

Methods of Material Selection for Sustainable Urban Furniture

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Abstract

The research project presented in this paper intends to achieve tools that can be used by product designers to enable a more sustainable outcome in the designs of their products. The project is based on the principle that sustainable design, in addition to economic and environmental values, includes all other aspects related to sustainable development and aims to put this principle into a more practical and functional subject. This paper presents the impacts that materials and production have on the environment and based on a literature review, different characteristics of sustainability applied in the furniture design industries are identified. A further in-depth analysis was conducted by mapping the characteristics of the most important characteristics and implemented in the design process. This review is meaningful to help furniture designers to use appropriate and effective sustainability standards in product design and manufacturing.

Keywords: Sustainable design, sustainable design tools, material selection, sustainability characteristics.

1. Introduction

Site materials in the twenty-first century must respond to entirely different forces—global climate change, air pollution, rising fuel costs, environmental destruction, and biodiversity loss. These forces are shaping the environment through the rapidly growing sustainable development movement.

Changes in the materials industry may include closed-loop material production systems that eliminate waste; use of renewable energy sources for production, processing, finishing and transport activities; significant reductions in pollution from the production, use and disposal of materials; focusing on minimally processed local or regional materials; and greater reuse of products (Calkins, 2009). To meet the goal of sustainable development, the production of building materials and the construction industry must redirect the use of resources and fuels from non-renewable sources to renewable sources, from waste generation to reuse and recycling. (Kiebert et al. 2002).

However, while progress is being made, choosing materials and products with the least impact on the environment and human health remains challenging and confusing. Appropriate materials for a sustainable environment will vary according to impact priorities, regional issues, project budgets and performance requirements. Some will emphasize materials that conserve resources by being reused without remanufacturing, and are extremely durable. Others place great emphasis on low product toxicity and

life-cycle emissions, while others may consider low environmental impacts or water conservation as the highest priority. With this wide variety of priorities comes an even wider variety of "right answers." So the definition of materials for sustainable solutions can vary a lot.

This paper will briefly define the definition and characteristics of sustainable materials and the impacts of material production on the environment. Therefore, the purpose of this paper is to investigate the characteristics of sustainability according to environmental, economic and social factors to be applied in furniture design. Hence, a tool will be developed based on the identified sustainability characteristics to help designers evaluate their current furniture designs and improve sustainable furniture design.

2. The Impact of Materials and Their Manufacturing on the Environment and Human Health

In the product and material manufacturing, interaction with the environment occurs in two different ways. The earth is the source of all material resources and the absorber of emissions, effluents and solid waste. It is in both of these ways that the use of materials affects the environment. Overuse of resources depletes both the quantity and quality of available resources. Also, resource extraction degrades source site ecosystems. Excessive generation and careless disposal of emissions and waste affect the balance of natural processes and ecosystems. The environmental and human health issues associated with the materials and their production are summarized in the table below.

Table 1: Environmental issues related to materials and their production (Calkins, 2009)

Environmental issues	Material relations
Global climate change	Greenhouse gas (GHG) emissions from energy use, non-fossil fuel emissions from material production (eg cement production, iron and steel processing), material transport, landfill gases.
Depletion of fossil fuels	Electricity and direct use of fossil fuels (eg, energy and power requirements).
Air pollution	Combustion of fossil fuels, mining, processing of materials, manufacturing processes, transportation, construction and demolition
Smog	Combustion of fossil fuels, mining, processing of materials, manufacturing processes, transportation, construction and demolition
Deforestation, desertification and soil erosion	Commercial forestry and agriculture, resource extraction, mining
Change of residences	Land appropriated for mining, quarrying and gathering materials. Cultivation of biomaterials, production, waste disposal
Loss of biodiversity	Resource extraction, water use, acid deposition, thermal pollution
Depletion of water resources	Water use and discharge of waste water from processing and production
Environmental toxicity	Solid waste and emissions from mining and manufacturing, use, maintenance and disposal of construction materials

3. Sustainable Materials: Definition and Characteristics

Based on the various environmental impacts that materials have, Calkins defines materials and products for sustainable sites as those that minimize resource use, have low environmental impacts, pose no or low risks to human health and the environment, and help with sustainability strategies (Calkins, 2009). Within this definition, the specific characteristics of sustainable materials are summarized in the tables below.

Table 2: Characteristics of ideal sustainability – Environmental aspects

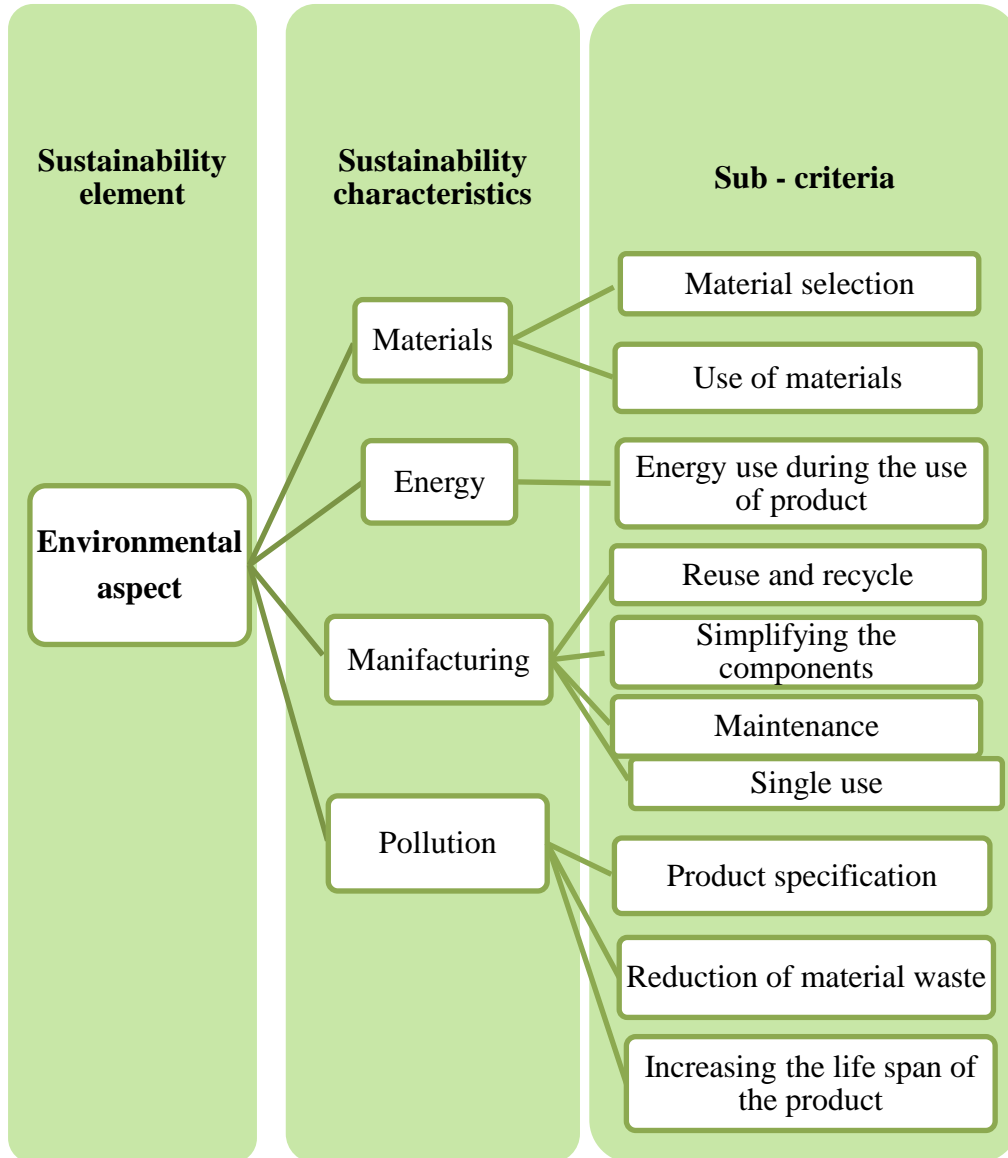


Table 3: Characteristics of ideal sustainability – Social aspects

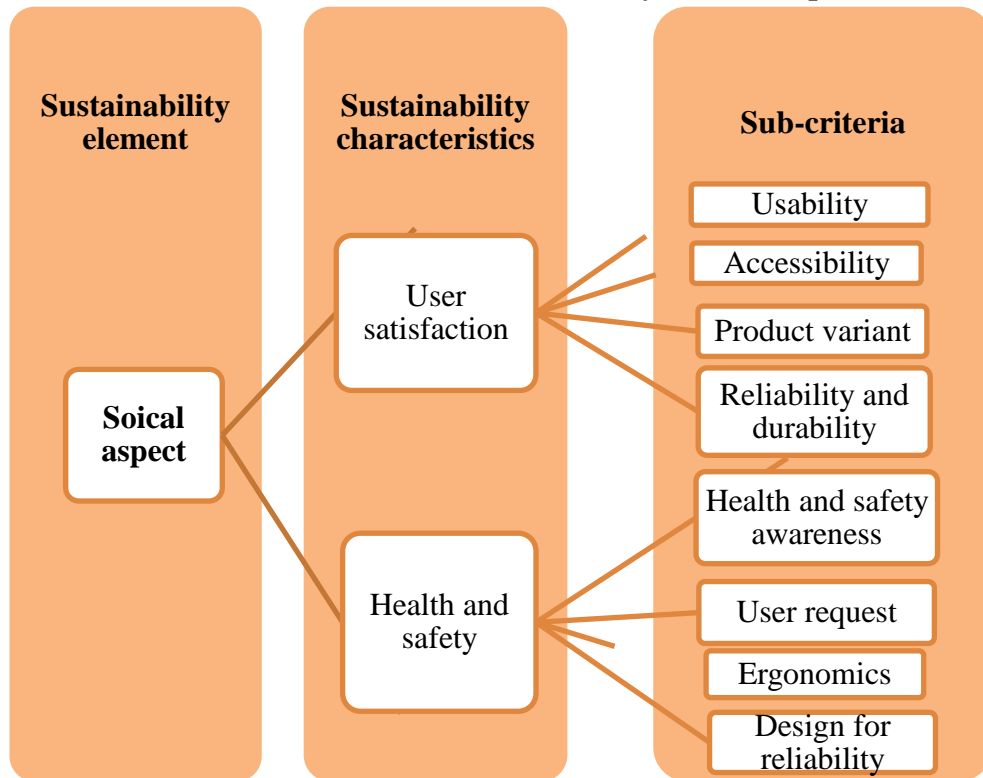
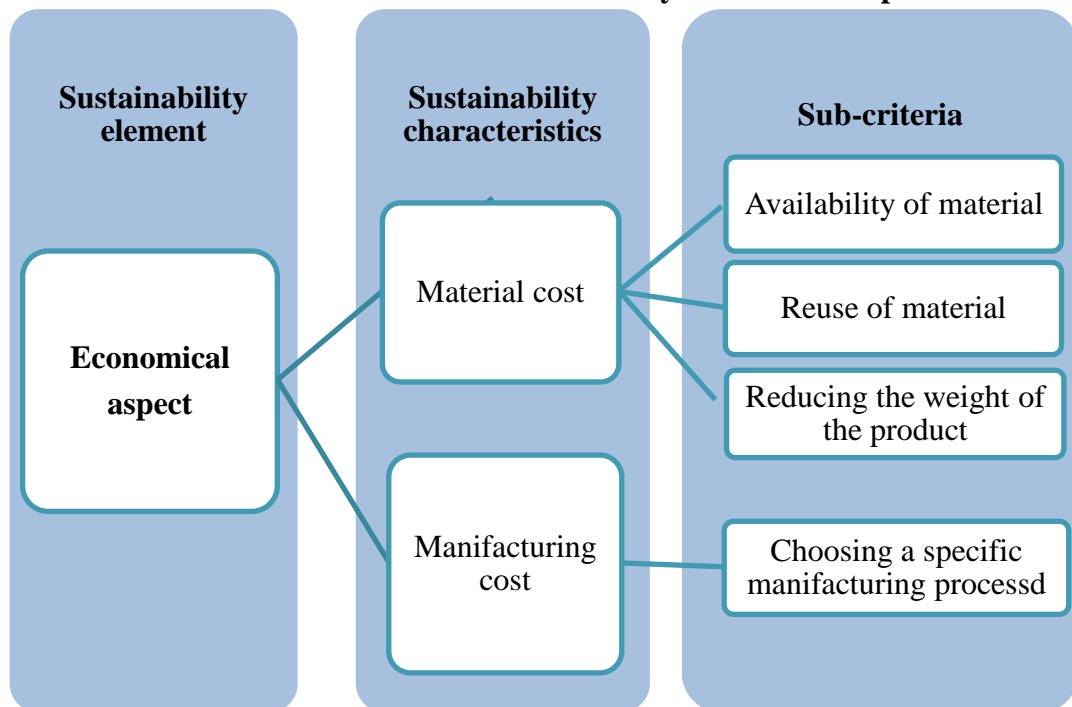


Table 4: Characteristics of ideal sustainability – Economic aspects



4. Method for Selecting Sustainable Materials

Each material and end product has an ecological footprint, characterized by its production, processing, design, durability and reuse. In the context of materials, sustainability is achieved through smarter manufacturing technologies, recyclability, longevity of materials, biodegradability, lower CO2 emissions and

a well-established circular economy Whether it's through discovering new materials that are less toxic to the environment or reusing and remanufacturing existing materials and products to minimize waste, sustainable materials are now more important than ever.

Nowadays, qualitative and simpler tools for designers and companies tend to become easier to integrate into the product development process (Fiskel, 2001). An example of a sustainable design tool that is an evolution of an ecodesign tool is the MET-Matrix. The MET matrix is based on an input-output analysis of materials, energy and toxicity. This tool allows a global inventory of the main problems and can be used to define the environmental profile of the product system, through five life stages (Brezet and Hemel, 1997). This synthetic inventory can be used to analyze product system weaknesses and identify potential environmental improvements. With the same objectives, but considering the whole range of sustainability, the Seeed matrix will be developed, Table 5. Its name reflects the integration of the three aspects of sustainability. The five rows represent the five stages of the product life cycle. Each of the three columns relates to aspects of sustainability and is divided into two. The left column presents the economic issues, which, although already highly embedded issues in the design process, should not be discarded for broad-view analysis. This column is broken down into a simple cost-benefit analysis for each stage of the life cycle. The Environment column combines the materials and energy in the subcolumn of Resources. The third column represents the social aspects, which is divided into internal and external factors. Internal factors are related to the company and the pre-products or products at any stage. The external factors column reflects all the impact that the product will have on other stakeholders, such as local communities, business organizations and so on. Each of these columns or rows can be subtracted or, if necessary, further developed, depending on the product being addressed.

Achieving relevant sustainability results through design activity is a complex task, of which the effectiveness of different strategies largely depends on the type of industry addressed (Hemel, 1998). Therefore, the best way to establish a profitable relationship is to focus our work on a specific range of products. This is expected to reduce the environmental and social burden of the product system and contribute to a shift towards sustainable production and consumption.

Table 5: Seeed Matrix

		Economic Aspects		Ecological Aspects		Social Aspect	
		Cost	Benefit	Resource	Toxicity	Internal	External
Pre-manufacturing							
Manufacturing							
Distribution							
End of life cycle	Reuse						
	Disposal						

5. Conclusion

The growing consumer interest in sustainable and green manufacturing and products, significantly affects the furniture design process and outcomes. Despite that, it is still very challenging to achieve a standardization of sustainability characteristics in furniture design. In this, a thorough literature review was conducted, which looked at the various sustainability features applied in the furniture design industries. This review paper aimed to identify the common characteristics of sustainability so that a new

standard could be established for the furniture industry. The paper found that, given the research gaps in the literature:

- Due to inconsistencies in the application of sustainable features, there is a great need to establish appropriate sustainable features as a standard in sustainable furniture designs. In this way, furniture manufacturing and other industries can implement these sustainability expectations on a global scale.
- The model described in the paper must be recognized to effectively achieve sustainable new product and market development, which provides additional opportunities for the furniture industry. Additionally, this will make the design process more effective, ensuring good sustainability practice and offering many benefits to businesses.

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