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ALTERNATIVE MATERIALS AND METHODOLOGY IN CONTEMPORARY DESIGN

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Abstract

Nowadays, concerns related to mankind's increasing and destructive impact on the environment have influenced and changed the paradigms of product development; this in turn has brought about the appearance of environmental considerations in the creation and design of new products. Numerous industrial sectors have changed their processes of product development and production to meet the ecological requirements. Issues such as the scarcity of natural resources, increasing consumption and increasing pollution also present a number of problems. This article presents a process of comparing new alternatives with a specific methodology of decision-making. It is primarily focused on the use of rare natural materials and resources that are extracted and processed.

Keywords*: alternative materials, design methodology, contemporary design, eco-design, sustainable development.*

1. New design methods in contemporary design

Sustainable planning priorities must meet the needs of both people and the environment, seeking to exploit technologies, materials, and design methods that reduce water and energy consumption.

The literature defines different conditions complying with the multifaceted decision-making procedures applied in the field of renewable energy sources.

Nowadays, the use of Multi-Criteria Decision Making (MCDM) in material selection processes has become an intensive field of research in product development. The study shows the application of a multi-point decision-making method for development needs that supports the work of a designer involved in the design and material selection tasks of noise barrier walls.

First, Opricovic [1] examined the VIKOR method published in 1998 (Vise Kriterijumska Optimizacija I Kompromisno Resenje), which assignes ranks to the alternatives and focuses on compromise during selection in case of criteria that are difficult to match.

The advantages and limitations of VIKOR's decision support application are presented using a case study of design theory. After presenting the results, conclusions are drawn and suggestions are proposed for further application of the methodology.

1.1. Designing noise protection walls

The accelerated technical development inherent in civilized societies is accompanied by a significant increase in noise within our environment. Most of that is due to significantly increased traffic at greater speed as a result of the profit-oriented industrial techniques. The increased environmental pollution and, within that, more specifically noise protection presents a new challenge.

There is need for new materials and methods which, besides providing the acoustic requirements of the construction should also be economically viable during use, economical and fit well within the construction's environment.

Noise pollution is defined as noise in levels that are harmful to the environment, usually above an established upper limit.

Noise suppression (or noise protection) is defined as natural or built-in obstructions, which act as a shield between traffic noise and the area or building that is to be protected from noise.

The noise shielding capability of a noise protection device is based on the noise shading phenomenon.

In case of an appropriately dimensioned noise shielding wall, the facility that is to be protected will be in the acoustic shadow of the wall, so sound can only reach it by bending the waves around the edges of the wall.

The level of Noise Reduction that can be achieved with a Noise Reduction Facility [2] is 6-13 dB. (Figure 1-2.).The noise-proof wall is built of recycled materials with a concrete bottom base and standard columns to fix the sides. The wall is equipped with a lower-upper axial fastening element. The results of the material testing were achieved on prototype models and simulation studies. The following material assemblies and designs were investigated:

I. Noise protection walls of 2 m height:

– A1: Straight Noise Shield Wal (Figure 3.)

– A2: wave-shaped noise-shielding wall (Figure 4.)

1.1.1. Defining basic criteria for noise protection wall design

Noise reduction with the noise suppression wall, i.e., the insertion loss, is a frequency-dependent quantity and depends on the type and frequency spectrum of the noise source (point source, linear source).

In addition, they affect:

- geometric dimensions of the wall (height, length);
- the structure of the wall, its shape, - its acoustic properties (sound absorption, sound insulation);
- wall thickness;
- geometry of its installation, source of noise, height, position of the protected facility, wall;
- the relative location of the noise source and the facility that must be protected;
- ground reflection;
- installation conditions (surrounding land, vegetation, buildings, etc.);
- meteorological conditions. [3]

Figure 1. *Three-dimensional model of noise-shielding wall: base material: wood, porcelain, ceramic, glass [2]*

Figure 2. *Three-dimensional model of noise-shielding wall: base material: wood, porcelain, ceramic, glass [2]*

Figure 3. *Composite prototype of straight noise protection wall: materials: wood, porcelain, ceramics, glass [2]*

Figure 4. *Waveform composite prototype wall: material: wood, porcelain, ceramics, glass [2]*

1.1.2. Assessment of available alternatives to material choice

The process of reaching a decision, a choice between the different alternatives, is characterized by the fact that each alternative may have an advantage and a disadvantage. This problem can be solved optimally by a decision support method. (**Figure 7.)** .

Table 1. shows the criteria considered for each of the alternatives during the comparative procedure and also the importance values for each criteria.

By analyzing the results of the models of the proposed alternatives and the evaluation criteria performed on them, the alternatives were ranked in Excel using the mathematical model of the VIKOR method. **[1]**

Table 2. shows the results of the evaluation process (ranking: A1> A2).

As a result of the elaboration of the VIKOR method ranking, the first alternative (A1) turned out to be have a better ranking.

2. Summary

In the study, we have focused on examining the areas of application for multicriteria assessment methods, especially the VIKOR method, which provides a promising solution for the assessment of alternative materials during the design process. The use of the design methodology presented here is one of significant interest for those who research eco-design.

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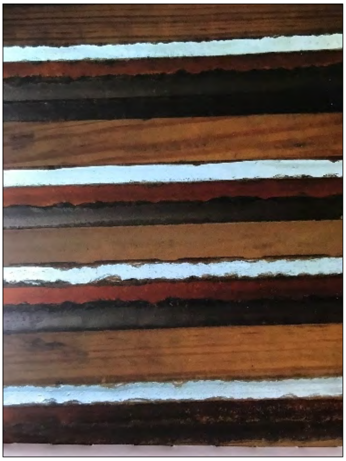

Figure 5. *The structure of the noise-shielding wall: material: wood, porcelain, ceramic, glass* ***[2]***

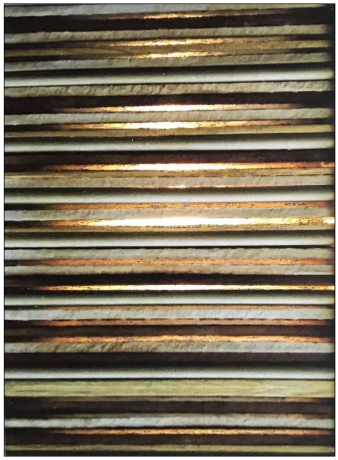

Figure 6. *Illuminated wall texture of a noise shield* ***[2]***

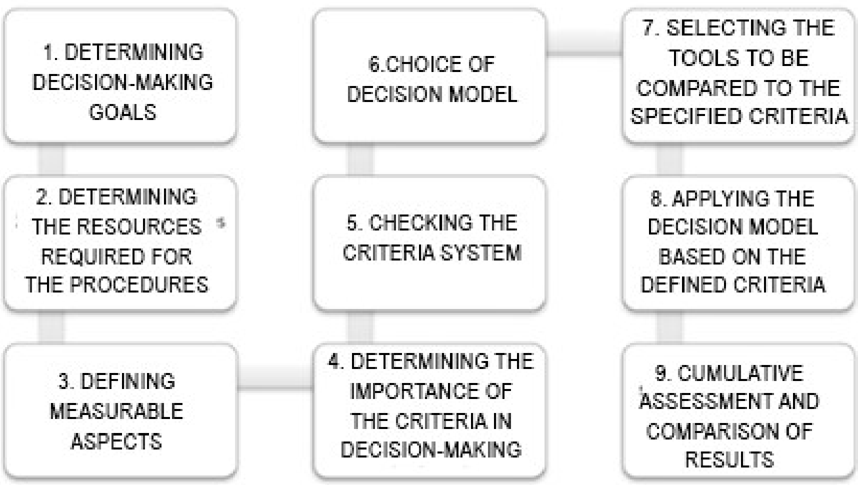

Figure 7. *The process of comparing prototypes with decision support methodology* ***[4]***

Table 1. *Considerations taken into account in the comparative procedure and their importance values*

	Evaluation criteria	Importance
C1	cost requirements	9
C2	Time requirement	6
C3	Reliability	10
C4	Technology	8
C5	material usage	5
C6	Construction design	8

Table 2. *Aspects of the comparative procedure of alternatives and their values*

Alternatives	**Viewpoints**					
	C1	C2	C3	C4	C5	C6
A1	9	6	1	8	50000	8
A2	9	6	1	7	50000	8
weighted	0.216	0.086	0.307	0.146	0.15	0.76

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