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REVITALIZATION PROCESS OF PRESCHOOL BUILDINGS

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Abstract. *This paper represents the research associated with establishment of the methodological approach to reviving architecture designed for children's upbringing and education, and consider new possible strategies for implementing eco-principles in the existing construction fund of preschool facilities in Serbia. Basic research problem is global state of resources, energy consumption and disrupted children comfort in preschool facilities. Research gives concrete proposals for future architectural praxis in Serbia in terms of eliminating the aforementioned problems. The aim of the research is to record and valorize practical measures for environmental, energy-efficient and economic reshaping in accordance with pre-set criteria, which will provide healthy, safe, comfortable, functional and progressive eco inner and outer environment of a child in preschool facility.*

Key words: *revitalization, methodology, preschool building, energy savings, children comfort*

1. INTRODUCTION

It is generally known that a man causes changes in the environment and thus many of these changes affect the relationship between man and his environment. Global development of human society, with the overall technical - technological prosperity, eventually caused the disruption of the natural balance, which was brought into question the survival of human civilization. This situation triggered the global community, woke its environmental awareness and prompted the man to turn around and return to nature in order to establish the initial state of equilibrium. As the world population continues to grow, natural resources are under intensified pressure and thus public health, social and economic developments are directly threatened.

In this paper, emphasis is on research of possible solutions which contribute to substantial energy savings, healthier children stay in the external and internal environment, which does not exploit energy sources and that are based on renewable energy sources and

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have no adverse effects on the environment. First part of research deals with the methodological work on preschool building revitalization. The final section of this part of observation includes analyses of the principles that have already been demonstrated as advantageous revitalization measures which make significant contribution to the improvement of comfort, facility performance and energy saving. Applied functional - technical solutions in the process of remodeling of international pre-school institutions are analyzed in order to identify their positive characteristics and potential, with the aim to create models adaptable to the areas and needs in Serbia. This can represent a guide for transforming the constructed preschool facilities in Serbia into green-environmental and sustainable facilities. The main goal of this research is to define practical package of measures to achieve a healthier living conditions, reduce the negative effects on the environment and climate changes and achieve significant energy savings.

2. PROCEDURE AND PRINCIPLES OF REVITALIZATION PROCESS

Revitalization certainly marks the comeback of active life of the facilities, which have, completely or partially, lost their purpose, usability, function and physical characteristics. "Renewal and revitalization of constructed facilities, as one of strategic approaches and instruments of modern building construction, is based on evaluation and estimation of real construction quality and modeling of the process which will lead to realization of optimal solutions for improvement of building performances and their positive influence onto human existence and environment". [1] The difference between real quality- condition of the facility and requested quality, or the quality that suits modern demands of accommodation in preschool facilities and current engineering regulative and standards indicates the manner, scope and type of renewal interventions. Revitalization can be construed as a process composed of phases and activities, i.e. mutually connected operations that happen in established order within certain time interval. A rough and approximate presentation of the stage, through which revitalization, as planned process of improvement of conditions in preschool facilities, is realized, implies the following:

- Research and recording of conditions in a preschool facility in terms of testing its organization and functioning; research and recording of conditions in macro-surrounding and preschool facility (value and significance, condition, architectural integrity and nature of the facility) – observing, measuring, sampling, noting and documenting, interviewing, etc.; analysis of the surroundings in which revitalization project is implemented;
- Analysis of researched condition, including analysis of obtained research results, tested indicators, measurements, calculations, etc.;
- Estimation of the state of the facility, as well as estimation of environment factor which can represent risk/threat or advantage;
- Synthesis of findings and determining the revitalization field;
- Implementation of solutions into individual projects;
- Creation and development of project revitalization;
- Project realization.

Principles which need to be considered and integrated into revitalization process are:

- Improvement of inner surrounding conditions is possible providing that façade shading is used properly, vegetation is grown near the facility, water surface is present, etc. Lowering the temperature in the area surrounding preschool facility reduces the amount of solar radiation that penetrates facility's mantle, which directly reduces the need for cooling.
- Redesign of facility's envelope has multiple implications and long-lasting influence on social, urban and natural existence of the settlement. [1] If estimated heat loss of external wall without insulation is compared to estimated heat loss of a wall with thermal insulation, one may conclude that increased insulation of external wall reduces heat losses by 50-80% [2] The accent is on determining the type and thickness of thermal insulation layer, as well as on defining the type of façade finishes, its shades and composition, which is not the case with the facilities having a historical built heritage. The use of insulation and advanced materials, greening the roofs and façades increase heat efficiency of the building and, combined with the use of natural ventilation techniques, reduce energy system consumption for air-conditioning, heating and cooling.
- Enhancing the existing energy systems with the aim of reducing specific energy requirements for heating (i.e. installation of module for reversible use of heat), cooling (use of platform fans, application of night ventilation, strategy of exposing thermal mass), ventilation (demand-controlled ventilation) and artificial lighting sectors (highly efficient lamps and lighting devices, lighting focused on specific areas- task lighting, compensation for natural light, etc.)
- From eco perspective, an important strategy implies reducing water consumption, reusing wastewater or finding alternative ways for water supply. An appropriate and inexpensive way to do this is to reuse rainwater. Waste water management is adequate measure which implies "catch and reuse" principle. Additionally, creation of green roofs represents exceptional eco strategy, as there is no better and more beautiful way to improve thermal efficiency of buildings. This will improve and facilitate air conditioning system operation and rainwater treatment.

One way to launch more extensive revitalization of preschool facilities, in terms of sustainable development, is initiating projects that would first define methodological approach and general principles, and then offer concrete actions for implementing building reconstruction, taking into consideration the possibility of switching to renewable energy sources and choosing the most rational form of application.

2.2. Spectrum of possible improvements in preschool buildings

There are many *long-term solutions* that could assist in saving energy and reducing facilities or kindergartens' operational costs. Investment in insulating products can be returned through energy saving in a short period of time. Increase of resistance value of the insulation results in increasing insulating power and reducing heat loss.

Solar water heating systems are designed to collect heat from the sun and use it to heat water. Heat is transferred from the collector (usually mounted on the roof) to water supply storage tank. These two main components are found in all solar water heating systems. There are two types of solar systems: Passive Systems which use no electronic controls or pumps to move water from the collector to the storage tank and Active Systems which use one or more pumps operated by an electronic controller to circulate fluid between the

collector and the storage tank. It is worth knowing that "a square meter of a south oriented roof collector is three times more effective than that of an east facade collector and 50% more effective than that of south facade collector".[3] This fact defines future course of action in the field of application solar systems.

Solar power via photovoltaic cells is another option which enables kindergartens to produce all the energy they need from the sun and eliminates dependency on municipal sources. Moreover, solar power can be saved for future use. Geothermal system transfers the earth's heat, which, at this level, remains at a fairly constant temperature, through underground-installed piping, into a building. In winter, the piping draws warmth from the earth. A water-based solution circulating through the pipes carries warmth to the heat pump. The pump then circulates heat into the rest of the building through air ducts. In summer, the process is reversed. Hot air inside kindergarten building is drawn back into outside ground piping. The system can use a part of interior heat to provide hot water in the summer.

Planting deciduous varieties of trees, such as oak or maple, in southern and western areas can help keep buildings cool in summer, as well as allow the sun to penetrate the windows in winter. When trees mature, tree shade can save up to 40 percent of summer cooling costs.

There are numerous *short-term activities* which can reduce our demand for electricity, help us use energy more efficiently, and produce energy savings. Day lighting has a major impact on building's functionality and occupant effectiveness and productivity, not only in terms of energy costs associated with illumination and space conditioning, but also in terms of enhancing building's comfort and ambiance. The technique of Day lighting, which implies using natural light instead of electricity, can reduce daily consumption by 100 percent. In addition, children taught in classrooms illuminated by natural light show significant progress in subjects, with scores 7 to 16 percent higher than those in classrooms with poor natural light. [4] Installing a programmable thermostat allows the users to set (reduce) temperature and use the unit only on specific occasion, thus achieving cost savings by using energy only when necessary. Excess leakage in windows and doors can increase heating and cooling bills by 30 percent and reduce fire safety. Caulking and weather-stripping, along with other products, including plastic window-well covers, can make significant energy savings difference.

Higher degree of thermal protection is needed to reduce heating costs and increase thermal comfort through the use of the facility at all times. This implies a certain increase in investment during construction or reconstruction. Numerous additional analyses on improving thermal protection investment costs prove economic justification for the investment. Aside from permanent reduction of heating costs, higher level of thermal protection implies pleasant climate within facility area, healthier and longer life of the building. [5] Good thermal insulation of external walls is only one of the measures for increasing energy efficiency in buildings and it represents basis of modern energy management and environmental protection. Experience in improving thermal characteristics and performance measurement of energy savings in reconstructed public buildings, especially in schools and kindergartens, is not at a satisfactory level in Serbia. Experience of countries in the region may be of significant assistance. In Croatia, for instance, modern energy efficiency measures are successfully applied on kindergarten premises. After reconstruction and establishment of a system for measuring heat transmission through walls, thermo-graphic recordings clearly indicate the validity of the chosen solution:

- Children's comfort and quality of nursery and kindergarten area are significantly improved;
- Savings in energy consumption are significant, but still considered to be less than their real potential;
- Change of users' habits is necessary for increasing energy savings.

As part of building energy review, infrared thermo-graphic can be a useful tool for quick and accurate problem diagnosing. It detects problems and abnormalities that cannot be detected during visual control, and helps avoiding big and costly repairs. Thermo-graphic measurements can be part of preventive maintenance and subsequent control of the work done. The ability of remote recording of the total facility area temperature offers great advantages over conventional analysis of parts of the building's external walls.

3. Ways of Addressing Existing Problems, Overcoming through Refurbishment and Remodeling

Keeping in mind the importance of preschool period for the development of healthy personality of a child and society as a whole, it is necessary to harmonize comfort level of the existing kindergartens with modern standards. The process of revitalization is a good opportunity to remodel preschool facilities in order to increase the ambient value of these buildings. [6] In order to achieve the necessary comfort of preschool facility users, the space is to fulfill certain requirements in terms of functional, shape and materialization aspects. Once the kindergartens are remodeled, several improvements can be made. [7] Primarily, this can be achieved through size and regular arrangement of skylights which enable passive solar gain, greater amount of daylight, as well as transverse ventilation. [3] Largest glass openings need to be orientated towards south, while small windows are located on the north side. Regular arrangement of facade and roof openings enables natural ventilation of the building. [3] The size of the windows can be enlarged and the window parapets can be lowered so the children can have a better view. [6] This enables connection with the surrounding environment, which is especially important during the days when the weather does not allow children to play outside. [8] The use of natural façade materials, which are more appropriate for children, would also be beneficial. [9] Remodeling of facility envelope (façades and roofs) leads to energy performance improvement, as well as the enhancement of functional and aesthetic values of the building. Repainting and the use of appropriate colors will make children feel better about these buildings. [10]

As a part of scientific project conducted at Faculty of Civil Engineering and Architecture in Niš, in the period 2010-2014, a large number of kindergartens, mainly in south-eastern part of Central Serbia, has been surveyed. [11] The reasons for survey are: preservation of the existing buildings, improvement of accommodation conditions for children and better learning environment. Negative aspects of these buildings are very similar. These include: inadequate functional organization of some kindergartens, their unsatisfactory energy efficiency, and façades that are in such poor shape which reduces the ambient value of the buildings. Reconstruction includes both changes in the interior and changes in the structural system of the building. Usually, façade remodeling is done simultaneously with the changes in function. However, there are only a few kindergartens that need such extensive reconstruction. On the other hand, many kindergartens should

have their façades revitalized. Structurally, the façades are in good condition, but functionally and aesthetically they do not fulfill the necessary requirements. In this context, façade envelope renovation is also significant from the aspect of improving architectural and visual integrity and identity, which is related to the feeling of pleasantness, affiliation and children's need to accept the facility as new home easily. [12]

Recent revitalization has been limited to repainting the walls and repairing the roofs, while nothing has been done in terms of improving efficiency. Revitalization is desirable because of unsatisfactory energy efficiency and inadequate functional and aesthetic aspects of these buildings. The process of revitalization is also a good opportunity to remodel kindergartens in order to increase the ambient value of these buildings. [6]

3.1. Current practice in the revitalization of preschool facilities

The following analysis considers examples of revitalized facilities in the Balkan region and beyond. These implemented revitalization projects point to real energy, environmental and economy savings that can be accomplished and feasibility of investing in revitalization processes. The tendency of all considered examples has been to accomplish revitalization goals, that is, to achieve and implement basic environmental, energy and economic aspects according to financial abilities. As for the considered example, applied measures of energy consumption reduction and improvement of conditions of facilities where children stay may serve as a pattern for that could be applied to preschool facilities around Serbia which have the same or similar problems.

The existing nursery "Ivancica", built in Osijek in 1974, had extremely bad mantle of windows (without thermo insulation layer), doors and the entire facility construction (walls and flat roof), which pointed to increased consumption of heating, cooling and ventilation energy, as well as costs (energy and economic problem- indirect and environmental). Reconstruction process included replacement of windows (PVC windows of heat characteristics k=1,1-1,4 W/m2K were placed), replacement of heat insulation (placement of fibreglass insulation d=10cm), and replacement of final façade-processed with three-layer silicate plaster, hydro and heat insulation (replacement of existing hydro insulation, placement of vapour barrier, placement of fibreglass insulation and hydro insulation). It also covered replacement of flat roof and increasing energy efficiency by means of heating and lighting systems. Energy analysis, accompanied by thermo graphic recording, indicated the decrease in heating requirements from 238.000 kWh to 62.000 kWh, or 74%, and decrease in heating load from 134.000 W to 37.000 W, or 72% per year. Nido Piccolo Day Care Centre is an older building, designed and built in 1983 in Berlin in the process of Housing System 70 (WBS 170). Renovation of the building was completed with the assistance of Stimulus Package II. The state of the façade and building's day care centre were in poor condition and required urgent renovation. The main principle of the project was to utilize the granted funds, not only to ensure thermal insulation, but also to apply a new coat for the façade. Economical budgeting and a sophisticated design made oriels for the group rooms possible, which were suspended in front of the insulated façade (Fig. 1.).

Fig. 1 Facility "Ivancica" during execution works on thermo-insulation and appearance after project completion (left), Nido Piccolo Day Care Centre (right)

Day care centre on Wolgaster Strasse was built in 1980/1981 as a one and two storey buildings in Berlin, Wedding (Fig. 2. left). This project of revitalization included the following measures: insulation of the roof and façades with extent insulation, replacement of windows and exterior doors, modernisation of the heating system and installation of 69sqm solar thermal facility on the roof. A special feature of the project was that solar thermal facility was for both heating and hot water. An annual primary energy consumption level of 323MWh was achieved. This corresponded to a reduction in CO2 emissions of around 50 t/a, and annual per capita emissions of around eight residents of Berlin. [13] Day care centre „Akazieninsel", the three-storey building was built in "Plattenbau" style, made of prefabricated concrete slabs (type WBS70) in 1977/1978 (Fig. 2. right). It was definitely time-initiated renovation to improve building energy efficiency, especially since the facility needed a lot of energy and money for heating. Despite the building's environmentally friendly heat supply via district heating from combined heat and power generation (CHP), the level of primary energy consumption was high with 431MWh/a, and associated CO2 emissions of 113 t/a. The main task of the project was to optimise the building's envelope. The façade was fitted with a thermal insulation system, flat roof was insulated and the windows and doors replaced. As compared to the requirements of national Energy Saving Regulation (Energieeinsparverordnung EnEV 2007) for each building component, improvement of 30% was achieved. In addition, heat loss of the building was reduced through structural improvements (reducing the amount of unnecessary glazed areas, incorporating terraces in line with the exterior walls). Ventilation systems for heat recovery and solar panels on the roof completed the energy concept. The project prevented 76 t/a CO2 from being emitted, which corresponded to the annual CO2 per capita emissions of 13 residents of Berlin. This was a true investment in the future, which would not have been possible without the assistance of ERP.

Fig. 2 Day care centre Wolgaster Strasse after renovation (left);
Day care centre „Akazieninsel" in Marzahn before and after reconstruction (right)
(Source: http://www.stadtentwicklung.berlin.de/umwelt/umweltentlastungsprogramm/download/broschuere_10_jahre_uep_en.pdf)

4. IMPROVEMENT OF THE QUALITY OF PRESCHOOL SPACE

Physical structures designed for preschool children upbringing and education, i.e. exterior and interior environment, have a multiple influence on cognitive, social and emotional development of the children. Preschool children, as especially sensitive and vulnerable social group, within lots of development-essential needs and demands, require interior environment that is the product of careful and precise design process, in other words- the environment that will provide comfortable, healthy and stimulating stay.

By implementing new technologies, existing materials of improved quality and the introduction of new environmentally friendly materials and equipment in the area of internal environment of preschool facilities, comfort of the children is rising at a significantly higher development level. Each architectural vision inspiring and imaginative enough for children's eye and touch, which transforms, already devastated and ruined children's environment, into a space for encouraging and stimulating work and study, is possible and imperatively desirable today. The concept and implementation of revitalization of the indoor environment area should be sure the answer to the children needs.

Revitalization of internal environment of pre-school facilities based on previous analyses includes the implementation of complex measures which affect improvement of physical, acoustic, aesthetic, light and air comfort. Implementation of desperately needed revitalization of facilities with damaged comfort is possible with the certain consumption of time and money but of course, with the support of the authorities of Republic of Serbia and local governments.

5. CONCLUSION

Nowadays there are a lot of types of intervention methods for better keeping and treatment of existing building fund. Adoption of the strategy and the principles of green design and construction / reconstruction can enlarge the economic, environmental performances of the buildings and also can contribute to the children more comfortable and stimulating stay in pre-school premises. 'Green' methods can be applied into buildings at any phase of building, starting from the phase of design and construction, to the reconstruction and demolition. In order to select the most appropriate treating measures, it is necessary to conduct previous researches and to gather information about certain building location (special microclimate conditions), physical structure, building condition, etc. Damage and imperfections to parts of the physical structure and the entire facility can be caused by numerous factors from outer surrounding, such as: natural-atmosphere influences, intentional acts of people, as well as internal factors, which aroused from the facility itself (type of applied materials). Mentioned influential factors have conditioned disturbing of children’s comfort within facility and outer surrounding. Therefore, in these cases it is necessary to start with the implementation of revitalizing steps of the internal and external environment suited to children's needs. The most important goals that need to be achieved by implementing of revitalization measures on preschool buildings are following:

- Firstly, providing comfortable and high-quality dwelling conditions for children and stuff in the pre-school buildings, as well as providing conditions and supporting environment criterion fulfilling so as to improve progress of children,
- Creating of ecological and high-quality outdoor and indoor surrounding,

- Preservation of non-renewable sources of energy, by introducing and applying renewable resources,
- Immediate environment protection.

Methodology of energy revitalization of buildings includes identifying and distinctly defining of primary and secondary factors of undue losses of energy, planning of future activities and realizing of planned steps leading to the elimination of major problems. Taking into account everything that has been researched and discussed in the paper, one can make a conclusion that the use of highly efficient energy systems of heating, cooling, ventilating and lighting, increasing of thermal insulation of buildings envelop, different type of greening building, modification in human behavior habits, etc. may have a significant impact not only on upgrading energy efficiency in structures but also lowering the costs as well as reducing the negative effects on the environment. In addition the quality of children resides in preschool premises is raised to a higher level.

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PROCES REVITALIZACIJE PREDŠKOLSKIH OBJEKATA

Rad prezentuje istraživanje koje se bavi uspostavljanjem metodološkog pristupa obnovi arhiterkture objekata namenjenih dečjem vaspitanju i obrazovanju, i razmatranjem novih mogućih strategija implementiranja eko-principa na postojeći izgrađeni fond u Srbiji. Osnovni problem istrživanja je opšte stanje resursa, potrošnja energije i narušen komfor boravka dece u predškolskim objektima. Istraživanje pruža konkretne predloge za buduću arhitektonsku praksu u Srbiji u smislu eliminisanja evidentiranih problema. Cilj istraživanja je registrovanje i valorizacija praktičnih mera za ambijetalno, energetski efikasno i ekonomično preoblikovanje u skladu sa unapred definisaim kriterijumima, a koje će obezbediti zdravo, bezbedno, funksionalno i podsticajno unutrašnje i spoljašnje eko-okruženje u predškolskoj ustanovi.

Ključne reči: *revitalizacija, metodologija, predškolski objekti, ušteda energije, komfor*