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Passive House model for quantitative and qualitative analyses and its intelligent system

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ABSTRACT

The Passive House, along with models of its composite parts, has been developed globally. Simulation tools analyze its energy use, comfort, micro-climate, quality of life and esthetics as well as its technical, economic, legal/regulatory, educational and innovative aspects. Meanwhile the social, cultural, ethical, psychological, emotional, religious and ethnic aspects operating over the course of the existence of a Passive House are given minimal attention or are ignored entirely. However, all the aspects mentioned must be analyzed in an integrated manner during the time a Passive House is in existence. The authors of this article implemented this goal while they participated in two Intelligent Energy Europe programs, the NorthPass and the IDES-EDU projects. The Passive House model for quantitative and qualitative analyses and its intelligent system was developed during the time of these projects. The model and intelligent system are briefly described in this article, which ends with a case study.

1. Introduction

Various models of a Passive House or its composite parts are being developed globally at the micro, meso and macro levels. Such models include the ground heat exchanger [1], heating system [2], heating model of the active solar heating system [3], earth-contact building structures [4], a regression model of energy efficiency [5], a computational fluid dynamics model [6] and others.

Furthermore scientists and practitioners from various countries are developing simulation tools for a Passive House and its composite parts. Such simulation tools include dynamic simulation software [7], computer-aided design tool for passive solar systems [8], simulation software for zero energy building design [9], design of low energy buildings [10], optimization tools BEopt and EGUSA [11] and others.

The aforementioned models and simulation tools for Passive Houses and their composite parts analyze their energetic, technical, technological, economic, legal/regulatory, innovative and microclimatic aspects. However, the social, cultural, ethical, psychological, emotional, religious and ethnic aspects of the Passive House during the process of its existence are generally paid no attention at all. It is necessary to analyze the life cycle of the Passive House comprehensively on the basis of the aforementioned system of criteria to achieve an integrated examination of a Passive House life cycle. The authors of this article developed the Passive House model for quantitative and qualitative analyses and its intelligent system while participating in two Intelligent Energy Europe Program projects: "Promotion of the Passive House Concept to the North European Building Market" (NorthPass) and "Master and Post Graduate education and training in multidisciplinary teams implementing EPBD and beyond" (IDES-EDU). The developed intelligent system additionally provides opportunities for designing hundreds of thousands of Passive House alternatives, selecting the most effective ones and establishing the market value of each alternative.

The structure of this paper is as follows: Section 2, which follows this introduction, describes the Passive House model for quantitative and qualitative analyses. Section 3 analyses the Passive House intelligent, design system. Section 4 contains a case study. Certain concluding remarks appear in Section 5.

2. Passive House model for quantitative and qualitative analyses and illustration of its several stages

2.1. Passive House model for quantitative and qualitative analyses

The Passive House model for quantitative and qualitative analyses was developed with the goal of integrating the energetic, technical, technological, economic, legal/regulatory, innovative,

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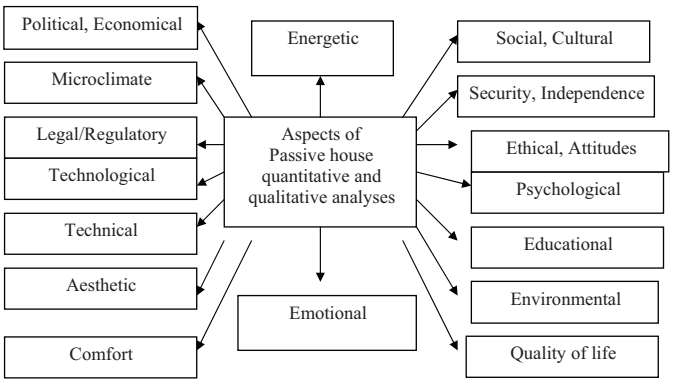

Fig. 1. Passive House quantitative and qualitative analyses aspects.

microclimatic, social, cultural, ethical, psychological, religious, ethnic and other aspects of the process over the life of the Passive House. This six-stage model is presented in brief heretofore (see Fig. 1).

Stage I. Comparative description of the Passive House in developed countries and in Lithuania (by economic, legal/regulatory, technical, technological, organizational, managerial, quality of life, thermic, indoor quality, social, cultural, political, ethical, psychological and other aspects):

- Determining a system of criteria characterizing the efficiency of a Passive House by employing relevant literature and expert methods.
- Describing, per this system of criteria, the present state of the Passive House in developed countries and in Lithuania in conceptual (textual, graphical, numerical and such) and quantitative forms.

Stage II. Comparison and contrast of the Passive House in developed countries and in Lithuania:

- Identifying the global development trends (general regularities) of the Passive House.
- Identifying the differences in Passive Houses between developed countries and Lithuania.
- Determining the pluses and minuses of these differences for Lithuania.
- Determining the best practice for the Passive House in Lithuania as per actual conditions.
- Estimating the deviation between the knowledge stakeholders have of worldwide best practices and their practice-in-use.

Stage III. Development of certain general recommendations on how to improve the knowledge levels of stakeholders.

Stage IV. Submission of certain recommendations to stakeholders including several particular alternatives for each general recommendation proposed.

Stage V. A multiple criteria analysis of the composite parts of a Passive House and selection of the most efficient life cycle for the project – henceforth interlinking the received compatible and rational composite parts of a Passive House into a full Passive House project.

Stage VI. Transformational learning and the redesign of mental and practical behavior.

A partial description of the two stages follow to illustrate the above-presented Model. These are Stage I – Passive House socio-cultural aspects, self-expression values, environmentalism and global warming and the Passive House and Stage II – Lithuania's low energy dwelling weaknesses.

2.2. Passive House socio-cultural aspects

Innovative construction of a Passive House serves the development and induction of new technologies in practice thereby laying the groundwork for economic growth. Furthermore, by offering innovative construction products, materials and services to a user, the user's viewpoint is broadened thus enhancing his/her good taste, and a need for a better quality of life forms. Nevertheless, a good deal of resistance and quite a few phobias that various socio-cultural factors stipulate are encountered at this point.

Ordinary people rely on cognitive shortcuts or heuristics to make sense of issues about which they have low levels of knowledge [12], just as they do with many other political and scientific matters. These heuristics can include predispositional aspects, such as ideological beliefs or value systems [13], as well as short-term frames of reference that the media or other sources of information provide [14]. Recent research suggests that "religious filters" are an important heuristic for scientific issues in general [15].

Representatives of different cultures have ambiguous views toward the Passive House. A great many socio-cultural factors influence such outlooks. The most important are *social, cultural, ethnic, ethical, psychological, political, security, independence, attitudes, public support, religious/spiritual and environmental* factors *and trustworthiness*. These are further presented in brief.

Social factors associate with people's income, social status, gender and other similar matters in life. A sufficient income lays the groundwork for the selection of an innovative Passive House when looking for more comfort, for a better quality home. The opposite is also true – a limited amount of funds forces selection of a traditional, more conservative home, because risk-taking is undesirable. The level of the quality of life in Lithuania is not high by EU standards. Thus it is no surprise that Lithuanians are not especially interested in decisions regarding innovative Passive Houses.

Some USA organizations have measured public levels of concern using various permutations of this question: How serious of a problem/threat is global warming? In a 1998 Mellman Group national poll, 70% of voters said global warming was a "very serious" or "somewhat serious" threat. By 2001 Time/CNN found that 76% thought global warming was a "very serious" or "somewhat serious" problem [16]. According to Dessai et al. [17], lay public perceptions and interpretations of a dangerous climate change, however, are "based on psychological, social, moral, institutional and cultural processes". Public risk perceptions are influenced not only by scientific and technical descriptions of danger but also by a variety of psychological and social factors, including personal experience, affect and emotion, imagery, trust, values and worldviews [18].

A religious filter is more than a simple correlation between religiosity and attitudes toward science: it refers to a link between benefit perceptions and attitudes that varies depending on respondents' levels of religiosity [19]. Leiserowitz [16] argues that religiosity is part of a package of cultural and social values that is often correlated with levels of skepticism about technological and environmental risks. According to Leiserowitz [16], public attitudes about environmental and technological risks significantly correlate with a package of larger cultural attributes that include religiosity. Furthermore public risk perceptions are critical components of the sociopolitical context within which policymakers operate. Public opinion can fundamentally compel or constrain political, economic and social action to address particular risks. For example, public support or opposition to climate policies (e.g., treaties, regulations, taxes, subsidies) will be greatly influenced by public perceptions of the risks and dangers inherent in climate change [16].