Multidimensional Approach to Sustainable Interior Design Practice

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***Abstract*—** Designing sustainable environments is a multifaceted practice. Especially in interior environments, the practice becomes more complex. Interior environments are the places that create the most intimate relationship with the user. There is a multidimensional interaction between people and the interior environment. The user defines the environment, the environment defines the user. In other words, there is a complex and bilateral interaction between the person and the space in its cultural, social and physical dimensions. Designing interiors captures all of these dimensions in order to create a sustainable environment. Interior design is a profession that serves for the human habitation in the environment. In need of long term habitation, creating sustainable environment is an obligation rather than a wish. This study aims to discuss the practice of interior design in the dimension of cultural, social, and physical sustainability.

***Keywords*—** Sustainable Interior Design, Social Sustainability, Cultural Sustainability

I. Introduction

Sustainability can only be affective phenomenon when it's considered as a multifaceted problem. After the Brundthland Commission report was publish in 1987, there produced large amount of knowledge in the field of social and positive sciences. The field of environmental design is a different field of study from positive and social sciences. The environmental design deals with both theoretical and practical knowledge produced in the field of social and positive sciences.

The researchers give direction to their studies aiming to cure the ecological balance in nature. The term became important in political, social, and scientific studies. In these studies, technological development stated to be considered in curing the ecological balance from 19th century up to the middle of 20th century. Continuing studies focused on to the human aspect [1]. Especially these studies focused on the dimension of human needs and the quality of human life. Accordingly, social and economical aspects of the sustainability started to be discussed intensively. Definition of need was redefined as "sustainable development is first and foremost about ensuring that everybody-both in poor and rich countries, and today as well as in future generations- can have their basic needs meet. This must be obtained without jeopardizing the natural systems on which life on the earth is dependent" [2].

In the field of design, the sustainability concept is considered to be in studies with an extensive term as environmental sustainability. This study focuses on the dimensions of sustainability in interior environments. According to Yaldiz and Magdi "Sustainability is a multi-dimensional concept that has environmental, social, political, economic, cultural, and spiritual dimensions". Therefore, sustainability can be described as a system or, in other words, an ecosystem within which various parts/elements interact". They considered these social, cultural and environmental dimensions in the field of interior design [3].

In this context, designers have a responsibility in creating sustainable environments. That is, interior environment is the first and the closer place to fulfill human needs in all of these dimensions. This study aims to focus on the interior design practice as a multifaceted problem and develops a context with the bilateral relationship between sustainability, social sustainability, and sustainability in design elements.

II. Social aspects in sustainable interior design practice

Social sustainability can be considered as an aspect that focuses on the human, environment, and development policies. Actually, all these aspects are parts of a whole system. According to Chiu, the only difference between these aspects is their priorities of significance [4].

If sustainable development in a society is to be achieved, the social relations, norms, and restrictions should be considered. Actually, if a socially sustainable design aim is to be achieved, these values become the most important terms [4]. After 1970, the level of technological development in countries ended up with growing poverty. Due to this fact, researchers started to focus on to the social aspects of sustainability. The sustainable development term turned out to be rendered as a sustainable human development [5]. According to the Brutland Commission report, these rules, norms, and values set the determiner of the distribution and sharing of natural sources. Nemli considered the social indicator of the sustainability as democracy in poverty and sex, health in services, nutrition, dead rate, water sources, education level, shelter as living condition, safety, and demographic measures [6].

Halliday's approach to sustainability is clearly specified by the human and social focus as "Sustainability is not a single clear and specified concept dealing with mathematics, or based upon hypothesis, inputs, and equations. Accordingly, specific results are not expected to be accomplished in a specific time. Basically, sustainability is a methodology that can be viewed

to represent a continuous and dynamic way of life" [7]. Sustainable Architecture and Building Design (SABD) at University of Michigan considered the social aspects of the sustainability as a one of the component of sustainability concept. In this chart, just like in Nemli's study, the aspects of the social sustainability are defined as the standard of living, education, and community equal opportunity.

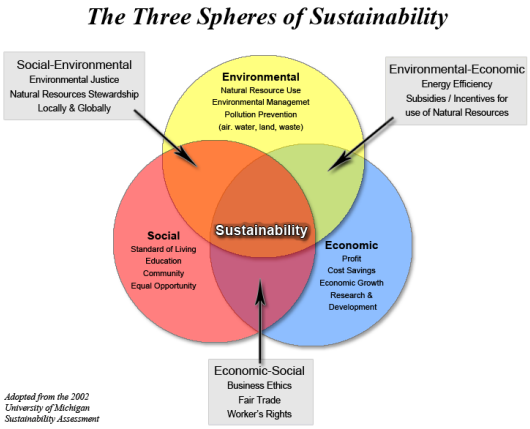

Fig 1. The Three Spheres of Sustanability

Considering the importance of social aspects in sustainability, interior design profession stands in the point of creating a shelter for all these dimensions: standard of living, education, and community equal opportunity. Design of an interior space can lead to a social interaction or it can prevent the way people are socialized. The organization of design elements can determine the standards of the living condition.

The main problem in sustainable design practice is to determine the definition of need. In other words, social standard of living is defined in respect to social statue. The definition of "the need" changes. In many practices, the main criterion here is to reflect the luxury standards. In this case, the interior design practice acts as an obstacle in sustainability. There occurs the problem of unnecessary use of natural sources. Designers must consider the social standards in the dimension of both poverty and riches. As an interior designer, it is a social responsibility to set a faithful definition of the need.

III. CULTURAL ASPECTS IN SUSTAINABLE INTERIOR DESIGN PRACTICE

As mentioned before, sustainability is a multidimensional term in interior design practice. The cultural sustainability is a dimension of the whole system. In this dimension, immaterial part of the sustainability is obvious. Defining an interior space as a cultural entity, space consisting of both living habits, traditional and the social values. Both the cultural and social dimensions of human needs are affective factors in the creation of this cultural sustainability. Hence this process became more complex. In fact, the interior space is the main environment that reflects the living habit of a society. In other words, interior space is an environment containing the identity of a specific culture. As in the definition of culture, it is "a way of being, relating, behaving, believing, and acting which people live in their lives and which is in a constant process of change and exchange with other cultures".

In a broad term, the culture
- is dynamic,
- involves a system consisting of rules,
- is expressed through the community as well as the self unit,
- conveys the sustainability of vitality of the community with help of the system,
- involves attitudes, values, belief, norms and behaviors
- is shared with groups,
- is interpreted with each member of the community,
- transforms the new generation,
- has a potential of change [8].

Actually, the identity is the main factor in creating design criterions for a specific culture. These specific criterions act as a guide for well-being of human in interior space. International Federation of Interior Architects considered the interior design practice as a mode of cultural product and defined it as: "As a creative enterprise, interior design and interior architecture are a mode of cultural production. They are a place-maker that interprets, translates, and edits cultural capital. In a global world, interior design and interior architecture must play a role in facilitating the retention of cultural diversity." [9].

Moreover, each of every cultural value creates the interior environment. In other world, cultural identity gives shape to interior environment. In a sense, cultural sustainability in interior designing affected with all these essential factors. The way people live, the way people behave and act and all their attitudes affected with their cultural background. Interior environments are the medium for creating these values.

"Space is a three dimensional volume. Interior designers start to design this empty volume and turn it to an environment that contains human existence in it." Interior space creates images to its' users. In this image formation, there is a two way correlation between interior and its user. The person defines the interior space, and the interior space defines the personal images. In this relation cultural images act as a bonding element. [10]

Especially the sense of place occurred with the cultural images in the interior environment. According to Hay when the human element comes into space, space becomes more of a place than a space. [11] Law and Altman have defined the place concept as the space which is given meaning through individual, group or cultural processes [12]. Thus, over the usage process, people create their own place identities and this transform spaces into their own places. This process is defined in the relevant literature as "place identity". As it is defined, identity is described as a biological organisation which develops through adjustment (settlement), assimilation and assessing the social world; and moves over time [13]

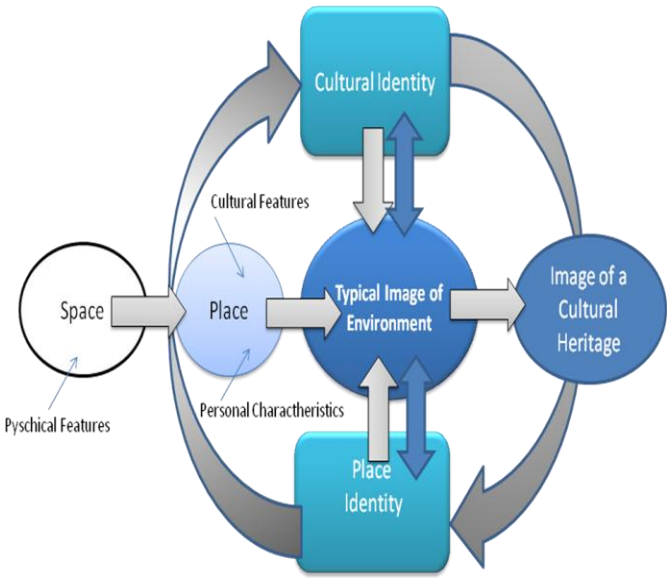

Fig 2. Image Formation Model

Detailed model aims to set the environmental, personal and physical features as an effective factor in the dimension of cultural identity formation. In this model cultural feature, personal characteristics, physical features of a place directly affects the formation of a image of a cultural heritage that is especially essential in cultural sustainability.

In case of interruption in acting these cultural needs in interior space, people do not use these spaces for a long time. In other words, the long term use of a space is affected by the cultural sustainability capacity of that space. If the space doesn't reflect their cultural identity, in most cases people feel apart from that environment. As interior design practice is "a mode of cultural production" it has the responsibility in sustaining cultural values in the space [10].

IV. PHYSICAL ASPECTS IN SUSTAINABLE INTERIOR DESIGN PRACTICE

In this multi dimensional perspective, physical features in interior design practice is another aspect in sustainability. The physical aspects consist of the design elements of an interior space. In other words, they are the elements used in designing interiors. The term of sustainability is not just a theoretical subject; it is also a very technical area in the problem solution. According to Stieg, the discipline has developed its basic understanding of sustainable design principles. The main problem is to connect the gap between theory and the practice [14].

As Sassi defined "Sustainability is not an academic pursuit or even a professional activity: it is a way of life affecting everything an individual does. Knowing what kind of a relationship we want to have with the global and local environment is the first consideration. Then, we should address how to achieve this relationship. To move from theory in to practice, it is necessary to understand the impacts associated with our work and life related activities" [14].

As a profession, designing interior environments can be defined as "determining the relationship of people to spaces based on psychological and psychical parameters, to improve the quality of life" [15]. In the core of sustainability, these physical parameters gain importance in the means of long term use.

Sustainable interior design is defined as "interior design in which all systems and materials are designed with an emphasis on integration into a whole for the purpose of minimizing negative impacts on the environment and occupants and maximizing positive impacts on environmental, economic and social systems over the life cycle of a building" [14].

Kang and Guerin defined the sustainable interior design practice in three dimensions as: global sustainable interior design, indoor environmental quality, and interior materials. The indoor environmental quality, that is also an assessment category in the LEED, is the most important implication in considering the sustainability of interior environments. Improving indoor air quality which is mainly the activity of reducing indoor pollutants, improves the thermal comfort and quality of interior lighting. Moreover, using materials those can have the possibility of recycling is another criteria in obtaining sustainability.

Ness considered the practice of sustainable design from theoretical point of view and classified these studies under five topics as [16]:
1. Reduction of the energy and emission in the environment.
2. Minimizing the distraction in the ecological, natural ion areas for food production.
3. Minimizing the consumption of environmentally harmful construction materials.
4. Recycling natural resources.
5. Preventing sound and air pollution in order to protect the inhabited health.

Furthermore, Stieg focuses on the interior design practice and considers the sustainable design practice from a different perspective. According to Stieg, a sustainable interior design practice has five aspects. These are connection, knowledge, process, practice, and commitment. Connection consists of intellectually and emotionally connects to nature. Knowledge consists of information about natural systems. According to her, an interior designer has to learn basic principles of environmental science such as [14]:

- Basic processes of natural systems: matter cycles, energy flows.
- Basic physical and chemical properties of classes of materials: inorganic (metallic minerals, nonmetallic minerals) and organic (fossil oils, plant-based, and animal-based).
- Typical environmental impacts of these classes of materials.

- Basic industrial processes, including energy production, petroleum-based industrial processes, and resource efficiency.
- The concept of biomimicry. (A new area of science that studies nature's models and uses these models in designs and processes them to solve human problems)
- Various theories of environmental design.
- Basic principles of environmental design.

All of these perspectives obviously reflect the importance of cooperation between the scientific and practical knowledge. In other words, the theoretically produced knowledge should be practically used in the design process. There are different areas of study in the sustainable interior design practice such as; the minimization of use of harmful construction materials, recycling and preventing pollution. In European Union Countries, total 40% consumption of energy, 30% of CO2 gas emission, and 40% of synthetic waste are produced in the construction industry [17]. That means the environmental design has a big role in the course of sustainable development. Moreover, 50% of natural material resources is used in the construction industry. From this perspective, there occurs the need of developing, suitable assessment criteria for built environments.

The assessment tools aim to provoke the designer and construction industry to serve environmental sustainability. There are many assessments tool such as BREEAM (England), SBTool (International), LEED (USA), EcoProfile (Norvey), Promise (Finland), Green Mark of Buildings (Singapore), Green Star (Australia), CASBEE (Japan). Among these, the widely used assessment tools are BREEAM and LEED [16].

The first example is BREEAM, which is established in 1990 as Building Research Establishment Environmental Assessment Method by Building Research Establishment. This assessment system evaluates the building in the context of sustainability under nine main topics as:

1. Management: in the dimension of policy of site management.
2. Health and wellbeing: Factors affecting the health and wellbeing.
3. Energy: energy consumption and gas emission.
4. Transport: transportation in the context of location and gas emission.
5. Water: efficiency in water consumption.
6. Materials: evaluation from the aspect of material life cycle.
7. Waste: waste products.
8. Land use and ecology: conservation of ecological sites.
9. Pollution: air and water pollution assessments.

In LEED, the categories of evaluation are under six topics as [18]:

1. Sustainable site development
2. Water efficiency
3. Energy efficiency
4. Material selection
5. Indoor environmental quality
6. Innovation and design process.

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When these categories are considered from the perspective of interior design, it is obvious that the design elements are the major substances in gaining sustainable interior environments. However, none of these assessment tools are focused on the

social or cultural aspects of sustainability in interior design practice. Actually the land and the condition of the land used change according to the cultural and social identity of a specific society.

V. PHYSICAL ASPECTS IN SUSTAINABLE INTERIOR DESIGN PRACTICE: MATERIALS

Material is one of the most important design elements that affects the sustainability in the interior environment. Every material has a different quality and potential in sustainability. In material selection, the most important criteria is to select the material according to the features of function. Each of every function has specific needs. As an example, materials used in the hospital interior and the shopping mall should be different due to sterilization aspects. Especially, the selection should aim to long term use. It is very important to use a material in its maximum potential in order to reduce waste of resources [20].

In the process of producing materials, the name of the energy used is called as "embodied energy". Each material has different amount of embodied energy. For example, concrete, steel, and the plastic has higher embodied energy amount in the construction materials. Especially, natural materials such as stone and timber gradually have less embodied energy.

There are also same different software programs evaluated the material's environmental aspects. Programs such as Athena and BEES are examples for this assessment tools. According to Stiueg, these software programs "get the designer one step closer to evaluating and identifying material with low environmental impact" [11].

One of the other important objectives in material selection is the recycling potential of the materials. There are many studies in the field of waste management which aim to innovate new construction materials. A Cierra Recycling can be an example to one of these. Basically, they collect and separate the waste, and then they transform it and remanufacture these waste products [21].

Recently, the concept of green design is used in the interior design practice as a surface treatment. The concept mainly focuses on ecological and green design in the interior environment. Green walls are an example for this approach [22]. Green components are used as a wall covering material. This is another approach in using natural materials in the interior design practice.

Fig 3. Green Wall Application 1

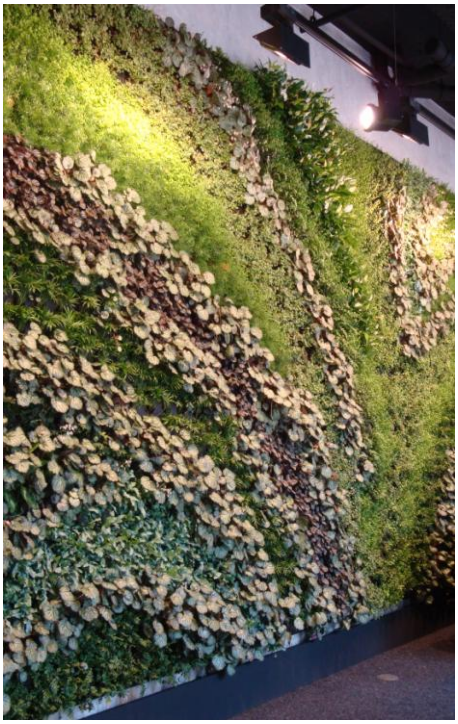

Fig 4. Green Wall Application 2

Furthermore, the level of emission of toxic gases both used in production process and during the using period of the materials is an essential criterion in achieving sustainability. Especially, most traditional techniques in construction and materials are widely sustainable. As an example, traditional materials like mud brick and adobe are highly sustainable in the means of level of toxic gases emission. They are natural

materials. All these criteria are important in maintaining indoor air quality. Materials, as interior design elements, should meet the requirement of sustainability in the potential of long term use, recycling, and less emission of toxic gases.

VI. PHYSICAL ASPECTS IN SUSTAINABLE INTERIOR DESIGN PRACTICE: FURNISHING

Furniture used in the interior design practice is another important element in achieving sustainability in interior design. In the context of sustainability, the first criterion is the material used in the production process. The second criterion is the life time of the product.

Materials used in the production process can be synthetic or natural. Some of the synthetic materials used in the furniture production have rick of emit toxic gases. As mentioned in the last part, these materials cannot be recycled. This is one of the important problems in achieving sustainability. There is also a problem in wood products used in furniture production. In their natural form, they can be recycled actually. However, some synthetic materials used in the wood production process cannot be recycled. Moreover, the waste occurred in the production process damages the nature. These waste products contain same toxic polymer based synthetic materials. The rate of the waste to the product is about 30% of the total amount of the product [23].

Rather than the production process, the old furniture also cannot be recycled. They have a big role in increasing the amount of global waste. In the process, the furniture should be selected according to the functional needs. The durability of the furniture should be considered according to the number of people and duration of use. Moreover, the construction and structural durability should be considered in long term use. Rather than long term usage, recycling potential is one of the important criteria in achieving sustainability. Recently, some of the furniture companies started producing furniture totally from waste.

Fig 5. Furniture produced from metal barrel.

Figure 6. Table produced from waste of barrels

Fig 6. Table produced from waste of barrels

Fig 7. Furniture produced from waste of textile

Furniture produced from waste sometimes face with the problem of aesthetics. They are sometimes considered as unaesthetic. This is the major problem in selecting them. The

aesthetic quality of the furniture should be considered. Then, it will both serve for the purpose of sustainability and be widely used [24].

Recently, there are innovative examples in the furniture production. In Cambridge University, design and engineering departments developed a joint project. They created a technology in order to generate electric from the plants. They conduct this system in a table. There is a light fixture and a plant on the table. The lighting fixture gets it energy from the plant. It should be considered as an example for the essence of interdisciplinary study in achieving sustainable environments.

Fig 8. Table and Lighting Unit Removable Energy

VII. PHYSICAL ASPECTS IN SUSTAINABLE INTERIOR DESIGN PRACTICE: LIGHTING

Lighting is another important dimension in achieving sustainable interior design practice. Using lighting sources efficiently is one of the important criteria in sustainability. Another consideration in lighting interiors is to achieve maximum use of daylight. Energy used in interior environment of lighting approximately captures the 40-50% of the total energy used in the building [25]. It occupies a large amount of energy consumption. Therefore, designers should use the maximum possible natural night in interior environments.

Daylight is the main source in natural lighting. It can be explain as "When lighting electricity consumption is considered along with heating and cooling as part of a whole building energy equation, day lighting typically provides a net energy benefit. Daylight is intrinsically more efficient than any electric source because it provides more lumens per unit of heat content. Therefore, if appropriate day lighting techniques are used to displace electric illumination, the savings for both lighting and cooling can be dramatic" [26]. In this context, the building should be located according to gain maximum daylight. Also, the size and the depth of the room should be appropriate to use maximum day light. [26]. The location and the shape of the building affects the amount of daylight in the interior. Moreover, the climate changes in the location of the building should be considered.

Recently, researchers developed new technological tools to carry daylight to the deep interior space of the building even to the basements. The main principal in these tools are to collect the sun light and reflect the light through the reflective tubes. Laser cut panels, light piping systems, horizontal and vertical light pipes are examples of these systems.

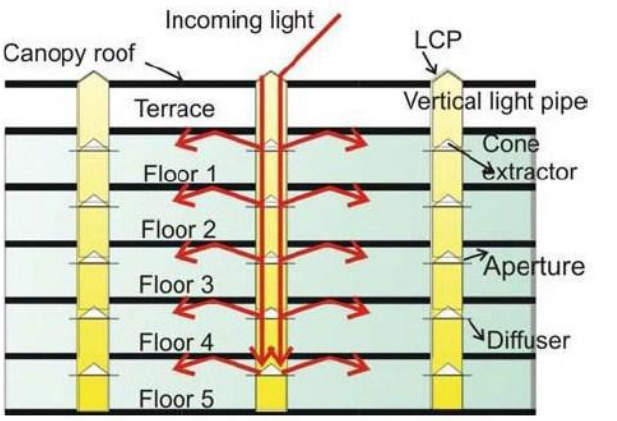

Fig 9. Vertical Light Pipes

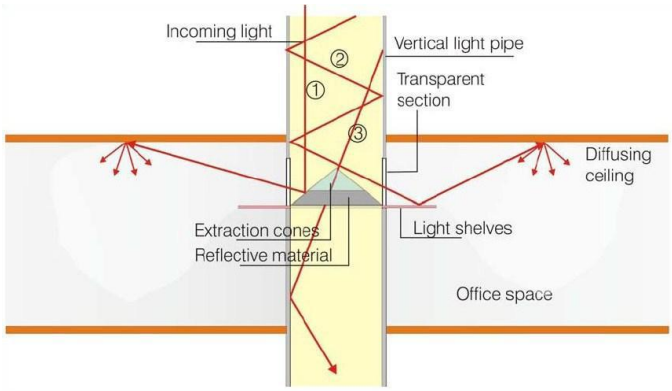

Fig 10. Light Distribution for Vertical Light Pipes

Fig 11. Vertical Light Pipes, Subterranean Train Station

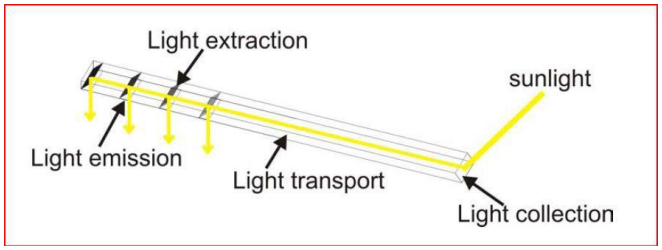

Fig 12. Horizontal Light Pipes


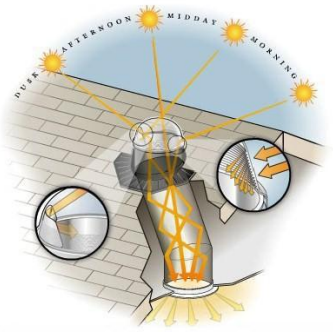
Fig 13. Sunlight Tracker of Mirrored



Fig 14. Mirrored Light Pipes in Showroom Roof San Diego

There is also there used Mirrored Light Pipes. The basic working principle is carrying the day light from outside to inside with a mirrored tube. The light is transmitted with the help of reflective surfaces this system is mostly suitable for domestic and commercial interior spaces. Supermarkets, galleries, and warehouses can be examples for these mirrored light pipes. [27].

Baker and Steemersall categorized these innovative lighting systems as light guiding systems and light transport systems;

- Light guiding systems, can transfer the light in to the building (direct and diffuse) up to 8 to 10 meters, (e.g. light shelves, louvers).
- Light transport systems, transmitted the light more that 8 or 9 meters with light guiding systems such as light pipes.

Ayers and Cater set the benefits of these lighting systems as;

- "The potential of integrating artificial and natural light into one system
- Providing a centralized lighting system in the building that pipes light to distribution system in the building that pipes light to distribution devices
- Eliminating infrared and ultraviolet radiation from sun light". [28]

Moreover, there are many research studies carried out on the benefits of daylight in life quality. Daylight can affect both psychological and physical well-being in interior environments. Especially, these studies demonstrate that daylight affect the productivity level in office environments. Yaldiz and Magdi considered the daylight in the context of sustainability in three categories as [29]:

1. Resource sustainability (using day light to affect the energy of the building performance).
2. Economical sustainability (in the dimension of financial benefit).
3. Human sustainability (in the dimension of human physical and psychological health).

The lighting is a major interior design element. It is obvious that it has a essential role in developing sustainable interior design practice. It is both important in energy reduction and for the sake of human health.

VIII. Conclusion

Sustainable design practice deals with the scales from city to interior space. Mostly, theoretical studies in sustainable discourse are focused on the political aspects of urban planning. As interior space has the most intimate relation with it is user, there are few studies in this area. It is obvious that the process of designing interior is a multi layer practice, as it is has the most intimate relation with its user.

This study focuses on the multi dimensional aspects of sustainable interior design practice. In achieving sustainability, interior environments are the core places to define and solve the problem. This design practice consists of social, cultural and physical dimensions. All these dimensions are correlated with each other.

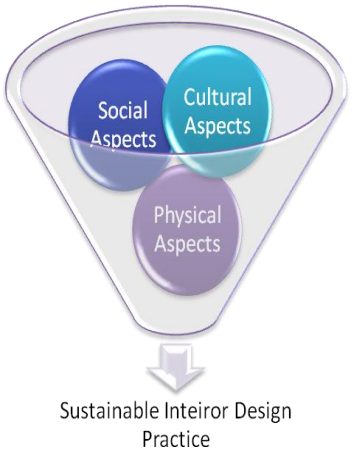

Fig 15 . Multidimensional Aspects in Interior Design Practice.

Considering the social dimension, sustainable interior design practice should develop standards in living conditions, and community equal opportunity in the interior environment. The design should focus on defining healthy social interaction and enhancing the life quality. Moreover, the interior design practice should define the functional needs in an equal social understanding. The organization of design elements can determine the standard of living condition.

The practice should achieve cultural sustainability in a sense; it should be considered the cultural values and norms. The design practice cannot be process without cultural identity of a specific society. This correlation affects the design decisions.

Moreover, physical elements used in designing interior environments take a significant role in sustainability. All cultural and social factors produce physical features in interiors. In other words, every physical feature in design is rooted in specific meaning, norm, and values. In this context, design elements such as lighting, materials and furniture can be important elements in achieving sustainability.

Finally, it is obvious that sustainability is a contemporary problem in every discipline. Therefore researchers produce valuable theoretical knowledge. They should be adapted to the professional practice with a multidimensional approach. Developing multidimensional perspectives are essential in achieving sustainability.

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