The Role of Animal-Aided Design in Sustainable Architecture

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ABSTRACT

Environmentally insensitive practices such as the unconscious use of natural resources, industrialization and unplanned urbanization cause the rapid destruction of natural habitats and even the extinction of some species. Today, as the importance of sustainable architecture has increased, architectural approaches that are compatible with nature have been adopted and thus the protection of natural life has been tried to be supported. As a definition, sustainability is a form of practice that aims to harmonize the built environment with natural life. In this context, the impact on animals whose habitats we are destroying is a significant topic within sustainability discussions. Studies show that the role and importance of human-animal based sustainable architectural habitats for enhancing animal welfare have not been extensively investigated. This study aims to discuss the importance of animal-aided designs within the sustainability approach. In addition, it is to carry out studies to improve the quality of life in society by strengthening the human-animal bond. In line with this purpose, animal-aided designs at urban, infrastructure, and building scales were analyzed within sustainability approaches, and their contribution to the sustainability approach was evaluated. As a result, it is emphasized that the sustainable animal-aided design approach provides innovative solutions for structures to be designed for animals and it also contributes to environmental, social, and economic sustainability, but in order for these designs to be successful, it is underlined that living spaces suitable for the needs of animals should be created and the negative effects of environmental impacts on animals should be considered. It is also emphasized that in addition to the principles of sustainability, factors that pay regard to the lives of animals contribute to the understanding of sustainability. It is expected that the discussion of the relationship between sustainability and animal-aided design, which is put forward through this study, will create an important discussion ground for future research and application examples.

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1. Introduction

This study investigates the place of animal-aided designs in the understanding of sustainable architecture. The basis of the study is how a concept such as sustainability, which should be handled in a multifaceted and comprehensive manner, will be related to animal-aided designs. Sustainability is a concept that emerged in the 1970s in order to reduce the adverse effects of urban density on living things. It is an ecological term that has been used since the early 1970s with the meaning of 'ensuring a continuous flow of what each part of the system needs for a healthy existence and maintaining the adequacy of the system'. When applied to an ecosystem inhabited by humans, the term implies certain limitations on the ability of the biosphere to absorb the impacts of human activities (Madge, 1997).

Analyzing the relationship between animal-aided designs and sustainability also addresses the problems created by the rapidly increasing human population. While industrial and construction activities have significantly damaged the nature we live in, such issues as environmental problems, depletion of natural resources, decrease in biodiversity, pollution, and energy use have come to the forefront. While the environmental impacts created by humans are increasing rapidly today, the living population is also gradually decreasing. According to the 'Living Planet' report of the World Wide Fund for Nature, the population of other living things decreased by 60% between 1970 and 2014 (McLellan et al., 2014: 9).

Conservation of biodiversity helps to keep natural ecosystems healthy and thus helps us to have a sustainable future. In many developed countries, the approach of planning for the sustainability of urban systems by utilizing the ecosystem services of the natural environment and green infrastructure has become an important component of urban planning efforts (Apfelbeck et al., 2020). However, current urban planning and architectural design practices often ignore biodiversity in the general sense and wildlife in particular. Furthermore, the destruction of habitats results in increased competition between species, ultimately leading to a decline in the number of species. To mitigate these negative impacts on urban wildlife, it is of necessity to develop wildlife-integrated planning strategies (Hess et al., 2014).

This study focuses on the significance of animal-aided designs in comprehending sustainable architecture. It provides a framework for understanding the connection between sustainable architecture and animal-aided designs that do not include humans. In this way, it is aimed to contribute to making future designs more sustainable for humans and other living beings.

2. Literature Review

2.1 Sustainable Architecture Approach and Animal-Aided Design

In the second half of the 18th century, the Industrial Revolution caused a rise in the number of people living in cities. Uncontrolled population growth brought along significant problems; rapidly increasing industrial and construction activities led to considerable damage to the environment. Toxic gases, fumes, and wastes from factories polluted water resources and reduced soil fertility. It was only in the 20th century that the importance of the issue was realized (Ciravoglu, 2006). After the 1980s, researchers and planners working on environment and environmental problems developed strategies for the sustainability of society and the environment.

Due to the multidimensional nature of the concept of sustainability, different disciplines working on this subject have developed various definitions. Meadowcroft (1997) defines sustainability simply as a concept that can be sustained, that is, that can be continued; Tekeli (2001) defines sustainability as the correct establishment of the relationship between society, which is the socio-economic system formed by humans, and the environment of the ecological system consisting of non-human living things and non-living things, which constitute the two subsystems of the ecological system.

After the 1970s, sustainability discussions have generally been shaped within the framework of sustainable development. The most accepted definition of the concept of sustainable development in the international arena is the definition in the Our Common Future report published by the World Commission on Environment and Development in 1987, which states that "sustainable development is the ability to meet the needs and expectations of today without compromising the ability of future generations to meet their own needs and expectations" (WCED, 1987). As a continuation of the steps taken towards sustainable development, "Agenda 2030: UN Sustainable Development Goals/Aims" was adopted (MFA, 2022). The 2030 Sustainable Development Goals basically reflect these expectations by aiming to stop the destruction of the natural and social habitats of the global community and to achieve the welfare of all segments in a more balanced and fair manner (Messerli et al., 2019). In this regard, the 2030 Agenda emphasizes that human well-being depends on the health of the global ecosystem and that the welfare of all animals is essential for a sustainable ecosystem in the future (Folke et al. 2016, as cited in Olmos Antillón et al. 2021).

Visseren-Hamakers (2020) states that animals are ignored in sustainable development discussions, because sustainable development is a very human-centred concept. Maulana (2018) emphasizes that the practice of sustainability is generally human-oriented, and in fact, the basis of sustainability should be a continuous harmony between human and nature. On the other hand, Apfelbeck et al. (2020) point to the relationship between biodiversity, ecosystem services and sustainable and healthy cities and clearly state that urban design focuses on the needs of all living things, including wildlife.

Sustainability in the context of building construction refers to the understanding of balancing economic, environmental, and social factors from the design of the buildings to their construction, from their use to maintenance (Aghimien et al., 2018). Today, sustainability has become a priority in the field of architecture. The impact of a building is not only limited to its users and its immediate surroundings, but also includes societies and nature. The building’s construction, operation and demolition can
consume natural resources and increase environmental impacts. Therefore, a sustainable design should consist of factors such as energy efficiency, waste management and water saving.

The role of animal-aided designs within the sustainable architecture approach has an important place both in reducing the environmental impacts of buildings and in protecting the habitats of animals. Throughout history, unplanned human construction has damaged the habitats of animals, disrupted the natural balance, and increased the risk of species becoming extinct. Moreover, the human-animal relationship is generally shaped by a human-centred approach, and studies into animals aim to increase the yield to be obtained from them in almost all disciplines. Instead of focusing only on efficiency and usefulness in animal studies, a broader perspective such as the continuation of the species and the balance of ecosystems should be adopted. For this purpose, interdisciplinary studies are carried out to protect/enhance the natural ecosystems of animals (Clevenger and Huijser, 2011; Weisser and Hauck 2017; Apfelbeck et al. 2020).

Animal-Aided Design (AAD), developed by Weisser and Hauck (2015), focuses on the protection of natural ecosystems and the improvement of animal habitats. AAD is a species-centred conservation approach that aims to increase the habitats of animal species and combines this effort with space design. It is also applied in urban areas where people live, aiming to design spaces that are suitable for both the needs of people and the needs of local wildlife. Weisser and Hauck (2017) state that the essential requirement of AAD in a design process requires knowledge of all the needs that arise throughout the life cycle of a species from birth to reproduction. Another study involves the design of so-called "animal lines" to provide a connection to the old city centre of Lucca, which surrounds the ancient city walls and disused green spaces. Different zones are created along these lines, accessible to both humans and animals. This approach aims to increase the interaction between humans and animals in urban areas (Granai et al., 2022).

Articles carried out into animal-aided design show that projects can be realized in urban areas that make it possible to both sustain the existence of local wildlife and design suitable spaces for humans. For the successful realization of animal-aided design, cooperation and communication between different disciplines is of great importance from the first design stage. In this way, it is aimed to design the most suitable living spaces by considering the protection of natural life and the welfare of animals.

3. Methodology

As a result of the sustainability literature review, certain common concepts were identified between the sustainable architecture approach and animal-aided designs in terms of functional and structural aspects. The functional design dimension of animal-aided designs with the understanding of sustainability aims both to increase the welfare of animals and to consider sustainable architectural approaches. Functionally, sustainable animal-aided designs within the scope of the study were evaluated under thirteen headings as a result of the literature analysis (Figure 1).

The structural design dimension of animal-aided designs with sustainability understanding aims to consider sustainable architectural approaches in the building production process and to minimize environmental impacts. From a structural point of view, both sustainability principles and the life cycles of animals have been effective in the issues to be considered in sustainable animal-aided designs (Figure 2).
FUNCTIONAL PARAMETERS | GENERAL EXPLANATION
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That it is a structure suitable for the natural life cycle of the animal | In order for the species to survive and continue its generation, meeting all of the critical needs in the life cycle should be determined as a priority goal (nutrition, reproduction, etc.) (Weisser & Hauck, 2017).

That it is an environment suitable for animal welfare (*five domains) | Considering the physiological, behavioural and psychological needs of animals, it is important to create environments that can sustain and support their lives in sustainable animal-aided designs. In order to improve the welfare of animals, five basic welfare dimensions to be considered are: 1- Nutrition 2- Environment 3- Health 4- Behaviour 5- Mental State (Mellor et al., 2020; Salgırlı Demirbaş, 2023).

That it is made in accordance with the environment | It should be suitable for the local texture (topography) where it is located, it should be designed considering the climatic conditions and the structure should be positioned according to the current sun-wind situation (Emekci, 2021).

Use of materials resistant to environmental conditions | It should also care about the safety of animals and their protection from environmental factors. The health of animals is directly or indirectly affected by the effect of increasing temperatures, especially due to climate change (Nardone et al. 2010 cited in Rojas-Downing et al. 2017).

Providing adequate natural lighting | Natural lighting is important for animals to maintain their natural behaviour, regulate their sleep patterns in a healthy way and reduce their stress. In addition, it should be kept in mind that ecological light pollution has negative effects on living things (Longcore and Rich, 2004).

Ensuring natural ventilation and indoor air quality | Natural ventilation can provide effective cooling by taking into account the land structure surrounding the building, its location and surrounding areas, as well as air movements at different times of the day and the direction of wind flow (Özmehmet, 1999).

Ensuring acoustic performance | For the health and welfare of animals, it is of great importance that the acoustic performance of the environment is appropriate (Newbury et al., 2010: 17).

That it is an environment suitable for health conditions and animal comfort | It has been revealed that the most important environmental factor affecting the health and physiological functions of animals is temperature (Bengtsson and Whitaker, 1986). Temperature stress in animals varies depending on temperature, humidity, species, genetic potential, age and nutritional status (Rojas-Downing et al., 2017).

Use of natural / local materials | It is associated with animals’ preference for living spaces made of natural materials (Denneboom et al., 2021).

Effective use of material | In resource management, which is one of the basic principles of sustainable architecture, it is aimed to reduce environmental pollution and create healthier living environments through the effective use of materials such as the reuse of existing buildings, material-saving design and construction, the use of renewed and recycled materials (Zindane, 2010).

Use of renewable energies | The use of renewable energy in animal-supported designs provides a more effective and efficient use of energy resources.

Preservation of existing vegetation | As a requirement of sustainable design, it should be aimed to ensure the continuity of plant and animal species in the area by protecting the existing vegetation and increasing the amount of green space. The use of green tissue in the appropriate direction, spacing and type in the design plays an important role in the control of climatic elements (Colombo et al., 1994: 37).

The design suitable for human-animal interaction | The human-animal bond, as defined by the American Veterinary Medical Association, is a mutually beneficial and dynamic relationship between humans and animals. This relationship is influenced by behaviours that are important for the health and welfare of both parties. It includes emotional, psychological and physical interactions between humans, animals and the environment (Avma, ?). The human-animal bond is an important relationship that has positive effects at both individual and societal levels and improves the health and well-being of humans and animals.

Figure 1 AAD Functional Design Dimension
Modular and repetitive

It is observed that in environments where animals are housed in an excessive way densely, dominance behaviours occur between species from time to time. For this reason, it should be ensured that sufficient space can be created in case of an increase in the number of animals (Salgırlı Demirbaş, 2023).

Fast and easy construction and installation

This approach ensures more efficient use of resources as it requires less time and labour. This makes a significant contribution to reducing environmental impacts and protecting existing natural resources.

Establishment with a small number of technical staff

Building installation with a small number of technical staff reduces labour costs and makes designs more economical. It also minimises environmental impacts such as noise, waste and energy consumption.

Long service life

The longevity of the building is possible with the right material selection, the use of quality construction methods, and the design in accordance with local data and climatic conditions.
leading to habitat fragmentation, isolation of populations and destruction of important habitats (Whittington et al. 2019). In this context, ecological bridges have emerged as structures that provide wildlife crossings (Doğan and Şahin, 2015). In order for these crossings to be effective, objectives should be determined and monitored.

3.2.1 Trans-Canada Highway Wildlife Bridges, Canada

Wildlife bridges linking Banff National Park and Lake Louise are located on the Trans-Canada Highway (Parks.canada.ca, 2022). These crossings provide wildlife conservation by connecting fragmented habitats (Figure 4). Also, fences are installed to prevent wild animals from interacting with traffic. Infrared cameras, tracking devices, and other technologies are used to monitor the passage habits of animals and the effectiveness of corridors (Alexander and Waters, 2000; Sawaya et al., 2019; Barrueto et al., 2020). In addition, vegetation sustainability is targeted through ecosystem protection and restoration.

3.2.2 Bat Bridge, Hollanda

Bat Bridge is part of Park Poelzone, an ecological corridor in the Netherlands. The bridge is characterized by being located on the flight route of several bat species, providing suitable habitats for different bat species in different seasons, and being suitable for shared use by humans and animals (Lola.land, 2015).

For hibernating bats, there is an empty area designed from reinforced concrete in the lower section of the bridge. The bridge deck and under the masonry parapet are designed as suitable areas for breeding. The openings have a rough surface for bats to cling to. Openings for roosting bats have been created on the bridge along the red brick wall line (Figure 5) (Archdaily, 2015).

The wildlife crossings on the Trans-Canada Highway and the Bat Bridge projects were designed by interdisciplinary teams in accordance with the natural life cycles and behaviour of animals. These examples can be considered as critical corridors to prevent habitat fragmentation and thus protect biodiversity. In order to prevent wild animals from being affected and stressed by vehicle noise and headlights, local vegetation has been emphasized at the crossings. The vegetative design of the habitat passages allows animals to pass through passages similar to their natural habitats. Both examples are built according to climatic data in accordance with the environment and consist of structures and materials resistant to environmental conditions. In addition, it is likely that there is sufficient natural ventilation and lighting so that the ambient air quality can be provided for animals. It is also likely to mention the use of natural/local materials with the use of local vegetal elements and the use of wooden materials as seen in the Bat Bridge example. In the studies conducted for wild animal crossings on the Trans-Canada Highway, it was pointed out that animal crossings were recorded less at crossings open to human use and that these crossings were not suitable for human-animal interaction. In the Bat Bridge project, spaces suitable for the life cycle of bats were created and designed to encourage human-animal interaction. Repetitive structures and materials in these projects enabled rapid installation and low-cost construction. Research has shown that Trans Canada wildlife bridges reduce animal-vehicle collisions and increase the cost-effectiveness ratio in the long term (Conteches, 2017). In this respect, wildlife crossings on the Trans-Canada highway have provided low-cost projects in the long time from a structural point of view. There needs to be a study on the cost comparison of the Bat Bridge project.

3.3 Examples of Animal-Aided Sustainable Approach At Building Scale

By analyzing the different types of buildings constructed in detail in various countries, the study will provide results that are to play a critical role in the planning of sustainable animal-aided projects. The analysis of building types in different climatic zones aims to provide valuable information for the design of environmentally and climate change friendly buildings in future urban developments.

3.3.1 Petting Farm, Almere/ Netherlands (2008)

The farm in Almere, the Netherlands, is used as a children’s farm (Figure 7) (Stadennatuur, 2008).

Figure 4 Wildlife bridges (Clevenger, 2007)

Figure 5 Bridges sections and façades (Archdaily, 2015)

Figure 6 Petting farm (Archdaily, 2009)
Thanks to the open façade system of the upper half of the building, the air circulation in the building is provided naturally and the whole farm is ventilated. The barn section was built as a single storey building with two floors in height. In the other half of the building, the toilets and storage are located on the first floor, while the office and hay storage are located on the second floor (Figure 8). Access to the building is provided by six shutters. The shutter system can be opened automatically or manually with the effect of the morning sun (Figure 6) (Archdaily, 2009). Salgırlı Demirbaş (2023) emphasized the suitability of the project for animal welfare and stated that the design was arranged to meet the needs of animals.

It is clear that the spaces in the farm are built in a way that allows the animals to live in a comfortable and healthy way and thus support the natural behaviour of the animals. In the barn sections, animals have enough space for their natural movements. Thanks to the fact that the barn section is a single storey with a height of two storeys and the overall structure is designed with intermittent wooden panels, good ventilation, and sufficient natural light environment is provided. Thus, the risk of respiratory diseases of animals is minimized. Providing sufficient natural light also helps to maintain the biological rhythms of the animals. The renewable energy source and solar-powered modular wooden panels used in the building have increased energy efficiency and contributed to environmental sustainability. Tall thuja, a tree species that does not grow naturally in the Netherlands, was used on the façades. This may have caused the construction cost to increase. Modular natural wood elements in the form of panels used in facades contribute significantly to speeding up the construction and installation processes. The use of panel systems makes the construction process more efficient by requiring fewer technical staff. Looking at the project in general, it is observed that the material is used effectively and therefore resources are used efficiently. Within the scope of the project, the existing vegetation cover has been preserved with the sustainable protection and utilization of natural areas in the region, thus ensuring the continuity of plant and animal species. In addition, the presence of areas suitable for human-animal interaction contributes to the increase in social welfare. The longevity of the structure is ensured by designing the farm in accordance with the climatic conditions of the period when it was built, selecting the right materials, and constructing it with quality construction methods.

3.3.2 Women and Children Therapy Centre, Iraq (2016)

Located in Iraq, this centre is a modern therapy centre for children and women victims of war. By emphasizing the importance of using traditional building materials and techniques, the project aims to reduce the effects of trauma by identifying with the past (Zrsa, 2019). The centre, which is made up of eleven simple earthen volumes, is arranged around a series of courtyards, creating a village-style atmosphere. Light shading elements connecting the different volumes increase the comfort of the users (Figure 9) (Archdaily, 2017). Salgırlı Demirbaş (2023) emphasized the project's compliance with animal welfare and stated that the design is organized to meet the needs of animals.

The Women's and Children's Therapy Centre is designed to provide animals a comfortable and healthy environment that supports their natural behaviour. In the pens in the example, animals have enough space for their natural movements. Designed with a courtyard plan scheme, it also improves the ambient air quality by providing adequate natural lighting (as well as the use of renewable energy) and ventilation. This project emphasizes not only the importance of traditional building materials and techniques but also the importance of human-animal interaction, providing a design that meets the needs of both users. Thanks to the use of adobe material, the temperature inside the building is regulated naturally, which is beneficial for energy saving. Furthermore, the adobe material is vital for the users' health by preventing dampness inside the building. It is also an environmentally friendly material as it is reusable and recyclable. The use of traditional materials in the building has ensured that construction costs are low and technically, a structure that anyone can easily build has emerged. The spaces in the project have a modular and repetitive structure. This approach helps to reduce maintenance and repair costs and allows the building to be built quickly. The longevity of the building was ensured by designing the facility by the climatic conditions of the period in which it was built, selecting the suitable materials, and constructing it with quality construction methods.
It is observed that the spaces in the Vietnam Bear Shelter are built in a way that allows the animals to live comfortably and healthily and thus support the natural behaviour of the animals. There is a large area in the project where they can move freely. In addition to free movement opportunities, the shelter lacks areas covered with trees, bushes, etc. where they can hide. It can be stated that the living conditions for bears rescued from their previous inadequate cage environment have been enhanced in this area. They are given the opportunity to live in a large area where they can sunbathe. They are also provided with natural ventilation instead of tiny cages where they are deprived of sunlight and health. With the provision of natural ventilation, the risk of respiratory diseases is minimized. The provision of sufficient natural light also helps to maintain the biological rhythms of the animals. The use of traditional materials in the building ensures that construction costs are low and technically it is a structure that can be built easily by anyone. This project emphasizes not only the importance of traditional building materials and techniques but also the importance of human-animal interaction, offering a design that meets the requirements of both users. The spaces in the Vietnam Bear Sanctuary have a modular and repetitive structure. This approach helps to minimize maintenance and repair costs and allows the building to be constructed quickly. The longevity of the building is ensured by designing the building by the climatic conditions of the period in which it was built, selecting the suitable materials, and designing it with quality construction methods. The façade design has been shaped by paying attention to the climatic data and the needs of the animals. Considering the cases of the heavy wind and precipitation, the building has a sloping form and openings are designed to help direct the flow of rainwater into the deep valley. The air circulation inside the building is provided naturally through the openings in the facade, thus minimizing the risk of respiratory diseases for the animals. The building is situated in an area that affords animals more leisure time to graze and play freely. Both the façade and the carrier system have been created by using a small number of materials. It is also designed to maximize the use of natural ventilation and natural light. The land where the building is located has a very green environment. Thanks to this green area, it is ensured that the sounds that may occur in the environment are absorbed, and their effect is reduced so that the animals will not get stressed. The use of traditional materials in the building has ensured that the construction costs are low and technically, a structure that anyone can easily build has emerged. Since it is a suitable environment for animal carers, human-animal interaction is favourable for both. The longevity of the building is ensured by designing the building by the climatic conditions of the period in which it was built, selecting the suitable materials, and constructing it with quality construction methods.

3.3.4 Haven the Eternal Experience Pavilion, India (2022)

The cow shelter is located in the village of Peermade, India (Earthscapestudio, 2022). The most important aspect of this project is that the architect has preserved the concept of "the idea of protecting nature" from selecting materials to the constructing building. The shape of the building follows the natural landform without disturbing the natural landscape and the surrounding trees (Figure 11).

3.3.5 Palanga Art and Architecture Farm, Turkey (1888)

Kutluğ Ataman spearheaded the project to revitalize the farm established in 1888 (Soistanbul, 2018). Aiming for a sustainable agriculture and animal husbandry model with animals using biodynamic methods, the farm also aims to maintain environmental sustainability (Attec.design, 2019). The project was shaped by Kutluğ Ataman's love of nature and Hasan Çalışlar's collaboration.

3.3.5.1 Palanga House of Chickens (2018)

The most important aspect of the Chicken House is that the design team created the structure according to design principles based on the daily routines of the chickens. Each design principle is based on the observation of chickens and the previous
experiences of local people. At each stage of the design, design diagrams were created to reveal whether they meet the daily routines of the chickens. Another critical factor affecting the design was the behavioural relationship between humans and animals. A corridor was created on the centre axis of the building so that people could collect eggs without disturbing the chickens. The side parts serve basic needs such as shelter, incubation, rest, and sleep (Figure 12). After collecting the data resulting from all these studies, low-cost materials and traditional construction techniques that are easy to maintain according to the climatic and regional characteristics of the region were preferred. Reinforced concrete was used for the foundations, wood for the carcass and cladding elements, and sheet metal for the roof (YouTube, 2021b).

The design of the Palanga Chicken House is to support the natural behaviour (daily routines) of the animals, allowing them to live in a comfortable and healthy way. In the poultry house sections in the example, animals have enough space for their natural movements. The semi-open space located on the central axis of the building allows animals to socialize even in bad weather conditions. In addition, this space provides shading in hot weather conditions. Thanks to the pivot panels used in the facade design, good ventilation and a sufficient natural light environment are provided. Thus, the chickens are not exposed to heat stress and the risk of respiratory diseases is minimized.

The Calm Shelter is a shelter that meets the needs of the calves by selecting materials that are compatible with the environment. (Figure 13) (YouTube, 2021b).

The design of the Palanga Calf Shelter is to support the natural behaviour (daily routines) of the animals, allowing them to live in a comfortable and healthy way. In the pens in the example, animals have enough space for their natural movements. As the facade design is shaped according to climatic data and animals’ needs, the south façade’s open design provides natural ventilation and a sufficient natural light environment. Thus, the risk of respiratory diseases is minimized. Providing sufficient natural light also helps to maintain the biological rhythms of the animals. The use of traditional materials in the building has ensured that construction costs are low and technically, a structure that anyone can easily build has emerged. The longevity of the building is ensured by designing the building by the climatic conditions of the period in which it was built, selecting the suitable materials, and constructing it with quality construction methods.

3.3.5.3 Palanga Goat Shelter (2021)

In the design process, user requirements were taken into consideration and in this context, goat physiology was given importance. In addition to other factors such as the geographical characteristics and climate of the project location, the seismic requirements of the building were taken into consideration due to its location in an earthquake zone. In addition, it is aimed to seek sustainable solutions, ensure compliance with today’s conditions, use natural materials, and adopt traditional stone-earth-wood workmanship as a construction technique (Figure 14). The building was constructed entirely using local and natural materials. The foundation of the building was constructed using stones from the stream in the farm (YouTube, 2021b).
The design of the Palanga Goat Shelter is to support the natural behaviour (daily routines) of the animals, allowing them to live in a comfortable and healthy way. In the pens in the example, animals have enough space for their natural movements. The façade design is shaped by considering the climatic data and the needs of the animals. It is designed to protect the goats from harsh weather conditions and a chimney form has been considered concerning the health of the animals. In this way, natural ventilation is provided, and the risk of respiratory diseases is minimized by increasing the air circulation inside the building. It is a structure that allows the animals to spend more free time and an area where they can freely graze and play around. The existing vegetation has been preserved in these areas. The use of traditional materials in construction has ensured low construction costs. In today's architecture, the importance of methods such as rammed earth and adobe, which were frequently used in ancient times, has unfortunately decreased. For this reason, it has become a structure that cannot be easily applied by everyone because it is a structure that requires technical competence to learn about these methods. The building is a structure that fits the climatic conditions of its location and responds to the user’s needs. The longevity of the building is ensured by designing the building by the climatic conditions of the period in which it was built, selecting the suitable materials, and constructing it with quality construction methods.

4. Evaluation and Conclusion

Today, architectural design approaches have been transformed due to the emergence of various environmental problems such as climate change, population growth, unplanned urbanization, pollution, and depletion of natural resources (Aslan, Selçuk and Avınc, 2022). This has resulted in the development of architectural approaches that are compatible with nature through the adoption of environmentalist techniques in the selection of building materials and construction techniques. The significance of sustainable architecture is on the ascent, as it seeks to harmonize building practices with the natural environment, supporting the protection and longevity of natural life. In this context, the role of animals whose natural habitats are being destroyed has an important role in sustainability debates.

The aim of sustainable animal-aided design is to create habitats where animals can live healthily and comfortably, suited to their natural life cycle. These habitats should be designed according to local climate, well-ventilated with natural lighting, and constructed from materials that can withstand natural and environmental conditions. Before designing animal shelters, it is crucial to comprehend the specific climatic requirements of each animal species and the negative impacts environmental factors can have on them. For instance, regions with cold winters require animal shelters to have sufficient heating systems and accessible areas that are shielded from temperature drops. Similarly, animals located in hot regions should have access to cooling systems and shaded areas. To avert negative environmental impact on animals, specific measures should be taken when designing their habitats. For instance, shelters to address water pollution concerns should be equipped with effective treatment systems to prevent harm to water resources caused by animal waste. Designs that do not consider the environmental needs of animals can harm their health. This can result in the use of additional resources such as veterinary services, improved building heating-cooling systems, and re-evaluating the building waste system. As a result, more materials are used, and construction costs increase. For sustainable animal-aided building designs to work, create living spaces that meet animal needs, fully understand the impacts of the environment on animals, and adapt designs accordingly.

These structures shield animals' welfare and health while promoting the efficient use of resources.

In this study, focusing on the importance of sustainability in animal-aided building design, the Ruhr Region example at the urban scale, samples at the infrastructure scale, and nine selected building scale sample projects from Turkey and around the world are analyzed comparatively.

The comparative analysis is based on interdisciplinary studies, and the findings highlight the benefits of animal-aided sustainable designs at urban, infrastructural, and building scales. Technical term abbreviations are explained when first used. Consistent citation and footnote style are followed. Quotations are clearly marked, and filler words are avoided. The building-scale findings reveal that animals' welfare and quality of life improve in spaces tailored to their natural behaviours and needs. The use of natural materials, lighting, and ventilation in design heightens animal comfort and diminishes stress levels. Such architectural features positively influence the animals' well-being.

Findings at the urban and infrastructure scale demonstrate that the inclusion of animals in urban areas has a positive impact on environmental balance and contributes to biodiversity conservation. It is important to recognize these benefits to facilitate their adoption and expansion in urban planning. The implementation of such designs yields numerous beneficial effects, including the expansion of green spaces, diversification of ecosystem services, and safeguarding of natural habitats. The examined instances have a crucial function in preventing species extinction, facilitating scientific inquiry, establishing spaces for human-animal interaction, promoting social consciousness, and emphasizing its significance in the sustainable architecture approach. Despite this, the scarcity of animal-aided sustainable designs, especially at the national level, is noteworthy. Increasing the number of animal-aided sustainable designs at
urban, infrastructure, and building scales is deemed a vital measure in safeguarding environmental and ecological harmony. Addressing this issue shall not only bridge a scientific gap but also promote the adoption of sustainable animal-aided designs that benefit humans and animals alike.

The parameters evaluated in the urban, infrastructure and building scale examples selected within the scope of the study reveal the main elements that need to be considered in order to design animal-aided buildings in a sustainable and animal welfare-oriented manner. Consideration of these elements helps designers to construct spaces that are designed in accordance with the needs of animals and thus help the sustainability of the species. Furthermore, these parameters ensure the environmental, social, and economic sustainability of the buildings. Therefore, it is extremely important to consider these parameters in the design of animal-friendly buildings and thus, sustainable-animal welfare-oriented buildings and urban areas can be built. The discussion of the relationship between sustainability and animal-aided design, which has been put forward through this study, constitutes an important discussion ground for future research and application examples.
## Animal Aided Design Parameters in Sustainable Architecture Approach

<table>
<thead>
<tr>
<th>Animal Aided Design at the Urban Scale</th>
<th>Animal Aided Design at Infrastructure Scale</th>
<th>Animal Aided Design at the Building Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robe Region</td>
<td>Trans Canada Highway</td>
<td>Petting Farm</td>
</tr>
<tr>
<td></td>
<td>Rat Bridge</td>
<td>Thracian Centre</td>
</tr>
</tbody>
</table>

### FUNCTIONAL
- That it is a structure suitable for the natural life cycle of the animal
  - Suitable habitat environment
  - Beginning of species appearance
- That it is an environment suitable for animal welfare (*five domains)
  - Nutrition, environment, health, behaviour and mental state
- That it is made in accordance with the environment
  - Suitability to local color
- Use of materials resistant to environmental conditions
  - Selection of the right materials suitable for the climate
- That it is suitable for the climate (insulation details suitable for the climate)
  - Selection of plants suitable for the climate
- That it is suitable for the topography (local color)
  - Suitability to local color
- Positioning of the structure according to the sun and wind
  - Design according to climatic elements
- Providing adequate natural lighting
  - Wide openings
- Providing natural ventilation
  - Adequate ventilation
- Ensuring acoustic performance
  - Adequate use of plant elements
- Use of natural materials
  - Vegetation suitable for the local color
- Use of local materials
  - Vegetation suitable for the local color
- Use of renewable energy
  - Open / semi-open areas
- Effective use of material
  - Protection and interconnection of existing natural areas
- Efficient use of resources
  - Preservation of the existing green field
- Design suitable for human-animal interaction
  - Ecosystem protection
  - Increased social welfare

### STRUCTURAL
- Modular and repetitive
  - Modular structural elements
- Fast and easy construction and installation
  - Modularity
- Establishment with a small number of technical staff
  - Modularity
- Simple yet high-strength of the load-bearing system
  - Modularity
- Long service life
  - Design according to local data
- Low cost
  - Protection of existing structures

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**Figure 15** Evaluation table of selected samples over the determined parameters - 1
**Animal Aided Design Parameters in Sustainable Architecture Approach**

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>FUNCTIONAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>That it is a structure suitable for the natural life cycle of the animal</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>That it is an environment suitable for animal welfare (<em>five domains</em>)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>That it is made in accordance with the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of materials resistant to environmental conditions</td>
<td>Selection of the right materials suitable for the climate</td>
<td>Selection of the right materials suitable for the climate</td>
<td>Selection of the right materials suitable for the climate</td>
<td>Selection of the right materials suitable for the climate</td>
<td>Selection of the right materials suitable for the climate</td>
</tr>
<tr>
<td>That it is suitable for the climate (insulation details suitable for the climate)</td>
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</tr>
<tr>
<td>That it is suitable for the topography (local color)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positioning of the structure according to the sun and wind</td>
<td>Design according to climatic elements</td>
<td>Design according to climatic elements</td>
<td>Design according to climatic elements</td>
<td>Design according to climatic elements</td>
<td>Design according to climatic elements</td>
</tr>
<tr>
<td>Providing adequate natural lighting</td>
<td>Open / semi-open areas</td>
<td>Having an open courtyard</td>
<td>Open / semi-open spaces</td>
<td>Semi-open spaces</td>
<td>Semi-open spaces</td>
</tr>
<tr>
<td>Providing natural ventilation</td>
<td>Open / semi-open areas</td>
<td>Adequate natural ventilation</td>
<td>Open / semi-open areas</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
</tr>
<tr>
<td>Monitoring indoor air quality</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
</tr>
<tr>
<td>Ensuring acoustic performance</td>
<td>Adequate use of plant elements</td>
<td>Adequate use of plant elements</td>
<td>Adequate use of plant elements</td>
<td>Adequate use of plant elements</td>
<td>Adequate use of plant elements</td>
</tr>
<tr>
<td>That it is an environment suitable for health conditions and animal comfort</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
<td>Adequate natural ventilation</td>
</tr>
<tr>
<td>Use of natural materials</td>
<td>Made with gabion wall technique</td>
<td>Local brick for the facade and load-bearing system, use of recycled tiles and local plants in the mortar mix for rigidity</td>
<td>Use of wood in the load-bearing system and facades</td>
<td>Use of wood in the roof carrier system</td>
<td>Use of river stones in building foundations</td>
</tr>
<tr>
<td>Use of local materials</td>
<td>Using natural stone</td>
<td>Using 8th-10th local bricks consisting of three layers</td>
<td>Use of wood and straw-soil mixtures</td>
<td>Use of stream stones, soil-straw mixtures</td>
<td>Use of lime and horsee mortar</td>
</tr>
<tr>
<td>Use of renewable energy</td>
<td>Open / semi-open areas</td>
<td>Prefer for local ingredients</td>
<td>Open / semi-open areas</td>
<td>Open / semi-open areas</td>
<td>Open / semi-open areas</td>
</tr>
<tr>
<td>Effective use of material</td>
<td>Preference for local ingredients</td>
<td>The fact that the load-bearing system and the facade are solved at the same time, Preference for local ingredients</td>
<td>Preference for local ingredients</td>
<td>Preference for local ingredients</td>
<td>Preference for local ingredients</td>
</tr>
<tr>
<td>Preservation of existing vegetation</td>
<td>Protection of existing natural areas</td>
<td>Protection of existing natural areas</td>
<td>Protection of existing natural areas</td>
<td>Protection of existing natural areas</td>
<td>Having a genre-specific design and effective use of material</td>
</tr>
<tr>
<td>Efficient use of resources</td>
<td>Preservation of the existing green color</td>
<td>Preservation of the existing green color</td>
<td>Preservation of the existing green color</td>
<td>Having a genre-specific design and effective use of material</td>
<td>Having a genre-specific design and effective use of material</td>
</tr>
<tr>
<td>Design suitable for human-animal interaction</td>
<td>Using indoor and outdoor areas that can be used together for both species</td>
<td>Using indoor and outdoor areas that can be used together for both species</td>
<td>Using indoor and outdoor areas that can be used together for both species</td>
<td>Using indoor and outdoor areas that can be used together for both species</td>
<td>Using indoor and outdoor areas that can be used together for both species</td>
</tr>
<tr>
<td><strong>STRUCTURAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modular and repetitive</td>
<td>Modular plan scheme and structural elements</td>
<td>Modular plan scheme and structural elements</td>
<td>Modular plan scheme and structural elements</td>
<td>Modular plan scheme and structural elements</td>
<td>Modular plan scheme and structural elements</td>
</tr>
<tr>
<td>Fast and easy construction and installation</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
</tr>
<tr>
<td>Establishment with a small number of technical staff</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
<td>Modularity</td>
</tr>
<tr>
<td>Simple yet high strength of the load-bearing system</td>
<td>Gabion wall technique</td>
<td>Surprisingly placed local bricks</td>
<td>Use of modular timber structural system</td>
<td>Earthquake resistance</td>
<td>Using adobe walls</td>
</tr>
<tr>
<td>Long service life</td>
<td>Design according to local data</td>
<td>Design according to local data</td>
<td>Design according to local data</td>
<td>Design according to local data</td>
<td>Design according to local data</td>
</tr>
<tr>
<td>Low cost</td>
<td>Use of local materials</td>
<td>Use of local materials</td>
<td>Use of local materials</td>
<td>Use of local materials</td>
<td>Use of local materials</td>
</tr>
</tbody>
</table>

**Figure 16** Evaluation table of selected samples over the determined parameters - 2
Acknowledgements

This article was produced from the thesis named 'The Role of Animal-Aided Design in Sustainable Architecture', [Sürdürülebilir Mimari Yaklaşımında Hayvan Destekli Tasarımların Yeri], made in the architecture program of Gazi University Graduate School of Natural and Applied Sciences (Tüzün, 2023). I would like to thank my supervisor Hilal Ayca, examining committee members Zeynep Uludag, Nilgün Kuloğlu and also Yasemin Salgırlı Demirbaş, Serma Arslan Selçuk for their valuable supports and comments.

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