Reconditioning and Reconstruction: a Second Wind for Serbian Kindergartens

Danica Stankovic\textsuperscript{a}, Milan Tanic\textsuperscript{a,*}, Aleksandra Kostic\textsuperscript{a}, Marko Nikolic\textsuperscript{a}, Jasmina Tamburic\textsuperscript{a}, Vuk Milosevic\textsuperscript{a}, Ljiljana Jevremovic\textsuperscript{a}, Nikita Sokolovskii\textsuperscript{b}

\textsuperscript{a}Faculty of Civil Engineering and Architecture in Nis, Aleksandra Medvedeva 14, 18000 Nis, Serbia
\textsuperscript{b}St. Petersburg State Polytechnical University, Politekhnicheskaya, 29, Saint-Petersburg, 195251, Russia

Abstract

A great number of preschool buildings in Serbia, mainly in south-eastern part of Central Serbia, have been examined as a part of scientific project carried at Faculty of Civil Engineering and Architecture in Nis. Even though this is an on-going project with data still being collected, there has been sufficient material to make an overview of field situation and draft framework for proposed reconstruction strategy as a main goal of this study. This analysis presents the basis for examining and valorizing local preschool facilities. In addition to treating structural, environmental and aesthetic (internal and external) properties of the buildings, we carried out analysis of energy status of preschool buildings. Investigation of foreign experience with the process of revitalization of this group of buildings has served as the framework for the final part of the chapter, which offers suggestions for improving quality of preschool facilities in Serbia.

© 2015 The Authors. Published by Elsevier Ltd.

Keywords: Energy efficiency, existing preschools, heat loss, energy recovery, heating.

1. Introduction

This chapter primarily focuses in the general principles related to refurbishment and remodelling of buildings. However, considering preschool facilities as buildings designed for children, there are some differences from other

* Corresponding author. Tel.: +381641148529 ; fax: +381 18 588 208.
E-mail address: tanicmilan@yahoo.com

1877-7058 © 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of SPbUCEMF-2015
doi:10.1016/j.proeng.2015.08.218
types of buildings. The chapter deals with specific aspects of refurbishment that are directly applied to preschool buildings.

All buildings are, to a large or small degree, eventually affected by some form of obsolescence or inefficiency; they fail to meet some, if not all, of the users’ needs or statutory requirements. Regardless of whether the building is fully or partially occupied or vacant, this occurs for three main reasons: firstly, construction standards and requirements that are continually improving (e.g. most recent is enhance in energy efficiency policy); secondly, ‘wear and tear’ as well as exposure to the elements results in on-going deterioration or other adverse changes in the building structure and fabric; thirdly, advances in technology and rising demands of users and workers for better and more comfortable internal environments. Additionally, educational concepts and policies have been changed, so even solidly built preschool buildings have to be renovated.

2. Benefits of changing the building

Before discussing the reconstruction of the buildings, two questions should be answered. Why is making a change necessary? And, how often should a building be reconstructed or refurbished? A prerequisite for reconstruction and/or refurbishment of a building is a capacity of the action to make a greater good in the space. If it is better and more affordable to change an existing building than to build a new one at the same site, reconstruction is feasible. James Douglas writes about several beneficial aspects of reconstruction strategy [1]:

- Environmental- Improving the quality of urban landscape and providing more sustainable environment is a goal of redevelopment procedure. Appearance and character of the building stock should be enhanced through this process. It can also provide an opportunity of upgrading the overall performance of a property. Sustainable construction is now an important part of political and environmental agendas; therefore, modernizing the existing buildings can result in more sustainable environment. This means increasing energy efficiency and reducing wastage of non-renewable fuels and materials.
- Psycho-social- Modernization of buildings enhances physical well-being of their occupants and has a positive effect on their overall educational performance. A refurbished property can provide more comfortable and soothing environment for its occupants. Creating a more attractive and pleasant habitat by using such measures can have a positive effect on health, morale and overall human behaviour and performance in many other ways.

It is important to emphasize that elements of a building can be changed in a reconstruction procedure. A change on a building, at least one of its elements, will be refreshing and useful.

Figure 1. shows proposed rhythm of change of the building that should contribute to regular maintenance of buildings. Brand’s chart [2] compares the building with the human structure (see table within Figure 1). This data can be used to estimate the level of obsolescence and disrepair of the existing kindergartens in Serbia, showing surveyed buildings as representative samples. As shown here, Brand recommends that furniture and equipment be changed within a period of 3 years, as a part of smaller investments in a building. Similarly, the interior and space layout should be reconstructed once in 3 years. Plumbing, heating, air-condition, etc. should be replaced after 7 to 20 years. Subsequently, façades are ready for reconstruction after 20 years of usage, while main supporting structure should be vital at least 30 years.
2.1. Refurbishment as an integrated approach

The United Nations has stressed that education has a basic role in transforming human life on the planet into a more sustainable one. The decade 2005-2014 has been announced as a decade of Education for Sustainable Development (ESD). [3]

McKenzie (2005) explains that when sustainability is defined and indicators determined at local level, they are most useful because definitions derived at global level are sometimes too broad for use in specific situations. Stanners (2007) believes that education might help us understand sustainability, its main components, and the way they should be implemented on local level. If we desire to tackle the challenges ahead, we should develop an array of skills and abilities needed for sustainable living through education. Some experts believe that a “sustainable school (or kindergarten) is the most appropriate strategy for renovating educational processes and achieving quality education” [4].

Papanek (1992) claims that design is education. Helweg (2009) explains that “as buildings must not be reduced to purely technical and craft aspect of production, education must not be limited to simple teaching of formal knowledge”. Bell and Wakepord (2008) believe that the architectural design in this process should have a crucial role, because architects are the ones who give new form to the various needs of the future. Goldberger (2009) adds that buildings can make us feel, they can make us think, and the whole building can be a lesson. Educational facilities should make a significant contribution to ensure sustainability at all levels, from local to global [4]. It seems that by knowing local challenges we can make a contribution to solving global social, economic and environmental problems and turn education facilities into places which are safeguarding the future [5].

2.2. Education by design- kindergartens

Kindergartens are institutions which provide care for children in terms of three key aspects- education, healthcare and socialization. When designing or making a reconstruction plan of these facilities, it is necessary to provide adequate conditions for children stay, according to the psychological and physical health and sensitivity of children aged 1 to 7. Children of this age are at the phase of full development and in most delicate phase of their life, so spaces in which they reside most of the day must adequately respond to all their demands. Young children in particular benefit the most from healthy indoor and outdoor environments and are the most susceptible to harm from environmental toxins [6].

A sustainable design provides kindergartens with healthy environments, good quality of internal air, thermal, visual and acoustic comfort and increased safety and security. Sustainable kindergarten design incorporates the
site’s natural advantages and features in order to achieve kindergarten’s high performance goals by embracing natural site conditions.[7]

Each of the users of the built environment has an active role in reducing energy, protecting the surroundings and incorporating a sustainable environment in the existing building. In this way, children have opportunity to see directly how human activities impact ecological systems and can actively be immersed into learning about strategies to protect natural habitats. Environmental education at an early age is the key to raising future generations of citizens who think green [8]. Preschool institutions have a unique opportunity to convey the significance and meaning of implementing green design and good environmental practice to the youngest population (Figure 2).

2.3. Sustainable reconstruction- a new opportunity

Process of renovating buildings may have different scopes. This refers to the state of the buildings and financial support for the reconstruction. The range of reconstruction will directly depend on the amount of available financial resources.

Green design is focused on health and well-being of the people and children who occupy preschool facilities, as well as on environmental protection. Children playroom should incorporate non-toxic materials. Using natural light and creating views to nature outside are advised. Discussing how kindergarten building impacts children is very important, because it can impede well-being and learning. From ecological perspective, it is important to educate teachers and children in terms of saving water and energy in order to reduce overall costs and dispersion of energy. It is also recommended to involve teachers and children in programs of greening external environment of preschool institutions through planting trees and other vegetation. Green roofs and façades, roofs with photovoltaic and solar panels, various types of wind turbines that function as windmills present suitable practices and instruments that promote energy and resource savings (Figure 3). When all of the mentioned principles of green design and sustainability are revealed and safely built in the kindergarten, they present a valuable teaching tool.
3. Principles of Sustainable Development in the Built Environment

According to Halliday (2008) and Sev (2009) the basic principles and strategies of sustainable development in the built environment should encompass environmental, economic and social aspects. These principles and strategies are:

- Maximizing the use of renewable, recyclable and natural resources and exploiting them effectively during material selection and sourcing, construction, use or disposal. Buildings have to be affordable, manageable and maintainable in use;
- Minimizing four generic resources used during construction and operation phase (energy, water, land and material), pollution and negative environmental impacts on the building throughout its life cycle;
- Enhancing biodiversity and improving natural habitats through appropriate planting and water use;
- Creating a healthy and comfortable environment at home and in workplaces, not jeopardizing the health of builders, occupants or any other parties;
- Supporting communities through identifying real needs, requirements and aspirations of people and engaging them in key decisions; and
- Managing the process to deliver sustainable projects and validate building-system functions, ensure performance over time through identifying appropriate targets, tools and benchmarks and managing their delivery.

3.1. Basic data and general discussion

As part of the above mentioned scientific project financed by the Ministry of Science and Education of Republic of Serbia, basic information and numerous technical data have been collected considering a great number of kindergartens in Serbia, mostly in south-east and central regions of the country. Table 4.1 shows preliminary research data that are considered important for further analysis of possible refurbishment processes of the kindergartens.

Table 1. Existing Building Stock—summary of the collected data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of surveyed buildings</td>
<td>32</td>
</tr>
<tr>
<td>Number of surveyed cities/towns</td>
<td>16</td>
</tr>
<tr>
<td>Average age of the building</td>
<td>31.5 years</td>
</tr>
<tr>
<td>Average floor area in the building</td>
<td>1324.7 m2</td>
</tr>
<tr>
<td>Average number of children in kindergartens</td>
<td>274</td>
</tr>
<tr>
<td>Average number of classrooms in the building</td>
<td>8.5</td>
</tr>
<tr>
<td>Average size of floor area of a classroom</td>
<td>59.5 m2</td>
</tr>
<tr>
<td>Type of present cladding</td>
<td>Brick (83%), Plaster (8.5%), Concrete (8.5%)</td>
</tr>
<tr>
<td>Type of present roofing</td>
<td>Pitched (83%), Flat (17%)</td>
</tr>
<tr>
<td>Type of present windows and glazing</td>
<td>Wooden (67%), Aluminum (21.5%), PVC (21.5%)</td>
</tr>
</tbody>
</table>

Table 1 shows that the building stock of kindergartens in Serbia is very old. The average age of the buildings is more than 30. Most of them were built in 1970s and 1980s, which was considered as the most prolific period of construction activity in Serbia. Further in the survey, it was concluded that the existing buildings were built in a good manner and with a good building praxis of the time. However, the problem is in regular maintenance of the buildings. In a period of more than 30 years, as it is suggested in Figure 1, the buildings should have already undergone numerous reconstruction and refurbishment cycles. For example, façades should have been revitalized at least once so far, services and fixture as well, while the interior should have been replaced at least five times.
Nevertheless, it was found that most of the buildings have not been reconstructed yet, aside from adding some furniture and other equipment (children’s toys etc.), mostly obtained through humanitarian donations.

3.2. Evaluation of the building(s)

Thorough analysis will be conducted through the analysis of one building among all surveyed kindergartens. This building is chosen as representative in order to be specific and clear when discussing particular aspects and elements of design and usage of the building. The observed building is the kindergarten “Bambi” in Nis, built in 1978, within new residential area that has been developing since late 1960s (Figure 5). With total built area of 1670sqm, this building is classified as large building in its building category. Total area is divided in two floors, ground floor and the first floor. The floor plans are given in Figure 4.4. The ground floor is design to be used by elder children (4-6 years), while the first floor has three specialized group rooms for the nursery.

![Fig. 4. Existing layout of Kindergarten “Bambi” in Nis (Lj. Kovacevic, 1978) - (left); exterior and interior of kindergarten (right)](image)

The building was constructed in massive system with bearing brick walls. This type of construction has shown great results from the aspects of durability, and in this case, it is evident that main supporting elements of construction are in good shape and do not need to be repaired. This is also approved by the table in Figure 4 (taken as a referential), showing that expected lifetime of structure can be much more than 34 years. Additionally, it is good to emphasize that this type of construction is not considered as unhealthy and dangerous, so there is no need for a replacement for these reasons (e.g. asbestos walls, which were used at the time, would be a problem).

The façades of the observed building are made of red brick, which makes durable skin that does not require frequent repair, which is the case with rendered facade. As shown in Table 1, facades made of brick are very common in this type of buildings in Serbia. Nevertheless, despite the durability of brick facade, after more than 30 years of use, such facades have been disrupted. In this particular case: the brick looks worn out, concrete elements have lost the intensity of pre-existing colour, there are inappropriate graffiti at façades and small physical defects have appeared in the surface. Overall methods of refurbishment may differ (from revitalization of existing structure to building new one over the existing one), but before final decision another aspect must be examined - energy efficiency of the envelope. Although the building has been built carefully and in accordance with building regulations of the time, since then, the policy regarding energy efficiency has been changed several times. Introduction of high level standards has resulted in a need for evaluating the existing building envelopes. True, this new policy cannot be used retrograde, but in terms of possible reconstruction which concerns a very fragile and vulnerable population, such as children, a legal basis is less significant than the overall welfare of children. Therefore, additional layer of insulation could be installed on external walls, if necessary.

The roof of the building is simple flat roof which is not used as a terrace. Maintaining this kind of roof on regular basis is a ground rule to avoid bigger problems and damages caused by leaking as result of failure of hydro-insulation on the flat surface of the roof. Beside this technical suggestion, it may be acceptable to re-design the existing rooftop and create green-roof construction in the form of open terrace which can be used by children and personnel.

Plumbing, sewage, heating system and other fixture should have been replaced more than once, but in the absence of financial support for maintenance, these systems are working in more or less original setup. The basic
concern should be addressed to renovation of all toilets and kitchen services in the building. However, at this point, beside the replacement of worn-out elements of mentioned services, it may be appropriate to consider installing adequate cooling system which will reduce overheating in summer period, the aspect that has not been counted on at the time of building design. Nowadays, this is a common element of building standards. Aside from convenient appliances, heating and cooling system may be improved by using and designing passive system for heating and cooling in the building (e.g. solar panels can be easily installed on the flat roof).

If we focus on the rooms which are used by the children, we can conclude from the layout of the examined kindergarten, shown on Figure 4, that our kindergartens have been designed with more concern for the safety of the children then for their developmental needs. For this reason, there are numerous partition walls which are used to divide the area into separate rooms for sleeping, playing, bathing and placing lockers. We can conclude that this simple scheme is a product of plain thought that a closed room is much easier to control. But at the same time, it is obvious that there are some areas in the building that are not used enough, and look like “waste of space”. Given that our research findings show that all our kindergartens are overloaded [7] it is justified to search for better utilization of the existing spaces.

Interior is a very important element of kindergartens. Interior is directly related to children, so it must be carefully designed and built. Moreover, this is the area of greatest action in renovation process. The easiest way to improve children’s environment without large structural changes is to make a new interior. As Figure 4.5 shows, the designer of the observed building has not paid so much attention to children’s environment in terms of making an inspiring environment for them. Furthermore, very few changes have happened since the kindergarten was opened 34 years ago. The interior has kept the original appearance, but today it looks rather “worn and torn” than it should be appropriate for 21st century children. Brand suggests furniture and equipment replacement once in 3 years [2], but in this case, only internal walls have been repainted once in 3 years.

4. Refurbishment and remodeling of preschool buildings- proposal for new practice in Serbia

There are three levels of a child’s positive feelings about a certain place, such as kindergarten, and these include: bonding to a place, identifying with a place, and a feeling of belonging to a place as the highest level [9]. In addition to the social aspect of this connection, the actual ambient of the place also plays an important role. 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 kindergartens in order to increase the ambient value of these buildings. 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 [10]. 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. Largest glass openings need to be orientated towards south, while small window locates on the north side. Regular arrangement of façade and roof openings enables natural ventilation of the building. The size of the windows can be enlarged and the window parapets can be lowered so the children can have a better view. This enables connection with the surrounding environment, which is especially important during the days when the weather does not allow children to play outside. The use of natural façade materials, which are more appropriate for children, would also be beneficial. 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 (Figure 5). Repainting and the use of appropriate colors will make children feel better about these buildings.
As a part of scientific project conducted at Faculty of Civil Engineering and Architecture in Nis, in the period 2010-2014, a large number of kindergartens, mainly in south-eastern part of Central Serbia, has been surveyed (Figure 6). 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.

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.
4.1. Experiences and benefits

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). The projekt of revitalizing “Ivancica” nursery began in 2003 (Figure 7). Thermo vision method was used for detailed recording of the facility and determining basic “points” of heat loss. 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 included 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.

Fig. 7. Facility “Ivancica” during execution works on thermo-insulation and appearance after project completion (left), Figure 4. 9. Kindergarten “Kekec”, Ljubljana (right)

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. Kindergarten facility- Zvezdichka, in Varna Municipality, with total constructed surface of 2.256 m², was built in 1985 (Figure 8). Conducted analysis of technical-energy performances of the facility pointed to the necessity of making revitalization steps in order to eliminate significant consumption of energy, funds and environmental influence onto the surrounding area. Outdated wooden windows, bad condition of facility’s mantle, lack of thermal-insulation, indoor lighting based on non-efficient lights, had influence on general inefficiency and facility’s outage. Indoor temperature, required for comfortable and pleasant stay of children, was kept on required level by over-using significant heating fuel quantities, which consequently caused higher energy consumption. All mentioned negativities had to be eliminated by means of appropriate actions. Therefore, they installed heating and cooling system (local oil as fuel and boiler room), completed heat insulation of the coldest “parts” of the facility (due to lack of funds, they insulated only the north part of the building with investment of € 18.000), changed indoor lighting and placed energy-efficient lighting. Implementation of energy saving measures through improvement of construction performances provided great benefits, which was shown in comparative display of achieved results.
Comparative analysis of total consumption of energy, water and CO2 emission for 2005 and 2006 (Table 2), from the aspect of energy efficiency, provided transmission of the facility from class F into class D, as well as transmission from class G into class D regarding emission of CO2 into the surrounding environment. Even though water consumption was decreased during this reporting period, the decrease was not sufficient enough to influence the change in water class. This project improved indoor comfort for children and personnel and decreased energy consumption from 189 kWh/m²/year (total of 247 MVh per year). Reported saving amounted to € 12,000 per year. The project also decreased CO2 emission for 42 kg/m²/year. The next step was providing significant water savings through better management and regular controls and repairs.

Educational institution placed in the Olympiades quarter is the first to comply with the City of Paris climate plan. The building’s envelope represents an answer to several environmental goals: visual protection, increased natural light to counteract the surrounding solar screens, no thermal bridges, natural ventilation and double flux in winter. The result, derived as a response to the mentioned environmental goals, is a thick façade with varied reliefs- bay, alcove, and concave windows- which are used horizontally on the roof as skylights and house air treatment machinery and ventilation chimneys (Figure 9). Community Kindergarten of Kajaran Town in Armenia was built around 1950. Its capacity was 116 children. Protection and preservation of the facility, its exterior and interior surrounding was not conducted for decades. Front door and windows were in extremely bad condition and their presence caused significant heat loss, which directly reduced energy efficiency of the building. Therefore, the Kajaran Municipality applied for the support project for improvement of facility’s performances, including installation of solar hot water supply system. The works on partial revitalization of the facility were completed in 2010 and they included implementation of energy-efficient lighting, windows and door with improved thermal characteristics (protection), improvement of floor thermo-insulation and construction of a new hallway. The project was realized with financial help of community budget, and investment value of works was $ 71,500. Measures of improving facility energy performances, including installation of solar hot water system, resulted in annual savings of 3400 Nm3 of natural gas and reduction of GHG emission, 6.4 t CO2 approximately.
Day care centre on Wolgaster Strasse was built in 1980/1981 as a one and two storey buildings in Berlin, Wedding (Figure 10). 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. Significant savings in operating costs were also expected. Day care centre was able to successfully safeguard its special educational services in a difficult area on a long-term basis thanks to the renovation which improved its energy efficiency [11]. Day care centre „Akazieninsel“, the three-storey building was built in “Plattenbau” style, made of prefabricated concrete slabs (type WBS70) in 1977/1978 (Figure 10). 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 percent 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.

Nowadays, there are large numbers of preschool buildings all over the world that represent green practice and examples which should be pursued (Figure 11). "If energy consumption in the existing building is more than 200-
300 kWh/m²a, as is commonly the case, savings of up to 90% are possible. According to the Energy Institute in Vorarlberg, Austria, which advises on school rehabilitation, economically optimized refurbishment measures can reduce heating - energy needs to 20-30 kWh/m²a. Considering the subject matter, future project proposals should focus on the development of innovative and affordable building renovation solutions for preschool buildings that can deliver significant improvements in energy performance, while ensuring indoor comfort requirements, non-invasive and reversible solutions. The emphasis should be on eco-innovation and sustainability by integrating cost-effective technologies for energy efficiency and renewable energy solutions.

Fig. 11. Façade and vestibule design within the context of thermal façade renovations of kindergarten in Berlin, renovation by Sabine Müller, Andreas Quednau with Rodney LaTourelle & Louise Witthoeft; Rehabilitation of 1970s kindergarten in Lochham near Munich, 2003

4.2. Proposals for improving preschool buildings in Serbia

4.1.1. “Cvrcak” kindergarten- proposed reconstruction model

Kindergarten “Cvrcak” is an old building, designed and built in 1983 in Nis (Figure 12). The building consists of ground floor and first floor. Considered building has the total built area of 1683.81 m² (the area of the ground floor is 911.30m² and the area of the first floor is 772.51m²). The building is specialized for admitting, nursing and educating 171 preschoolers and children between the ages of four and seven who are divided in eight groups (four educational groups and four nursery groups). On the ground floor, rooms are projected for groups of children of different age, i.e. there are three groups for children aged 4 to 7, and two groups for children aged up to 3. The space on the first floor is formed and capable for admitting, nursing and educating two nursery groups of children aged 3 to 6 and one preschool group of children aged 6 to 7.

Fig. 12. Floor plan, section and elevation of “Cvrcak” kindergarten and proposed redesign

For the purpose of preserving heating and cooling energy of “Cvrcak” kindergarten building, the following has been suggested: installation of photovoltaic panels on the gable roof, increasing building outline insulation efficiency by means of thermal insulation layer (stone wool) on the object façade, reconstructing one part of the
gable rooftop into intensive green flat rooftop, due to which, among other things, dwelling comfort will raise to a higher level (Figure 13).

![Fig. 13. “Cvreak” kindergarten and proposed redesign (Author of the model: J. Tamburic)](image)

4.1.2. "Petar Pan" kindergarten- proposed reconstruction model

Kindergarten “Zvoncici” was built in 1992. Two more kindergartens were built based on the same architectural design, “Vilin grad” in 2001, and “Petar Pan” in 2005. Kindergarten "Petar Pan" is newly constructed building, i.e. the structure was built in 2005 in the City of Nis. The project has a total built area of 1720.60sqm developed into two-storey building. Total number of children that can be accommodated and nurtured is 160 and they are set up in eight groups. The overall area of ground floor is 1028.51sqm and the upper floor has an area of 692.09sqm. The ground floor is intended to be used by children aged up to 3 years and has three units. Also, ground floor blueprint shows one unit for children aged 6-7. Four group rooms on the first floor are organized for educational group of children aged 3-6.

![Fig 14. Floor plan, section and elevation of “Petar Pan” kindergarten](image)

The main reasons for remodeling are increasing energy efficiency and improving inappropriate design. In order to decrease electric energy consumption and achieve optimal warmth comfort inside the object, the photovoltaic system, considering photovoltaic chains located on the south side of the roof, has been implemented. As far as esthetic comfort improvement and upgrading are concerned, interventions are achieved via design of façade surface and, among other things, via color parameter (Figure 15).
5. Conclusion

Achieving sustainable development implies that humankind lives within the limits of the environment’s capacity, provides resources for human activities and subsequently absorbs the pollution and waste that these activities generate. Sustainable construction, as a necessary contributing element of sustainable development in the built environment, aims at reducing environmental impact of a building over its entire lifecycle, whilst improving its comfort and safety of its occupants and ensuring economic viability. A significant part of construction fund of preschool facilities in Serbia and region dates back to the period when environmental and energy efficiency aspects in architecture were not sufficiently present in design and construction processes. This fact presents the preschool buildings as energy inefficient. Also, the research has shown that the existing fund of preschool facilities does not satisfy the needs of society in terms of capacity. Every year there is a waiting list with large number of children who are waiting to be enrolled into kindergartens. The result of the above mentioned facts are facilities that are not suitable for their users - children and the environment. These problems point to the need of revitalizing the existing fund of preschool facilities in terms of environmental, energy aspects and functional aspects/capacities (ensuring sustainable storage capacity).

The above analysis has shown several different points. Kindergarten buildings in Serbia are old, and that is a fact. With average total area of more than 1300m², they can be considered as large facilities that go beyond the size of average kindergarten building of modern age. Also, it has been seen that those large facilities accommodate large number of children, which makes facilities overloaded. This results in reduced level of living standard for the occupants (children and staff) and in additional burdening of the property, which declines faster due to its buildings performances.

Possible way of achieving this is making kindergarten reconstruction a joint venture, an action that will include several participants. The process of kindergarten reconstruction may include all interested parties and building users. It also would enable the users (in this case the children attending kindergarten) to identify with the institution by encouraging a rational, emotional and, especially, personal bond with kindergarten. If children are closely involved in the design process, they are able to identify themselves the newly created environment. Inspired by children’s lively drawings, visions and wishes, architects can interpret moods and atmospheric effects and thus define them more precisely through sketches and spatial models. Architects may also get inspiration for their designs by observing children’s movements, communication and daily routines. The result may be as a cost-effective building project, which complies with statutory and technical building regulations. All of this implies a highly experimental design approach. Such renovations may include young professionals, even the students of architecture. The advantage of involving young people in such projects is a fact that they are closer in age to children and thus can better connect with them and understand their needs. As for the re-design process, realisation can be result of collaboration. Even elements of interior design, as well as garden equipment, can be made on site by children, staff or parents. Naturally, they would need a little help of professionals.

Principles of green design can be incorporated into new construction projects, major renovation projects, as well as smaller improvement projects in the existing buildings. Therefore, the adoption of a passive design approach,
which takes into consideration climate change and its impacts, will ensure that buildings remain resilient, healthy, affordable and resource efficient. The existing buildings are to withstand the impacts of climate change over the next 50-80 years to guarantee their long term sustainability. Therefore, it is important to look into the future, analyze the way the existing buildings will cope with climate changes using UKCIP scenarios, and take appropriate sustainable and green measures.

Construction of new facilities or revitalization of the existing ones and their additions need to be based on the use of solar, wind, etc. power and high energy efficiency heating, cooling, ventilating and lighting systems, while the existing facility may introduce children and staff with environmental education by designating areas for recycling, composting, implementing water conservation methods, or using non-toxic cleaning products. One of the most important aspects of revitalization process is increasing building energy efficiency. This especially refers to preschool facilities for two reasons: one is that they are public buildings and the other is that children, as primary occupants, learn about the importance of environmental protection from the early age. Additionally, it is very important to keep in mind that the users of kindergartens are children who are beginning to learn about the world. If we are able to get them accustomed to using renewable energy sources at early age, we can be sure that the future of our environment is in good hands.

The aim of this research is to emphasize the direction of future architectural practice in the area of preschool institution buildings design. Basic tendency is in the idea that the new design activity is to see the concepts and principles of green architecture as an imperative. This will, no doubt, result in a well-thought and detailed environmental-energy successful green buildings

References