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ENVIRONMENTAL DISCOURSE AND CONCEPTUAL FRAMEWORK FOR SUSTAINABLE ARCHITECTURE

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ABSTRACT

The ecosystem is made up of groups as inorganic substances, living organisms, and human beings. Buildings affect the ecosystem and environment via a series of interrelated activities and processes. Site organization and construction influence ecological characteristics of the environment. Manufacturing of materials impact the environment. After being built, building imposes long-lasting impact on the environment. The professional duty of architects is to design and produce sustainable environments for these groups. Within this context, the aim of sustainable design is to find architectural solutions that secure the environment, the well-being and coexistence of organic and inorganic groups. In this article, the literature is reviewed and a conceptual framework is gathered by considering objectives, means, and ends of creating environmental awareness, the building ecosystem, and considering how to design and produce sustainable buildings.

Key Words: Environment, ecology, sustainable architecture

ÇEVRESEL SÖYLEM VE SÜRDÜRÜLEBİLİR MİMARLIK İÇİN KAVRAMSAL BİR ÇERÇEVE

ÖZET

Çevre, denge içinde varlığın sürdürüldüğü ortamı ifade eden bir kavramdır. Tüm varlıklar ekosistem adı verilen holistik bütünlük içindedirler. Ekosistem inorganik maddeler, canlı organizmalar ve insan gruplarından meydana gelir ve mimarlık bir dizi ilişkili eylemler ve süreçlerle yerel ve global ölçekteki çevreyi etkiler. Örneğin, bina yapımının henüz ilk aşaması olan şantiye organizasyonu ve yapım süreci yerel çevreyi, yapı malzemelerinin üretim yöntemleri ise çevrenin global ölçekteki ekolojik özelliklerini etkiler. Ekosistemde var olan gruplara sürdürülebilir çevreler tasarlamak ve üretmek mimarların sorumluluğu altındadır. Bir bina inşa edildikten sonra çevre ile uzun süreli etkileşim içine girer. Bu bağlamda, sürdürülebilir tasarımın amacı organik ve inorganik grupların birlikte varlıklarını sürdürebilecekleri çevreyi güvence altına alan, sağlık ve güvenliği sağlayan mimari çözümler bulmaktır. Yayınlanmış literatür taranarak ve derlenerek, çevresel duyarlılığı yaratan, yapı ekosistemini açıklayabilen ve sürdürülebilir binaların nasıl tasarlanacağını ve üretileceğini dikkate alan bir yaklaşım doğrultusunda amaçlar, çözüm yolları ve sonuçlar bağlamında, sürdürülebilir mimari tasarımın incelenmesine yönelik bir kavramsal metod geliştirilmeye çalışılmıştır.

Anahtar Kelimeler: Çevre, ekoloji, sürdürülebilir mimarlık

1. FUNDAMENTAL CONCEPTS OF ENVIRONMENT AND SUSTAINABILITY

Sustainable development is defined as; "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (1). The need for finding long-terms solutions that warrant continuing human existence and well-being is far more compelling than that of finding a proper terminology to describe the human need (2). Within this respect, the debate on the terms green, sustainable, or ecological architecture is not important. During a building's existence, it affects the local and global environments via interconnected human activities and natural processes. At the early stage, site development and construction influence indigenous ecological characteristics. Though temporary, the influx of construction equipment and personnel onto a building site and process of construction itself disrupt the local ecology (3) (4). The procurement and manufacturing of materials impact on the global environment also. Once built, building operation inflicts long-lasting impact on the environment. For instance, the energy and water used by its inhabitants produce toxic gases and sewage; the process of extracting, refining, and transporting all the resources used in building operation and maintenance also have numerous effects on the environment.

The global ecosystem is made up of three groups; inorganic substances, living organisms, and human beings. Buildings increase the combined impact of architecture on these global ecosystem. The term sustainable architecture is used to describe the movement associated with environmentally conscious architectural design and has created ambivalence and confusion. An examination of the meaning of "sustainable" identifies why this occurs (5). Sustainable architecture describes the fact that we receive what we need from the universe. Sustainable building, then, is a response to an awareness and not a prescriptive formula for survival (6). In other words, the goal of sustainable design is to find architectural solutions that undertake to engage the well-being and coexistence of constituent groups (7). To meet the goal of well-being and coexistence, a conceptual approach to framework is considered in this article. Three fundamental concepts of the framework: Objectives, Means, and Ends are related to the environmental responsibilities: creating environmental awareness, explaining the building ecosystem, and designing sustainable buildings.

2. THE OBJECTIVES OF SUSTAINABLE DESIGN

Three objectives of sustainable architecture are proposed in this study as in the following: Protection of resources, life cycle design (LCD), livable design.

Protection of resources is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building. Life cycle design (LCD) provides a methodology for analyzing the building process and its impact on the environment (8). Livable design focuses on the interactions between human beings and the natural environment. Each of these objectives embodies a unique set of intentions. Studying these intents leads architects to a more thorough understanding of architecture's interaction with the environment.

2.1 Protection of Resources

The architect reduces the use of nonrenewable resources in the construction and operation process of buildings by protecting resources (9). The resources are natural and manufactured and there is a continuous flow of resources in and out of a building. This flow begins with the production of building materials and continues throughout the building's life in order to create an environment for sustaining human well-being and activities. When examining a building two streams of resource flow is essential (Figure1).

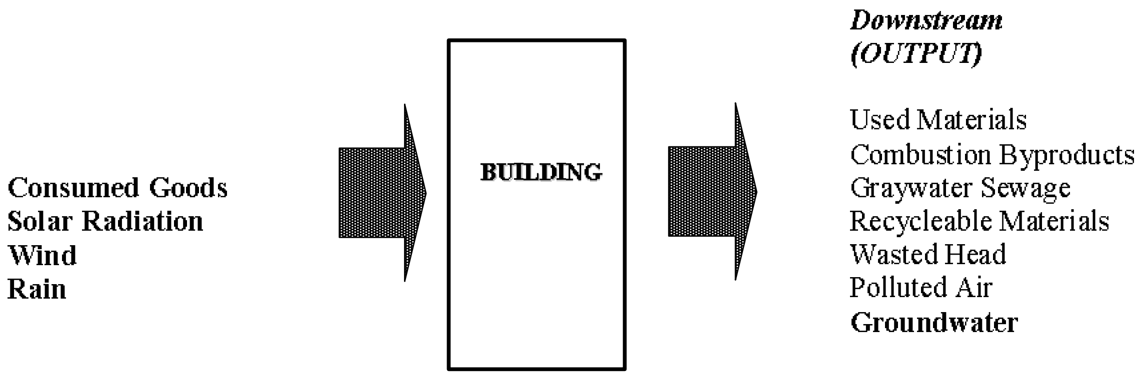

Figure 1. The input and output streams of resource flow

Upstream, resources flow into the building as input to the building ecosystem. Downstream, resources flow out of the building as output from the building ecosystem (7). The means of protection of resources are; Energy conservation, Water conservation, and Material conservation. Each of these focuses on a particular resource necessary for building construction and operation. The environmental impacts of energy consumption by buildings occur primarily away from the building site, through mining or harvesting energy sources and generating power. The energy consumed by a building in the process of heating, cooling, lighting, and equipment operation cannot be recovered. A building requires a large quantity of water for the purposes of drinking, cooking, washing and cleaning, flushing toilets, irrigating plants, etc. Water requires treatments and delivery, which consume energy. The influx of building materials occurs primarily during the construction stage. The waste generated by the construction and installation process is significant. After construction, flow of materials continues for maintenance, replacement, and renovation activities. Consumer goods flow into the building to support human activities. All of the construction materials, in the end, are output, either to be recycled or dumped in a landfill (10)

2.2 Life Cycle Design (LCD)

As it is seen in Figure 2, the life cycle process of the building is a linear process (11) consisting of four major stages:

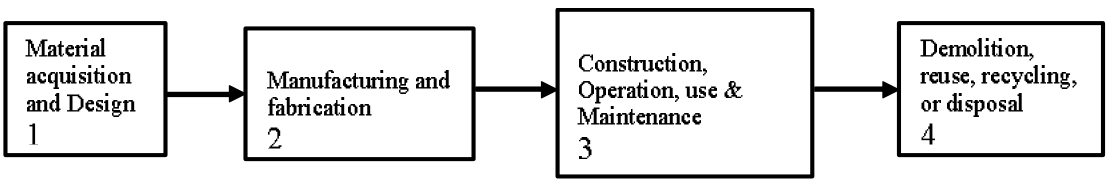

Figure 2. The Life Cycle process of building

The life cycle design (LCD) cannot tell the decision maker what the "correct" decision is. LCD can only contribute information to assist in the decision. This approach recognizes environmental consequences of the entire life cycle of architectural resources, from procurement to return to nature (12). For the purpose of conceptual clarity, the life cycle of a building can be categorized into three phases: Pre-building, Building, and Post-building. The phases can be developed into LCD means that focus on minimizing the environmental impact of a building. Analyzing the building processes in each of these three phases provides a better understanding of how a building's design, construction, operation, and disposal affect the ecosystem. In the pre-building phase site selection, building design, and building material processes are essential. This phase does not include the installation of the building. Under the sustainable design approach, the environmental consequences of the construction materials used, structure's design, orientation, its impact on the landscape must be examined (13). The procurement of building materials impacts the environment: harvesting trees could result in deforestation; mining mineral resources disturbs the nature and creates environmental pollution. Building phase refers to the stage of a building's life cycle when a building is physically being constructed and operated. In the sustainable design, the construction and operation processes for ways to reduce the environmental impact of resource consumption, also long-term health effects of the built environment on its occupants must be examined. Post-building phase is the most important stage which begins when the useful life of a building has ended. In this stage, building materials become resources for other buildings or waste to be returned to nature. The solution results in the sustainable design focuses on reducing construction waste by recycling and reusing buildings and construction materials (13).

2.3 Livable Design

Protection of resources and life cycle design deal with efficiency and conservation, livable design, on the other hand, is concerned with the livability of all constituent groups of the global ecosystem (14). The livable design considers the coexistence between buildings and the environment, and between buildings and their occupants. Therefore, the objectives are deeply rooted in the need to preserve the elements of the ecosystems that allow human being survival. An essential role of architecture is to provide built environments that sustain occupants' safety, health, physiological comfort, psychological well-being, and productivity. The livable design objectives is examined under three particular means of topics: Preservation of natural conditions, Acceptable urban design and site planning, Design for human comfort

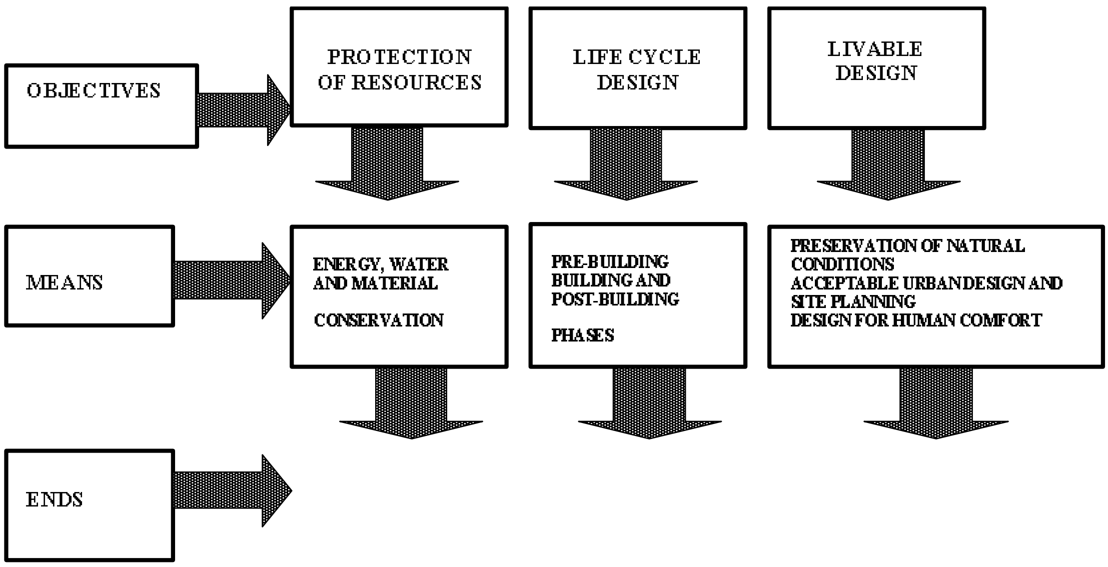

Figure 3. Conceptual Framework of Sustainable Design

An architect should minimize the impact of a building on its local ecosystem. Neighborhoods, cities, and entire geographic regions can benefit from cooperative planning to reduce energy and water demands. The result can be a more pleasant and acceptable urban environment, free of pollution and convenient to nature. As discussed previously, sustainable design need not preclude human comfort. A sustainable building must be as good for it's occupants and users. This means that it must produce an interior environment that is safe, healthy, comfortable and supportive of human performance and well-being. To enhance environmental sustainability, a building must holistically balance and integrate all three objectives: Sustainable Design, Protection of resources, and

Life Cycle Design in architectural design, construction, operation and maintenance, recycling and reuse of architectural resources.

The conceptual framework for ecological architecture and sustainable design is proposed in Figure 3.

3. THE ENDS FOR ACHIEVING SUSTAINABLE DESIGN

The goal of sustainable design is to find solutions that provide quantitative, qualitative, physical, and psychological benefits to building users. The three objectives of sustainable design provide a broad awareness of the environment issues associated with architecture. The means within each objectives focus on more specific topics. These means intend to understanding of how a building interacts with the internal, local, and global environments (see Figures 4, 5, 6).

3.1. Protection of Resources

Energy, water, and materials conservation can yield specific design methods that will improve the sustainability of architecture. These acts can be classified as two types. Input-reduction means reduce the flow of nonrenewable resources input to buildings. A building's resource demands are directly related its efficiency in utilizing resources. Output-management means reduce environmental pollution by requiring a low level of waste and proper waste management (15, 16).

3.1.1. Energy conservation

The main scope is to reduce consumption of fossil fuels. Buildings consume energy not only in their operation, for heating, lighting and cooling, but also in their construction. The solutions of these means focus on specific topics:

Energy-Conscious urban planning; Cities and neighborhoods that are energy-conscious are not planned around the automobile, but around public transportation and pedestrian walkways. These cities have zoning laws favorable to mixed-use developments, allowing people to live near their workplaces. Urban sprawl is avoided by encouraging redevelopment of existing sites and the adaptive reuse of old buildings.

Energy-Conscious site planning; Such planning allows the designer to maximize the use of natural resources on the site. In temperate climates, open southern exposure will encourage passive solar heating; trees provide shade in summer and solar heat gain in winter. Evergreens planted on the north of a building protects it from winter winds, improves its energy efficiency. Buildings can be located relative to water to provide natural cooling in summer.

Passive heating and cooling; Solar radiation incident on building surfaces is the most significant energy input to buildings. It provides heat, light, and ultraviolet radiation necessary for photosynthesis. Historically, architects have devised building forms that provide shading in summer and retain heat in winter. Passive solar architecture offers design schemes to control the flow of solar radiation using building structure, so that it may be utilized at a more desirable time of day. Shading in summer, by plants or overhangs, prevents summer heat gain and the accompanying costs of air-conditioning.

Insulation; High-performance windows and wall insulation prevent both heat gain and loss. Reducing such heat transfer reduces the building's heating and cooling loads and thus its energy consumption. Reduced heating and cooling loads require smaller HVAC equipment, and the initial investment need for the smaller equipment. The installation of smaller HVAC equipment reduces mechanical noise and increases sonic quality of the indoor space.

Alternative sources of energy; Solar, wind, water, and geothermal energy systems are all commercially available to reduce or eliminate the need for external energy sources.

Daylighting; Building and window design that utilizes natural light will lead to conserving electrical lighting energy, shaving peak electric loads, and reducing cooling energy consumptions. At the same time, daylighting increases the luminous quality of indoor environments, enhancing the psychological well-being and productivity of indoor occupants. These qualitative benefits of daylighting can be far more significant than its energy-savings potential.

Energy-Efficient equipment; Operation costs can even exceed construction costs over a building's lifetime. Careful selection of high-efficiency heating, cooling, and ventilation systems becomes critical. The initial price of this equipment may be higher than that of less efficient equipment, but this will be offset by future savings.

Materials with low embodied energy; Building materials vary with respect to how much energy is needed to produce them. The embodied energy of a material attempts to measure the energy that goes into the entire life cycle of building material. Using local materials, over imported materials of the same type, save transportation energy (12).

3.1.2 Water conservation

Water conservation may reduce input, output, or both. This is because, conventionally, the water that is supplied to a building and the water that leaves the building as sewage is all treated by municipal water treatment plants. Therefore, a reduction in use also produces a reduction in waste (15). The specific ends are in the following:

Reuse water onsite; Water consumed in buildings can be classified as two types: graywater and sewage. Graywater is produced by activities such as handwashing. While it is not of drinking-water quality, it does not need to be treated as nearly as intensively as sewage. In fact, it can be recycled within a building, perhaps to irrigate plants or flush toilets.

Reduce consumption; Water supply systems and fixtures can be selected to reduce consumption and waste. Vacuum-assisted and biocomposting toilets further reduce water consumption. Biocomposting toilets, available on both residential and commercial scales, treat sewage on site, eliminating the need for energy-intensive municipal treatment. Indigenous landscaping reduce water consumption.

3.1.3 Materials conservation

Choosing the right materials, products and components for a building is not an easy task under any circumstances. Designers who specify environmental materials must know that production and consumption of building materials has diverse implications on the environment. Extraction, processing, manufacturing, and transporting building materials all cause ecological damage to some extent. There are input and output reduction methods for materials conservation (18).

Accommodate existing buildings to new users; One of the most effective methods for material conservation is to make use of the resources that already exist in the form of buildings. Most buildings outlive the purpose for which they were designed. Many, if not all, of these buildings can be converted to new uses at a lower cost than brand-new construction (18).

Combine the reclaimed or recycled materials together; Buildings that have to be demolished should become the resources for new buildings (10). Many construction materials, such as wood, steel, and glass, are easily recycled into new materials. Use recycled materials; During the process of designing the building and selecting the building materials, look for ways to use materials that can themselves be recycled. This preserves embodied energy during their manufacturing.

Bring buildings and systems to proper size; When a building is too large or small for the number of occupants, it must contain its heating, cooling, and ventilation systems, typically sized by square meter, will be inadequate or inefficient. Architects are encouraged to design around standardized building material sizes as much as possible. Excess trimming of materials to fit non-modular spaces generates more waste.

Reuse Non-Conventional products as building materials; Building materials from unconventional sources, such as recycled tires, pop bottles, and agricultural waste, are readily available. These products reduce the need for new landfills and have a lower embodied energy that the conventional materials they are designed to replace.

Consumer goods; Consumer goods lose their original usefulness in time. The useful life quantifies the time of conversion from the useful stage to the loss of original usefulness stage. For instance, a daily newspaper is useful only for one day. The shorter the useful life of consumer goods, the greater the volume of useless goods results. Consequently, more architectural considerations are required for the recycling of short-life consumer goods. The conventional term for consumer goods that have lost their original usefulness is waste. But waste is or can be a resource for another use. Figure 4 shows how each solution relates to the means of Protection of Resources.

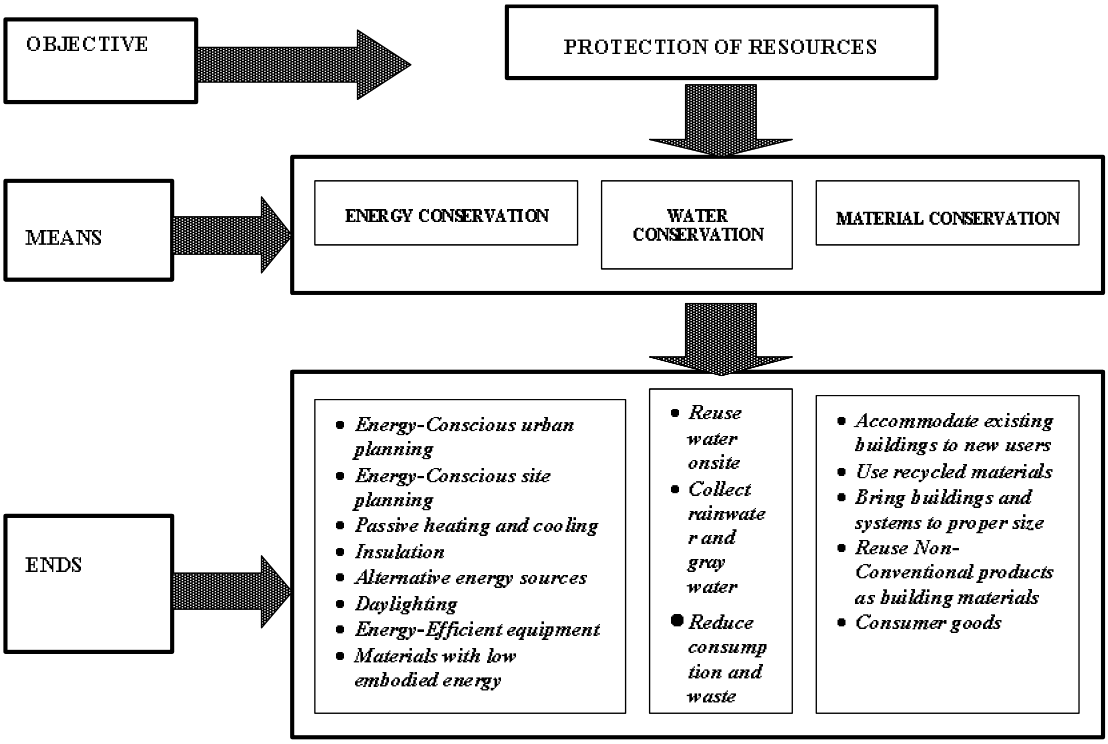

Figure 4. Application strategy of Protection of Resources

3.2. Life Cycle Design

As discussed earlier, the objectives of LCD embodies three means: pre-building, building, and post-building. These means, in turn, can yield specific design methods that will improve the sustainability of architecture. Figure 4 shows how each end relates to the means of Life Cycle Design.

3.2.1. Pre-Building phase

During the Pre-Building Phase, the design of a building and materials selected for it are examined for their environmental impact. The selection of materials is particularly important at this stage: the impact of materials processing can be global and have long-term consequences.

Use materials made from renewable resources: Renewable resources are those that can be grown or harvested at a rate that exceeds the rate of human consumption. Using these materials is, by definition, sustainable. Materials made from nonrenewable materials (petroleum, metals, etc.) are, ultimately, not sustainable, even if current supplies are adequate. Use materials harvested or extracted without causing ecological damage; Of the renewable materials available, not all can be obtained without significant environmental effects. Therefore, the architect must be aware of how various raw materials are harvested and understand the local and global ramifications.

Use recycled materials: Using recycle materials reduces waste and saves scarce landfill space. Recycled materials also preserve the embodied energy of their original form, which would otherwise be wasted. This also reduces the consumption of materials made from virgin natural resources. Many building materials, particularly steel, are easily recycled, eliminating the need for more mining and milling operations.

Use materials with long life and low maintenance: Durable materials last longer and require less maintenance with harsh cleansers. This reduces the consumption of raw materials needed to make replacements and the amount of landfill space taken by discarded products. It also means occupants receive less exposure to irritating chemicals used in the installation and maintenance of materials.

3.2.2. Building phase

The ends and methods associated with the Building Phase means are concerned with the environmental impact of actual construction and operation processes. Specific topics are in the following:

Minimize site impact: Careful planning can minimize invasion of heavy equipment and the accompanying ecosystem damage to the site. Excavations should not alter the flow of groundwater through the site. Finished structures should respect site topology and existing drainage. Trees and vegetation should only be removed when absolutely necessary for access.

Use nontoxic materials: The use of nontoxic materials is vital to the health of the building's occupants, who typically spend more than three-quarters of their time indoors. Adhesives used to make many common building materials can out gas for years after the original construction. Maintenance with nontoxic cleansers is also important, as the cleaners are often airborne and stay within a building's ventilation system for an extended period of time.

3.2.3. Post-building phase

During this phase, the architect examines the environmental consequences of structures that have outlived their usefulness. At this point, there are three possibilities in a building's future: reuse, recycling of building components, and disposal. Reuse and recycling allow a building to become a resource for new buildings or consumer goods; disposal requires incineration or landfill dumping, contributing to an already overburdened waste stream (4).

Reuse the building and components: The embodied energy of a building is considerable. It includes not only the sum of energy embodied in the materials, but also the energy gone into the building's construction. If the building can be adapted to new uses, this energy will be conserved. Where complete reuse of a building is not possible, individual components can be selected for reuse; windows, doors, bricks, and interior fixtures are all excellent candidates.

Recycle materials: Recycling materials from a building can often be difficult due to the difficulty in separating different substances from one another. Some materials, like glass and aluminum, must be scavenged from the building by hand. Steel can easily be separated from rubble by magnets. Concrete can be crushed and used as aggregate in new pours.

Reuse existing buildings and infrastructure; It has become common for new suburbs to move farther from the 'city center' as people search for "space" and "nature." The development of new suburbs from virgin woods or fertile agricultural fields destroys the qualities of suburbanites are seeking. Moreover, in addition to the materials for new houses, new development requires investments in material for roads, sewers, and the businesses that inevitability follow. Meanwhile, vacant land and abandoned structures in the city, with its existing infra-structure, go unused, materials wasted.

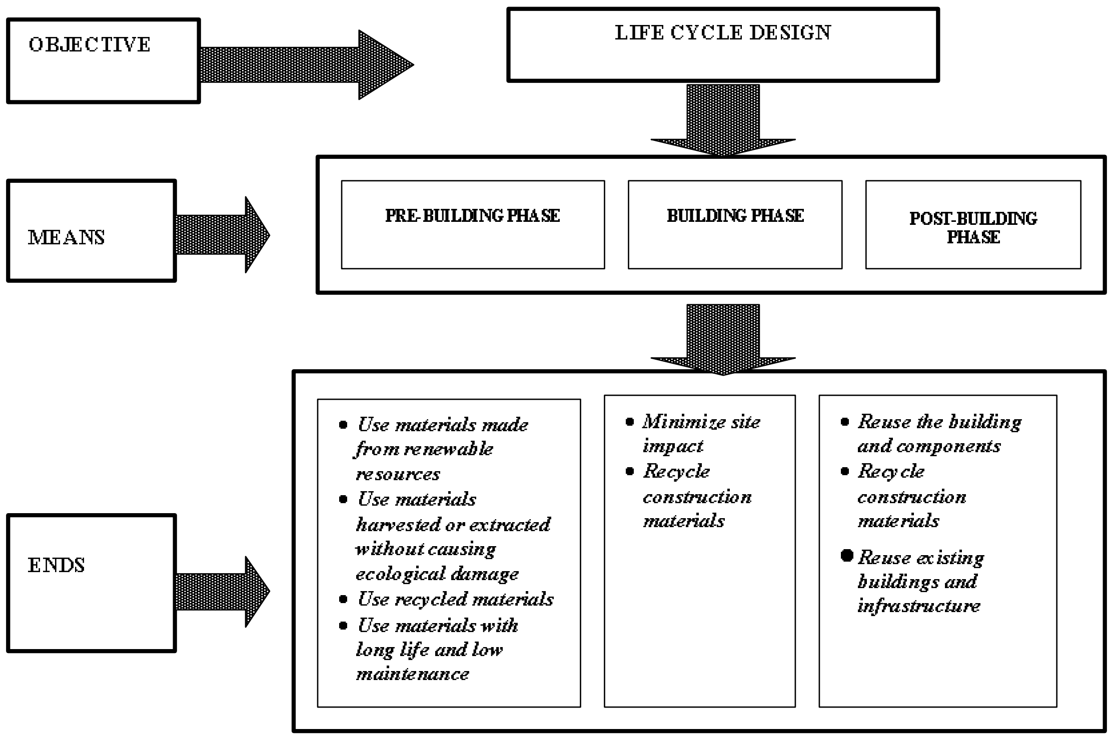

Figure5. Application strategy of Life Cycle Design

3.3. Livable Design

As described in the introduction, this objective embodies three means. These means in turn, yield specific design methods that will improve the sustainable architecture (14). Specific topics are as in the following:

3.3.1. Preservation of natural conditions

Respect topographical contours: The existing contours of a site should be respected. Radical terraforming is not only expensive but devastating to the site's microclimate. Alteration of contours will affect how water drains and how wind moves through a site. Do not disturb the water table; Select sites and building designs that do not require excavation below the local water table. Placing a large obstruction (the building) into the water table will disturb natural hydraulic process. If the water table is exposed during construction, it will also become more susceptible to contamination from polluted surface runoff.

Preserve existing flora and fauna: Local wildlife and vegetation should be recognized as a part of the building site. When treated as resources to be conserved rather than as an obstacle to be overcome, native plants and animals will make the finished building a more enjoyable space for human habitation.

3.3.1. Urban design and site planning

The methods associated with the Urban Design and Site Planning strategy apply sustainability at a scale larger than the individual building.

Integrate design with public transportation: Sustainable architecture on an urban scale must be designed to promote public transportation. Thousands of individual vehicles moving in and out of area with the daily commute create smog, congest traffic, and require parking spaces.

Promote mixed use development: Sustainable development encourages the mixing of residential, commercial, office and retail space. People then have the option of living near where they work and shop. This provides a greater sense of community than conventional suburbs. The potential for 24-hour activity also makes an area safer.

3.3.2. Design for human comfort

Environmental impacts can also affect human health. Three areas on human health is: Potential impacts on workers and installers, Potential impacts on building occupants or users, Potential impacts on the community or general population (19). Figure 6 shows how each solution relates to the means of Livable Design.

Provide thermal, visual, and acoustic comfort; People do not perform well in spaces that are too hot or too cold. Proper lighting, appropriate to each task, is essential. Background noise from equipment or people can be distracting and damage occupants' hearing.

Provide visual connection to exterior: The light in the sky changes throughout the day. Humans all have an internal clock that is synchronized to the cycle of day and night. From a psychological and physiological standpoint, windows and skylights are essential of keeping the body working properly.

Provide operable windows: Operable windows are necessary so that building occupants can have some degree of control over the temperature and ventilation.

Provide fresh clean air: Fresh air through clean air ducts is vital to the well-being of building occupants. The benefits of fresh air go beyond the need for oxygen. Continuous recirculation of interior air exposes people to concentrated levels of bacteria and chemicals within the building.

Use nontoxic, Non-outgassing Materials: Long-term exposure to chemicals commonly used in building materials can have a detrimental effect on health.

Accommodate persons with differing physical abilities; Buildings that are durable and adaptable are more sustainable than those that are not. This adaptability includes welcoming people of different ages and physical conditions. The more people that can use a building, the longer the building's useful life.

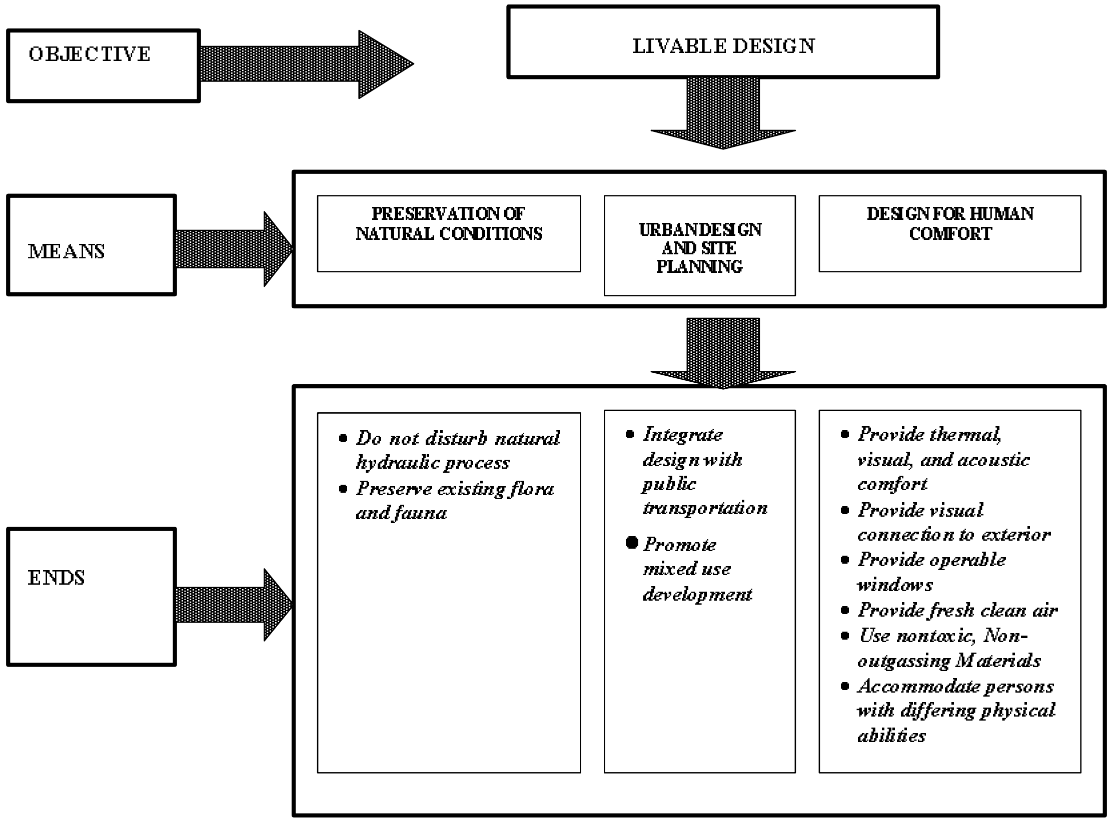

Figure 6. Application strategy of Livable Design

4. CONCLUSION

Environmental discourse refers to an ecological/sustainable architecture which is emerging as a distinct discipline. As a new field, there is danger of confusion from multiple and competing visions of what ecological architecture is, and of the scope of its application (20). We have attempted to provide an inclusive definition, and suggest potential applications where an environmental approach to architectural design can augment the efforts of other professionals to solve complicated and pressing problems. Environmental awareness represents the marriage of ecology and architectural design, and as such can perhaps have its greatest contribution in changing how design is practiced. In this article, from printed literature and own work (14), we have proposed design principles for ecological/sustainable architecture and tried to define the goal of sustainable design. A critical aspect of sustainable design is that it is not simply a checklist of disconnected objectives, strategies or ends. It mirrors ecological systems in that all parts are interconnected and interdependent and this happens at many scales.

In this context, the goal of sustainable design is defined: to find architectural solutions that secure the well-being and coexistence of organic and inorganic groups (21). To meet this goal of ecological coexistence, a conceptual framework is represented by considering objectives, means, and ends in sustainable design. The conceptual framework of the proposed systematic approach, which is presented in the Figures 4, 5, 6, indicate the architectural framework and terminology of environmental discourse within the context of sustainability.

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