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ESTABLISHING THE DATABASE OF STANDARDS FOR EDUCATIONAL SYSTEM FACILITIES

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Abstract

Current construction codes and standards determine minimal infrastructure, financial and human resource indicators for realization and development of primary education. Disproportion that appears in construction practice directs to the need for establishing upper, maximum values indicators. The need for indicators is pointed out by the government of Republic of Croatia in its "General program for construction and reconstruction of public facilities according to public-private partnership" from 2012. The main goal of this paper is to present database of standards for construction, maintenance and utilization of educational system facilities in the Republic of Croatia. Beside the quantitative indicators, it is necessary to define certain qualitative indicators (in term of various technical solutions, materials and other) that would lead to more rational solutions and improved management of government budget. Database is organized in a table form, with technical, functional and quality indicators arranged in groups. Established database contributes to definition of the acceptable construction problem solutions for educational system facilities.

Key words

Standards; educational system facilities; sustainable development; qualitative indicators

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1 INTRODUCTION

Current construction codes and standards determine minimal infrastructure, financial and human resource indicators for realization and development of primary education. The establishment of standardized 'whole building' performance goals and indicators has proven to be a difficult and complex task for the building industry, especially in terms of energy and environmental performance. This is due in part to the fact that building energy and environmental performance varies significantly based on climate, building type, operational use profiles, and other variables. In addition, technology is rapidly transforming the configuration, composition and use of materials and equipment [1]. The need for indicators is pointed out by the government of Republic of Croatia in its "General program for construction and reconstruction of public facilities according to public-private partnership" from 2012 [2]. The main goal of this paper is to present a database of standards for construction, maintenance and utilization of educational system facilities in the Republic of Croatia. It is necessary to define certain qualitative indicators (in term of various technical solutions, materials and other) that would lead to more rational solutions and improved management of government budget.

2 SUSTAINABLE DEVELOPMENT

The role and importance of the built environment in achieving more sustainable development has often been discussed and analysed [3, 4, 5]. The concept of sustainable development as well as associated principles and management rules are increasingly being acknowledged by numerous corporations, organisations and institutions worldwide. Buildings and constructed works manufacture, construction and management have a significant share in energy and mass flows as well as in impacts on the environment [6].

The recent decades have witnessed a maturing of concern and interest in building performance that is increasingly evidenced in building design. A sustainable intelligent building can be understood to be a complex system of three basic inter-related issues [7]:

- People (owners, occupants, users, etc.);
- Products (materials, fabric, structure, facilities, equipment, automation and controls, services); and
- Processes (maintenance, performance evaluation, facilities management) and the inter-relationships between these issues.

Whilst sustainable buildings have advanced in many aspects including design and construction, there remains a strong argument that the financial viability of a building will determine to what degree a building is allowed to be sustainable. The common aspirations are to reduce emissions of greenhouse gases through fossil fuel consumption, to reduce the consumption of scarce resources like water, to recycle resources and waste less, to reuse materials wherever possible, to use renewable resources, and to improve occupant comfort and well-being [8].

Sustainability within the built environment is not strictly limited to energy consumption. Other factors do play an important role as well. One of these factors is the durability of building materials, i.e. the environmental effects of building materials. Another important factor is the effect of maintenance of building materials on the performance of buildings [9]. Building concepts are constantly under development. Due to the large environmental impact of buildings, a lot of attention is given to the sustainability of buildings and building concepts. The current challenge is to create sustainable buildings, which are also healthy and comfortable [10, 11]. Bougdah et al. in [12] expressed it as follows: "A challenge for architects is to create climatically-responsive architecture that is in tune with its environment and context." An option to reach sustainability is to maximise the use of solar energy for heating during the cold season and to reduce its unwanted effects in the warm season.

3 KEY QUALITATIVE INDICATORS FOR SUSTAINABLE BUILDING

Any building forms a system with a number of sub-systems, characterised by a large quantity of parameters that need to be considered during the design process. Traditionally, the design process involves multiple design and engineering disciplines, which design, analyse and optimise individual sub-systems and their components separately. Nevertheless, all building component parameters are inter-related and affect each other. In order to optimise the dynamic interaction between different building systems and components, it is necessary to use an integrated design approach [13].

The recent trend called "whole building design approach" asks the members of the design and construction team to look at materials, systems and assemblies from many different professional perspectives. The design is evaluated for cost, quality-of-life, future flexibility, efficiency, overall environmental impact, productivity and creativity and how the occupants will be enlivened [14]. The reasons for determining the key qualitative indicators are various: raising expectations for the facility's performance among the various participants; ensuring that capital budgeting design and construction practices result in investments that make economic and environmental sense; creating partnerships in the design and construction process around environmental and economic performance goals; saving taxpayers money through reduced energy and materials expenditure, waste disposal costs and utility bills; improving the comfort, health and well-being of building occupants and public visitors; construction of design buildings with improved performance which can be operated and maintained within the limits of existing resources; stimulating markets for sustainable technologies and products [1].

The key indicators can apply to either renovation or new construction. They define objectives, strategies, benefits and performance goals. In cases of building renovation the performance goals may differ because of the already set indicators, such as building site, orientation, massing, structural systems and other. Their performance may be upgraded, but they cannot be radically altered and therefore performance expectations may be realistically downgraded. One key principle relates to building integration, which recognizes that the various architectural, mechanical and electrical systems are interdependent. Capital planning therefore should take into account a long-term view of the whole building. Even with limited capital funding, incrementally improving the building envelope and various building systems in the right order will result in long-term operating and capital savings when the following principles of building integration are applied:

- Make comprehensive facility investments and perform them in proper sequence to ensure appropriate load matching;
- Improve the thermal performance of the building envelope first, while properly sequencing the upgrade(s) of mechanical and electrical systems. Replacement of whole central systems should come last in the order of priority.

For example, building exterior stabilization, such as window replacement or improved roofing insulation, reduces heating and cooling loads. High-efficiency lighting upgrades and replacing fans and motors in air-handling systems may further reduce loads. These improvements should precede or be performed simultaneously with replacement of major HVAC equipment to ensure proper load matching. This sequence avoids wasting money on major HVAC equipment investments that would otherwise become partially redundant based on later load reductions.

A new facility that is planned with an eye toward sustainability from day one represents an unprecedented opportunity to showcase high performance principles and optimize building features in an integrated manner. These principles and practices applied to site-selection issues, site planning, and design can reap significant capital and operating savings as well as other municipal benefits. They encourage retooling of conventional programming and budgeting processes, and provide roadmaps for effective change [1]. The key indicators that identify costs and benefits, thus encouraging long-term (life-cycle) approaches to capital decisions, as opposed to those driven solely by first cost are shown in Table 1, with brief description after the table.

Tab. 1: Key qualitative indicators [1]

<table>
<tr><th>City process</th><th>Design process</th><th>Site design and planning</th><th>Building energy use</th><th>Indoor environment</th></tr>
<tr><td rowspan="2">program planning</td><td rowspan="2">client awareness and goal setting</td><td rowspan="2">understanding the site</td><td>site and massing considerations</td><td rowspan="2">good indoor air quality (IAQ)</td></tr>
<tr><td>interior layout /spatial design</td></tr>
<tr><td rowspan="2">site selection and planning</td><td rowspan="2">team development</td><td rowspan="2">building-site relationship</td><td>building envelope</td><td rowspan="2">light sources</td></tr>
<tr><td>Day lighting /sun control</td></tr>
<tr><td rowspan="2">budget planning</td><td rowspan="2">well-integrated design</td><td rowspan="2">sustainable landscape practice</td><td>light pollution</td><td rowspan="2">noise control</td></tr>
<tr><td>high performance lighting</td></tr>
<tr><td rowspan="4">capital planning process</td><td rowspan="4">resource management</td><td rowspan="4">encourage alternative transportation</td><td>electrical systems and equipment</td><td rowspan="4">controllability of systems</td></tr>
<tr><td>energy sources</td></tr>
<tr><td>mechanical systems</td></tr>
<tr><td>energy load management</td></tr>
<tr><th>Material and product selection</th><th>Water management</th><th>Construction administration</th><th>Commissioning</th><th>Operations and maintenance</th></tr>
<tr><td>selection for a healthy indoor environment</td><td>minimize the use of domestic water</td><td>environmental and community considerations</td><td>fully integrated operating systems</td><td>operating and maintaining building systems</td></tr>
<tr><td>selection for resource efficiency</td><td>water quality</td><td>health and safety</td><td rowspan="2">commissioning existing buildings</td><td>healthy and efficient custodial operations</td></tr>
<tr><td>selection for external environmental benefit</td><td>water reuse</td><td>construction and demolition waste management</td><td>waste prevention and recycling</td></tr>
</table>

A brief description of key indicators:

- City process: During the site selection, programming and budgeting executives make decisions on account of various stakeholders' input. Community and environmental impacts, as well as project's present and future anticipated capital requirements are considered. The design process is optimized through constant participation, examination and refinement, thus reducing operating costs and avoiding costs of future maintenance and repair.

- Design process: The delivery of a sustainable, high performance project calls for significantly increased collaboration among the various design disciplines, with the emphasis on interdisciplinary design and resource management, together with use of new design tools with the information on the traditional efficiency methods and techniques.
- Site design and planning: Sustainable site planning identifies ecological, infrastructural and cultural characteristics of the site to assist designers in integration of building with the site through preservation of site resources and conservation of energy and materials, both during construction and in ongoing building operations.
- Building energy use: Energy efficient design begins with a methodical reduction of the building's heating and cooling loads imposed by climate and generated by people and equipment, thus optimizing the performance of each of the building's components and systems both individually and in interaction with other energy-consuming systems.
- Indoor environment: Indoor environment provides supportive ambient conditions, including thermal and visual comfort, acceptable indoor air quality, humidity and acoustic quality.
- Material and product selection: Selecting materials and products for high performance sustainable buildings involves consideration of environmental and health issues in addition to more traditional criteria such as cost, durability, performance and aesthetics.
- Water management: The design of a plumbing system must incorporate not only traditional issues of sanitation, flow and pressure, but also environmentally based preferences for recycling wastewater, use of non-utility water and different treatments for potable and non-potable water.
- Construction administration: High performance construction practices can help reduce adverse effects during construction while improving the building's long-term environmental performance with encouraging better waste management.
- Commissioning: The commissioning process assures the building owner that the equipment, systems and controls providing light, heat, cooling and ventilation are effectively working together in conformance with design intent.
- Operation and maintenance: Adequate planning for the efficient operation and maintenance of a building and its systems is a critical component of high performance design and construction, resulting in reduced custodial costs and lower energy consumption, as well as enhancing the indoor environment and positive contribution to occupant's well-being and productivity.

Public facilities building projects bring a wealth of social and economic benefits to our communities. Yet in weighing these benefits, we should also be aware of how our buildings directly and indirectly contribute to environmental and human health problems. Few people in the building trades, let alone average citizens, fully realize the extent to which building construction and operation generates material waste and results in energy inefficiencies and pollution. These so-called 'externalized costs' do not show up on any balance sheet, meaning that the environment – and ultimately society in general – will be forced to absorb them. Every day buildings squander valuable capital by wasting energy, water, natural resources and human labour. Most of this waste happens inadvertently, as a result of following accustomed practices that often just meet, but fail to exceed, building codes. Progressive owners, manufacturers and developers have begun to convert these liabilities into economic opportunities by adopting cost-effective new technologies, processes and materials that dramatically reduce environmental impacts while increasing profitability. Municipalities also pay indirect premiums for less efficient, traditionally built facilities. These buildings can impose unnecessary additional burdens on municipal services such as water supply and treatment and solid waste management, indirectly affecting local taxes and municipal budgets. By incorporating environmentally sound materials and systems, improving indoor air quality and day lighting, the facility will be improved in the value of its interior public spaces and indirect returns through improved health and well-being of students, workers and other building occupants or visitors. Especially in educational facilities, where the building is a part of nurturing environment for the most vulnerable population of users, the key indicators must be set to present a valid starting point for construction. For example, careful decisions on building shape and window placement that take into account both prevailing wind and sun angles, may not only enhance a building’s thermal performance, but can also result in improved day lighting. These measures will reduce both heating and cooling loads, and in turn, could generate first cost savings achieved through downsizing HVAC equipment and reducing mechanical space requirements. Different for other types of buildings, key indicators for educational facilities must be much more sensitive for end users. Setting a database of standards a model for educational building cost calculation can be made, thus leading to more rational solutions and improved management of government budget.

An integrated building design process re-examines the use of traditional products or building assemblies, and identifies innovative technologies or green product and system alternatives that offer significantly improved environmental performance. These progressive design approaches can be further refined through the use of computer energy modelling. Energy modelling simulates the proposed design’s response to climate and season. Designers can preview and improve the performance of interdependent features such as orientation, day lighting, alternative building shell design and various mechanical systems. Energy modelling quickly evaluates cost-effective design options for the building envelope or mechanical systems by simulating the various alternatives in combination. This process takes much of the guesswork out of green building design and specification, and enables a fairly accurate cost/benefit forecasting.

4 CONCLUSIONS

It is necessary to define certain qualitative indicators (in term of various technical solutions, materials and other) that would lead to more rational solutions and improved management of government budget. These key indicators should set out a range of ‘best practice’ for planning, designing, constructing and operating healthier, more energy – and resource – efficient facilities. The standard system must be brought into relation with structure classification according to the structure (educational) purpose – nursery schools, pre-schools, primary schools, faculties, or other public facilities with health, cultural or judicial purpose. The main spatial, technical, energy, function, quality and cost standards must be determined, as well as the limits of minimum and maximum standards. Further research goes in the direction of quantifying the stated key indicators, giving them minimum and maximum limits according to the facility type and purpose. With quantifying the indicators, a model for building cost calculation can be made, thus leading to more rational solutions and improved management of government budget.

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