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Modern Architecture and Sustainability: A Retrospective Review (1910-1940)

Modern Mimarlık ve Sürdürülebilirlik: Geriye Dönük Bir İnceleme (1910-1940)

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Abstract

The possibility of seeing modern-period structures starting from the 1900s in countries with different cultures in the world. Investigating the architectural criteria for residential buildings constructed between 1910 and 1940 in various nations in compliance with modern architectural approaches and sustainability parameters is the main objective of this study. The 3 residential buildings investigated within the scope of the research were assessed based on economic, environmental cultural, and social, sustainability parameters. A methodology regarding theoretical and analytical approaches was applied within the scope of the study. The collected data were evaluated regarding sustainability parameters, function, construction, and form of selected modern period houses in the framework of sustainability parameters and modern architectural approaches. Within the residences under analysis, Functionalism De-Stijl, International Style, Cubism, and Purism approaches arise as architectural criteria. In the context of the research's outcomes, it has been showed that the parameters of sustainability that appeared in the modern period are directly connected to the principles, ideas, and approaches of the modern period. In this regard, modern architectural criteria should be included in and implemented in today's sustainable designs. Considering the criteria and approaches that emerged in the modern period, it is aimed to contribute to the literature by applying

Özet

Dünyada farklı kültürlere sahip ülkelerde 1900'lü yıllardan başlayarak modern dönem yapıtlarını görmek mümkündür. Bu çalışmanın temel amacı, 1910-1940 yılları arasında dünyanın farklı ülkelerinde inşa edilmiş konut yapılarının, modern mimari yaklaşımlar ve sürdürülebilirlik parametreleri doğrultusunda mimari kriterlerini araştırmaktır. Çalışma kapsamında incelenen 3 konut yapısı sürdürülebilirliğin parametreleri olan ekonomik, sosyal, kültürel ve çevresel açıdan değerlendirilmiştir. Çalışmada teorik ve analitik yaklaşımlara dair bir metodoloji uygulanmıştır.. Toplanan veriler, sürdürülebilirlik parametreleri ve modern mimari yaklaşımlar bağlamında seçilen modern dönem konutlarının sürdürülebilirlik parametreleri, işlev, konstrüksüyon ve formu açısından değerlendirilmiştir. İncelenen konutlarda mimari kriter olarak İşlevselcilik De-Stijl, Uluslararası üslup, Kübizm ve Pürizm yaklaşımları öne çıkmaktadır. Araştırma sonucu ortaya çıkan bulgular bağlamında modern dönemde ortaya çıkan sürdürülebilirlik parametrelerinin, modern dönemin ilke, fikir ve yaklaşımları ile doğrudan ilişkili olduğu ortaya çıkmıştır. Bu bağlamda, günümüz sürdürülebilir tasarımlarında modern mimari kriterlerinin entegre edilmesi ve uygulanması gerekmektedir. Modern dönemde ortaya çıkan kriter ve yaklaşımlar dikkate alınarak, günümüzde tasarlanacak konut yapılarında sürdürülebilirlik parametrelerinin uygulanmasıyla literatüre katkı sağlanması amaçlanmaktadır.

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sustainability parameters in residential buildings to be designed today.

Keywords: Modern Architectural Approaches, Modern Houses, Modern Architecture, Sustainability Parameters.

Anahtar Kelimeler: Modern Mimarlık, Modern Evler, Modern Mimari Yaklaşımları, Sürdürülebilirlik Parametreleri.

Introduction

Modern ideas and concepts in architecture first surfaced in the 20th century, along with the introduction of creative architectural designs and the presentation of cutting-edge examples in both practice and discourse (Beyaz & Erçin, 2023a). It is clearly seen that there were significant breakthroughs, from the breaking of an atom to Einstein's Theory of Relativity in the twentieth century, while the art of painting, which is closely related to architecture, started to take a basic and abstract approach. Modernism was described as a worldwide movement that impacted architecture, visual arts, theater, music, and Western literature in the second part of the nineteenth century, as well as art in the twentieth century (Frisby, 2004), (Beyaz & Erçin, 2023b).

New approaches appeared in the context of "modern architecture". These approaches are employed in a variety of architectural applications throughout different countries. Functionalism, Purism De-Stijl, International Style, and Cubism were some of the approaches that gave the architectural designs of the time a new appearance. Modern architecture encompasses a variety of approaches as well as includes several criteria. The modern period has come to the fore through designs prioritizing functional forms, wide wall openings, open floor plans, straightforward lines, clean, and combining modern and traditional building materials. Sustainability initially appeared throughout the course of the modern era's expansion and progress, and it has since surpassed modernism in the framework of technological, economic, social, cultural, urban development, and environmental. Sustainability, which has been closely related to architecture, adopts environmentally friendly design strategies, preserves an existing structure approach while permitting long-term use of the newly constructed building, and adopts and incorporates all of this explicitly into the design.

It has been observed that the houses built in different countries of the world during the modern architecture period were built by taking into account the living conditions of the users as well as environmental and societal issues. Due to societal events, a profound change was observed during this time, and everything previously understood about how the human mind perceives reality was completely upside down.

The main problem that emerged as a result of the research and observations is the possibility of buildings and their surroundings bearing the characteristics of the modern period losing their cultural values and sustainability by remaining unmaintained for a long time. Buildings that lose their identity in the modern period lose their value, are exposed to many different functions, and lose their historical identity and cultural heritage.

Within the scope of the study, these houses, which were built between 1910-1940 and have the distinctive architectural features possess the characteristic modern architectural elements and were built utilizing a reinforced concrete building method that spans two to three stories. It was observed that the design of these houses was created by bringing together basic geometric shapes. The exterior and plan designs of the residences under examination incorporated modern period styles such as Cubism De-Stijl, Functionalism, Purism, and International. In this regard, the houses under examination were assessed based on modern architectural criteria, architectural approaches, and sustainability considerations.

The Research Objectives

In the extent of this study, through the design of the chosen houses, it seeks to analyze the architectural principles by exposing the original identity of the modern period. The primary goal of this research is to present the economic, social, environmental, and cultural circumstances of the houses under investigation within the framework of sustainability parameters. The study highlights how sustainability and modern architectural principles and approaches are related. There are many common points between modernism and sustainability. Therefore, the current examination of the chosen dwellings was presented by examining sustainability parameters and modern-period criteria combined.

Literature Review

Modern, Modernity and Modernism

Unlike other eras, the word "modern" is derived from the Latin word "Modo," meaning "Today." The word "modern" is highly helpful in all facets of daily life and has been used in numerous contexts to differentiate between traditional and modern ways. (Azizi & Eshaq, 2022). According to the definition of the term of "modern" is used to define the time period from the medieval period and subsequent periods, the social transformation that persisted after the start of the Renaissance and reform movements. However, these times are now defined as classical or nostalgic. Due to this circumstance, the definition of the modern notion now calls for a standard that takes into account the way of life of modern, developed societies. In this context, the term modern, which is utilized to define the transition between "old" and "new," has been attempted to be equal to today's usage by dividing the domains of culture, science, and art (Benian, 2010).

The idea of modernity is frequently used to define the current state of the globe in contrast to prior epochs or more rudimentary existent civilizations. It frequently takes the place of ideas like industrialization, capitalism, reason, secularism, media, and communication society, as well as other organizational or ideological qualities (Madsen, 2014).

Modernism is a new point of view, a development in culture, and a new way of living. Modernism is a response to Middle Ages thought and behavior. Modernism has a logical, forward-thinking, and positivist viewpoint; in this way, it is similar to Enlightenment philosophy. Modernism has been described in a variety of ways; for instance, Faulkner Peter defined it as all the different styles of art that developed in the twentieth century (Barzinji, 2013). Modernism, which is commonly used as a synonym for both modern architecture with functionalism, is basically an architectural style that favours the use of the plain form over adornment in structures. In response to changing needs and a rapidly growing population, simple constructions resulted (Menga, 2022).

Modern Architecture

Modern architecture was thought to have its beginnings in the 19th century in the industrial revolution with the subsequent introduction of mass production, which sparked a widespread dislike of historicism, fascination with functionalist planning, and utilization of modern building materials and cutting-edge technologies (Ali, 2018; Arenibafo, 2017).

The modern movement starts when sculptors and painters start to gravitate more and more toward industrial design. The modern trend first emerged in England and evolved into fashion with the designers' ideas. After England, it started to develop widely in Germany and the United States. Due to the congruent efforts of the modern movement's founders, this movement has evolved into a universal movement. As a worldwide architectural approach, it has also gained widespread (Biçer, 2006). In the 20th century, novel and distinctive theories, inventions, and works of art were created in the fields of science, philosophy, architecture, and art. Especially towards the start of the twentieth century, it can be observed that art, science, and also architecture evolved collaboratively by influencing one another. It has a close relation to social, political, economic, aesthetic, and technological aspects as well as factors of ideology and science (Benian, 2010).

Modern architecture, which arose in reaction to 19th-century design, has given the physical environment a variety of unique meanings by exhibiting features like glass surfaces, open floor plans, and functionality. Modern architecture emerged as a result of a shift in architectural thought away from historicism and toward openness. Early modernism pioneers included Frank Lloyd Wright, Walter Gropius, Auguste Perret, Peter Behrens, Adolf Loos, Le Corbusier, and Mies van der Rohe (Moffett et al., 2003), (Beyaz, 2023).

One of the most important architects of the twentieth century, Adolf Loos, promoted simple, ornament-free architecture and emphasized that architecture should have a functional purpose. Additionally, Loos rejected the symbolic elements of the structures and stated that they should be constructed economically and with societal appeal (Birol, 2006). The "Raumplan" (volumetric plan) notion that Loos introduced revolutionized architecture. Le Corbusier eventually interpreted this as the "Freeplan" (free plan). Purist techniques have also been based on the ornamentation from Loos' designs, employing pure forms of materials, and emphasizing space (Frampton, 2007).

The forerunners of the modern movement constructed a number of iconic new white structures in the 1920s: Mies van der Rohe constructed the German Pavilion in Barcelona, Gropius created the Bauhaus school building, and Alvar Aalto created Gropius' hospital and private home. Nicholas Pevsner, a well-known historian of the modernist movement, likewise admired the cold and impersonal nature of new abstraction (Zhao, 2021).

Modern Architectural Approaches

The emergence of various ideas, perspectives, and notions a new era in the period of modern architecture began. With this period, Modern Architecture has different architectural approaches that are parallel or opposite to each other. These approaches served as the foundation for modern architecture and have basically adopted the same idea by directing the designs. Within the scope of this research, Functionalism De-Stijl, Cubism International style and Purism, which are modern period approaches, come to the fore in the 3 residential buildings examined.

A structure is the consequence of a function if it best serves the objective for which it was designed to be employed. The most pertinent kind of architecture is one that derives a structure's personality, from its purpose from the reason it was designed or constructed (Żychowska, 2019). Examples of functional shortcomings include the layout of a building and the color, comfort, and shape of its areas. Additionally, maintaining the integrity of a structure while striking a balance between form and function is the essential goal of architecture (Schumacher, 2002). During the early Modern period, L. Sullivan's dictum "The form follows the function" resonated uniquely with functionalism concepts (Nia, & Rahbarianyazd, 2020).

De-stijl approach started as a periodical that aimed to improve the general public's access to art. Supporting the integration of the arts, the publication primarily featured the works of visual artists, designers, and other artists. The artists felt that it was crucial to understand many disciplines (such as painting, architecture, sculpture, etc.) at their most fundamental levels in order to cleanse them and then merge them in a way that was harmonious. (Holdren, 2016). The main characteristic of De Stijl is its pure universality, which is attained by reducing elements to their most fundamental shapes and hues. This is particularly evident in the usage of horizontal and vertical lines together with primary colors, black, and white (Blotkamp, 2001).

Purism, stated by Carol S. Eliel, originated in 1918 as a reaction to the both social and artistic circumstances of the period (Eliel, Ducros, & Gronberg, 2001; Simic, 2006). Le Corbusier first learned about the post-Cubist avant-garde through Ozenfant, who also introduced him to some of its key figures, such as the painter Fernand Leger. Le Corbusier succeeded in reuniting the broken universe of cubist paintings into polished creations of artwork that were machined with mathematical in their accuracy. During the 16th through the 19th centuries, the more noble aspects of nature held the position in still-life paintings that was later raised by purism to mass-produced items of daily life (Slutzky, 1987; Shannon, & Shannon, 2020). These key figures frequently occur in their Purist artwork and were closely related to Le Corbusier's future construction. The plans, sections, with facades on his interiors and structures, were influenced by the shapes, colours, and spatial arrangements of his artwork (Shannon, & Shannon, 2020). Purism has been more steady, symmetrical, and deductive due to its use of pure and geometrical shapes.

Cubism was one of the trends in art that challenged the Naturalist conception of art and introduced a fresh perspective on form.

Cubists subscribed to the principle of rejecting the apparent reality. They behaved rationally and analytically, in contrast to German expressionists who tried to develop topics and forms through emotions (Krausse, 2005). Cubism is based on the principle of separating the object into parts and putting it back together with a different interpretation. In the process of reassembly, two different methods are applied. These; Geometric pieces obtained from the analysed shapes are either sprinkled on the canvas or stacked on top of each other. As a result of both methods, the object loses its original form and becomes unrecognizable, and turns into a new object consisting of a series of interlocking geometries. Based on this, in cubist painting, the same objects are drawn on top of each other with different viewing angles, emphasizing the relativity and variability of time and space (Birol, 2006). Its utilization of space is as fluid as an endeavor that evolved project over time was Cubism. It achieved greater abstraction and universality the further it deviated from early pieces like Picasso's Demoiselles d'Avignon (1907) (Haftmann, 1960; Falcetta, 2007). Picasso went one step further by emphasizing the complex web of relationships between volumes and spaces as well as the tenuous connection between transparency and solidity, transforming their

ambiguities into contradictions and shattering any illusion of spatial coherence (Cottington, 2004; Diamond, 2011). Leger's wheel, Picasso's illustration of a nose, Cezanne's pipe, and Gris's bottle shapes are all comparable to what Le Corbusier looks for in a cube. In addition, cubism had an impact on Frank Lloyd Wright as well. The Robie House, his first real masterpiece, was built from 1908 to 1910 outside of Chicago and is the best illustration of this ground-breaking use of architectural space (Sherrye, 1985; Wadsworth, 2011).

Johnson Philip Cortelyou who is an American architect is credited with creating the International Style, often known as American Rationalist European Architecture or International Modern. Johnson Philip Cortelyou belongs to a second generation of notable American architects, which also included Henry Hitchcock, Paul Rudolph, Kevin Roche, and Eero Saarnen. American architects had a reputation for being formalists, refiners, and redefinitionists. Le Corbusier, Mies Van der Rohe, Frank Lloyd Wright, and others made up the first generation. Johnson coined the phrase "International Style" to describe what they saw as significant changes in modern architecture that were moving toward designs for buildings that were straightforward, unadorned, and explicitly displayed their structural elements using contemporary materials. "International style" and minimalist aesthetics conception Around 1900, there was a lot of debate in Europe about the function of architecture and designers in society. Every good architect is also an outstanding poet, according to Frank Lloyd Wright. Wright must be a superb, sincere interpreter of his period. There was growing criticism of ornament usage overall as well as ornament overuse. The nineteenth-century architecture is harshly attacked from a variety of angles because it employs modern technologies but does not fundamentally relate to them. It was agreed upon during these conversations that it was vital to employ fair materials that weren't embellished with plaster or paintings. According to architects, a building's beauty is found in its usefulness rather than how it is decorated. The proponents of this concept were Mies van der Rohe, who stated that "Less is more," Frank Lloyd Wright, who remarked that "Five lines where three were enough is foolishness," Adolf Loos, who wrote a book titled "Ornament and Crime" and others (Proskuryakov et al., 2018). The best of the International Style's examples are Le Corbusier's Citrohan House (1922), Gropius' Bauhaus Design School in Dessau (1925-26), Richard Neutra's Lovell Health House in Los Angeles (1927-1929), Mies van der Rohe's German Pavilion at the Barcelona World Exhibition (1929) can be counted among her pioneering works (Erenler, 1997).

Sustainability and Sustainability Parameters

The words "sustainability" and "sustainable" refer to the capacity to create and preserve settings in which nature and humans may live while meeting the demands of both the current and future generations in terms of economic, social, and other aspects (Office of the Federal Register, 2009; Fiksel et al., 2012). A sustainable way of living optimizes social, environmental, and economic factors while accounting for long-term and indirect repercussions (Litman, 2010). The threat of environmental contamination and the depletion of natural resources has been brought on by the rapid rise in global population and consumption, as well as technological advancements. The idea of sustainable development has been viewed as one that stops social and environmental advancements while providing economic benefits to the raw material processing that began with the industrial revolution and continues now (Meadows et al., 1972; Duran, 2018).

Up until the latter half of the 20th century, environmentalism and the protection of the natural world were the concept and main goals of sustainable development. Throughout history, there has been and will always be a relationship involving man and the environment. These relationships increased, and it can be observed that human actions have proven detrimental to nature, especially since the industrial development that occurred in the 19th century (Eş, 2008). The panel on the path to sustainable growth on an international level about environmental concerns convened in Founex, Switzerland, in 1971 was the first to discuss both the development and protection of the environment together side. The production and consumption patterns of industrialized nations, poverty, and underdevelopment are all cited in the report that was written up following the meeting as contributing factors to environmental issues. This outcome, which forms the basis of the sustainable development paradigm, led many poor nations to take part in the 1972 Stockholm "Human and Environment" conference (Erdem et al., 2004). The Rio Declaration was published by the UN in 1992. This proclamation proposes identifying priorities and trade-offs while balancing the economic, environmental, and social facets of sustainability (Manzi et al., 2010; Yenidünya, & Limoncu, 2020).

The four primary pillars of sustainability are social, cultural, economic, and environmental sustainability (Beyaz & Erçin, 2023b).

Out of the economic, environmental, and social pillars of sustainability, the social pillar has had the least amount of research, but it did receive greater attention after 2000 (Doğu, & Aras, 2019; Dempsey et al., 2011). Ensuring fair provision for people's socio-cultural and spiritual needs is the aim of social sustainability. Each person has unique demands, which vary depending on the status of society at the time (Assefa & Frostell, 2007). The Brundtland Report, Our Common Future, defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition is used by many people who use the phrase "social sustainability" (McKenzie, 2004). Given that the aim of sustainable development is to improve people's quality of life in both the environmental and social environments, it may be argued that social sustainability is one of the most significant aspects of sustainability. Stress levels among employees, job satisfaction, and aspirations toward attaining sustainability are all markers of social sustainability (Popovic et al., 2013).

The most complex of two or three challenging terms, according to cultural sustainability, is culture (Williams, 2014; Soini, & Dessein, 2016). Culture is made up of a society's beliefs, values, customs, and aspirations as well as the ways in which those values are articulated and practically implemented in day-to-day activities (Hawkes, 2001; Pop et al., 2019). According to Hawkes (2005), culture does in fact have a transformative effect on present development strategies, assisting in enlarging the scope of the present-day development discussion and increasing the relevance of development to the requirements of the general public (Hawkes, 2005; Naibei, 2014). Furthermore, an approach based on human rights that respect cultural diversity can promote intercultural understanding, avert conflicts, and defend the liberties of marginalized groups both within and across national boundaries, fostering the ideal environment for the achievement of development objectives. This understanding of culture increases the sustainability of development (Hawkes, 2005; Naibei, 2014).

The term "environmental" is almost always used in reference to human interactions with ecosystems. It appears appropriate to see "environmental" as a part of the broader notion of "ecological," that is, as the intersection of natural processes and human activity, in order to increase certainty (Jeronen, 2023). Hence, environmental sustainability could be defined as a condition of balance, flexibility, and interdependence that enables human society to meet its demands without exceeding the ability of the ecosystems that sustain it to continue producing the services needed to do so (Jeronen, 2023). An environment is considered sustainable nowadays if it leaves the planet in a more productive state or better for generations to come (Boström, 2012).

The sustainability of the economic system itself is what "economic sustainability" seeks to achieve. The term "economic sustainability" was initially used by Hicks (Berardi, 2015). Economic sustainability is concerned with the real economic impact on its economic environment, according to Bernardi et al. (Bernardi et al., 2017; Ozay, 2005). Researchers contend that the developing discipline of sustainability economics could be characterized by four key characteristics by interpreting the current economic contributions in light of the general concept of sustainability (Baumgärtner & Quaas, 2010). These are;

1. The link between people and nature is the main topic of discussion.
2. A focus on the future, which is long-term and intrinsically uncertain.
3. A normative basis based on the concept of justice between humans and the natural world, as well as between current and future generations.
4. An emphasis on economic efficiency, which is defined as not wasting resources, in the distribution of natural goods and solutions as well as their man-made complements and replacements (Beyaz, 2023).

Sustainability in Architecture

The term "sustainability" in architecture refers to future-focused design and development. Architecture that is sustainable combines human and technological goals. The International Council on Building (CIB) established the goal of sustainable architecture as building and innovating a synthetically healthy environment founded on ecological design with resource efficiency in 1994. A structure that is sustainable is one that can best adapt to its surrounding natural and manmade environments. This includes the building itself as well as the local, national, and international environments (Mofidi Shemirani et al., 2008; Soflayi 2006; Zabihi & Habib, 2012).

According to Owen and Dovey, in order to develop sustainable design, "both sustainability with architecture as social practice" must be positioned (Owen & Dovey, 2008; Elkady & Goubran, 2022). Guy

and Framer argue that a social constructivist point of view should be adopted in place of the positivist tenets that support sustainable design practice and research (Guy & Farmer 2001). Despite the fact that modernism appeared before sustainability as we know it today, both ideas share a fundamental ethos (Elkady & Goubran, 2022).

The providing its occupants with secure and comfortable living spaces, sustainable architecture is defined as a design for buildings that preserves the environment by using natural resources as little as possible. In this situation, the aspect of sustainable development that should be taken into account is architecture. By designing and developing sustainable structures, adhering to sustainability principles at each phase of construction, with continuing the procedure at the end of usage, architecture will be able to contribute to sustainable development (Canan, 2003). In order to be sustainable, architecture must include ecology at all stages of design and construction. This includes using resources that are renewable, energy-efficient technologies, materials that are environmentally friendly, recycling, and reuse activities (Üstün, 2009).

The main objective of sustainable architecture is to balance development, social equity, ecology, and economy while still providing for human needs. Today, methods known as ecological, bioclimatic, and energy-efficient design or architecture which essentially serve the same functions and concentrate on particular subjects are widely used, especially in accordance with the individual approaches of designers and users (Sakınç, 2006).

Methodology

The research methodology was presented by examining the architectural approaches, criteria, and sustainability framework of the modern period of residential buildings in different countries of the world with the data collection method. Then, the modern period was investigated in the context of residential buildings selected from different countries of the world and how it developed was explained. The residential buildings built between 1910 and 1940 in the modern period are among the residential buildings that best reflect and emphasize the architectural criteria and approaches of the modern period. At the same time, they are the houses that have a direct relationship with the sustainability parameters that emerged years later. For this reason, Steiner House, Schröder House, and Fallingwater House were selected within the scope of the study. Theoretical approaches were used in the context of sustainability parameters and approaches of modern architecture in 3 residential buildings chosen and observations and analysis approach evaluation methods were used during the data collection phase. While the data was analyzed, functions and the typologies of the plans of the houses were determined, and architectural criteria were determined within the framework of sustainability parameters and modern architectural approaches. Consequently, this study demonstrates the connection between sustainability and modern architectural approaches and criteria. It also emphasizes the necessity of evaluating modern architectural approaches and criteria together with sustainability parameters.

Results

The 20th century has been a period in which new theories and concepts emerged in the field of architecture, innovative examples were presented in architectural discourse and practices, and architectural designs began to be simplified. At the same time, developing technology, science, philosophy, art, and economy around the world have been influential in the change of societies and the emergence of new thoughts and ideas.

Different design approaches, which started with the industrial period and emerged with the modern architectural period, caused the architectural criteria to develop and change. According to these changes have also started in architectural spaces. With the emerging architectural approaches, these changes show themselves in the spaces. With the modern architectural period, the design fiction of the buildings and the relationship between interior and exterior began to be considered as a whole. In this context, many modern period architects responded to these criteria and approaches in the buildings they designed in this period. To accomplish the study's goal, three modern-period houses that were relevant to the study area's boundaries were chosen, and these houses were assessed using sustainability parameters as well as modern-period approaches and criteria. The sample houses selected in relation to the subject will be analysed with a systematic approach. These will be assessed based on their material, form, and function in terms of architectural criteria, and social, economic, cultural, and environmental in terms of sustainability.

According to this research's findings, the Steiner House, Schröder House and Falling Water House were analyzed.

Examining the different examples related to the subject will strengthen the study. In this context, it will clarify the relationship between this type of modern period houses and the criteria and sustainability parameters of the period. At the same time, it will create a foreword on how the criteria and approaches of houses will be evaluated with sustainability parameters for the selected houses.

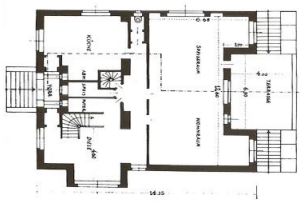
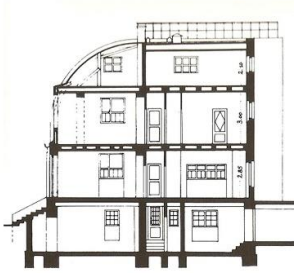
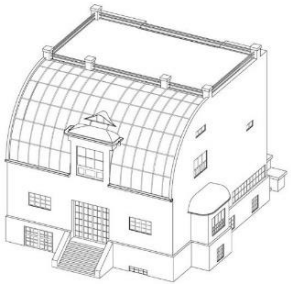
Modern Architectural Approaches and Sustainability for Steiner House (1910)

Adolf Loos has become a well-known architect for his simple, compact constructions. The Steiner House, which is regarded as one of the most iconic structures of European modernism, was constructed in Vienna, a city with strict planning regulations (Irving, & St John, 2007). Adolf Loos, a critic of the modernist movement, is regarded as one of the forerunners of modern thought thanks to the idea of the free plan. due to the Steiner House being the first building that sparked the growth of the ideas of freedom and the plan of multitudes. Adolf Loos' theories are reflected in the House's architecture. It is built on a hill with a plain surface and big windows, and its roof is made of a combination of wood, concrete, and curved metal. The structure is an unadorned, symmetrical bulk, and both its front and back facades lack ornamentation. The house is displayed as an illustration of the International Style in 1930s architecture as a very simple concrete building with a smooth, basic, and simple facade with sharp rectangular lines (Khan, 1998; Frampton, 2007).

The Steiner House, with its refusal of ornamentation on the facades, its windows that are simply constructed and arranged with exact lines, and its cubic shape, is the first modern structure to be designed in Vienna in the entire history of twentieth-century architecture. Three main floors, plus a basement floor make up the structure. Loos created a mansard roof and opened a rooftop window on the house's street-facing facade. He also curled the roofing to the ground (Vergo, 1981; Benian, 2010). The basement floor's roof was elevated using the whole width of the home to create a terrace on the back facade that looks out onto the garden and is directly accessible from both the primary living with dining areas. The Steiner House's interiors have a more luxurious appearance thanks to the extensive use of wood for the doors, windowsills, cladding, and ceiling grids. By not resembling numerous designs from that era, this design technique has produced a unique piece. (Moffett & Fazio, & Wodehouse, 2003).

Steiner House is located both on foot and by car, access is simple. Additionally, it has a positive social and economic impact on the area. The design is a valuable building in the context of sustainability because of all of these features. The structure still reflects the modern architectural approaches it has quite well, and it is protected sustainability. It has elements for social sustainability like density, neighbourhood relationships, walkability, and vehicle transportation. When examined in terms of cultural sustainability, Steiner House's design, use of modern materials, and architectural technique all reflect the time period's distinctive architectural identity. Due to the strength and environmental friendliness of the modern materials used for the construction of Steiner House, they have been preserved up to this day without degrading. Steiner House, which was designed and built in the modern period, was designed as a house. Today, it still preserves its cultural value as a house and is visited by tourists. The building, which upholds the values of society and culture, continues to be economically sustainable today. The building's location in a tourist, friendly city raises the value of the surrounding, land property, residential, and commercial. Thus, it continues to be economically sustainable while maintaining its environmental sustainability. See Table 1.

Table 1.
Modern Architectural Approaches and Sustainability for Steiner House (1910)

<table>
<tr><th colspan="3">Austria/Vienna - 1910 - Adolf Loos House</th></tr>
<tr><td> 
Plan (Architectuul, 2023)</td><td colspan="2">   
Entrance Facade (Architectuul, 2023)
Interior Spaces (Architectuul, 2023)</td></tr>
<tr><td rowspan="4"> 
Section (Architectuul, 2023)</td><td>Form analysis</td><td>Steiner House has been simplified in the form of a mass and designed symmetrically and simply with the free plan technique. It is without decorations and has the shape of a plain white cube. The interior spaces are designed as open, flowing into each other. Being one of the prototypes of early modernism, Steiner House carries the approaches of, cubism, functionalism, international style, and purism.</td></tr>
<tr><td>Function</td><td>Steiner House, which was designed as a house, is now a residence and opened to tourists.</td></tr>
<tr><td>Construction</td><td>The house is designed from concrete and wood materials. The roof is made of sheet metal and the walls are made of concrete and brick.</td></tr>
<tr><td></td><td colspan="2">Sustainability Parameters</td></tr>
<tr><td rowspan="4"> 
Axonometric drawing (Architectuul, 2023)</td><td>Social Sustainability</td><td>Social sustainability parameters for Steiner House' are accessibility, walkability, transportation, and car accessibility are some of the requirements.</td></tr>
<tr><td>Cultural Sustainability</td><td>Steiner House is a crucial historical-cultural value in the perspective of cultural sustainability since it shapes Vienna's architectural character in terms of construction method, construction style, and structural form.</td></tr>
<tr><td>Environmental Sustainability</td><td>The Steiner House was constructed with the environment in mind. Given that they were created as ecologically friendly building materials, the materials utilized to construct this house preserve their environmental sustainability.</td></tr>
<tr><td>Economical Sustainability</td><td>Steiner House raises the worth of the nearby land and of residential and business properties while yet ensuring economic sustainability. While maintaining its social, cultural, and environmental sustainability, it continues to contribute to economic sustainability.</td></tr>
</table>

Source: (Author, 2023).

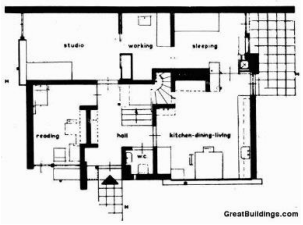
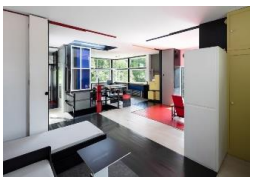
Modern Architectural Approaches and Sustainability for Schröder House (1923)

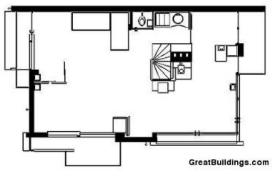
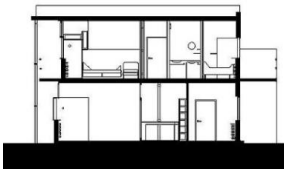
The Schröder House, which Gerrit Rietveld built in Utrecht in Netherlands in 1923, is regarded as the De Stijl approach's most iconic building, and its outside has been compared to Piet Mondrian's artwork (Kortan, 2000). Based on the disintegration notion of a cube, the house's harmony is provided by the horizontal and vertical harmony of the colors and materials with geometric forms. The De Stijl approach's architectural philosophy is based on the idea that a building and a free plan system should first be divided into its areas, and to carry these spaces should be reassembled in an arbitrary order (Gürer, 1995). The front side of the balcony faces the southeast facade, and the glass-only roof hung over the east corner gives the appearance that it is floating in space. A 90-degree angle connects the windows which open outward to the façade, which is bordered by trees of various colours (Leuthauser, 2001).

The Schröder House, which had been designed to be a private house, was later placed under UNESCO's protection. According to the 1988 Monuments and Historic Buildings Act, the Rietveld Schröder house is recognized as a national heritage monument. The adjacent region is designated as a green space. In cooperation with the Rietveld Schröder Home Foundation, the Central Museum, and the city Museum of Utrecht, manages and maintains the house (Van Thoor, 2019). The house is formed up of both horizontal and vertical planes that are painted white or grey, rather than just made up of walls and a roof. Contrary to popular belief, the walls are composed of plastered brick rather than concrete. Some balconies have projecting walls composed of reinforced concrete (Leuthauser, 2001). Similarly radical and Mondrian-like is the use of colour. All linear components are painted in strong hues like red, blue, and yellow, with surfaces being either white or grey (Curtis, 1996; Leuthauser, 2001; Benian, 2010). The Schröder House is defined as a "whole of art" that combines the visual arts with the built environment (Curtis, 1996).

Schröder House was built in Utrecht. It is easy to reach the location of the house by car and on foot. It makes a social and economic contribution to its location. Because of these features, design is a valuable structure in terms of social sustainability. The building still carries the criteria of modern architecture and continues to function as every house. It has social sustainability criteria such as neighbourhood relations, density, vehicle access, and walkability. Schröder House supports the architectural character of the region in terms of construction method, construction style, and structural form. It is a very important historical-cultural value in terms of cultural sustainability. It is also protected by UNESCO as a cultural heritage. The environment was taken into consideration when building the Schröder House. The materials used to build this home maintain their environmental sustainability because it was designed as environmentally friendly building materials. The Schröder House preserves economic sustainability. It increases the value of land, residential and commercial properties in the surrounding area. While maintaining its social, cultural, and environmental sustainability, it continues to contribute to economic sustainability as it is listed as a cultural heritage and is visited by tourists as a museum. See Table 2.

Table 2.
Modern Architectural Approaches and Sustainability for Schröder House (1923)

Uthrect/ Netherlands - 1923 - Gerrit Rietveld House			
 **Ground Floor Plan (Great Buildings, 2021)**	 Entrance Facade (Block, 2018)		 Interior Spaces (UNESCO, 2010)

 **First Floor Plan (Great Buildings, 2021)**	Form analysis		The Schröder House, that embodies every element of the De-Stijl movement, is founded on the idea of initial space division using the free plan technique, followed by an unordered reunification of these spaces. The house contains the plastic building elements of modern architecture such as mass, function, surface, time and space, light, color and material. The house, which is designed on the fragmentation of the cube, is provided by the horizontal and vertical harmony of materials, colors and geometric forms.
	Function		Schröder, which was originally designed as a house, was now opened to tourists as a museum in Utrecht after being restored.
	Construction		The walls are made of plastered brick. Large windows are designed on the facades.
	Sustainability Parameters		
 **Section (Great Buildings, 2021)**	Social Sustainability		The Schröder House meets requirements for social sustainability, accessibility, transportation, walkability, and by car.
	Cultural Sustainability		Schröder House shapes the architectural character of Uthrecht in terms of construction method, construction style, and structural form. It is a very important historical-cultural value in terms of cultural sustainability.
	Environmental Sustainability		The environment was taken into consideration when building the Schröder House. The materials used to build this home maintain their environmental sustainability because it was designed as eco-friendly construction materials.
	Economical Sustainability		The Schröder House keeps up economic sustainability. It increases the value of land, residential and commercial properties in the surrounding area.

Source: (Author, 2023).

Modern Architectural Approaches and Sustainability for Fallingwater House (1935)

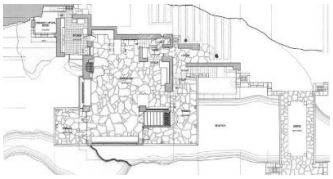
Wright created The Fallingwater House, a getaway home in Pennsylvania from 1935 and 1939, for Edgar J. Kaufman on a property containing a waterfall. Wright brilliantly reflected organic architectural approach in the construction of this home by placing it atop a flat piece of rocks above the water that was seeping out from beneath it. The House rests on the horizontal axis of the building and is centered on four stone columns. Similar to tables that have been overlay, these planes stretch in all directions. It terminates with a protruding smooth concrete patio. When the dwelling is accessed through a path, its existence is noticed. The house's tight connection to the outside is a notable aspect of the design. The arrangement of the rocks, plants, and water has been planned to look like it belongs inside the house (Prina & Demartini, 2006; Doordan, 2001). The Fallingwater House, in Wright's opinion, perfectly exemplifies the concepts of organic design. On the other hand, Wright defined organic architecture as the home growing naturally from the inside out in balance with its own existence (Benian, 2010).

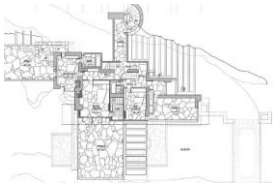
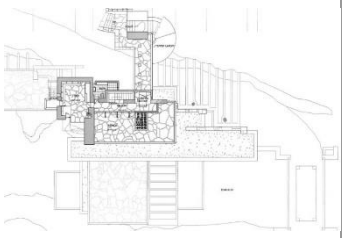
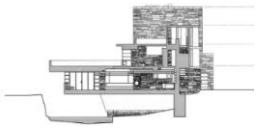
The house's structure lacks curved edges, horizontal eaves, and a hipped roof. On the horizontal plane, white prisms and natural stones intersect the structure. The structure has a system of intersecting horizontally and vertically placed prisms. Wright used geometric shapes and right angles when designing a building, but he also took the waterfall into account. The structure stands out by generating contrast in the surrounding landscape thanks to the horizontal white bands on its façades. Together, the waterfall with the surroundings becomes a whole (Kortan, 1996).

Wright used the 'breaking the box' and De Stijl design philosophies in the creation of this home. Theo van Doedburgh stated in 1924 that he did not attempt to lock different functions in an enclosed cube, instead designing them into planes that project outward. The building is given dynamism by it, as though the functional rooms were being thrown out from the building's center. (Kortan, 1986). Every aspect of this design, from the material selection to the room layout and even the creation of the plan drawings, demonstrates the idea of "breaking up the box" of the house. It has to do with how geometric shapes are arranged both horizontally and vertically in a certain system. These entities seem to have been hurled in various directions after being fragmented by an inner force and its result (Yırtıcı, 1996).

By utilizing earth, fire, air, and water the essential components of life earth and plant science served as the inspiration for designing the Frank Lloyd Wright Fallingwater House. The structure, which was created by combining stone and concrete, has an antique and modern appearance (Doordan, 2001). Located in Ohiopyle, Pennsylvania, Fallingwater House embodies the parameters of social sustainability. It includes parameters such as easy access, walkability, transportation by vehicle, and accessibility. Fallingwater House shapes the architectural identity of Ohiopyle, Pennsylvania. Both its construction technique and building form and its harmony with its environment ensure its cultural sustainability. The building, which has historical cultural value, was included in the World Heritage List by UNESCO in 2019. During the construction of the house, the design was carried out without ignoring its surroundings. It is in close contact with the surrounding land. Eco-friendly building materials were employed to build the house. Thus, its compatibility with the environment is also ensured in terms of materials. The house continues to be environmentally sustainable, as environmentally friendly materials are used in its construction. The house, which is used as a museum, contributes to economic sustainability by gaining even more value thanks to the visitors. In addition, the house also adds real estate value as residential and commercial to the region where it is located. See Table 3.

Table 3.
Modern Architectural Approaches and Sustainability for Fallingwater House (1935-39)

<table>
<tr><th colspan="3">Ohiopyle, Pennsylvania - 1935-39 - Frank Lloyd Wright House</th></tr>
<tr><td> 
Ground Floor Plan
(Ruschak, P., 2023)</td><td colspan="2"> 
Entrance Facade
(Creager, 2023)
  
Interior Spaces
(Perez, 2023)</td></tr>
<tr><td></td><td>Form analysis</td><td>The Fallingwater House has a horizontal plan plane. It skillfully reflects the organic architectural style, which is one of the movements of the modern period. In addition, the principle of fragmentation of the box, which is one of the principles of De Stijl, is also seen in the house. Indoor and outdoor are intertwined. The structure includes a set of prism systems and a system that intersects horizontally and vertically.</td></tr>
</table>

 **First and Second Floor Plan**  **(Ruschak, P., 2023)**	Function	Fallingwater House is a weekend house designed between 1935-1939 on a plot of land with a waterfall in Pennsylvania. The house, which was later transferred to an institution, is now a museum. In 2019, UNESCO added the house to the list of World Heritage sites.
	Construction	There are no curvilinear lines, horizontal eaves, or a hipped roof in the design of the house. The building intersects with white prisms on the horizontal plane and natural stones on the vertical. There are horizontal white bands on their facades. By using a combination of stone and concrete in the building. The concrete staircases and facade also have wide windows. The light-colored concrete railings of the terraces and verandas also draw attention to the house.
	Sustainability Parameters	
  **Sections** **(Ruschak, P., 2023)**	Social Sustainability	In Fallingwater House, social sustainability criteria are included. Such as accessibility, walkability, transportation, and car transportation.
	Cultural Sustainability	Fallingwater House, Ohiopyle, Pennsylvania's building technique and building form shapes its architectural character. It has a valuable historical cultural value for cultural sustainability.
	Environmental Sustainability	During the construction of the house, the design was carried out without ignoring its surroundings. The materials used in the construction of the house are compatible with its surroundings. Since environmentally friendly materials are used in its construction, the house still maintains its sustainability.
	Economical Sustainability	Housing increases the value of the environment in which it is located. Therefore it contributes to economic sustainability.

Source: (Author, 2023).

Discussion

The study's objective is to analyze the current state of residential buildings constructed during the modern period in various countries worldwide.

Despite the fact that the field of architecture is continually up to date, it does not clash with the idea of sustainability, which is also always evolving, much like architecture. While the concept of sustainability is associated with architecture, it develops in the light of its past and makes architecture rich in terms of structure. The fact that sustainable architecture as a concept has become an important issue is due to the fact that it affects architecture in many ways. Accordingly, Vandevyvere and Heynen (2014) argue that Modernism and sustainability have much more in common than many current debates offer and that it should be examined from a broader perspective by embracing the legacy of modernism, accepting its continuity with the desire to modernize. They also argue that "the convergence between the discourses of modernism and sustainability" and "sustainable modernism" can provide a good paradigm for developing architectural education and architectural culture.

Architectural approaches, which reflect the understanding of design in architecture, are the set of concepts formed by characteristic and periodical features in the definition of buildings. The approaches that arose during the modern era had a significant impact on the evolution of modern architecture and reflected the architectural criteria of the time. Today, it is possible to see that many buildings designed in the modern period have lost their criteria and approaches and cannot maintain their sustainability. Within this regard, it was determined in the findings that when the modern period buildings change their function or are renewed, they will preserve the modern period identity when considered together with the approaches and criteria of the modern period, parameters of sustainability.

With the modern period, Louis Sullivan's (Venturi, 2005) slogan, "form follows function," has become the basic principle of the period, emphasizing that buildings should be designed in accordance with their own nature and special conditions and allowing them to develop logically. Accordingly, Le Corbusier (Venturi, 2005), who said that "the operation of the plan happens from the inside out, it is the result of the external environment" supported Sullivan's words. In this context, the function, which is the determinant of the building forms, has been the most important criterion of the designs. Thus, houses designed with function, which is a defense of the modern period, should respond to the needs of the user, be designed by respecting the location and culture of the region where they are located, and a modern life should be fictioned. Even though approaches that arose during the modern period provide distinct designs, they basically contain the same ideas and principles. It has emerged in research that many of the buildings designed with the materials that appeared in the modern period and the technique of the period still survive even if they change their functions and are renewed in today's conditions.

It is clearly seen that the residences selected in the study carry the modern architecture criteria (sharp lines, simplicity, geometric forms, and open plan) and approaches (Functionalism, Cubism De-Stijl, Purism and International Style) and sustainability parameters.

Conclusions

This research has demonstrated a strong link between the architectural approaches of the modern period and the principles of sustainable design. By analyzing a diverse range of modern period houses, we identified key features of these approaches, such as being built with an environmentally friendly appearance and being designed to establish a relationship with the interior and exterior environment to create a whole. When we evaluated the building materials used in the design in terms of environmental sustainability, it was observed that they were built with durable and environmentally friendly building materials that contribute to environmental sustainability and resource efficiency. Today, it is possible to see that many buildings designed in the modern period have lost their criteria and approaches and cannot maintain their sustainability. In this context, it has been determined in the findings that when the modern period buildings change their function or are renewed, however they will preserve the modern period identity when considered together with the criteria and approaches of the modern period, parameters of sustainability. While constructing structures that can be transferred to future generations, it is necessary to respect the natural environment and the time. Using the right design principles and natural resources, as well as taking advantage of the technology of the period, ensures the sustainability of the buildings until today. In this context, it is an important factor to consider and implement sustainability together with its social, cultural, environmental, and economic parameters. This finding suggests that architects and designers can draw inspiration from modern period approaches to create buildings that are both aesthetically pleasing and environmentally responsible.

Our research also underscores the importance of preserving culturally significant homes from the modern period. These structures not only embody valuable architectural knowledge but also contribute to the social, economic, cultural, and environmental fabric of their communities. Buildings, which were designed in the modern period, are a historical cultural value that determines the architectural and cultural identity of the region with its architectural style, building form, and construction technique in the context of cultural sustainability. These buildings, meet criteria such as simple accessibility, walkability and vehicle accessibility, neighbourhood relations, functionality, and the social benefits they provide to the environment, so these houses-it also contributes to the social structure of their communities. These houses, which were built in the modern period and carry cultural value, maintain their economic sustainability because they are built with up-to-date construction materials. They create a tourist attraction center by increasing the land value and residential real estate values in their surroundings. These structures, which continue to be environmentally sustainable, continue to contribute to the economic structure of their

communities. Preserving these buildings ensures that future generations can benefit from the design principles and cultural heritage they represent.

This study provides a valuable foundation for understanding the relationship between modern architectural approaches and sustainability. However, further research is needed to reveal the original identities of modern period buildings without losing them, the development of strategies for preserving modern period houses in rapidly urbanizing areas, to make decisions to strengthen the relationship between modern approaches and sustainability in urban planning and design processes, also the adaptation of modern architectural approaches to contemporary building technologies to explore. By continuing to investigate these, topics, we can gain a deeper appreciation for the enduring legacy of modern architecture and its potential to inform a more sustainable future.

Recommendations

The study looked at the sustainability parameters with the modern architectural approaches and criteria for houses built in the various nations of the world during the modern period, as well as their current state.

As for the conclusions of this study, the necessity to safeguard houses built during the modern architectural period has an inevitable outcome. The investigations have shown that Modernism's understanding helped to create and develop the foundation of the idea of sustainability, which evolved after the modern period's criteria and approaches were established. Because of these reasons, it has to be crucial to maintain the criteria of the modern period for providing a sustainable design.

As a result, the following is the list of the study's research findings and recommendations:

- It should be ensured that the modern period buildings are protected without spoiling its identity.
- If residential buildings constructed in the modern period are to be renewed nowadays no changes should be made in the approaches and criteria of the modern period.
- If possible, it should be renewed with modern building materials and traditional construction techniques.
- Recommend is all subjects, institutions, and organizations that supervise, implement, and manage the protection of modern structures should be developed and trained in the subjects of protection of modern structures.

Consequently, it is recommended that building designs that are compatible with social, economic, environmental, and cultural sustainability parameters be used, as merely adhering to modern architectural approaches and criteria will be not enough to preserve the modern period identity. Accordingly, It ought to be put into effect by incorporating modern period architectural criteria with the present day's modern sustainable designs.

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