How Can Residential Designs Create Spaces That Are Environmentally Smart: A Literature Review

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Introduction

Sustainability has become a trending word in several different fields. As interior designers, we have the ability to contribute to impacting the environment with sustainability. Not only are smart designs focusing on how to solve problems for clients, but they are also starting to focus on how to solve the environment's problems. Interior designers can do this by choosing energy-efficient appliances, being conscious of material/product selection, knowing the life cycle of the design choices, and educating the end users. Designers should make a conscious choice to find responsible materials and products, lower waste by reusing or recycling, and strive to be cognizant of the health of their clients and the environment. The need to lower carbon footprints is an important movement for the environment. Lowering a carbon footprint focuses on decreasing emissions and pollution while also being concerned with energy consumption. A big part of lowering one's environmental impact is consciously choosing the appliances and products that are used in design choices. It has become a global effort to understand the energy usage in a space and reduce any unnecessary emissions. This information can allow for the lowering of a design's carbon footprint which can lower costs to the client.

Sustainable material and product selections go further than just color, aesthetics, and usage. Interior designers can go as deep as understanding the impact of processing and the cost of energy in extraction, handling and refining, overall processing of products, transportation, life cycle, and possible disposal. Awareness of the process and factory policies can aid designers when deciding on environmentally smart products. Environmentally friendly products can support designers and end users in sustainable practices.

Interior designers can practice an important aspect of sustainability by teaching the clients how their homes can become more environmentally safe while also saving money. This can be done through the use of energy-efficient appliances, LED lighting, window and door selections, and smart home tools. The use of energy-efficient appliances can help lower the power and maintenance needed. Next, we look at how material and product selection can affect the environment overall.

Significance

The significance of this paper is to describe the importance and benefits of sustainable practices in the residential design process. First, we will analyze how energy-efficient choices can help lower the carbon footprint and be financially profitable for the homeowner. We will also look at ways we can create energy efficiency in designs, and how to make the home function for us through the internet of things, with the internet of things being technology used in the home that communicates through sensors or devices (Hu et al., 2020). In the second section of this paper, we look at how material or product selection can benefit the design process. Lastly, we look at how we can take what we learn as interior designers and use it to educate homeowners to spread sustainable practices in everyday life choices.

Energy Efficiency

One way an interior designer can be environmentally smart is to look at the energy efficiency of the house. There are numerous ways a house can become energy efficient. Selecting household appliances that have built-in technology to save energy is a major way to create a sustainable home. Other ways to create energy efficiency is through proper windows or using household accessories known to save energy. These accessories can include LED light sources and smart technology like sensors or virtual assistants.

Looking at energy efficient appliances, an easy way to classify if the appliances are effective in lowering carbon footprint and costs to the consumer is by looking at the Energy Star Rating. An Energy Star Rating is administered by the U. S. Environmental Protection Agency. As quoted from their website,

> "Since 1992, Energy Star and its partners have helped American families and businesses:
>
> - Save 5 trillion kilowatt-hours of electricity.
> - Avoid more than $500 billion in energy costs.
> - Achieve 4 billion metric tons of greenhouse gas reductions (U.S. Environmental Protection Agency, n.d.)."

Energy-efficient appliances have been shown to make a huge impact in lowering the carbon footprint of a household. According to a study by Hossain et al. (2022), "Increasingly, household appliances are the primary source of energy consumption and CO2 emissions. According to the International Energy Agency IEA (2017), the residential sector consumed approximately 21% of total global consumption in 2017." Energy-efficient appliances have the ability to use less water, can use less energy through gauging load size, and can assess soil levels. This is important because the

appliances can tell how much water is needed, possible water temperatures, and the length of load wash time.

There is concern about the limitation of smart energy appliances, materials, or accessories to the majority of the world. Middle- to lower-income residences and developing countries lack the ability for these upgrades (Talele et al., 2018). This is becoming less of an issue as energy-efficient appliances are becoming more accessible and prices are lowering.

Another added benefit of using energy-efficient appliances is that they are being created to fit the internet of things movement and smart buildings. This movement details how objects within the home can link up, create routines, and work on an overall system that benefits the homeowners. As noted by Hu et al. (2020),"These systems not only enhance the occupants' accessibility, security, and control over interior environments but also aim to boost productivity and user comfort levels." Small home appliances that can be installed to fit the internet of things are room sensors for temperature, smart thermostats, light bulbs, smart plugs, and more. Added benefits that the internet of things can provide are extra security and safety measures. There are ones that can specify if an elderly adult has fallen and can automatically call for help (Hu et al., 2020).

In a research study conducted by Ashour and Rashdan (2023), the use of technology in a residential capacity was analyzed to see what the benefits were for interior design. The article discussed the value of an interior designer to be able to create spaces that are adaptive and functional through the use of technology. Looking at the intelligence of the home, commonly known as a smart home, it has trends where the aim is to create spaces that work for the occupants by learning behavior and needs. In time, the prediction of needs can take place and be implemented through lighting, heating and cooling, as well as security. Using the internet of things can add to "resource conservation on a global scale, promoting environments that are healthier, beneficial, and comfort-enhancing" (Ashour & Rashdan, 2023, p. 40). Through the usage of smart devices, the homeowner can create routines that can turn lights on and off at certain times of the day. The homeowner can also set up temperature sensors in rooms that can link to the HVAC and thermostat. This technology can learn the behaviors of occupants and create routines that will help lower energy consumption.

Another way to help the energy efficiency of a design is the usage of windows to improve natural lighting. Natural lighting has two main benefits in design, with the first being a mood stabilizer, as it offers a biophilic concept to a design. The second benefit is that it can lower the cost and energy output of a residence. Both of these concepts can also, in turn, add to the longevity and life cycle of the building design.

Using natural lighting through windows can help add a sense of calm. Humans seek to be connected with the outside world and have views of nature. It also can help with maintaining a sense of time progression and viewing weather changes. According to Isopescu et al. (2024), the benefits of natural lighting on an individual are "its impact on mitigating depression, with morning light demonstrating twice the efficacy compared to evening light. Additionally, natural light has been observed to influence the duration of hospital stays, reduce stress levels, and alleviate pain among occupants. These findings underscore the multifaceted health benefits associated with exposure to natural daylight within built environments."

The usage of natural lighting during the day reduces around 75 percent of lighting energy output for the home (Danpal, 2020). This is because artificial lighting produces heat which, in turn, can change the temperature of the space. Adding heat to a space causes a chain reaction that includes the simultaneous running of an HVAC system to create a comfortable temperature in the space. The utilization of natural lighting can help improve the needed energy consumption of a house. In some places where extreme heat or cold temperatures take place, a balance must be created to help counter heat gain or loss. This can be countered through the use of glazing windows and window treatments. The use of shutters or blinds on the outside of a residence has also been effective in improving the temperature gained through windows.

Another way to increase the energy efficiency of a residence with the use of natural lighting is to orient the home to the sun's compass (Danpal, 2020). This means putting as much window surface as possible to match the pathway of the sun. In America, the sun rises in the east and sets in the west. It also stays on the south side of the buildings. So, the addition of windows on the south side of a building can create more natural lighting. Sunroofs and window wells are also utilized to help create more natural lighting in a space.

Material and Product Selection

Material and product selection can be one of the most important jobs we do as interior designers because it has the biggest impact on the design and even the world. As interior designers, we have to think about where these products or materials originally come from. Is the material made out of recycled material that helps lower landfills? Is the material sourced from locally grown products such as wood or wool? Is an entire ecosystem being affected by the selection of this product? As designers, we need to be conscious of how the design impacts the environment.

In a research study conducted by Marsahala et al. (2022), the use of recycled plastic is analyzed in the effects of its design quality. Due to the

environmental impact plastic has, this study values the importance of finding other ways the raw material can be effectively used. This article highlights the benefit of reusing waste as it reduces landfills and adds to the lifespan of the material. Recycled plastic can be mixed with raw materials which add to the characteristics of the overall product, adds to longevity, and can increase the performance of the object. The benefit of using recycled plastic in creating a new product is the ability for the material to be melted down and shaped into new forms. It is easily molded and can add to the rub resistance and water/stain proofing.

As interior designers, we need to be conscious of the longevity of the material or products. We also need to be conscious of the pricing, performance, and safety. Sustainable fabrics are low or free in Volatile Organic Compounds, VOC's. This adds to the longevity and overall health of the design as it does not put out any toxic or strong odors. We also need to be aware if the fabric is next to a heat source or is a fire liability. Does the material have a colorfast tendency, or does it fade quickly? Knowing the material's characteristics can help ensure the proper use in order to gain a longer life span.

Vân Nguyen (2018) describes the importance of understanding a material and the role it takes economically and environmentally, which they demonstrate through their knowledge of bamboo. Vân Nguyen (2018) calls for interior design to merge with sustainable architecture by focusing on the materials sourced in order to create a responsible environment. This article explains how bamboo is one of the leading sustainable materials because of its natural ability to grow fast, its abundance in developing countries, and bamboos innate ability to absorb massive amounts of carbon dioxide. Bamboo has also been discovered to be a gentle material comparable to cotton. Vân Nguyen also highlights how bamboo does not harm the environment from harvest to disposal, which is an overall goal that sustainable materials should be concerned with. This article demonstrates the importance of knowing the background and characteristics of a raw material. In understanding these concepts, interior designers can make a more educated decision on a sustainable material that is healthy for the planet and homeowners. Knowledge of materials also enables the ability to find a material source that can withstand its intended use and have longer value in the design.

He (2022) stated in their article "Application of Ecological Environment Materials in Interior Design" important concepts to pull an ecologically smart design into practice. The first is that designers need to think about the ecological impact their choices have on the environment. The second is how designs need to value health principles to ensure well-being both mentally and physically. This is through indoor air quality, lighting, temperature, and humidity following the needs of human standards. A third

concept acknowledged in this paper is if the cost of the product is valued in terms of longevity and impact. This is for both the interior space as well as the overall well-being of the environment. The design needs to analyze how the materials can alter the balance of the ecosystem. Some materials are harder to renew, while others take a long time to be broken down in the natural world. Lastly, this article looks at how to optimize the design's impact by reducing waste, supplanting harmful substances, avoiding pollution, utilizing natural energy sources that are renewable, and optimizing the resources being used. In doing so, designs become active in creating a green environment.

He (2022) states that "Human-attributed ecological design includes two aspects. One is that the designer should establish an awareness of environmental protection based on the ecological concept, save natural resources as much as possible, and produce less garbage (garbage in the broad sense)." Designers should always consider the impact design has on the environment and the responsibility of choosing materials that are ecologically smart. Designers should also focus on lowering the amounts of garbage. Being mindful of waste in construction or renovation projects can make an impact on the environment. It is also important to discuss donating, reselling, or recycling old furniture with homeowners. This will help lower the household items or materials being thrown in landfills. Spreading knowledge can make a lasting impression on designs.

He (2022) further develops these concepts by finding how to use passive indoor space planning, such as indoor ventilation and daylighting, to help work with the climate and environment. Another thing to consider when creating a healthy space is to be aware of how the density in materials can either increase or decrease auditory stressors. Porous materials will absorb high-frequency sounds. Another way materials can better serve a design is through thermal insulations. There are energy-saving wall materials that work with the building structure and thermal performance. Keep in mind the insulation should not put off harmful pollutants. For example, straw walls are thermally efficient by being passive in hot and cold temperatures. Straw walls also have an inherent fire resistance.

Looking at the environmental impact in an ecosystem and interior space continues to be developed in this article because of its analysis of furniture design. The manufacturer and the use of the furniture should not create pollution. It should use resources and energy responsibly and take into consideration the ecological cycles involved. This also considers the post-maintenance and servicing of the furniture. An example would be furniture made from bamboo. The material is quick to grow, which makes it easily renewable. It does not put out any volatile organic compounds (VOCs),

reducing the harm caused by pollutants. It is strong and tough in nature which allows it to replace other materials used in furniture making. Using materials that closely represent outdoor landscaping has also shown to have psychological benefits (He, 2022).

For example, putting plants in interior spaces can enrich color and soften a design. Plants are known to clean air and can help maintain humidity levels. Also, plants have been shown to improve work efficiency, body, and mind (He, 2022). This article expresses the occurrence of how indoor spaces and outdoor environments becoming blurred in designs and importance. It calls for the need to find balance. This balance can strive to keep the health of both the ecosystems and environments, along with humans and their interior spaces.

He (2022) states that "The purpose is to find materials that have the lowest environmental burden, purification, and restoration of the environment in the process of processing, extraction, preparation, use and regeneration. The adjustment of the current material industry structure to the development of reasonable resources, emphasizing the harmonious coexistence of man and nature, and meeting the needs of human survival and development (p. 3950).

Educating Homeowners

One way interior designers can make the most improvements in designing a space with sustainability in mind is through the education of homeowners. Allowing the homeowners to be part of the product selection process can help them understand why some choices are smarter economically and can help the environment. Engaging in discussion with the homeowners will help in being aware of how choices can both improve the homeowner's financial standing and benefit the environment in the long term. Building and strengthening knowledge will create a mindset to improve sustainability.

In a study conducted by Blasch et al. (2022), educating the consumers on the importance of balancing the upfront cost of the appliance in relation to the life cost of running the appliance can help relieve stress in making a choice in purchasing. Energy consumption would be lower if consumers were educated in lifetime cost calculations on appliances and lighting options. This study also suggests using the internet as a tool for cost calculators and education programs. In the end, this can help empower consumers to make decisions that are financially and economically better (Blasch et al., 2022).

Another study conducted by Moore et al. (2017) showed that a higher NatHers star rating of 8.2 would benefit the homeowners financially, as well as their overall health. NatHers is a national rating of house energy efficiency in Australia. There is a setting requirement that calls for a minimum standard of efficiency of 6. The study discusses the importance of showing homeowners the benefits of putting more money down up-front toward upgrades to solar panels, hot water heating pumps, and better thermal barriers in the home

(insulations and glazing windows). The savings could be up to $45,000 over a 20-year period. This is because of the significantly lower cost of utility bills. The homeowners can also rest easier knowing that they are making an impact in lessening greenhouse emissions (Moore et al., 2017).

Conclusion

Interior designers need to be aware of how their choices can impact the environment. One of the biggest impacts can be through the use of appliances. Lowering the carbon footprint of a residential home through the use of energy-efficient appliances can help save money and increase savings on utilities, benefiting both the environment and the economy. Also, energy intake can be lowered through window selections, lighting choices, and utilizing the internet of things. Combining techniques of energy-efficient appliances, materials, and technology can make huge economic impacts if one is intentional in selections during a design process. Material selection and the life cycle of products can also help create longevity in design elements. Design longevity can help in increasing global health. Interior designers need to strive to include the homeowners in all choices in order to help educate the impact that a sustainable design can have on the environment. Knowledge can also help alleviate stress for the homeowners by being better equipped to make choices that have a financial and environmental impact. The knowledge impact does not only benefit the homeowners, but also local communities and globally. Sustainable practices should be a priority for all choices in the design process because they are important for both the environment and the end users of the residence.

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