araştırmaları:** Gözlem ve anketlerle kullanıcı davranışları ve kullanım yoğunluğu analiz edilmiştir.
  - **Görüşmeler:** Park yöneticileri ve uzmanlarla görüşmeler yapılmıştır.
  - **Teknolojik İnceleme:** Parktaki hali hazırda bulunan teknolojik uygulamalar incelenmiş ve yeni teknolojik öneriler geliştirilmiştir.

3. Uygulanabilirlik: Modellerin pratikte uygulanma potansiyeli nedir?

- **Model 1:**
  - **Potansiyel:** Teorik bilgiler ve dünya çapındaki örneklerle desteklenmekte, ayrıca tarihi parkları modernleştirmek için stratejik bir plan sunmaktadır.
  - **Sınırlamalar:** Spesifik uygulama adımları ve performans ölçüm araçları detaylandırılmadığı için pratikte uygulanması daha genel düzeyde kalabilir.
- **Model 2:**
  - **Potansiyel:** Detaylı performans ölçüm modeli ve KPI'ları sayesinde doğrudan farklı parklara uygulanabilir. Pratikte dönüşüm süreçlerini yönetmek ve izlemek için güçlü bir araç sunmaktadır.
  - **Sınırlamalar:** Modelin karmaşıklığı ve geniş kapsamı, uygulama sürecinde kaynak ve uzmanlık gerektirebilir.
- **Model 3:**
  - **Potansiyel:** Spesifik bir park üzerinde derinlemesine çalışıldığı için benzer ölçekteki diğer parklara da uyarlanabilir. Kullanıcıya yönelik yaklaşım çözümlerin uygulanmasını kolaylaştırmaktadır.
  - **Sınırlamalar:** Model, genel bir çerçeveden ziyade spesifik bir örneğe odaklandığı için genelleştirilmesi sınırlı olabilir.

4. Performans Ölçümü: Hangi model daha somut ve ölçülebilir kriterler sunmaktadır?

- **Model 1:**
  - **Kriterler:** 10 temel boyut belirlenmekte ancak performans ölçüm değerlendirmesi daha çok nitelik bazlı incelemelere dayanmaktadır.
  - **Somutluk:** Ölçülebilirlik açısından sınırlı; genel prensipler ve öneriler sunmaktadır.
- **Model 2:**
  - **Kriterler:** 8 ana, 25 alt kriter ve 84 KPI ile detaylı bir performans ölçüm modeli sunmaktadır.
  - **Somutluk:** Ağırlıklandırma ve nicel değerlendirme yöntemleri sayesinde ölçülebilir ve somut sonuçlar elde etmeyi mümkün kılmaktadır.
- **Model 3:**
  - **Kriterler:** Performans ölçümünden ziyade mevcut durum analizi ve önerilere odaklanmaktadır.
  - **Somutluk:** Nicel performans ölçümüne yer verilmemiş; değerlendirmeler daha çok niteliksel ve gözlemseldir.

5. Kullanıcı Odaklılık: Hangi model kullanıcı ihtiyaçlarını daha fazla dikkate almaktadır?

- **Model 1:**
  - **Yaklaşım:** Kullanıcı gereksinimlerinin doğru şekilde anlaşılması ve kullanıcı etkileşimi boyutlarını içermekte ancak derinlemesine kullanıcı analizi yoktur.
  - **Odak:** Genel kullanıcı etkileşimini optimize etmeyi hedeflemektedir.
- **Model 2:**
  - **Yaklaşım:** Modelde "Akıllı İnsanlar" ve "Kullanıcı Etkileşimi" gibi kriterler bulunmaktadır.
  - **Odak:** Kullanıcıların eğitim düzeyi, etnik çeşitlilik ve yaşam boyu öğrenme gibi sosyal unsurlara odaklanmakta ancak doğrudan kullanıcı davranışlarına yönelik saha çalışması içermemektedir.
- **Model 3:**
  - **Yaklaşım:** Gözlem ve anketlerle kullanıcı davranışlarını ve gereksinimlerini kapsamlı bir şekilde analiz etmektedir.
  - **Odak:** Kullanıcı odaklılık yönünden en kapsayıcı modeldir; parkın kullanım yoğunluğu ve kullanıcı memnuniyeti üzerine yoğunlaşmaktadır.

6. Sürdürülebilirlik ve Teknoloji Entegrasyonu: Modellerin sürdürülebilirlik ve teknolojik entegrasyon konusundaki yaklaşımları nasıldır?

- **Model 1:**

    - **Sürdürülebilirlik:** Tarihi parkların korunması ve sürdürülebilirliğinin artırılması temel hedeflerden biridir.
    - **Teknoloji Entegrasyonu:** IoT ve akıllı teknolojilerin entegrasyonu detaylı bir şekilde ele alınmıştır.
- **Model 2:**
    - **Sürdürülebilirlik:** Enerji verimliliği, çevresel sürdürülebilirlik ve su yönetimi gibi kriterlerle sürdürülebilirliği merkeze almaktadır.
    - **Teknoloji Entegrasyonu:** Akıllı sulama, akıllı yönetim uygulamaları ve dijitalleşme gibi teknolojik çözümleri performans kriterlerinin içine dahil etmektedir.
- **Model 3:**
    - **Sürdürülebilirlik:** Yeşil alan yönetimi, su yönetimi ve enerji tasarrufu konularına odaklanmaktadır.
    - **Teknoloji Entegrasyonu:** Mevcut teknolojik uygulamaları analiz etmekte ve yeni teknolojik öneriler sunulmaktadır. Dolayısıyla teknolojinin entegrasyonuna odaklanmaktadır.

Güçlü Yönler ve Zayıf Yönler:

- **Model 1:**
    - **Güçlü Yönler:** Tarihi ve kültürel açıdan zengin parkların modern teknolojiyle nasıl uyumlu hale getirilebileceği konusunda stratejik bir çerçeve sunmaktadır.
    - **Zayıf Yönler:** Performans ölçümü ve kullanıcıyı merkeze alarak daha genel bir yaklaşım benimsemekte, somut uygulama adımları sınırlı kalmaktadır.
- **Model 2:**
    - **Güçlü Yönler:** Ölçülebilir performans kriterleri, parkların akıllı dönüşümünü yönetmek ve izlemek için güçlü bir araç sağlamaktadır.
    - **Zayıf Yönler:** Kullanıcı alışkanlıkları ve beklentileri yeterince incelenmemiştir; modelin karmaşıklığı uygulamada zor olabilir.
- **Model 3:**
    - **Güçlü Yönler:** Kullanıcı merkezli yaklaşımı ve uygulamaları sayesinde spesifik ihtiyaçlara yönelik çözümler sunmaktadır.
    - **Zayıf Yönler:** Performans ölçümü için nicel bir model sunmuyor; daha çok niteliksel değerlendirmeler yapmaktadır.

Genel Değerlendirme:

- **Amaç ve Hedefler Açısından:**
    - Model 1, tarihi parkların bakımı, korunması ve modernleştirilmesi üzerine odaklanırken, Model 2 genel olarak parkların akıllı parklara gelişimini hedeflemektedir. Model 3 ise spesifik bir parkın ihtiyaçlarına yönelik çözümler sunmaktadır.
- **Metodolojik Yaklaşım Açısından:**
    - Model 1 ve 2 teorik temeller ve literatür incelemesiyle başlarken, Model 3 saha çalışmaları ve gözlemlere dayanmaktadır.
- **Uygulanabilirlik Açısından:**
    - Model 2'nin detaylı performans ölçüm modeli pratik uygulamada avantaj sağlamaktadır. Model 3'ün kullanıcı odaklı yaklaşımı, bazı parklarda uygulama potansiyelini artırmaktadır.
- **Performans Ölçümü Açısından:**
    - Model 2, en somut ve ölçülebilir kriterleri sunmaktadır. Model 1 ve 3 bu açıdan daha genel kalmaktadır.
- **Kullanıcı Odaklılık Açısından:**
    - Model 3, kullanıcı ihtiyaçlarını en fazla dikkate alan model olarak öne çıkmaktadır.
- **Sürdürülebilirlik ve Teknoloji Entegrasyonu Açısından:**
    - Üç model de bu konulara önem vermekte ancak yaklaşımları farklılık göstermektedir. Model 1 stratejik, Model 2 sistematik ve Model 3 pratik çözümler sunmaktadır.

Bu üç model, akıllı parkların tasarımı, dönüşümü ve yönetimi bağlamında farklı perspektifler sunarak birbirlerini tamamlar niteliktedir. Modellerin her biri, belirli bir odak noktasına ve metodolojik yaklaşıma sahiptir, bu da akıllı park kavramının geniş ve çok boyutlu yapısını yansıtmaktadır.

Model 1, tarihi kentsel parkların modern teknolojilerle tekrar hareketlenmesini ve kültürel mirasın korunmasını hedeflemektedir. Bu yaklaşım, tarihi dokunun korunması ile teknolojik yeniliklerin entegrasyonu arasındaki dengeyi sağlamaya çalışmaktadır. Model 2 ise genel olarak parkların akıllı parklara geçişini ve bu geçişin performansının ölçülmesini amaçlamaktadır. Bu modelin kapsamlı performans ölçüm sistemi, dönüşüm sürecinin yönetilmesi ve izlenmesi için önemli bir yardımcı sunmaktadır. Model 3, spesifik bir parkın (Busan Citizens Park) akıllı şehir altyapısına entegrasyonunu ve kullanıcı gereksinimlerini merkeze almaktadır.

Model 1'in literatür incelemesi ve uluslararası örnekler üzerinden geliştirdiği teorik çerçeve, genel stratejiler belirlemek için faydalıdır ancak pratik uygulamada somut adımların eksikliği hissedilebilir. Model 2'nin detaylı performans ölçüm modeli ve KPI'ları, parklarda somut değerlendirmeler yapmaya olanak tanımaktadır. Ancak, bu modelin karmaşıklığı ve uygulama sürecinde gereken kaynaklar, pratikte zorluklar yaratabilir. Model 3'ün saha araştırmaları ve kullanıcı perspektifinden özel gereksinimlere yönelik kolaycı çözümler sunmakta ve uygulanabilirliği yüksek kılmaktadır. Ancak, genel bir çerçeve sunmaması nedeniyle farklı parklar için genelleştirilmesi sınırlı olabilir.

Performans ölçümü yönünden Model 2, en somut ve ölçülebilir kriterleri sunmaktadır. Bu, park yönetiminde nesnel kararlar almak ve gelişimi izlemek için değerlidir. Model 1 ve Model 3 ise daha çok kalitatif değerlendirmelere dayanmaktadır. Kullanıcı merkezlilik konusunda Model 3 öne çıkmakta; kullanıcı davranışları ve onlara neyin gerekli olduğu üzerine yapılan detaylı analizler, parkın kullanıcı deneyimini arttırmak için önemli içgörüler sağlamaktadır. Model 1 ve Model 2, kullanıcı gereksinimlerini genel düzeyde ele almakta ve derinlemesine saha çalışmaları içermemektedir.

Üç model de sürdürülebilirlik ve teknoloji entegrasyonuna önem verir, ancak yaklaşımları farklıdır. Model 1, tarihi parkların sürdürülebilirliği ve IoT teknolojilerinin entegrasyonu üzerine yoğunlaşmaktadır. Model 2, su yönetimi, çevresel sürdürülebilirlik enerji yönetimi gibi konuları detaylı performans kriterleri içine dahil etmektedir. Model 3, pratik uygulamalara odaklanarak mevcut teknolojilerin etkinliğini ve yeni teknolojik çözümlerin uygulanabilirliğini değerlendirmektedir.

Modellerin güçlü yönleri ve zayıf yönleri hususunda Model 1**,** tarihi ve kültürel mirasın korunması ile modern teknolojilerin entegrasyonunu kritik bir çerçevede ele almakta ancak somut uygulama adımları ve performans ölçüm gereçlerinin eksikliği pratikte sınırlılıklar yaratabilir. Model 2**,** kapsamlı performans ölçüm modeli sayesinde değişim süreçlerinin yönetimi ve izlenmesi için güçlü bir imkan sunmakta ama kullanıcı hareketlerine yönelik saha çalışmalarının eksikliği ve modelin karmaşıklığı uygulamada zorluklara neden olabilir. Model 3 ise, kullanıcı öncelikli yöntemi ve basit çözümleri ile gerekli ihtiyaçlara yanıt vermekte ve uygulanabilirliği yüksektir fakat genel bir model olmaması ve performans ölçümü için nicel araçlar sağlaması genelleştirme kapasitesini azalmaktadır.

4. Sonuç ve Öneriler

Bu çalışma, akıllı parkların tasarımı, dönüşümü ve idaresi konusunda çeşitli yaklaşımlar sunan üç modeli detaylı bir şekilde inceleyerek 6 parametrede (hedef ve amaçlar, metodolojik yaklaşım, uygulanabilirlik, performans ölçümü, kullanıcı odaklılık, sürdürebilirlik ve teknoloji entegrasyonu) karşılaştırmalar yapmaktadır. Modellerin her biri, akıllı park kavramının farklı boyutlarını ele alarak, parkların sürdürülebilirlik, teknoloji entegrasyonu, kullanıcı odaklılık ve performans ölçümü gibi kritik alanlarda nasıl geliştirilebileceğine dair önemli içgörüler sağlamaktadır.

Parkların farklı özellikleri ve ihtiyaçları göz önüne alındığında, modellerin esnek bir şekilde uyarlanması ve spesifik koşullara göre modifiye edilmesi önemlidir. Esneklik ve spesifik koşullara modifiye, modellerin uygulanabilirliğini artıracak ve farklı ölçeklerdeki parklara uyarlanmasını sağlayacaktır. Ayrıca gelecekteki çalışmalarda, kullanıcı davranışlarının gereksinimlerine yönelik daha fazla saha çalışması yapılması ve bu verilerin performans ölçüm modellerine entegre edilmesi, parkların kullanıcı merkezli geliştirilmesine katkı sağlayacaktır.

Akıllı parklar, şehirlerin sürdürülebilirlik hedeflerine ulaşmasında ve kent sakinlerinin yaşam kalitesinin artırılmasında önemli bir rol oynamaktadır. Bu çalışma, üç farklı model üzerinden akıllı park tanımının çok boyutlu yapısını ortaya koymuş ve parkların tasarımı, dönüşümü ve yönetimi konusunda yaklaşımları değerlendirmiştir. Modellerin güçlü yönlerinin bir araya getirilmesi ve eksikliklerinin

giderilmesi ile, parkların hem kültürel mirası koruyan hem de modern teknolojilerin avantajlarından yararlanan akıllı alanlara dönüştürülmesi mümkündür.

İncelenen üç model, akıllı parkların tasarımı, değişimi ve yönetimi konusunda farklı perspektifler sunuyor ve birbirlerini tamamlayıcı özelliklere sahiptirler. Amaç, tarihi parkların korunması ve modern teknolojilerle yeniden canlandırılması ise, Model 1 uygun bir rehber olabilir. Amaç, Parkların akıllı parklara dönüşüm sürecini ölçülebilir ve yönetilebilir hale getirmek ise, Model 2 kapsamlı bir fırsat sağlamaktadır. Amaç, kullanıcı ihtiyaçlarına odaklanarak spesifik bir parkta pratik çözümler geliştirmek ise, Model 3 daha uygun bir seçenek olacaktır. Bu değerlendirmeler ışığında, parkların akıllı teknolojilerle donatılması ve sürdürülebilirlik hedeflerine ulaşılması için bu modellerin bir arada kullanılması en etkili yaklaşım olacaktır.

Akıllı parkların tasarımı, gelişimi ve koordinasyonu kompleks bir süreç olup, çok disiplinli bir yaklaşım gerektirmektedir. Bu üç model üzerine yapılan incelemeler, farklı perspektiflerin ve metodolojik yaklaşımların bir araya getirilmesinin, daha etkili ve sürdürülebilir çözümler üretebileceğini göstermektedir. Park yöneticileri, peyzaj mimarları, şehir planlamacıları ve ilgili paydaşlar, bu modellerin sunduğu içgörüleri kullanarak, hem kültürel mirası koruyan hem de modern teknolojilerin faydalarından yararlanan akıllı parklar geliştirebilirler.

Çalışmada akıllı kent parklarının performansını ölçmeye yönelik 3 model, farklı kriterlere dayanarak başarılı sonuçlar vermektedir. Kullanıcı memnuniyeti ve enerji verimliliği konularında öne çıkan modeller, gelecekte geliştirilecek karma modeller için referans niteliğindedir. Akıllı kent parklarının performansını ölçmek için, bu üç modelin güçlü yönlerini birleştiren daha kapsamlı bir modelin geliştirilmesi önerilmektedir.

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Examination of Model Initiatives for Smart Parking Performance Measurement

Summary

This study presents a comprehensive overview of performance measurement for smart city parks that aim to enhance urban quality of life. The concept of smart parks has garnered increasing attention in recent years as part of the expanding smart city approaches. Such parks are supported by Internet of Things (IoT) technologies, sensor-based data collection infrastructures, energy efficiency systems, and digital platforms designed to optimize user experience. Through these elements, they aim to increase residents' access to green spaces, strengthen environmental sustainability, and adopt a more holistic perspective in urban planning.

However, the efficiency and sustainability of smart parks have yet to be tracked by a standardized performance measurement system. To address this gap, three different model initiatives are examined in detail in the study. The first model primarily focuses on data collection and real-time monitoring functions, emphasizing user satisfaction.

The second model centers on energy consumption and resource efficiency, while the third model highlights social, cultural, and economic activities within the park. Each model demonstrates certain strengths (e.g., ease of implementation, low cost, holistic approach) and weaknesses (e.g., difficulties in data verification, technological infrastructure requirements, limited scalability).

The comparative analysis in the article reveals that accurately and sustainably evaluating smart park performance requires a multidimensional approach. A single metric or measurement method often fails to capture all operational and user-oriented success criteria for a park. Consequently, future research should expand the range of metrics, identify needs through stakeholder (public institutions, private sector, local community) collaboration, and strengthen technological infrastructure.

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Thermal Comfort Evaluations of Monumental Anatolian Seljuk Mosques in Konya in the Temperate-Dry Climate Region

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Abstract

Monumental mosques are valuable elements of cultural and architectural heritage. Documentation of the features of these structures is important. It is important to document the architectural design properties of these buildings. Mosques are characterized by unique and intermittent working hours. This affects the climate-related design properties of mosques. Providing comfort conditions in interior spaces with energy-efficient methods is an important issue. This study handles the monumental mosques built during the Anatolian Seljuk Period in Konya, a city located in the temperate-dry climate region. It aims to document and create an inventory of monumental religious buildings and investigate them in terms of thermal comfort parameters. In the study prepared within the scope of the Scientific Research Project (BAP), the Tahir and Zühre Mosque built during the Anatolian Seljuk Period is handled. The religious building that is determined the architectural design properties is modeled using the DesignBuilder simulation software and analyzed in terms of thermal comfort. The findings show that monumental religious buildings have great importance in terms of thermal comfort in line with their architectural design features. Studies in this field are limited and this study is pioneering in this respect.

Keywords: *Monumental mosques, Anatolian Seljuk period, thermal comfort.*

Ilımlı-Kuru İklim Bölgesinde Konya'da Yer Alan Anıtsal Anadolu Selçuklu Camilerinin Termal Konfor Değerlendirmeleri

Öz

Anıtsal dini yapılar kültürel ve mimari mirasının değerli öğeleridir. Bu yapıların mimari tasarım özelliklerinin belgelenmesi önem taşımaktadır. Camiler benzersiz ve aralıklı çalışma saatleriyle karakterize edilmektedir. Bu durum, camilerin iklime bağlı tasarım özelliklerini etkilemektedir. İç mekanda konfor koşullarının enerji verimli bir şekilde sağlanması önemli bir konu olarak karşımıza çıkmaktadır. Bu çalışmada, Ilımlı-kuru iklim bölgesinde yer alan Konya'da Anadolu Selçuklu Döneminde inşa edilen anıtsal camiler ele alınmaktadır. Anıtsal dini yapıların envanterinin oluşturularak belgelenmesi ve bu yapıların termal konfor parametreleri açısından araştırılması hedeflenmektedir. Bilimsel araştırma projesi kapsamında (BAP) hazırlanan çalışmada, Anadolu Selçuklu Döneminde inşa edilen Tahir ile Zühre Camii ele alınmaktadır. Mimari tasarım özellikleri belirlenen dini yapı DesignBuilder simülasyon programı aracılığıyla modellenerek, termal konfor açısından analiz edilmektedir. Elde edilen bulgular anıtsal dini yapıların mimari tasarım özellikleri doğrultusunda termal konfor açısından büyük bir değere sahip olduğunu göstermektedir. Bu alanda yapılan çalışmalar sınırlıdır ve bu açıdan bu çalışma öncü niteliktedir.

Anahtar kelimeler: *Anıtsal camiler, Anadolu Selçuklu dönemi, termal konfor.*

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1. Introduction

Konya is one of the important cities that has hosted many civilizations throughout its history. The city, which has the capital status of the Anatolian Seljuk Civilization, has preserved its importance for many years. At the same time, it is one of the important state centers of the Ottoman Empire. The city, which has valuable elements of cultural and architectural heritage, has been one of the most important main centers of Turkish-Islamic culture and art and architectural center in Anatolia throughout its history (Baykara, 2002). Religious buildings such as mosques belonging to the Anatolian Seljuk and Ottoman periods provide the formation of the city morphology and are the religious buildings of great importance in this respect. This architectural heritage needs to be protected and documented.

Mosques, which are valuable elements of cultural heritage, represent the central area where people bring together for their daily and weekly prayers. They are also considered social, educational, and cultural spaces for Muslims' activities. Mosques are characterized by having a unique intermittent working plan, compared to other building types. They are used simultaneously in a certain region and time zone. Mosques include a large prayer hall that is used intermittently during congregational prayers, five times a day and the mosques' occupancy rates vary in Friday noon prayers and daily times (Azmi & Kandar, 2019). In this situation, the periods when heating and cooling of the building are required affect the energy demand depending on the climate zones (Al-Homoud et al., 2005).

Religious buildings designed with a sense of sacred worship represent a space with unique functions and operations. In this respect, thermal comfort and operation in mosques are of great importance, and mosques should be carefully evaluated in the scope of thermal comfort and energy requirements. The climate-related design properties of mosques affect the interior comfort conditions and the thermal performance of the building (Abdou et al., 2005). Therefore, the thermal comfort of the mosque building largely depends on the overall thermal performance of the building components such as walls, roofs, and windows working together as a system (Al-Homoud et al., 2009). The heating and cooling load of the mosque is important, especially in terms of energy efficiency, because a mosque with poor thermal performance consumes more energy to provide comfort conditions.

Al-ajmi studied thermal comfort in air-conditioned mosques located in the hot-dry climate zone of Kuwait and six mosques were investigated in terms of thermal conditions. On-site measurements included indoor air temperature, operative temperature, relative humidity, and air velocity. In addition, a survey was conducted with worshippers to investigate the factors affecting thermal comfort conditions. The study stated that mosque buildings in Kuwait should be designed to maintain an indoor temperature of 26.1 ^{0}C to achieve significant energy savings (Al-ajmi, 2010). In Ahriz et al. study, it is determined the mosque building components that can control and determine thermal comfort conditions as the orientation of the building, the area surrounding the building, the size and geometric shape of the building, architectural form, covered galleries, roof shape, prayer halls, the prayer hall's height, building materials, openings, and surface colors (Ahriz et al., 2021).

In this study, the Tahir and Zühre Mosque built in Konya during the Anatolian Seljuk period is handled, and the architectural design properties of the mosque are documented and the mosque is analyzed in terms of thermal comfort in line with the simulation results. It aims to create an inventory of the monumental mosque, which is a valuable element of architectural heritage, to explain the plan, section, and facade typologies, to reveal the construction technique and material properties, and to evaluate the buildings in terms of thermal comfort. There is not enough research in the literature on the basic design properties of mosques and their thermal comfort and energy performance. In this respect, this study is pioneering for future studies on cities and buildings with historical and architectural value. At the same time, the relationship between the design criteria and construction techniques of monumental mosques and thermal comfort parameters is aimed to inspire and guide designers in providing thermal comfort conditions with energy-efficient methods for designing religious buildings with a sense of sacred worship.

2. Material and Method

This study is prepared for the Scientific Research Project (BAP) scope. Among the monumental religious buildings investigated within the scope of this project, the Tahir and Zühre (13th century) Mosque built in Konya during the Anatolian Seljuk Period is handled in this study. First of all, information about the Konya city and mosques belonging to the Anatolian Seljuk Civilization are collected in the light of the literature. The mosque is visualized with the drone and its properties are documented with photographs. The drawings of the mosque in the electronic environment are taken from the Konya Regional Directorate of Foundations and the drawings are colored and the current situation based on on-site determinations and its relationship with its immediate surroundings are processed on the drawings. In line with the literature review, visuals, on-site determinations and drawings, plan section, facade, and top cover elements are explained, as well as construction techniques and material properties. The mosque's architectural design properties are documented and the mosque is modeled in the Design-Builder simulation software. Design Builder is an EnergyPlus-based software developed to measure and analyze the buildings' performance such as energy, comfort, carbon, and lighting (Zhang, 2014). In the DesignBuilder simulation program, models specific to mosque buildings with characteristic properties are developed, taking into account the worshippers, occupancy rate, and usage times. According to the simulation results, the mosque is analyzed in the scope of thermal comfort parameters. At the same time, the relationship between the temperate-dry climatic region and thermal comfort. The evaluations are explained according to the findings.

3. Findings and Discussion

In this section, first of all, Tahir and Zühre Mosque's architectural design properties are explained. This mosque is also analyzed in terms of thermal comfort.

3.1. Tahir and Zühre Mosque's Architectural Design Properties

Tahir and Zühre Mosque was built in Konya in the 13th century Anatolian Seljuk Period. The mosque was built in masonry technique. Tahir and Zühre Mosque's form is square and the building has three spaces in terms of plan organization. The mosque's top cover property is a dome. The religious building order is detached. The Mosque's height (h) is 9.24 m and the total area is 80.78 m^2. In Figure 1 Tahir and Zühre Mosque's top view and plan are shown.

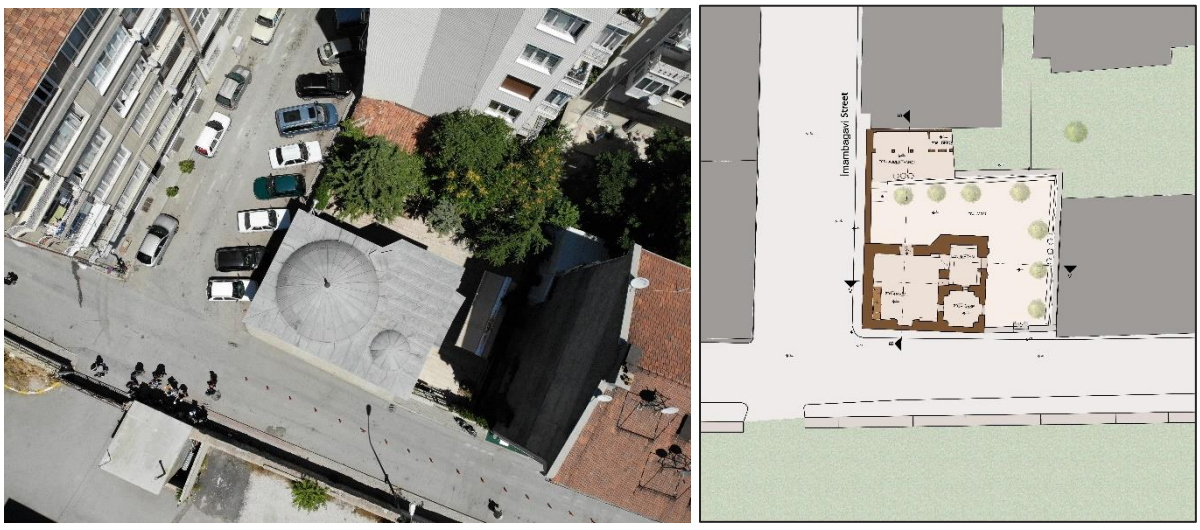

Figure 1. Tahir and Zühre Mosque top view and plan (Photograph and image by the authors, 2019)

Regarding construction techniques and material properties, stone and brick were used together in the Tahir and Zühre Mosque's walls, the mosque's wall thickness is 95 cm, and the bond technique is masonry. In terms of openings, window ratios are mixed. Square windows and 1/2 ratio windows were used together. There are three windows on the north facade, one on the west facade, and two on the east facade. There is no opening on the south facade. The Mosque has a dome and the mosque's top cover technique is masonry. The dome's material is brick, the dome's diameter is 560 cm, and the

dome's thickness is 60 cm. There are no openings on the top cover. The mosque's flooring material is wood flooring. The mosque has no minaret. In Figure 2 Tahir and Zühre Mosque's A-A Section is shown and in Figure 3 Tahir and Zühre Mosque's east elevation is shown.

Figure 2. Tahir and Zühre Mosque's A-A section (Authors, 2019)

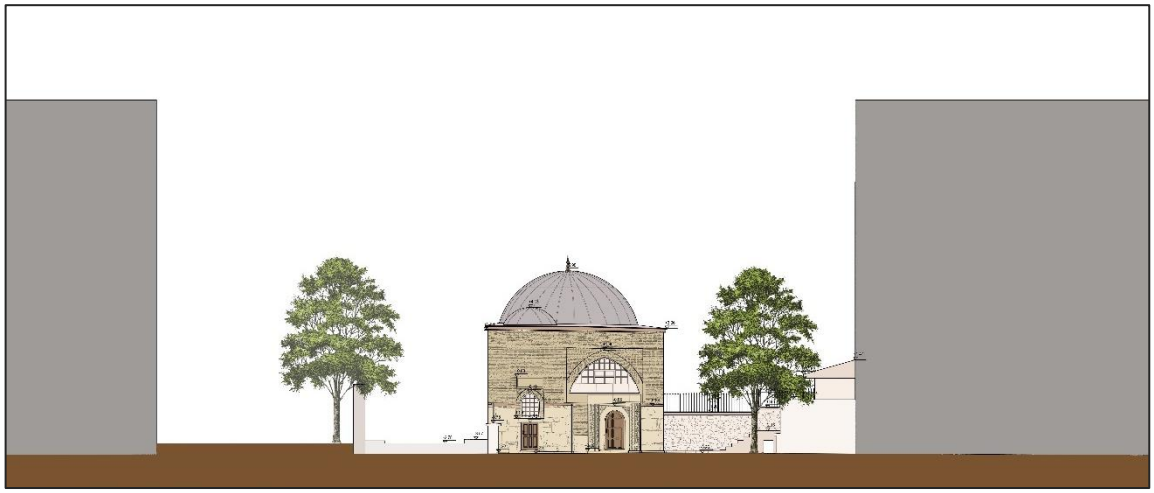

Figure 3. Tahir and Zühre Mosque's east elevation (Authors, 2019)

3.2. Tahir and Zühre Mosque's Thermal Comfort Evaluations

Thermal comfort is provided by controlling environmental conditions such as temperature, humidity, air movement, etc. while balancing the heat gains and losses of the human body. It must understand the heat dissipation mechanisms of the human body and the environmental conditions together to create thermal comfort (Lechner, 2015). Seasonal characteristics and activities performed indoors are important factors affecting thermal comfort. These factors require the increase or decrease of the heat value of the space. Thermal comfort parameters can be classified as user-related and environmental. Environmental parameters include air temperature, mean radiant temperature, relative humidity, and air movement. User-related parameters include users' physical activity status and clothing. It is important to feel comfortable while praying in a mosque. Various models have been developed to relate the feeling of comfort of the person to the relevant environmental factors. ASHRAE is a very important evaluation model for evaluating thermal comfort conditions (Al-Homoud et al., 2009).

The comfort zone should be the goal of the thermal design of a building. To provide thermal control with passive methods, passive design parameters can be handled as the building's location, building orientation and space design, the distance between other buildings, building form, building envelope optical and thermophysical properties, solar control, and natural ventilation layout (Lechner, 2015). Konya is located in the temperate-dry climate zone of Türkiye, where the heating period is important. The building form is a compact, almost square form that will be closed to the wind when heating is desired. Building walls should have an insulation rate that will provide comfort conditions in the

interior. The openings in the facade should be large enough to provide the necessary heat control. It can be said that these passive design parameters are also valid for mosque buildings. However, mosques have characteristic design elements that direct their basic design such as qibla, qibla wall, mihrab, and minbar. The mosque buildings' orientation with a characteristic design approach is the direction of the qibla. The Konya mosques' (their qibla) orientation is in the south direction. The Tahir and Zühre Mosque's building form is square. The square building is the compact form desired in the temperate-dry climate zone. The settlement texture, buildings' locations according to each other, the distance between buildings, and the buildings' heights affect passively benefiting from or being protected from the sun and wind environmental factors. In this respect, the mosque's building order is one of the parameters that directly affect the thermal comfort of a building. The Tahir and Zühre Mosque have a detached order property and this affects the thermal comfort of the mosque. In Figure 4 Tahir and Zühre Mosque's thermal comfort graphic is shown.

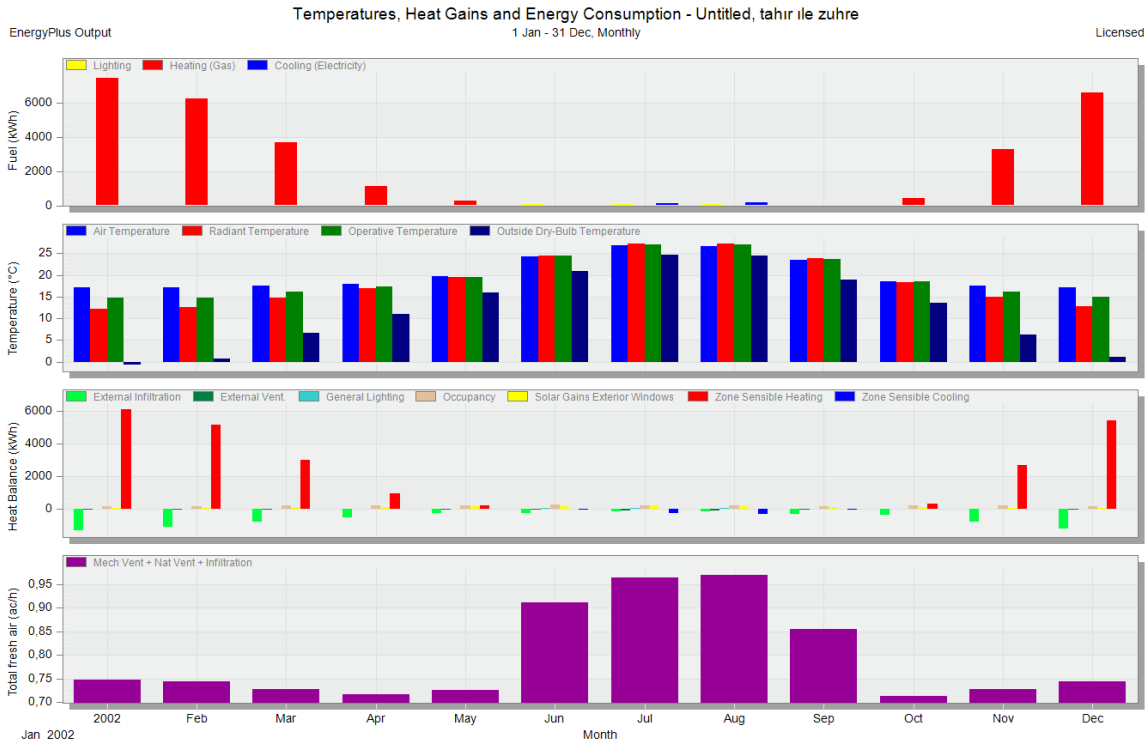

Figure 4. Thermal comfort graphic of Tahir and Zühre Mosque (Authors, 2019)

In line with the temperature graphs, it is seen that the outdoor air temperature, radiant temperature, and indoor air temperature values for Tahir and Zühre Mosque are close to each other. The main reason for this situation can be stated as a phase shift. The building wall's thermophysical properties and the wall thickness are factors that affect phase shift. Phase shift is a property that supports thermal comfort, and the wall thickness and material properties of the Tahir and Zühre Mosque provide this situation. Building envelope optical and thermophysical properties affect the amount of heat transfer through the building envelope's opaque and transparent components, indoor air temperature, and building energy demand. Tahir and Zühre Mosque's wall materials are stone and brick, and the wall thickness is 95 cm. The mosque's dome material is also brick. Stone and brick building materials contribute to the structure in terms of thermal performance. The thermal conductivity properties of the building envelope opaque and transparent components are important parameters that can affect the energy demand and thermal comfort of the buildings and the building envelope thermal conductivity varies depending on the building materials and wall thickness properties. The period when the Tahir and Zühre Mosque (13th Century) was built, the type of stone and brick materials used, the wall thickness of the mosque, and the glass types used in the openings should be handled as factors that affect the thermal conductivity of the wall.

According to the heat balance results, heat transfer in mosques consists especially in cold periods when heating is required. It can be said that this situation is caused by the openings in the building envelope.

Window elements, old joinery due to construction dates and window-wall compositions can cause heat transfer between the interior and exterior. Windows or openings are important for solar radiation gain. The openings in the south direction provide direct solar radiation gain, but multi-directional openings, especially in the north direction, cause heat losses. The size of the windows, the thermal conductivity properties of the windows, and whether they are single or double-glazed are factors that affect heat gain and loss. The total fresh air rate in the interior of Tahir and Zühre Mosque varies by month, and it is seen that these rates are higher between June and September compared to other months. Natural ventilation is one of the most important factors affecting indoor air circulation. Factors such as the size and location of openings directly affect natural ventilation. In this context, the directional openings of the Tahir and Zühre Mosque are one of the important factors affecting thermal comfort.

As a result, mosques' design properties such as building layout and order, building materials, wall thicknesses, directional openings, top cover properties, and thermal conductivity are the properties that can affect the thermal comfort of mosques. At the same time, for mosque buildings, building volume is a parameter that should be evaluated in terms of thermal comfort. In line with the monumental Tahir and Zühre Mosque and the mosques examined within the scope of the project, it should be stated that the architectural design properties of the monumental and historical mosque buildings contribute significantly to thermal comfort.

4. Conclusion and Suggestions

In this study, the monumental Tahir and Zühre Mosque built during the Anatolian Seljuk Period in the Konya, one of the most important main centers of Turkish-Islamic culture and art, is investigated in terms of thermal comfort parameters. The plan, section, and facade properties of the historical mosque have been documented and the thermal comfort of the mosque is analyzed. Konya monumental mosques from the Seljuk Period provide the formation of the urban morphology of our civilization and create a unique typology with their plan, section, and facade properties. In this context, it is important to document the architectural properties of these religious buildings, determine their place in the historical process and their current status, and also analyze them in terms of thermal comfort.

Stating that the mosques built during the Seljuk and Ottoman periods were analyzed, it can be said that mosques, which are valuable elements of the monumental architectural heritage, are valuable in terms of thermal comfort parameters in line with their traditional design properties and construction techniques. Especially in terms of building materials, traditional materials usage with thermal mass suitable for climatic conditions is a sustainable approach that affects the thermal comfort of a building positively. As a result, it can be said that positive results are achieved in terms of thermal performance. Studies in the field of monumental mosques and thermal comfort are insufficient. In this respect, it is expected that this study will create a potential research area for future research. Documenting and analyzing cultural and historical heritage in terms of thermal comfort is pioneering and will light on future studies.

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Investigation on the Applicability of Hybrid Floating Renewable Energy Structure Systems in Coastal Areas

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Abstract

Renewable energy systems are important technologies that reduce the use of fossil resources and emerged as a solution to the problem of global warming. Today, these technologies are installed both onshore and offshore. In this study, hybrid floating renewable energy structure systems were discussed to meet the energy needs of Türkiye's coastal areas from renewable energy sources. The policies and legislative aspects regarding offshore installations were analysed. In order to implement floating energy structure systems in Türkiye's coastal areas, the features of the floating foundation structure, energy systems and sustainability dimensions were evaluated. The floating energy structure design example proposed in the doctoral thesis "Sustainable Floating Urban Park Model: The Case of Fethiye" was examined. For Türkiye's sustainable energy future, suggestions have been developed for the application of hybrid floating renewable energy structure systems in coastal areas.

Keywords: *Coastal areas, floating renewable energy, hybrid energy, floating structure systems, Türkiye.*

Kıyı Alanlarında Hibrit Yüzer Yenilenebilir Enerji Yapı Sistemlerinin Uygulanabilirliğine Yönelik İrdeleme

Öz

Yenilenebilir enerji sistemleri, fosil kaynak kullanımını azaltan ve küresel ısınma sorununa çözüm olarak ortaya çıkan önemli teknolojilerdir. Günümüzde bu teknolojiler, hem karada hem de deniz üstünde kurulmaktadır. Çalışmada, Türkiye kıyı alanlarında enerji ihtiyacının yenilenebilir enerji kaynaklarından temin edilebilmesi amacıyla hibrit yüzer yenilenebilir enerji yapı sistemleri ele alınmıştır. Deniz üstü kurulumlarına yönelik izlenen politikalar ve mevzuat boyutları incelenmiştir. Türkiye kıyı alanlarında yüzer enerji yapı sistemlerinin uygulanabilmesi için taşıyıcı temel yapı özellikleri, enerji sistemleri ve sürdürülebilirlik boyutları değerlendirilmiştir. "Sürdürülebilir Yüzer Kent Park Modeli: Fethiye Örneği" doktora tez çalışmasında öneri olarak sunulan yüzer enerji yapı tasarımı örneğinden bahsedilmiştir. Türkiye'nin sürdürülebilir enerji geleceği için hibrit yüzer yenilenebilir enerji yapı sistemlerinin kıyı alanlarında uygulanabilmesine yönelik öneriler geliştirilmiştir.

Anahtar kelimeler: *Kıyı alanları, yüzer yenilenebilir enerji, hibrit enerji, yüzer yapı sistemleri, Türkiye.*

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1. Introduction

Coastal areas, which have natural, cultural and social values, are the places where people generally establish their living spaces to meet their primary needs and to engage in various activities such as transport, trade, tourism and industry. Coastal areas are regions where land and sea intersect, have high value in terms of natural structure components, and have been home to human settlements since ancient times (Avcı, 2017). These areas play an important role in ensuring environmental sustainability and strengthening the interaction of societies with nature.

The use of coastal areas is important for agricultural cultivation, animal husbandry, fisheries, forestry activities, natural gas and oil production. In addition, it has versatile advantages in terms of having structural uses for settlement, transportation, industry and defence purposes, meeting the recreation needs of people and becoming tourism destinations (Avcı, 2017). In addition to this, open green space arrangements in coastal areas are becoming important not only for recreation and entertainment purposes but also in terms of environmental sustainability.

However, coastal areas are sensitive and highly vulnerable ecosystems against rapid changes due to increased human activities and other factors (De La Cruz, 2021). One of the biggest risks and environmental problems of the 21st century facing these areas is sea level rise due to global climate change (Nicholls & Cazenave, 2010; El-Shihy ve Ezquiaga, 2019; Kurt & Li, 2020). More than 10% of the world's population lives on the coasts (Şahin, Navruz & Yılmaz, 2018) and 90% of the largest cities are located by the water (Cosgrave, 2017). In this respect, low-elevation coastal zones along the world's coastline that are less than 10 metres from the coastal boundary and defined as land area contiguous are expected to be affected by climate change (McGranahan, Balk & Anderson, 2007).

In Türkiye, 28 provinces are located directly on the coastal areas (Kurt & Li, 2020). The total area of these coastal cities is 220,447 km² and the total population has been determined as approximately 46 million as of 2020 (Yaman Kocadağlı, 2022). Türkiye's coastal areas are primarily used for public physical activities such as settlement, tourism, sports, recreation and transport (Kurt & Li, 2020; Serim, Karataş, Çırak, Yörür & Kılıç, 2022). According to the calculated morphological values of the coastal cities of Türkiye, the city with the largest urban settled area is İstanbul and the city with the smallest is Sinop. When the open green space utilisation of Türkiye's coasts is examined, the highest city is İstanbul and the lowest cities are Giresun and Çanakkale (Kahraman & Aydın, 2016). In this respect, it is likely that climate change will affect these and other coastal areas of Türkiye where human settlements and activities are intensively realised (Şahin, Navruz & Yılmaz, 2018; Kurt & Li, 2020).

For this reason, floating renewable energy systems are usable and developable technologies for reducing the effects of global climate change in intensively used coastal areas, increasing renewable energy production against fossil fuel use and making sustainable coastal arrangements (Jacobson, Delucchi, Bazouin, Bauer, Heavey, Fisher, Morris, Piekutowski, Vencill & Yeskoo, 2015; Cesur, Gül & Ay, 2018; Cesur Durmaz & Üçgül, 2023; Martinez & Iglesias, 2024).

Renewable energy systems are necessary for the protection of natural areas and ecological balance, human health and the continuity of living life. Countries attach importance to renewable energy with the idea of reducing the use of fossil-based resources, increasing green energy production and achieving a livable world future (Cesur Durmaz & Üçgül, 2023). Renewable energy sources are classified as solar energy, wind energy, water-based energy sources (hydro energy, wave energy, tidal energy, ocean energy, current energy), geothermal energy, biomass energy and hydrogen energy (Üçgül & Elibüyük, 2016).

Today, when we look at the world examples, renewable energy systems widely applied in terrestrial areas, are also developing on the seas thanks to floating structure systems. Floating energy sources such as solar, wind, wave, current, thermal provide alternative energy supply for coastal areas and are used appropriately.

Some of the largest floating solar power plants projects in the world, which are under construction or completed according to their capacities, are Saemangeum floating solar energy project (South Korea), Omkareshwar Dam floating solar farm (India), Hangzhou Fengling Electricity Science Technology's solar

farm (China) and Cirata Reservoir floating photovoltaic power project (Indonesia) (Şenli, 2023). The floating wind platform developed by Enerocean and W2Power is the first multi-turbine floating solution in the world to be tested offshore (EnerOCEAN, 2019). The InSPIRE project, developed in partnership with TechnipFMC and Bombora, is a floating platform system that can generate wave + wind energy (Bombora, 2024). A wave energy converter that can periodically move up and down in sea waves has been designed by FDN company (FDN, 2016). Simec Atlantis Energy provides installed capacity of up to 2 MW with its SeaGen 'S'tidal and bottom current turbine (Jackson & Persoons, 2012).

When the world examples are examined, it is understood that different floating renewable energy structures are used in mega sizes and are generally constructed in offshore. When analysed in terms of Türkiye, there are mostly projects where floating solar energy structures are installed in stagnant water areas such as rivers, lakes and ponds (Gökmener, Çiçek, Oğuz, Haspolat, Melek & Deveci, 2023). Azmak 2 'Hydroelectric Power Plants + Floating Solar Power Plants Project' and Büyükçekmece 'Floating Solar Power Plants Project' are among the first examples (Bulut, Kaplanoğlu & Geylani, 2018; ASKİ, 2023).

However, the development of hybrid renewable energy systems on smaller floating structures will make it possible to generate energy even in different climatic conditions (Qu, Yao & Du, 2021) and to apply it to near coastal areas. In this way, by increasing the applicability of these technologies in the coastal areas of Türkiye, it will be possible to meet the energy needs, to increase environmental awareness in recreation areas, to reduce the ecological footprint, to support sustainability and raise social awareness in the fight against global warming.

In this study, floating renewable energy structure systems was discussed in order to meet the energy needs of Türkiye's urban coastal areas from renewable energy sources and to increase their use especially in narrow coastal areas. In this respect, the policies and legislative dimensions for offshore installations in Türkiye was analysed. The basic structural design principles of floating renewable energy systems and technical specifications of energy systems was investigated. By mentioning the hybrid floating renewable energy design example proposed in the "Sustainable Floating Urban Park Model: The Case of Fethiye" doctoral thesis, evaluations were made in terms of the development of floating energy installations in the coastal areas of Türkiye. As a result, suggestions for its applicability in Türkiye's coastal areas was presented.

2. Management Policies and Legislative Status of Floating Renewable Energy Structure Systems in Türkiye

Türkiye is a country dependent on foreign energy sources to meet its energy demand by approximately 74%. For this reason, the use of renewable energy resources is of great importance in Türkiye (T.C. Dışişleri Bakanlığı, 2022). In accordance with the National Energy Policy framework adopted in 2017, Türkiye has prioritised increasing domestic and renewable energy resources (Emeksiz & Fındık, 2021). By the end of 2022, production from renewable sources in Türkiye constituted for 54% of the total installed capacity (T.C. Dışişleri Bakanlığı, 2022).

If floating renewable energy resources are examined at the scale of Türkiye; it is seen that resources such as solar, wind, wave, tide, current have started to be utilised (Emeksiz & Fındık, 2021). According to the Türkiye Solar Energy Potential Atlas, the average daily sunshine duration is 7.5 to 8.5 hours/day and the average total radiation intensity is calculated as 4.18 kWh/m2-day (MGM, 2024; Emeksiz & Fındık, 2021). In terms of offshore wind energy potential, Türkiye has a fixed 12 GW and floating 57 GW potential 200 km off the coast (ESMAP, 2019). Türkiye's tidal energy potential is very low and the current energy source is suitable in Çanakkale and İstanbul Straits, but it is not developed due to sea traffic. Wave energy potential is estimated to be 28 GW for a coastal length of 2600 km, excluding the Marmara region (Emeksiz & Fındık, 2021).

Türkiye Ministry of Energy and Natural Resources plans to increase the share of renewable energy sources such as wind and solar in total electricity production in line with its current capabilities and the flexibility it may have in the coming period. Accordingly, the installed capacity is expected to increase to 29.6 GW in wind energy (24.6 GW onshore, 5 GW offshore) and 52.9 GW in solar energy in

2035 (Enerji ve Tabi Kaynaklar Bakanlığı, 2022). However, these projections are not addressed due to technological or economic barriers for marine-based resources such as waves, tides or currents.

In this direction, in Türkiye the Law No. 5346 on the "Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy" aims to "Expand the utilization of renewable energy sources for generating electric energy, to benefit from these resources in a secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing industries for realizing these objectives" (Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanun, 2005).

In the Regulation on the "Güneş Enerjisine Dayalı Elektrik Üretimi Başvurularının Teknik Değerlendirmesi Hakkında Yönetmelik" dated 30/06/2017; "The procedures and principles regarding the formation of the technical opinion to be given on the applications made based on solar energy in order to ensure the effective and efficient use of solar energy in the production of electrical energy have been determined" (Güneş Enerjisine Dayalı Elektrik Üretimi Başvurularının Teknik Değerlendirmesi Hakkında Yönetmelik, 2017).

In the Regulation on "Rüzgar Kaynağına Dayalı Elektrik Üretimi Başvurularının Teknik Değerlendirmesi Hakkında Yönetmelik" dated 20/10/2015; "To ensure the effective and efficient use of wind energy in electrical energy generation, to make technical evaluations of pre-licence or unlicensed electricity generation applications made based on wind resource, to make technical evaluations of pre-licensed, licensed or unlicensed projects whose technical evaluations have been concluded positively, the procedures and principles regarding the issuance of the letter of conformity regarding the change of coordinates, capacity increases and change requests regarding turbine technical specifications have been determined." (Rüzgar Kaynağına Dayalı Elektrik Üretimi Başvurularının Teknik Değerlendirmesi Hakkında Yönetmelik, 2015).

In order to increase the use of renewable energy in Türkiye, the Yenilenebilir Enerji Destekleme Mekanizması (YEKDEM), support for domestically manufactured components used in facilities generating electricity from renewable energy sources (Yerli Aksam), and competitions to determine of Yenilenebilir Enerji Kaynak Alanları (YEKA) are implemented (Albayrak, 2024).

Accordingly, the purpose of the "Yenilenebilir Enerji Kaynak Alanları Yönetmeliği / YEKA Regulation" dated 09/10/2016 is "to use renewable energy resources effectively by creating renewable energy resource areas in public and treasury real estates and privately owned real estates, to realise investments rapidly by allocating these areas to investors, to ensure that advanced technology components used in electrical energy generation facilities based on renewable energy resources are produced domestically or procured domestically, and to contribute to the transfer of technology" (Yenilenebilir Enerji Kaynak Alanları Yönetmeliği, 2016). Within the scope of the Regulation, capacity allocation competitions are held on the areas called YEKA (Kütükcü & Yalılı, 2022).

However, in the Law No. 5346 and YEKA Regulation, the areas declared as YEKA are defined as "public and treasury territory and immovables subject to private ownership". In this context, it is seen that the areas declared as YEKA refer to onshore installations (Kütükcü & Yalılı, 2022). For this reason, in the Law on the"Maden Kanunu ile Bazı Kanunlarda Değişiklik Yapılmasına Dair Kanun" dated 02/05/2024 and in the title of Article 6 of the Coastal Law No. 3621 the phrase "in the sea" was changed as "in water areas". At the same time, the phrases "Renewable energy production plants can be established in seas, dam lakes, artificial lakes and natural lakes declared as renewable energy resource areas by the Ministry of Energy and Natural Resources, excluding reservoirs and wetlands where drinking water is supplied and coasts and shorelines within the scope of this Law, without making a zoning plan" were added (Maden Kanunu ile Bazı Kanunlarda Değişiklik Yapılmasına Dair Kanun, 2024).

In Türkiye, domestic and renewable energy resources are more than sufficient to meet the country's needs in terms of electrical energy generation, provided that the right policies are followed (Kütükcü & Yalılı, 2022). In this regard, studies are ongoing to reduce external dependency on energy, increase

the use of local resources and increase the share of renewable energy resources (T.C. Dışişleri Bakanlığı, 2022).

In the Strategic Plan 2024-2028 of the Ministry of Energy and Natural Resources, 7 objectives and 31 targets were determined with the principle of sustainability and nationality for the increasing need for energy and natural resources, and 113 performance indicators were established for these targets. It is envisaged to increase the share of electricity generation based on renewable energy resources in total generation from 43% to 50%. In order to utilise offshore renewable energy resources in this direction, strategic decisions were taken stating that studies should be carried out for the installation of renewable energy plants such as offshore wind power plants and floating solar power plants (Enerji ve Tabii Kaynaklar Bakanlığı, 2024). In this regard, it is also seen that Turkey has begun to make political decisions to increase floating renewable energy installations.

3. Technical Specifications for the Design of Hybrid Floating Renewable Energy Structure Systems

The energy required for coastal settlements, public areas, or coastal parks in Turkey's coastal areas can be met from modular floating renewable energy structures that are compatible with the coastal edge line and have high aesthetic quality. In this respect, floating carrier foundation structure design and renewable energy system technical details were analysed. In addition, the floating energy power plant developed as a proposal in the “Sustainable Floating Urban Park Model: The Case of Fethiye” doctoral thesis study was given as an example.

3.1. Design concept and principles of floating renewable energy foundation structure system

It is important that floating renewable energy foundation system remain stable on the water and and do not hinder energy production efficiency. In this respect, the building materials used should be durable, long-lasting, recyclable and have features that minimise environmental problems.

When the materials used in the design of floating foundation structure are analysed, although regarding durability and stability concrete has high-pressure strength, nevertheless it has low-tensile one. Steel is implanted inside the concrete structure to reinforce the tensile strength. When the concrete coating thickness is increased to prevent corrosion of the steel, the weight of the structure also increases. For this reason, Fibre Reinforced Concrete applications are developing (El-Shihy & Ezquiaga, 2019).

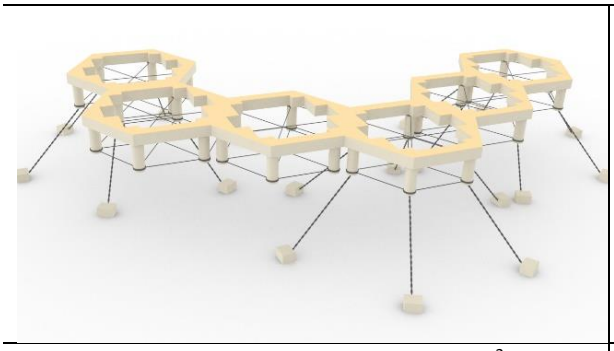
Expanded Polystyrene Concrete floating structure designs combined with concrete and foam are lightweight, stable and flexible to the movement of the structure (Koekoek, 2010). At the same time, it is environmentally friendly, has zero carbon footprint and supports sustainability features (Vu, 2016). In this respect, it is preferred more in floating foundation structures.

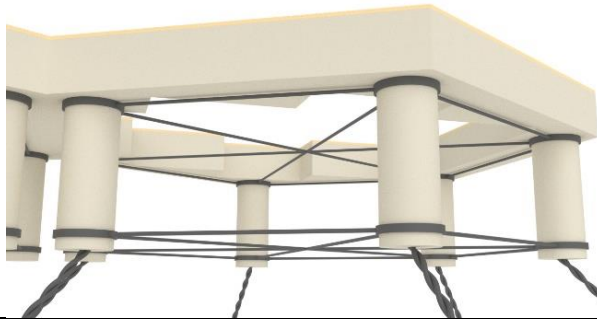
Other factors to be taken into consideration when determining floating renewable energy structures are listed below.

- Floating renewable energy foundation structures are in constant movement in the wave loads marine environment. This situation reduces or changes the energy production (Claus & López, 2022). Therefore, the floating structure must be able to remain stable and ensure structural safety.
- Since floating energy structures are exposed to wind and wave loads, attention should be paid to corrosion when selecting the construction materials (Claus & López, 2022). Waterproof concrete and steel with appropriate standard properties should be used to prevent corrosion of steel reinforcement in concrete.
- Considering natural and environmental factors, the materials used should have ecological properties and should not contain environmental pollutants. In this respect, sustainable building materials with high recycling rates should be preferred.
- The use of local materials should also be considered in order to reduce the cost of floating energy structures.

In the doctoral thesis study titled Sustainable Floating Urban Park Model: The Case of Fethiye, the floating power plant concrete foundation structure system was designed in a hexagonal form with a center hollow in order not to block the sunlight required for underwater ecosystems. EPS foam filled concrete columns with a diameter of 150 cm and a length of 400 cm were placed at the corners of the floating structure in order to increase the buoyancy and to keep the module balanced in the water. The column length was determined by considering the wind turbine height (500 cm and 1000 cm). These columns were placed on the base of the main body consisting of 150 cm high EPS foam filled concrete material. The six columns were connected to each other from top and bottom with steel connection elements. A cross connection was provided between all opposing columns and the centre. Natural looking laminated wood was used as the covering material on the upper part (Table 1).

Table 1. Example of floating renewable energy foundation structure design





Foundation structure area	205 m^2	Hexagonal steel column connection
Main body	150 cm	Cross steel column connection
Foundation sub-column	150 x 400 cm	Centre steel column connection

In order to keep the modules stable under the effect of waves and to prevent displacement, they were connected to the underwater concrete blocks with a steel anchor system.

3.2. Technical specifications of floating renewable energy systems

The hybrid use of renewable energy systems installed on floating structures provides better results in different climatic conditions. In this respect, solar energy, wind energy and wave energy are emerging as technologies that are being used in hybrid use (Habibi, 2015).

Floating solar energy is generally limited to inland water bodies such as lakes, ponds or hydroelectric dam reservoirs that do not have wave motions. The float consists of the PV modules and their supporting system, which supports the weight of the modules and transmits the stresses on the float, electrical equipment, mooring and anchoring elements (Oliveira-Pinto & Stokkermans, 2020).

Wind energy is divided into two types according to the rotation axes of the turbines: horizontal axis and vertical axis. Horizontal axis wind turbines are systems that have high noise generate and can cause negative environmental effects. Vertical axis wind turbines are easy to manufacture and install, produce less noise and can operate in omni-directional winds. In addition, vertical turbines can generate electrical power at low wind speeds and create more cost-effective performance (Rajpar, Ali, Eladwi & Bashir, 2021).

Since wave energy is affected by wind pressures and physical conditions, wave height, wave length and wave period determine the energy to be obtained. Therefore, electricity generation with wave energy differs from other renewable energy sources. In general, wave energy converters are divided into three categories as oscillating water column, overtopping devices and wave activated bodies (Amir, Sharip, Muzanni & Anuar, 2016).

In the doctoral thesis study titled Sustainable Floating Urban Park Model: The Case of Fethiye, the solar, wind and wave energy systems were used considering the carrying capacity of the floating structure. For the solar energy panel, 380 W, high nominal power and monocrystalline 72-cell panel system of Anchor by Panasonic was preferred (Anchor by Panasonic, 2022). Since wind energy is an important input in renewable energy production, a vertical axis Senwei Energy Technology wind

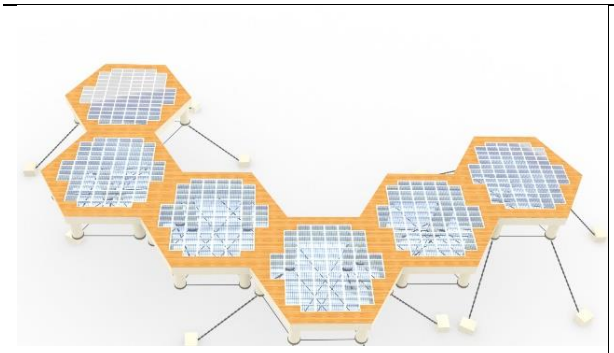
turbine with high nominal power was used (Senwei Energy Technology, 2022). Two different mast lengths of 500 cm and 1000 cm were determined in order to benefit optimally from the wind angle and the turbine placement was positioned so as not to block the wind angle. For the wave energy converter, a floating two-body, multi-point, wave absorber converter described in Guo et al. (2022) was preferred. Since no system suitable for the size of the floating structure and providing energy calculations was found in the literature, the WaveStar C6-600 kW model wave energy converter (WaveStar, 2022) was used scaled down to 1:10, to cover the surroundings of the floating structure. However, an approximate value was taken as a suggestion for wave energy calculation. Technical details of solar, wind and wave energy company products are shown in Table 2.

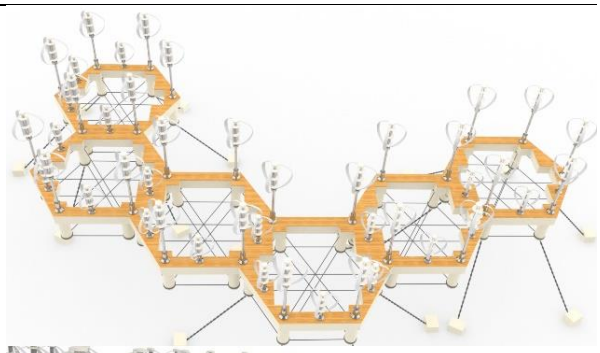
Table 2. Solar, wind and wave energy company product features used on the floating renewable energy structure

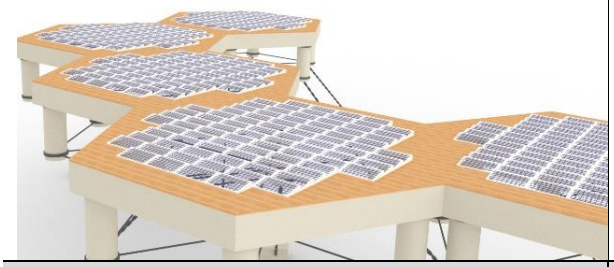
SOLAR		WIND		WAVE	
Feature	Monocrystalline	**Rotor diameter**	4 m	**Diameter of the float**	600 cm
Weight	22.5 kg	**Rotor weight**	460 kg	**Length of steel arm**	1200 cm
Cells	72	**Wing length**	4 m	**Maximum water depth**	20 m
Panel size	1985 x 1003 x 40 mm	**Commissioning wind speed**	2 m/sec	**Maximum wave height**	8 m
Nominal power	380 Wp	**Nominal power**	10 kW	**Nominal power**	30 kW

In the doctoral thesis study titled Sustainable Floating Urban Park Model: The Case Of Fethiye, the power values of the hybrid floating energy plant were calculated approximately. The total power calculations of solar, wind and wave energy systems are given in Table 3.

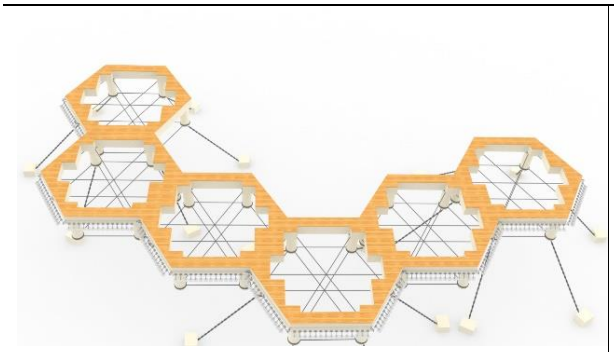
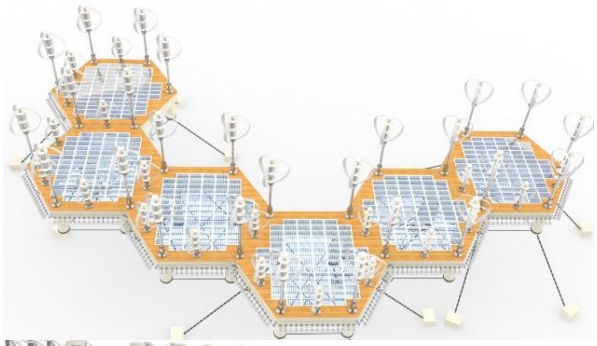
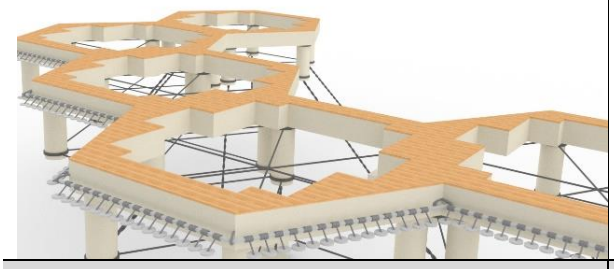
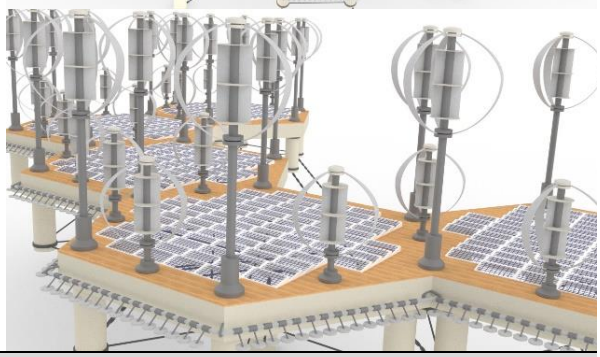
Table 3. Total power calculations of solar, wind and wave energy systems







Solar Energy		Wind Energy	
Type	PV	Type	Darrieus Savonius
Power	380 Wp	Power	10 kW
Number	528	Number	46
Total Installed Power	~200 kW	Total Installed Power	460 kW

Wave Energy		Hybrid Power Plant	
Type	Reciprocating Converter	Solar energy TIC	200 kW
Power	1 kW	Wind energy TIC	460 kW
Number	206 kW	Wave energy TIC	206 kW
Total Installed Capacity (TIC)	206 kW	**TOTAL**	**866 kW**

As a result of the approximate power calculations obtained regardless of the ambient conditions, a total value of 866 kW was reached. However, since the floating energy structure was developed as a proposal, energy potential calculations were not performed.

4. Evaluation and Discussion of Hybrid Floating Renewable Energy Plant Example

Floating energy structures can be implemented in protected coastal regions or partially sheltered waters and offshore areas (Martinez & Iglesias, 2024). Coastal areas and the open seas provide the large area utilization needed for renewable energy production and support sustainable energy production. Floating energy systems have many environmental, economic and technological advantages in coastal areas.

Floating energy structures have advantages such as preventing land loss and deforestation (Bulut et al., 2018; Dünya Bankası Grubu, ESMAP & SERIS, 2019; Şenli, 2023), preventing soil pollution and erosion, preventing damage to bird migration routes and ambient creatures, reducing ecological destruction (Ferrer Gisbert, Ferrán Gozálvez, Redón Santafé, Ferrer Gisbert, Sánchez Romero & Torregrosa Soler, 2013), obtaining relatively lower ambient temperature required for photovoltaic systems (Ferrer Gisbert et al., 2013; Bulut et al., 2018; Claus & López, 2022; Şenli, 2023). These advantages are important factors for the development of floating energy systems and increasing their application areas.

In this respect, evaluations were made regarding the foundation structural features, energy systems and sustainability dimensions in terms of the development of hybrid floating renewable energy structure systems in the coastal areas of Türkiye.

Evaluation and discussion of the floating foundation structure findings:

Floating structures are functional and can be constructed easily and quickly (Kizilova, 2019). Additionally, it has an easy transport feature (Huang et al., 2023). In this respect, the fact that floating energy systems consist of modular structures provides easy installation, relocation and transportation (Kizilova, 2019).

Sea water causes damage to the durability and functionality of floating structures, photovoltaic systems and electrical equipment. Therefore, it is necessary to take anti-corrosion measures and determine the appropriate structural form (Claus & López, 2022; Huang, Tang, Chen, Chen & Jiang, 2023). The floating renewable energy carrier base structure is made of EPS foam filled concrete material, which is also mentioned in different literature applications, and is one of the materials that will reduce the corrosion threat (El-Shihy ve Ezquiaga, 2019; Amphibious Houses, 2021; Engineered Foam Products, 2021; STYRO EPS, 2021).

Land reclamation implemented to obtain land area in coastal cities with narrow coastlines creates high costs for national economies (El-Shihy & Ezquiaga, 2019). However, the installation of energy systems on floating modular structures significantly reduces the cost and prevents the change of coastal form.

Floating energy structures do not require site preparation (Dünya Bankası Grubu et al., 2019). In this respect, the development of floating energy structure systems facilitates their integration into Türkiye's coastal areas.

Evaluation and discussion of the hybrid energy systems findings:

It is possible to generate energy from solar, wind, waves, currents and tidal conditions with different floating energy systems (Chen & Wu, 2024). With a hybrid floating power plant using solar, wind and wave systems, the sustainability of energy production becomes possible in all climatic conditions.

Floating energy installations make it possible to generate clean energy on existing water resources without causing any loss of agricultural or forest land in offshore environments (Claus & López, 2022; Şenli, 2023).

The installation of onshore solar panels can damage valuable land that can be used for agriculture, mining, tourism and other activities (Huang et al., 2023). Floating PV systems prevent land use conflicts, provide an innovative and sustainable approach.

Floating photovoltaic structures significantly reduce evaporation by reducing the water surface temperature (Huang et al., 2023). In this respect, the development of floating energy structure systems contributes to the improvement of the environment by preventing evaporation in water resources.

The cooling effect of water ensures PV systems operate more efficiently (Oliveira-Pinto & Stokkermans, 2020; Claus & López, 2022; Huang et al., 2023; Martinez & Iglesias, 2024). Thanks to the development of floating energy structures, energy performance increases compared to land installations.

Floating photovoltaic systems are difficult to clean and maintain, so malfunctions may occur within the system (Huang et al., 2023). The installation of PV systems on floating structure modules offers easier maintenance and cleaning.

The greater flexibility and scalability of offshore wind energy increases energy efficiency and reduces environmental impact compared to onshore installations (Hong, McMorland, Zhang, Collu & Halse, 2024). In this way, visual and noise distractions are eliminated.

Floating offshore wind turbines experience more severe environmental loads than fixed offshore wind turbines (Hong, 2024). The use and positioning of wind turbines suitable for the size of the floating structure reduces the environmental loads.

Evaluation and discussion of the floating energy structures' sustainability aspects:

Floating energy systems create 5% less environmental impact than fossil resources and generate energy by protecting underwater reservoirs (Kizilova, 2019). Thanks to the power to be generated from the floating energy structure, a solution for efficient and sustainable energy production suitable for environmental conditions is provided.

If the application dimensions of floating energy systems are studied by the relevant disciplines, it will be easier to integrate them into the coastal areas of Türkiye. In this way, renewable energy production that is integrated with coastal ecosystems and considers environmental sustainability is possible.

The production of floating energy structures for coastal areas allows the energy required to be met independently of the grid. Thus, by supporting economic development in coastal areas and increasing the use of renewable energy resources, Türkiye's full independence in energy supply is contributed.

At the same time, it is expected that the carbon footprint will be significantly reduced if the application areas are increased throughout Türkiye.

5. Conclusion and Suggestions

Renewable energy sources are important technologies that provide solutions to the global warming problem. Due to the effects of the global climate crisis, there is a significant growth in land installations of solar and wind energy in the world. However, the scarcity and high price of available land needed for renewable energy installations in coastal cities constitute an obstacle to expansion in coastal areas (Martinez & Iglesias, 2024). In this context, offshore or nearshore environments provide large area utilisation for renewable energy production and emerge as an alternative (El-Shihy ve Ezquiaga, 2019; Martinez & Iglesias, 2024).

While a large portion of energy production in Türkiye comes from fossil resources, floating solar power plant applications on dam lakes are also frequently encountered today (Şenli, 2023). The fact that Türkiye is surrounded by seas on three sides and there are densely populated urban settlements in coastal areas indicates that renewable energy generation should be increased on the seas as well. However, Türkiye's coastal areas generally have narrow borders and the open lands needed for renewable energy installations are insufficient. For this reason, in coastal areas with intensive energy consumption, energy needs are generally met from the grid, increasing public costs. However, the production of different types and sizes of hybrid floating renewable energy technologies and establishing relations them with coastal areas will support Türkiye's green energy generation and facilitate the achievement of sustainability goals.

As a result, hybrid floating renewable energy structures are necessary to meet the energy needs in Türkiye's coastal areas, as they will minimise environmental damage and provide sustainable energy supply. At the same time, it creates advantages that play an important role in reducing Türkiye's ecological footprint, provide coastal cities with a new added value and identity in terms of energy, increase social environmental consciousness and awareness, and contribute to the economy. At this point, new decisions are being made in the legislation regarding offshore installations in our country and strategic targets and goals are being determined in energy generation. However, since there are no hybrid combinations of floating energy systems in Türkiye today, it is necessary to study the developments and innovative solutions in floating renewable energy technology in the future. In order to increase the applicability of floating energy systems for Türkiye, the following recommendations should be considered.

- Hybrid renewable energy systems should be decided by taking into account factors such as Türkiye's climatic characteristics, environmental conditions and social dimensions.
- Sustainability criteria should be taken into consideration when determining the material use, structural form and size of floating energy structure modules.
- Numerical analysis methods should be developed for optimum location selection of floating energy structures.
- Cost reports should be prepared as an example for future studies.
- R&D and scientific activities should be carried out for the development of floating renewable energy structures.
- In order to increase its use in coastal areas of Türkiye, all design and implementation stages should be detailed in the laws and regulations.

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Challenges and Proposed Solutions in Modes of Transportation at International Airport Operations; Sabiha Gökçen Airport Sample

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Abstract

The historical development of transportation, dating back to the pre-recorded history, began primarily with the people's access to resources. Later, it diversified with the addition of different modes of transportation, and gained its modern definition of the movement of people, goods and services for a purpose. Development in transport is directly proportional to the level of development of societies, given globalizing world and economy of today. In this context, the main focus of the study is the airport operations, having become one of the main sectors of major economic size in the world, which involve or integrate with almost all modes of transportation (air, waterway and land transportation). Within the scope of the study, the current status of the modes of transportation at Sabiha Gökçen Airport, the second largest airport in Turkey, was identified and the problems encountered in these modes of transportation were addressed. As a result, proposals were presented for the challenges encountered in the integration of all modes of transportation and their individual setting-up.

Keywords: *Airport operations, integration, transportation, modes of transportation.*

Uluslararası Havalimanı İşletmelerinde Ulaşım Türlerinde Yaşanan Sorunlar ve Çözüm Önerileri; Sabiha Gökçen Havalimanı Örneği

Öz

Kayıtlı tarihten öncesine dayanan ulaşımın tarih içerisinde gelişimi, öncelikle insanların kaynaklara ulaşımı ile başlamış, sonrasında çeşitlenerek farklı ulaşım araçları da eklenmiş, modern dönemde insanların, malların ve hizmetlerin bir amaç uğruna yer değiştirmesi tanımına uygun niteliğe dönüşmüştür. Ulaşımdaki gelişmişlik, günümüzde küreselleşen dünya ve ekonomi dikkate alındığında toplumların gelişmişlik derecesi ile doğru orantılıdır. Bu noktadan hareketle, dünya üzerinde başlıca ekonomik büyüklüğe sahip bir sektör durumuna erişen ulaşımın neredeyse tüm türlerini (havayolu, su yolu ve kara ulaşım) içerisinde barındıran veya bu türler ile entegre olan havalimanı işletmeleri bu çalışmanın ana konusunu oluşturmaktadır. Çalışma kapsamında Türkiye'nin 2. büyük havalimanı olan Sabiha Gökçen Havalimanı'nda yer alan ulaşım türlerinin mevcut durumları tespit edilerek, bu türlerde yaşanan sorunlar ele alınmıştır. Sonuç olarak tüm ulaşım türlerinin kendi içerisindeki entegrasyonu ve münferit olarak tesisinde yaşanan sorunlara yönelik çözüm önerileri sunulmuştur.

Anahtar kelimeler: *Havalimanı işletmeleri, entegrasyon, ulaşım, ulaşım türleri.*

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1. Introduction

Transportation is one of the main factors of development as well as indicating the level of economic development of countries. From the beginning of humanity to the present day, transportation has been a necessity to meet basic needs and also a phenomenon for the masses to have access to goods and services. There are three main modes of transportation, and air transportation, the most high-tech of them, is the main subject of the study.

Air transportation, which enables reaching long distances in short periods, is seen as an attractive option due to the increasing comfort, reliability, and speed provided by its services and advancing technology. So much so that a growing airline network has formed worldwide. Throughout the day, thousands of airplanes participate in air traffic globally, transporting passengers and cargo (Arabacı, 2010). Air transportation is also rapidly developing in our country. According to data from DHMI, there is an increase in the number of people preferring air travel in our country. For places without airports, travelers journey to the nearest airport and continue by road transfer. To promote the proliferation of air transportation in our country, the number of airports is increasing. The number of flight points in our country increased from 26 in 2003 to 58 by 2019 (SHGM a, 2019). The increase in airports not only facilitates transportation but also provides employment to the region where they are located (Erdoğan & Ercoşkun, 2021).

While air transportation is covered within the scope of the study, the other modes of transportation required for this service are also examined, and airport operators, which integrate all these modes of transportation, are scrutinized.

The study focuses on the sample of Sabiha Gökçen Airport in examining the modes of transportation at the airport operations. Problems encountered during the development of modes of transportation at the airports and further problems in their integration were addressed.

The study presents problems related to transportation in Airport Operations, which covers almost all modes of transportation, and solution proposals to these problems.

1.1. Overview of the Concept of Transportation

Transportation is a word of Latin origin, formed by the combination of “trans” (from one place to another) and “portare” (to carry). In English, transportation is also expressed with the word “transport”. In Ottoman Turkish, it corresponds to the words, “münakale”, “münakalat”, “muvasala” (inservient, intermediary), and nowadays, it is expressed with the words “ulaşım”, “nakliye” and “taşımacılık” in Turkish (Tümertekin, 1987).

The history of transportation dates back to times even before recorded history. Initially, people formed footpaths and routes with their desire to hunt animals to meet their food needs. As civilization progressed, agricultural activities and settled life began to emerge. This led to the formation of routes between settlements. In fact, we can consider these routes as the prototype of modern highways. Later on, humans started to use animals as pack animals, which were pivotal in transportation, and interestingly, transportation still relies on animal power in underdeveloped regions. However, when thinking about transportation in the modern sense, it's essential to consider the Industrial Revolution, which began around 150-200 years ago. The Industrial Revolution, the defining epoch of humanity, brought about entirely new effects on societies, shaping people's lifestyles, expectations, consumption patterns, and so forth. Modern transportation began with the replacement of human power by machines. The mass production and travel of goods and services constitute the fundamental factors of modern life, and thereore, the development in these factors can only be possible through the advancement of transportation (Kadiyali, 2016).

Today, the level of development of a society is also measured by the progress in transportation. In other words, the development in transportation forms the dynamism of social development. It is well known that the discovery of railways significantly contributed to the modernization of the transportation system. Although transportation in its modern sense started with the discovery of railways during the Industrial Revolution, motor vehicles also emerged during this era and established

the automobile as a cornerstone of the economy with its production, fuel, and various other aspects. It can be said that thanks to such developments, the concept of modern transportation emerged entirely during this era (Akın & Sultanoğlu, 2006).

The traditional purpose of transportation is to enable people to access goods and services. Transportation is a widely provided service, similar to other public services. It plays a crucial role in various aspects such as economy, utilization of natural resources, the quality and preservation of goods and services, acceleration of agricultural development, tourism, defense, meeting strategic needs, managing vast areas, disaster management, and so on (Zimmerman, 2012).

Transportation is affected by crisis situations, but at the same time, it has the ability to cope with them. While some of the numerous dangers present in daily life affect transportation and its users, others can lead to different outcomes (Zimmerman, 2012).

Today, transportation is not only a field of science but also an indispensable primary infrastructure for all sectors. It has become a sector with significant economic importance worldwide due to the economic value it creates. As civilization advanced and inventions proliferated, people began to move, and besides this movement of people, goods produced in one place were also transported to entirely different locations along with people (Doğan, 2015).

1.2. Modes of Transportation at the Sample of Sabiha Gokcen Airport

The Advanced Technology Industrial Park and Airport Project (ITEP) was planned as a development project aiming to create a dynamic, scientific, technological, and, more importantly, local infrastructure for economic growth, technological development, and global competitiveness, involving the commercialization of technology through effective public and private sector investments (ARUP, 2008). The project, which began in 1987 with the expropriation of the necessary areas and construction works, consists of three main components: an airport, a technopark, and aviation maintenance repair-overhaul centers. A total of 1301 hectares of land were expropriated for the ITEP project, and, the construction of Sabiha Gökçen Airport, one of its most significant elements, was completed in 2000, and the airport is opened to passenger and aircraft traffic in 2001 (SSB, 2024)

1.2.1. Air transportation

When Sabiha Gökçen Airport opened in 2001, it served only to 47,000 passengers. Until 2005 when Pegasus Airlines was acquired by Esas Holding and began to use this airport as a main base for scheduled flights, unscheduled private (charter) flights were conducted during this period (HEAŞ a, 2024) (Figure 1).

Figure-1. Sabiha Gokcen Airport (2001-2009) (Google Earth Image, 2001)

With the commencement of scheduled flights in 2005, it was anticipated that the existing terminal structures would be insufficient due to steady growth. Therefore, in 2007, when the annual passenger count reached approximately 4 million, a build-operate-transfer (BOT) tender was held for the New Terminal and Ancillaries project. The newly established infrastructure capacity quickly filled up due to the increasing demand (Figure 2).

Figure-2. Sabiha Gokcen Airport (2009) (Google Earth Image, 2009)

The New Terminal Building and Ancillaries project was opened in 2009, and since then, significant infrastructure investments have been made at the airport to increase its aircraft and passenger capacity. These investments include additional aircraft parking areas, rapid exit taxiways, and an additional dock block. (SHGM b, 2009)

The construction of the Second Runway project, which began in 2012, was completed and the runway opened on December 25, 2023. This eliminated capacity issues on the air side of the airport, and the terminal capacity, where passenger services are provided, became a bottleneck. As a result, work for a new terminal (Terminal III) has begun to address this issue (Figure 3).

Figure-3. Sabiha Gokcen Airport (2023) (Google Earth Image, 2023)

The rapid and record braking growth of the passenger numbers can bee seen in Figure 4 and Table-1.

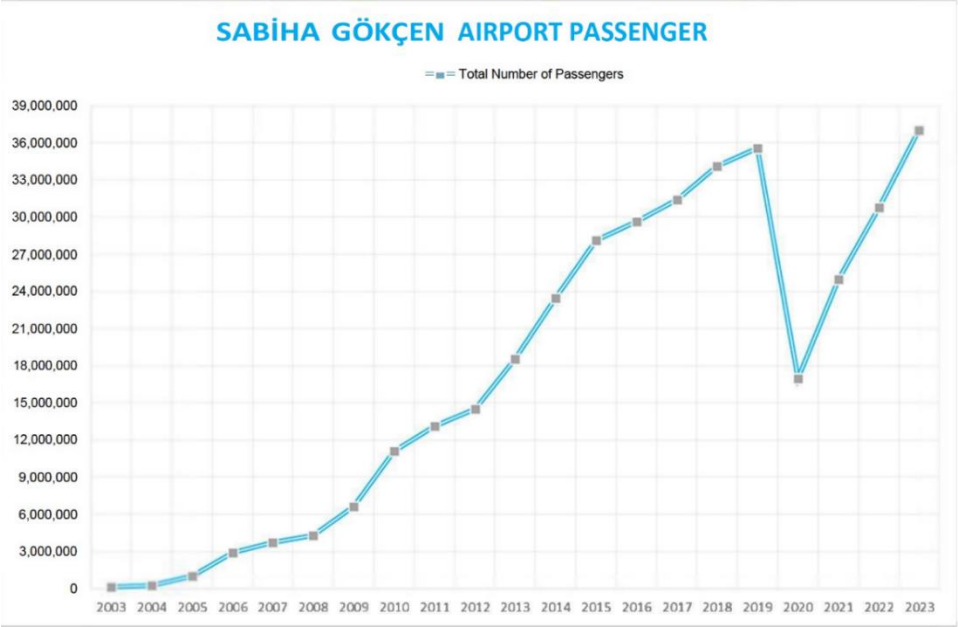

Figure 4. Sabiha Gokcen Airport Number of Passengers Annually

Table-1. Sabiha Gokcen Airport Annual Passenger Numbers (DHMI)-2023).

İstanbul Sabiha Gokcen Airport Number of Passangers Annually				
Year	**Domestic**	**International**	**Total**	**Change %**
2023	17,661,416	19,368,589	37,030,005	▲20%
2022	15,218,165	15,551,563	30,769,728	▲24%
2021	16,122,988	8,845,773	24,968,761	▲47%
2020	11,687,578	5,263,612	16,951,190	▼-52%
2019	21,505,088	14,055,522	35,560,610	▲4%
2018	22,514,048	11,619,569	34,133,617	▲9%
2017	21,056,767	10,329,074	31,385,841	▲6%
2016	20,196,261	9,471,592	29,667,853	▲6%
2015	18,525,649	9,583,089	28,108,738	▲20%
2014	14,955,571	8,539,075	23,494,646	▲27%
2013	11,928,074	6,593,688	18,521,762	▲26%
2012	9,486,469	5,000,773	14,487,242	▲10.0%
2011	8,704,249	4,420,421	13,124,670	▲17.3%
2010	7,435,158	3,694,314	11,129,472	▲71.0%
2009	4,547,673	2,092,285	6,639,958	▲52.3%
2008	2,764,856	1,516,337	4,281,193	▲15.1%
2007	2,528,549	1,191,946	3,720,495	▲27.6%
2006	2,153,561	762,893	2,916,454	▲186.0%
2005	559,824	459,922	1,019,746	▲315.2%
2004	10,323	235,278	245,601	▲56.3%
2003	2,826	154,346	157,172	-

1.2.2. Waterway Transportation

Maritime Transportation

DFDS Pendik Port, located just 12 km away from Sabiha Gokcen Airport by road, has been providing transportation to Italy's Trieste Port since 1994. Air and maritime transportation, which play an important role in freight and cargo transportation, is integrated at these points (Figure 5).

Figure-5. DFDS Pendik Port and Sabiha Gokcen Airport (DFDS, 2024)

Inland Water Transportation

IDO Pendik Ferry Terminal, located just 15 km away from Sabiha Gökçen Airport by road, has been in operation since 1998. The terminal initially operated only between Tuzla-Pendik-Kartal-Kabataş-Karaköy in the morning and evening. However, nowadays, it has become one of the busiest points connecting Yalova to Istanbul via high-speed ferries. Additionally, Bostancı Terminal, which can be integrated with buses, offers ferry services to both the Princes' Islands and many other docks in Istanbul (IDO, 2023). (Figure 6).

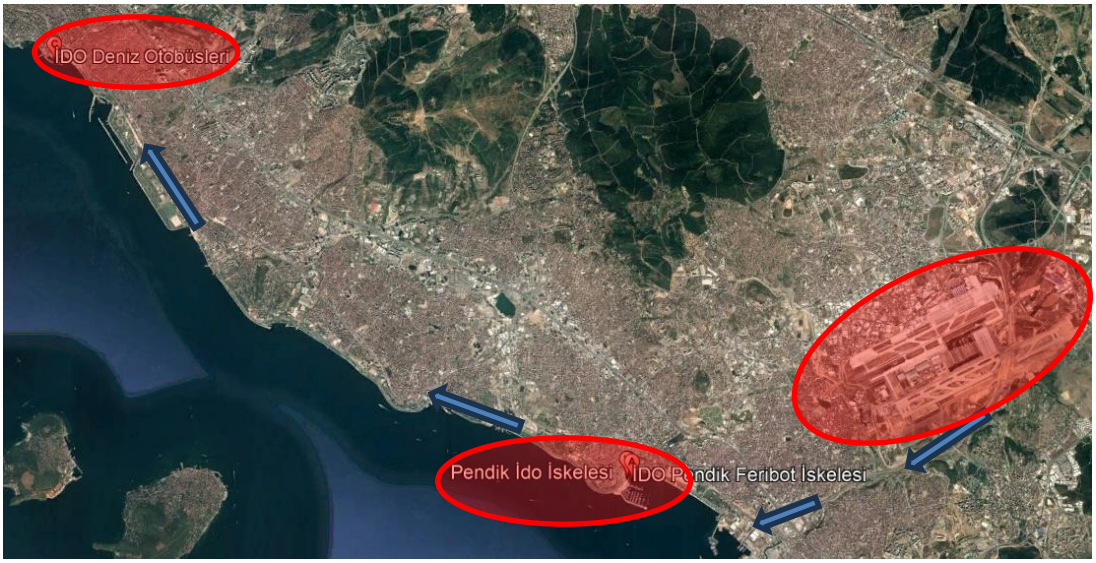

Figure-6. Pendik and Bostanci IDO Terminals and Sabiha Gokcen Airport (IDO, 2023)

1.2.3. Land Transportation

Road Transportation

Sabiha Gökçen Airport is located between two main highways connecting to Istanbul: the O-4 (TEM) to the east and the D100 (E-5) to the west. It is easily accessible from the airport to these two highways using the TEM-E5 link road.

Furthermore, the North Marmara Highway (O-7), opened at the end of 2020, also provides an alternative route for accessing the airport (Figure 7).

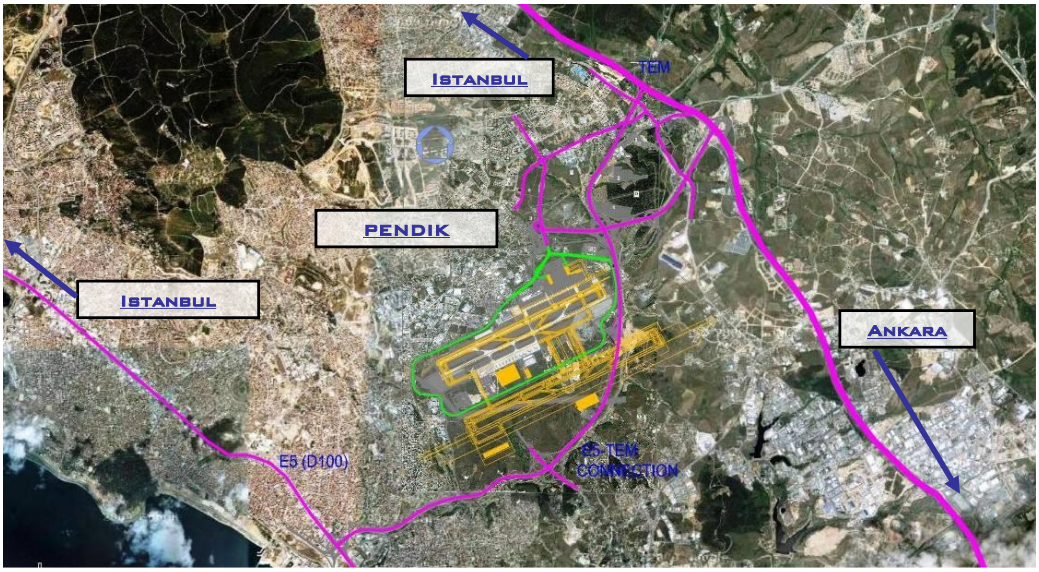

Figure-7. Road Transportation of Airport (ARUP, 2008)

The TEM highway is a toll road with three lanes and serves as the primary access route to the airport. Access to the airport from the TEM highway is provided via the Sabiha Gökçen Airport cloverleaf interchange on the TEM-E5 link road, which has two lanes. Transportation provided from the two-lane E5 highway on the west side of the airport also utilizes the same cloverleaf interchange.

Passengers can reach the airport using private vehicles, taxis, or public transportation (buses) via the aforementioned highways.

SawKoop company operates the transportation from the airport to the city center by taxi.

For public transportation from the airport to the city center, the following İETT bus lines (10 lines) or Havabus services are available.

Due to its location and catchment area, Sabiha Gökçen Airport serves not only to Istanbul but also to Bursa, Izmit (Kocaeli), and Sakarya (Adapazarı) provinces. Regular bus services from the airport to these provinces, which are at a distance of 1.5-hour from the airport by road, have been provided through mutual agreements with the local governments of these provinces. Ulaşımpark (İzmit) started its passenger transportation services in 2016, followed by Burulaş (Bursa) in 2017, and Havasak (Sakarya) in 2020.

Additionally, since the opening of the new Istanbul Airport in 2019, shuttle services connecting the two airports have been operated by Havaist.

In June 2023, bus services from Balikesir (BTTBUS) to airport have been started (Figure 8).

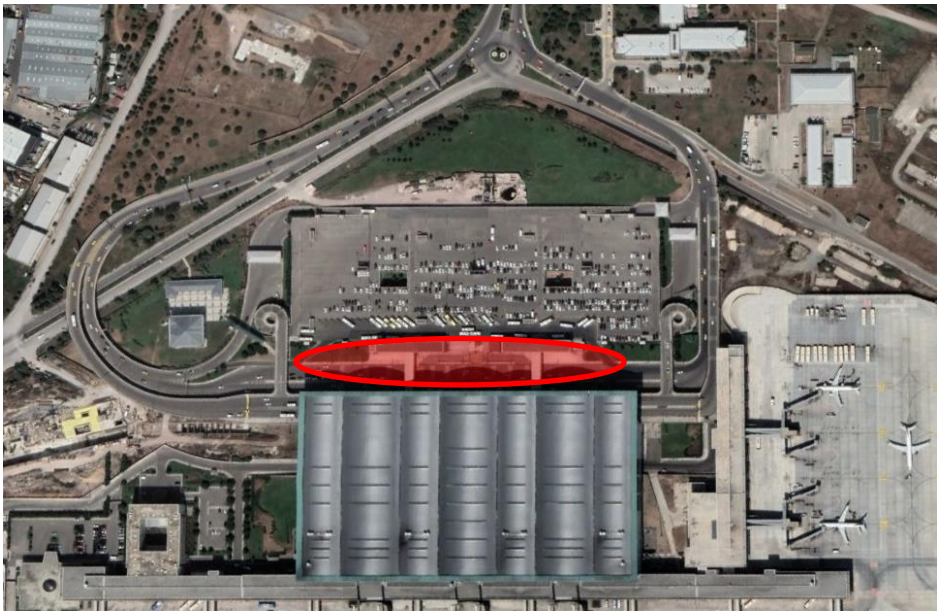

Figure-8. Bus Parking at the Airport (Google Earth Image, 2024)

Railway Transportation

Marmaray and Metro

Until 2022, Sabiha Gökçen Airport was accessible only by road. There are planned railway systems and also construction works of some of them continue. Once completed, these lines will provide significant alernatives for the transportation to and from the airport.

The initial planning was made for connecting Marmaray to both Atatürk and Sabiha Gökçen Airports based on a conceptual project prepared by Doğan Engineering and Consultancy company for the General Directorate of Railways, Harbors, and Airports Construction (DLH) Marmaray Regional Directorate in 2005.

In 2008, the status of the railway network was as follows:

- To the southwest of Sabiha Gökçen lies Marmaray, Istanbul's main railway line, extending in east-west direction and connecting Ankara to Istanbul.
- The Kadıköy-Kartal M4 metro line, located on the Asian side of Istanbul and under construction along the E5 highway, connects the west and east on the Anatolian side.
- The Pendik-Sultanbeyli metro line, for which project studies are ongoing by Istanbul Transportation Inc., aims to connect the airport to the Kadıköy-Kartal metro line and Marmaray.

DLH conducted project studies for another metro line which would directly connect the airport to Marmaray, preferably at grade. This line, along with a branch from Marmaray to Atatürk Airport, would ensure the medium to long-term connection of Sabiha Gökçen Airport to Atatürk Airport via a rail system.

The relevant authorities, DLH and Istanbul Transportation Inc., conducted joint efforts for these two significant projects.

The routes of the lines planned by the institutions are shown below (Figure 9).

Figure-9. Rail Lines 2008 (ARUP, 2008)

In meetings held with officials from Istanbul Metropolitan Municipality (İBB) and Istanbul Transportation Inc. in 2009, discussions were conducted regarding the location of the station to be established within the airport for the Pendik-Sultanbeyli Line.

In meetings with DLH in 2010, it was stated that the Marmaray line would be considered independently of the İBB project and its construction would also be carried out independently. Following ongoing discussions, a solution was developed in 2014, which involved only the connection of the Kadıköy-Kartal-Kaynarca metro line to Sabiha Gökçen Airport, with integration with the Marmaray project at Pendik Station in the future (Figure 10).

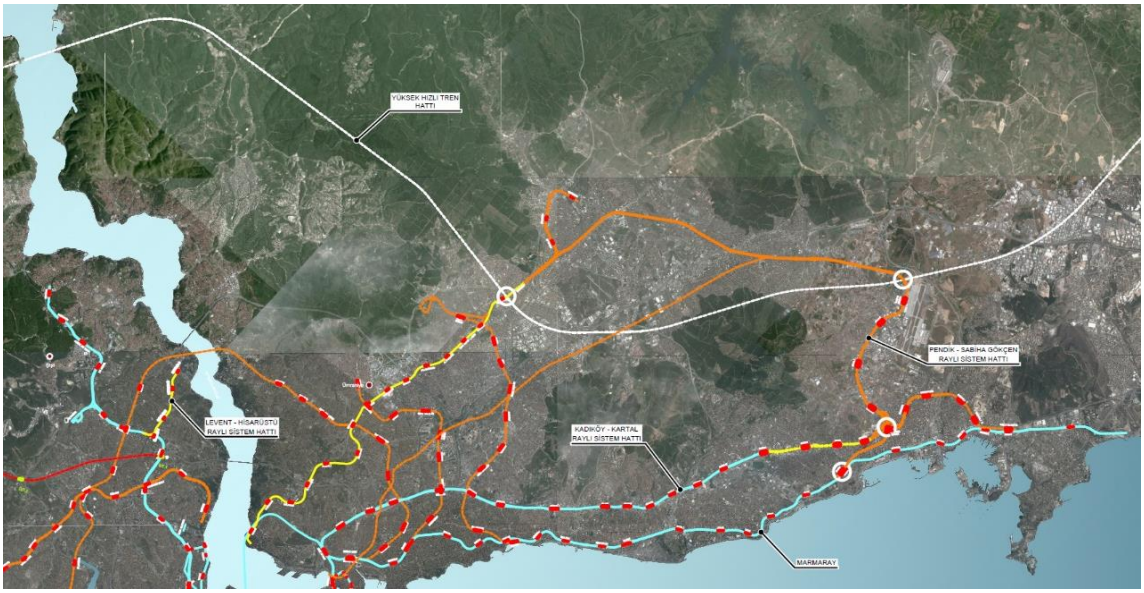

Figure-10. Rail Lines 2014 (DLH, 2014)

In 2014 and 2015, studies were conducted to determine the location of the station within the airport premises, and a final decision was made on its current location. The decision-making process prioritized minimizing the impact on airport operations while ensuring that passengers could reach the terminal building in the shortest distance possible. Additionally, considering construction difficulties, the most ideal location for the station structure was determined.

The Sabiha Gökçen Airport Metro Connection Line was opened on October 2, 2022 (Figure 11).

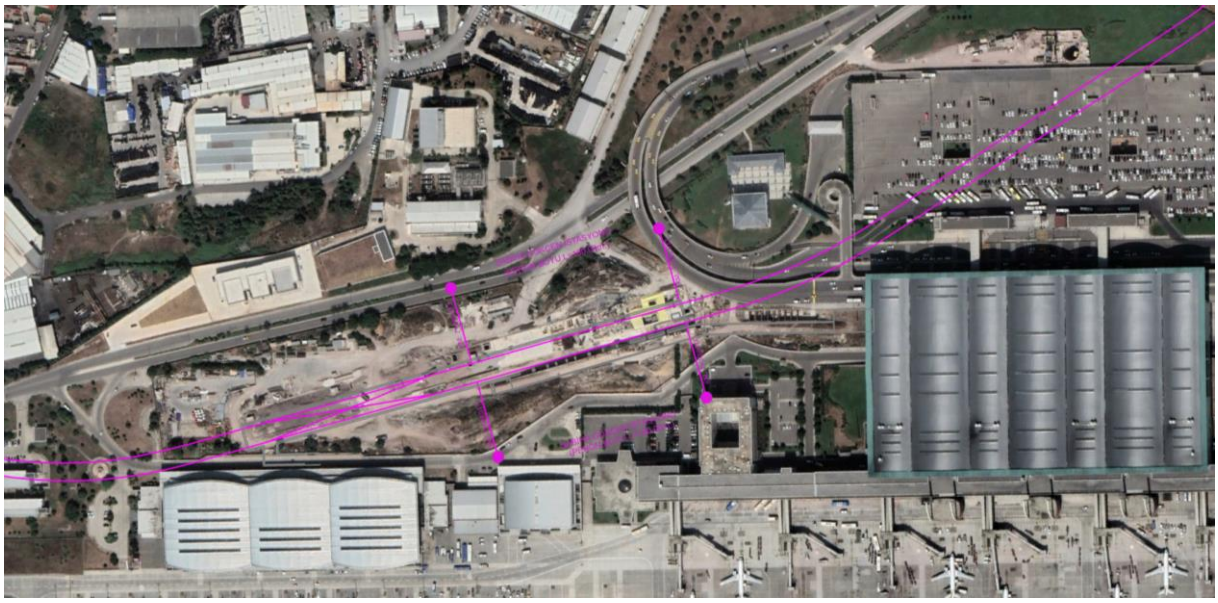

Figure-11. Structure of Sabiha Gökçen Airport Connection Station of Kadıköy-Pendik Line 2021 (AYGM, 2021)

In the fourth quarter of 2019, Istanbul Metropolitan Municipality (İBB) commissioned project studies for the extension of the Çekmeköy-Sultanbeyli Line to the airport under the project titled "Implementation Project Work for the Veysel Karani-Sabiha Gökçen Airport Rail System Line and Kurtköy Depot and Sorting Area Rail System Line." A meeting was organized for this purpose. During the evaluation, it was noted that there was no available space for an additional station considering the ongoing metro connection works by AYGM in the existing terminal area and the operational requirements of the airport. Additionally, it was mentioned in the same meeting that construction of a new terminal was planned between the two runways after the construction of the Second Runway, and it was requested to plan the route of the line accordingly to accomodate a station at this point (Figure 12).

Figure-12. Veysel Karani – Sabiha Gökçen Airport Rail Line 2019 (IBB, 2019)

High-Speed Train

As part of the High-Speed Train Adapazarı-Istanbul North Crossing project commissioned by the Turkish State Railways (TCDD) to the SWS company, the first meeting regarding the Sabiha Gökçen Airport connection was held in 2011. In January 2012, the first alternative settlement plan was prepared and shared with all relevant institutions (Figure 13).

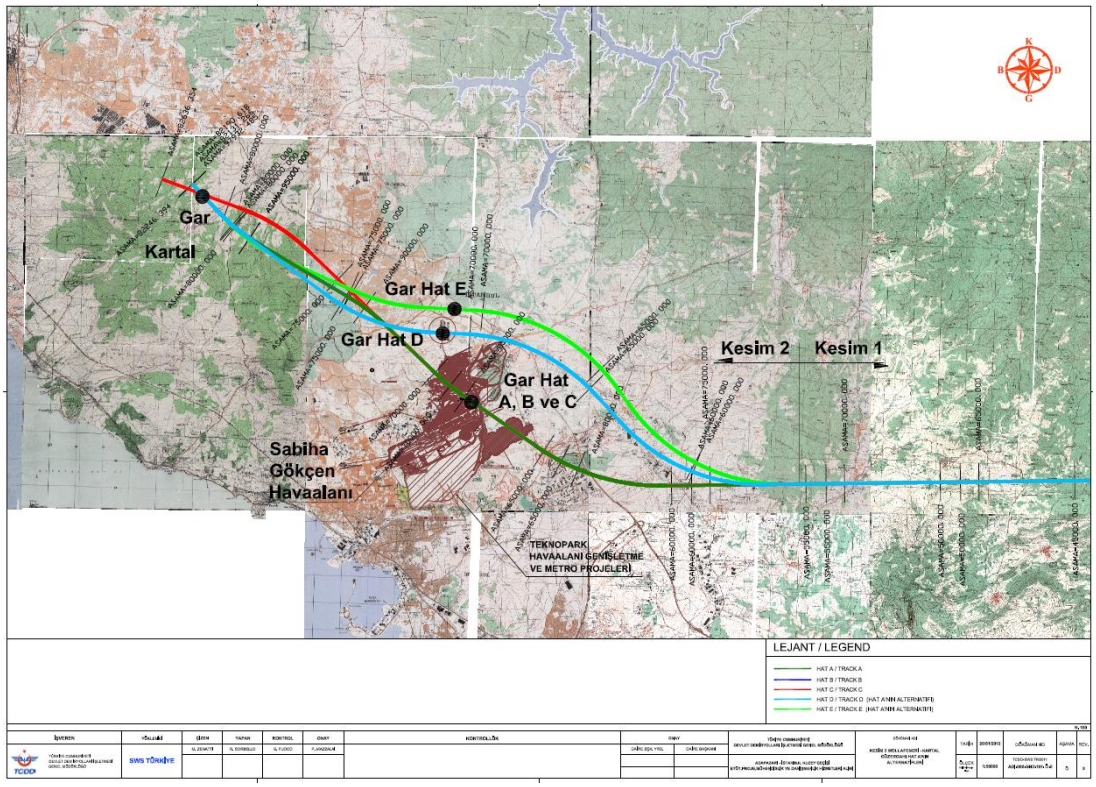

Figure-13. High-Speed Train Adapazarı-Istanbul North Crossing, 2012 (TCDD, 2023)

The station within the airport was initially designed to be situated at-grade on the fuel farm, where fuel tanks that supply fuel to aircrafts are located. However, after assessments concluding that implemention of this design was not feasible, efforts were made on alternative designs where the line was planned entirely as a tunnel and the station was relocated underground. Following these efforts, revision projects were prepared in 2015 (Figure 14).

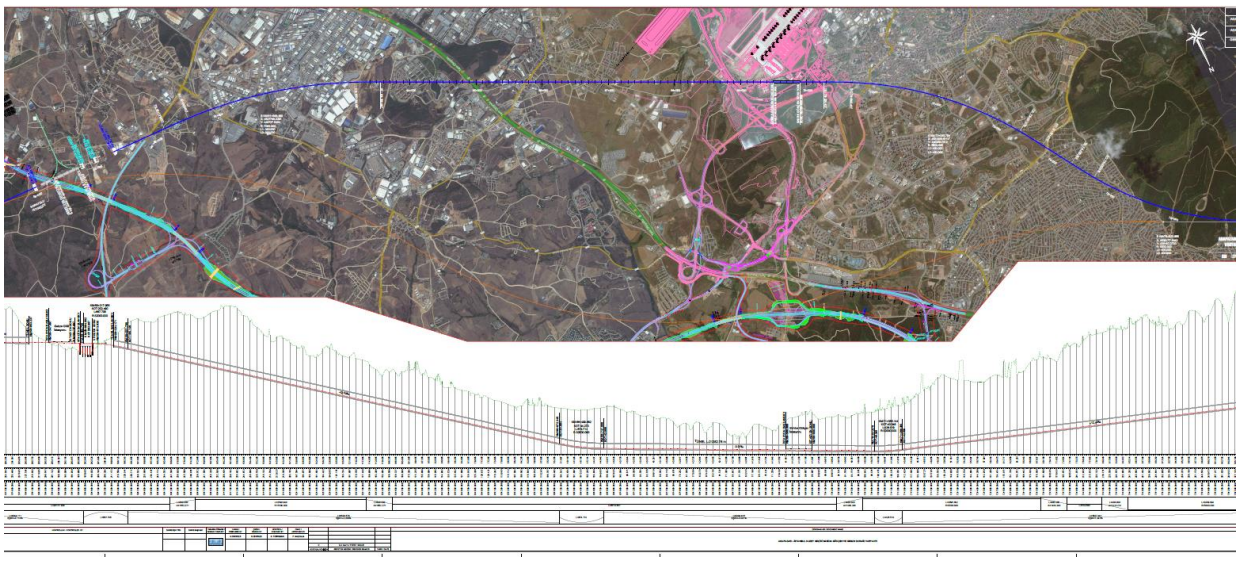

Figure-14. High-Speed Train Sabiha Gokcen Station, 2015 (TCDD, 2023)

Following the analysis conducted by TCDD officials in the revision project, it was decided to abandon the idea of routing the line through the airport due to a significant increase in costs. Instead, a decision was made to establish the station at a location adjacent to the TEM highway to ensure integration with the metro lines (Figure 15).

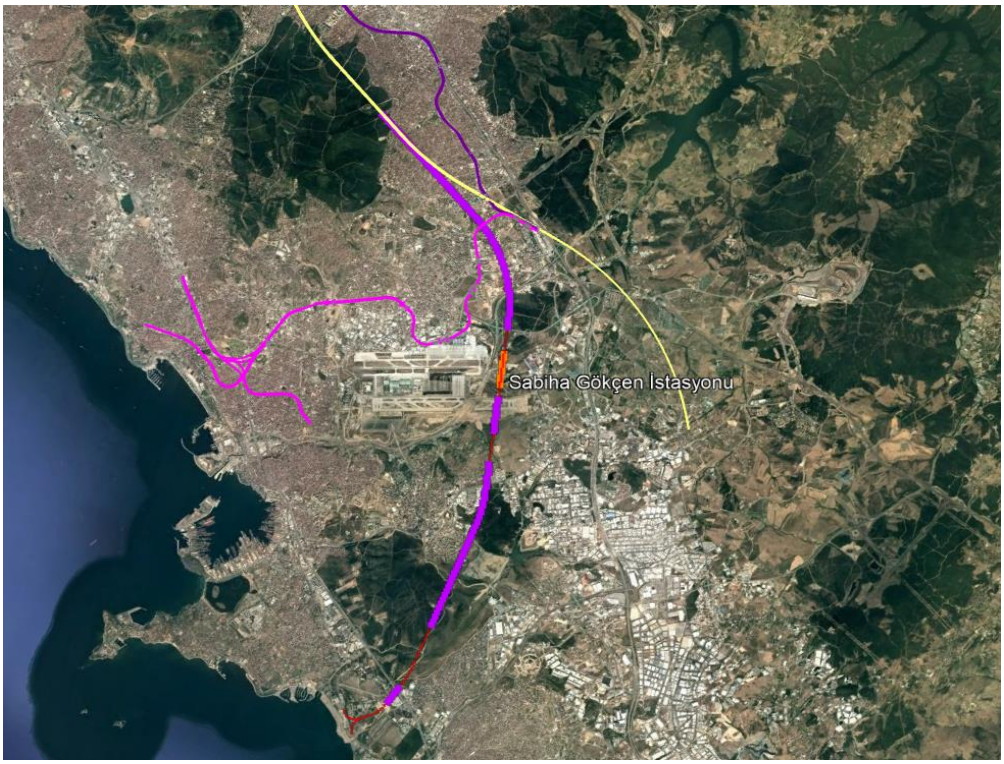

Figure-15. High-Speed Train Sabiha Gokcen Station Revision, 2017 (TCDD, 2023)

Pipeline Transportation

Sabiha Gökçen Airport has a branch of the NATO Pipeline, operated by the Ministry of National Defense (MSB) and carrying fuel from the Tüpraş refinery. This pipeline was used to supply aircraft fuel to the airport. However, due to security issues with the pipeline, its usage was terminated in 2016.

Following the closure of Atatürk Airport, an agreement was reached that the pipeline would no longer be used for supplying aircraft fuel (Jet-A1). As a result, the supply of fuel from the main pipeline was completely discontinued (Figure 16).

Figure-16. Fuel Supply Pipeline (HEAŞ, 2001)

There is a fuel hydrant line extending from the airport to the aircraft parking areas, where aircraft refueling takes place. The fuel hydrant line is configured as a dual pipeline, present in all parking areas to ensure the most efficient and safest refueling operations (Figure 17).

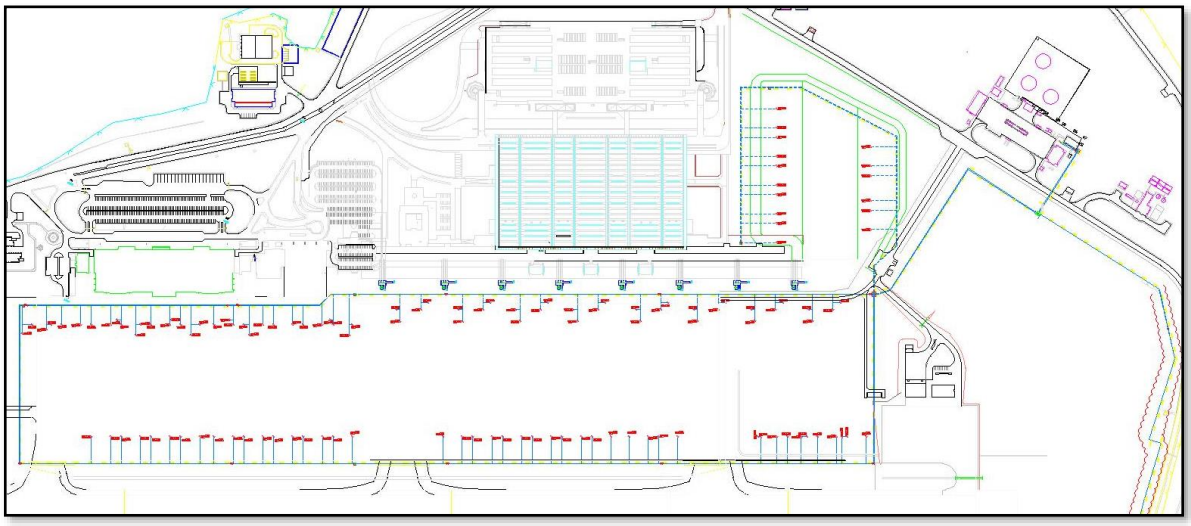

Figure-17. Fuel Hydrant System in the Passanger Apron (HEAŞ, 2014)

2. Material and Method

The first part of the study was dedicated to the literature review about the concept of transportation. The research method chosen was qualitative, specifically interpretive, focusing on evaluating the meaning and presence of a phenomenon. The phenomenon examined in the study was the modes of transportation present in international airport operations. The analysis primarily focused on assessing the problems encountered, especially integration, during the planning and construction of these modes of transportation.

Among qualitative methods, descriptive analysis was adopted. A literature review on concept of transportation was carried out.

Secondary Data was employed for gathering data related to the airport in the study,. Secondary data refers to information collected and stored regularly and in an ongoing manner by governments or private enterprises. The data were obtained from the tasks, meetings, and correspondences conducted during the researcher's tenure at the airport.

3. Findings and Discussion (Problems Experienced in the Modes of Transportation at Sabiha Gokcen Airport)

3.1. Air transportation

The main source of the problem in slot allocation procedures lies in the fact that the hourly airport capacity is planned, approved, and implemented by a single authority. The General Directorate of State Airports Authority (DHMİ) is responsible for air traffic and manages both the airport capacity and slot allocation. Airport capacity is not solely related to airspace management but is also directly associated with the physical conditions of the airport and the policies of airlines. Additionally, the hourly capacity is a crucial commercial issue for the stakeholders of the airport. Therefore, it is necessary for the hourly capacity to be planned jointly by the airport authority, the main airline using the airport, and the authorities providing air traffic control, and then submitted to the authority for approval, as in European countries.

It is considered that the fact that the Second Runway project, which was planned as the main solution to the capacity problem mentioned above, has not been completed since 2012, the coordination problems and administrative issues experienced during the process need to be further analyzed in a separate study.

3.2. Land Transportation

Road Transportation

The total traffic capacity around the airport appears to be sufficient to meet the estimated demand. However, it has been identified that there may be potential problems at several points by the year 2028. The following images depict areas with transportation issues.

The location and number of toll booths at the Kurtköy exit of the O4 (TEM) highway have been observed as problematic. It is necessary to increase the number of these toll booths at this exit and/or redirect traffic to the next toll booths (Orhanlı).

This problem tried to be addressed by removing the tool booths and installing Free Passage Automatic Payment System in 2024. However, this solution led to traffic junction along the right lane of highway (Figure 18).

Figure-18. Kurtköy Toll Booths (Google Earth Image, 2023)

The speed of the trumpet interchange at the end of the airport approach road is quite low. If deemed necessary, increasing the radius of the trumpet could provide a solution to increase the capacity of the interchange (Figure 19).

Figure-19. Trumpet Interchange (Google Earth Image, 2023)

The two-lane security entrance at the airport entrance will pose problems in the long-term. It may be necessary to increase its capacity by adding extra lanes to accommodate future traffic expectations (Figure 20).

Figure-20. Main Entrance of the Airport (Google Earth Image, 2024)

The solution to the findings regarding road transportation mentioned above can be achieved through the collaborative efforts of multiple institutions. The access roads to the airport are under the authority of the General Directorate of Highways, while the area beyond the main entrance falls under the responsibility of the airport. Therefore, it is necessary for these institutions to ensure proper coordination. On the other hand, it is also observed that an upper scale Transportation Master Plan, where solutions to the identified and potential future problems are planned, should be prepared in coordination with the relevant institutions.

Railway Transportation

Due to the lack of coordination between institutions inadequate and planning throughout the process, there was a discussion about bringing two separate lines into the airport premises. However, ultimately, it was agreed upon to integrate both the metro and Marmaray with a single line. This process not only resulted in a waste of time and resources but also, due to the absence of a clear project for the rail system before the BOT project, the station could not be constructed directly under

the terminal structure, which was the most ideal location. Instead, due to the foundation piles being installed in the ground during terminal construction, the station structure could only be positioned a certain distance away from the terminal building. It is deemed necessary for both local and central administrations to jointly address rail system projects in coordination, and plan for both the present and the next 20 years using common sense.

4. Conclusion and Suggestions

Transportation systems are crucial components of modern societies, facilitating economic activities, social interactions, and mobility. Transportation can be briefly defined as the movement of people, goods, and services for a purpose, and airports are indispensable infrastructures for transportation with the adoption of the global economy and the inclusion of the most valuable asset, the concept of time.

Airports are autonomous areas subject to national and international regulations, encompassing various modes of transportation.

Being subject to the Civil Aviation Law No. 2920 independently of zoning laws, airports require collaboration with numerous public institutions and private sector stakeholders due to the multiple modes of transportation they accommodate. Locally, they may span multiple municipal boundaries and directly influence numerous municipalities in terms of zoning, particularly due to the necessity of height restriction plans for flight operation safety, which are essential for aviation.

The inadequacy of sequential planning in our country, along with the rapid urbanization driven by infrastructure and superstructure needs, leads to integration problems in modes of transportation.

While airports may prepare their own master plans internally, these plans need to be shared with all relevant institutions at a higher level to ensure collaborative planning, particularly in infrastructure-related areas, primarily transportation.

Transportation spans diverse disciplines, from engineering and urban planning to economics and environmental science. Advances in technology, coupled with effective policy interventions, are essential for creating sustainable and inclusive transportation systems. Future research should focus on integrating technological innovations with robust policy frameworks to address emerging challenges and opportunities in transportation (Forum, 2020)

Acknowledgements and Information Note

The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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