RAZLIČITE METODE VENTILACIJE I NJIHOV UTICAJ NA POTROŠNJU ENERGIJE ZA GREJANJE JEDNE PREDŠKOLSKE USTANOVE

DIFFERENT VENTILATION METHODS AND THEIR IMPACT ON ENERGY CONSUMPTION FOR HEATING A KINDERGARTEN

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Cilj ovog istraživanja je ispitivanje uticaja dve različite metode ventilacije (Metode 1 i Metode 3), definisane prema standardu EN 16798, na predviđenu potrošnju energije za grejanje jednog vrtića u gradu Kragujevcu (Srbija). Zahtevi za ventilacijom Metode 1 se zasnivaju na podacima o prisustvu ljudi. Iz tog razloga, analiziran je i efekat različitih rasporeda prisustva ljudi, rasporeda stvarnog, prosečno godišnjeg i maksimalnog prisustva ljudi, na predviđanje energetskog ponašanja odabrane zgrade. Metodu 3 karakteriše stalna vrednost protoka svežeg vazduha, određena prema zapremini prostorije koja se ventiliše (0.5 ach). Dobijeni rezultati simulacija ukazuju da kod Metode 1 potrošnja toplotne energije raste sa povećanjem protoka svežeg vazduha ili broja ljudi u zgradi. Suprotno tome, pri stalnoj količini svežeg vazduha (Metoda 3) potrošnja toplotne energije se smanjuje sa povećanjem broja ljudi. Pokazano je da upotreba rasporeda maksimalnog prisustva dece daje najveću grešku u predviđanju potrošnje toplotne energije (do 11.38%), nezavisno od metode ventilacije. Za raspored prosečnog godišnjeg prisustva ljudi greška se kreće do 3.90%. Na osnovu prikazanih rezultata, u cilju približavanja predviđenog energetskog ponašanja zgrade njenom stvarnom ponašanju preporučuje se upotreba rasporeda stvarnog prisustva ljudi. Raspored maksimalnog prisustva ljudi, u svakom slučaju treba izbegavati.

Ključne reči: *grejanje; ventilacija; prisustvo ljudi; vrtić; simulacija*

The objective of this study is to examine the influence of two different ventilation methods (Method 1 and Method 3), defined according to the standard EN 16798, on the predicted heating consumption of a kindergarten in the city of Kragujevac (Serbia). Ventilation requirements of the Method 1 are based on people occupancy data. For that reason, the effect of different people occupancy schedules, real, average yearly and maximum occupancy schedules, on the prediction of the energy behavior of the selected building was analyzed. The Method 3 is characterized by a constant value of fresh air flow rate, determined by the volume of the ventilated room (0.5 ach). The obtained simulation results indicate that in the Method 1 the heating consumption increases with the increase of the fresh air flow rate or the number of people in the building. In contrast, with a constant amount of fresh air (Method 3), heating consumption decreases with the increase of the number of people. It has been shown that the use of the maximum people occupancy schedule gives the largest error in predicting the heating consumption (up to 11.38%), regardless of the ventilation method. For the average yearly occupancy schedule, the error ranges up to 3.90%. According to the presented results, in order to bring the predicted energy behavior of the building closer to its actual behavior, it is recommended to use the real people occupancy schedule. The maximum occupancy schedule, in any case, should be avoided.

Key words: *heating; ventilation; people occupancy; kindergarten; simulation*

1 Introduction

Inadequate indoor air quality in education buildings has been reported to cause health problems, contagion, poor academic performance and absenteeism of occupants [1]. One of the indicators of indoor air quality is the CO_2 concentration. High level of CO_2 indicate inadequate ventilation and poor indoor air quality. Ventilation of spaces can be achieved in various ways by simple manual

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window opening (natural ventilation) and/or by complex mechanical ventilation systems with or without heat recovery. Gao et al. [2] investigated how different ventilation system types influence classroom temperature and air quality. They concluded that classroom with manually operable windows had the highest CO_2 concentration levels while the classrooms with automatically operable windows and exhaust fan and with mechanical ventilation systems achieved the best thermal environment and air quality during heating season among all classrooms examined. Bakó-Biró et al. [3] investigated the effects of classroom ventilation on pupils'performance in 8 primary schools in England. Ventilation rates in the order of 8 l/s per person were recommended in all teaching facilities to prevent any impairment of pupils'performance due to inadequate ventilation. Kindergartens are often neglected in terms of indoor air quality. In this geographical area, the vast majority of kindergartens, including newly built ones, do not have mechanical ventilation systems, but only natural ventilation is used. In such conditions, the quality of the indoor environment is often unacceptable. In an average kindergarten in north-eastern Poland the analysis of stack ventilation system effectiveness was carried out [4]. It was proved that air duct cleaning considerably improves effectiveness of ventilation from minimum growth of 10% to maximum of 100%. The average increase for the whole examined building equalled 62%. Also, with unsealed windows, the air change rate can grow up to 30%. Branco et al. [5] evaluated indoor concentrations of particulate matter (PM) in urban nurseries of Porto city. It was found that PM concentrations in the studied classrooms were often above the limits recommended by WHO. Indoor sources (children's activities, cleaning and cooking) were the main contributors to indoor PM concentrations. Enhancing ventilation flow rate and performing cleaning activities after the occupancy period were proposed measures for reduction of PM concentrations in nurseries.

In the future, educational buildings will have to meet the criteria of very low or net-zero energy consumption in addition to the criteria of the indoor environment quality. Ahmed et al. [6] assessed the indoor environment quality and energy performance of four NZEB daycare centers and three NZEB school buildings from Finland and Estonia. In all buildings the mechanical ventilation systems (DCV, CAV or VAV) with heat recovery were used. Results showed that all buildings achieved low CO_2 levels. In contrast, the measured energy use in 5 buildings out of 7 was increased by factor 2.1-3.0 compared to calculated annual energy use due to a full-time operation of the ventilation system and presence of hot kitchens. According to the [7] demand controlled ventilation (DCV) system can reduce the energy use significantly compared to a constant air volume (CAV) system. The total energy demand for the fan can be reduced with 24% compared to a CAV, by controlling the air flow rate using the CO_2 concentration which is in correlation with people occupancy. People occupancy and its behaviour plays a key role in the energy demand of either residential or non-residential buildings, and its importance will only increase when moving towards NZEB. To reduce energy use in buildings, the accurate modelling methods for energy demand that take into account both building characteristics and user behaviour are needed [8]. Accurate occupancy data can encourage users to save energy by managing a building automation system based on actual occupancy. The analysis of a Norwegian primary school revealed that the savings in energy use are around 40% [9], if the volume of supply air is controlled by the actual number of people inside the space. Sekki et al. [10] assessed the energy saving potential of heating and electricity consumption in the studied daycare centres and schools in the city of Espoo in Finland. The heating saving potential was 10.4 kWh/m^2 and the electricity saving potential 4.3 kWh/m^2. They found that mechanical ventilation was in operation even when the buildings were unoccupied. Due to the lack of information, people behaviour is often included in the building performance simulation software through a fixed occupancy schedule. To obtain more accurate energy demand simulations, detailed and realistic people occupancy schedules are needed. Sekki et al. [11] introduced a new indicator for building energy efficiency which takes into account both space and occupancy efficiency. Their findings indicate that there is a relationship between the measured energy consumption of daycare centres and occupancy but not strong, due to the deviations related to the different types of occupation hours. In both investigations [10,11], building occupancy was calculated by using the maximum number of occupants and yearly operating times of studied buildings.

The objective of this study is to examine the influence of two different ventilation methods (Method 1 and Method 3), defined according to the standard EN 16798, on the predicted heating consumption of a kindergarten in the city of Kragujevac (Serbia). The study includes for the first time variable weekly occupancy schedule, for kindergarten in Serbia, derived from the realistic occupancy data. The energy consumption of a buidling with ventilation system which operation is based on the variable occupancy schedule is compared with energy consumption related to the fixed schedules of average and maximum people occupancy. In other words, this paper is aimed to present the effect of people occupancy schedules on the accuracy of building energy performance simulation.

2 Ventilation methods for non-residential buildings (kindergartens)

Ventilation is a process by which, naturally and/or mechanically, the outdoor air is brought into the desired space in order to maintain the appropriate quality of the indoor environment. The quality of the indoor environment is expressed through the required level of ventilation, which is based on the criteria of human health and comfort. According to the standard EN 16798, design parameters for indoor air quality shall be derived using one or more of the following methods: Method 1 (method based on perceived air quality), Method 2 (method using limit values for substance concentrations) and Method 3 (method based on predefined ventilation air flow rates).

The Method 1 takes into account air pollution caused by emissions of harmful substances originating from people (q_P) and the building itself (q_B). The standard gives the recommended values of the total ventilation requirements (q_{tot}) for kindergartens, which differ according to the categories of indoor air quality (C) and the levels of building pollution. There are four categories of indoor air quality (C1-C4) and three different levels of building pollution: very low-polluted buildings (VLP), low-polluted buildings (LP) and non-low-polluted buildings (NLP). The building pollution level is determined, among other things, by the type of construction materials from which the building was built and the type of material of the used furniture. Although the very low-polluted buildings are very rare, simulations of the energy behavior of selected kindergarten were conducted for all three levels of building pollution. For children as users of these buildings, it is recommended to provide a high level of air quality (C1). In addition to this category, simulations were conducted for the lowest air quality category (C4), which refers to the minimum ventilation requirements prescribed by the WHO (Table 1).

The basis for the calculation of ventilation requirements according to the Method 2 are the limit values for the concentration of pollutants. To calculate the design ventilation air flow rate, the most critical or relevant pollutant shall be identified and the pollution load in the space shall be estimated.

Table 1. Recommended values of ventilation requirements of kindergartens for the first (C1) and fourth (C4) air quality category of the Method 1 [12]

Type of building	Category of air quality	q_{tot} l/(s·person)		
		Very low-polluted building (VLP)	Low-polluted building (LP)	Non-low-polluted building (NLP)
Kindergarten	C1	11	12	14
	C4	4	4	4

When this method is used CO_2 representing the pollutant emission from people shall be used as one of the substances. The limit value of this concentration of 950 ppm corresponds to the total ventilation requirement of the air quality category C1, while the limit value of 1750 ppm corresponds to the ventilation requirement of the air quality category C4 (Table 1). For the mentioned reason and the impossibility of determining the emissions of pollutants from the building and HVAC systems, in the selected kindergarten, the Method 2 was not considered.

The Method 3 refers to determination of the certain pre-defined minimum ventilation air flow rate estimated to meet requirements for both perceived air quality and health in the occupied zone.

The pre-defined ventilation air flow rates shall be expressed by one or more of the following parameters: total design ventilation for people and building components (q_{tot}); design ventilation per unit floor area (q_m); design ventilation per person (q_p); design air change rates (ach) and design air flow rates by room and building type (q_{room}) [12]. The value of the pre-defined minimum ventilation air flow rate of 0.5 ach was chosen since it is often used in practice and investigations of this type of non-residential buildings.

3 Description of the building

3.1 Building model

A kindergarten on the territory of the city of Kragujevac was selected for the case study. The building consists of three levels, basement, ground floor and first floor (Fig. 1). As it can be seen from Fig. 1 the kindergarten is surrounded by two buildings that can affect its heating consumption. The total number of rooms is 44, of which 39 are heated. The total floor area of the building has a value of 2078.16 m^2, while the total area of the heated floor is 1269.14 m^2. The 3D model of the kindergarten created via SketchUp software [13] is used as geometry input for the EnergyPlus software [14]. The EnergyPlus software is confirmed and verified [15], and provides the ability to simulate the thermal behavior of very complex buildings in very difficult conditions.

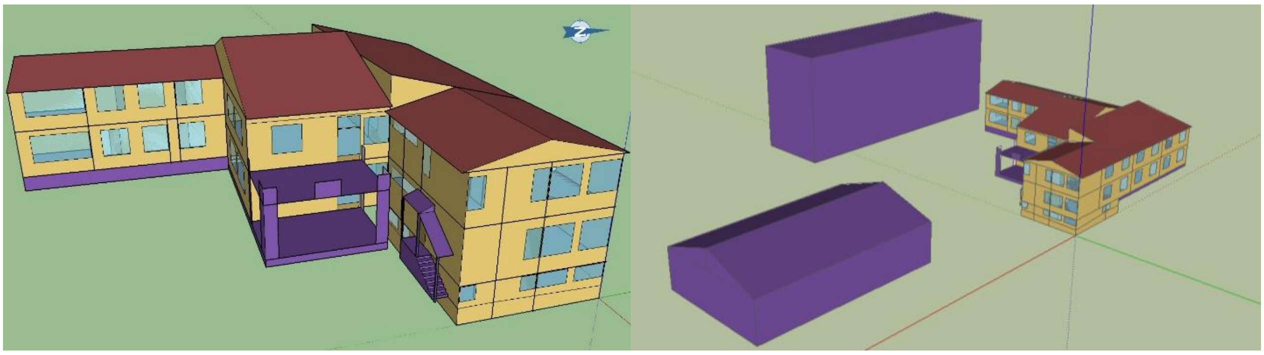

Figure 1. Isometric view of the analysed kindergarten and surrounding buildings

The 3D model of the kindergarten was made under the assumption that the values of the overall heat transfer coefficient of all elements of its thermal envelope are less than or equal to the maximum allowed values, determined by the Rulebook on energy efficiency of buildings [16]. In Table 2 the thermal characteristics of the kindergarten building constructions are given.

Table 2. Thermal characteristics of the building constructions

	Building constructions						
	Roof	Exterior wall	Ground floor	Floor above unheated space	Floor under unheated space	Exterior window	Exterior door
U-value [W/m^{2}K]	0.288	0.293	0.267	0.281	0.294	1.5	1.6

3.2 Building operation

When simulating the energy behavior of a building, it is necessary to understand and know how people use the building. This is one of the conditions that must be met in order to bring the predicted energy consumption of the building closer to the real one. In many studies, the impact of people occupancy is neglected. In other words, it is assumed that it does not change during the heating season or year. In this regard, this paper includes an analysis of kindergarten energy consumption with different ventilation methods and differently defined people occupancy: real (actual) people occupancy, average yearly people occupancy and maximum people occupancy. The analysis is based on the use of the children occupancy schedules for 2016/2017 year. The schedules were created on the basis of records kept in the diaries by the educators during the working days of the kindergarten. It should be emphasized that the presence of educators was neglected when creating the people occupancy schedules. It was taken into account that on weekends and non-working days, when kindergartens do not work, there is no presence of children. Data on the exits of children from the observed rooms to the dining room, toilet or living room, as well as their stay outside were excluded from the analysis.

Fig. 2 shows the actual percentage children occupancy by educational groups in the selected kindergarten during 2016/2017 year. According to their age, children are divided into different educational groups: younger nursery group (YN), older nursery group (ON), younger educational group (YE), middle educational group (ME), older educational group (OE) and mixed educational group (MXE). In 2016/2017 year there were two ON, YE and OE groups, three ME groups and one YN and MXE group. Each of these groups of children was in a separate room.

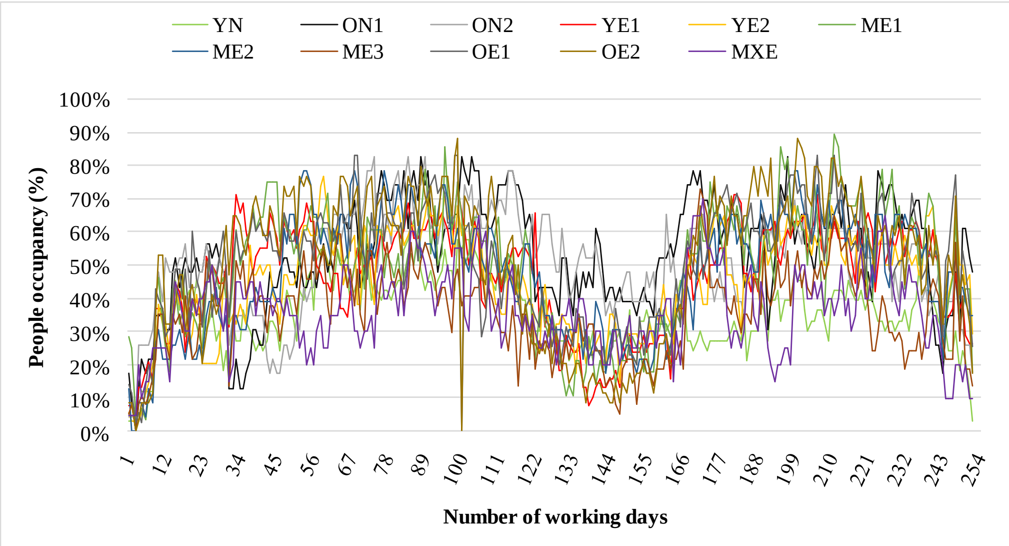

Figure 2. Real percentage people occupancy during 2016/2017 year in the analyzed kindergarten

Looking at Fig. 2, it can be noticed that the presence of children within all groups, throughout the year was below the maximum value of 100%. On the one hand, the lowest people occupancy was recorded during the winter months (December and January) and the summer months (July and August). On the other hand, the highest children occupancy was achieved during the spring and autumn months. The main reasons for the significant change in the children occupancy during the year are annual vacations and the absence of children due to illness.

The average yearly people occupancy schedules for each of the educational groups are determined on the basis of the real children occupancy of the corresponding educational group in six kindergartens, on the territory of the city of Kragujevac, for the period of three years, from 2015/2016 to 2017/2018. The average percentage children occupancy, given in Table 3, ranges from 43.50% (YN group) to 56.37% (YE group). It should be noted that preschool educational groups (the oldest educational groups) are not included in this analysis.

Table 3. Average yearly people occupancy for each of the analyzed educational group

	Educational group					
Average yearly people occupancy (%)	YN	ON	YE	ME	OE	MXE
	43.50	53.72	56.37	53.78	55.64	53.03

The maximum people occupancy schedules are based on the highest possible (maximum) presence of children of a certain educational group. The children occupancy in these schedules is, as with the average yearly occupancy schedules, constant throughout the year. The maximum number of children by educational groups, for all kindergartens, is determined by the conditions of the competition for enrollment of children in kindergartens. Table 4 shows the values of the maximum number of children by educational groups of the selected kindergarten for 2016/2017 year.

Table 4. The maximum number of children by educational groups in the considered kindergarten for 2016/2017

	Educational group										
Maximum number of children	YN	ON1	ON2	YE1	YE2	ME1	ME2	ME3	OE1	OE2	MXE
	33	23	23	34	38	28	37	23	35	34	20

As for the heating system, the kindergarten is connected to the district heating system. Radiators are installed in all heated rooms. The design supply and return water temperature is 90/70˚C. It was assumed that the heating system during the entire heating season (October 15 - April 15) maintains the indoor air temperature at 16˚C, in the period when the kindergarten is closed (4 pm - 6 am) and at 20˚C when the kindergarten is open to users (6 am - 4 pm).

In this group of non-residential buildings, not enough attention is paid to the ventilation of the rooms in which children stay. Ventilation is performed naturally, by opening windows. Although there are no mechanical ventilation systems, it was assumed that these systems, but without heat recovery, are installed in order to establish and maintain the appropriate quality of indoor environment. Only the rooms where children stay are ventilated. It should be noted that the adopted value of air infiltration for all rooms is 0.2 ach. It was determined that this value meets the condition of the standard, which refers to the ventilation requirement for the kindergarten spaces in periods when there are no people present. Unlike the heating system, it was adopted that ventilation system operates only during the maximum children occupancy in kindergarten during the day, from 8 am to 2 pm. In addition to affecting the operation of the ventilation system, the occupancy schedules also affect the amount of heat gain from people. In order to bring this consumption closer to the real one, it was adopted that people heat gains are 38.3 W/person, for children under 4 years of age and 62.1 W/person for children aged 4 to 6 years [17].

4 Simulation cases

Two ventilation methods were considered, the Method 1 and Method 3. In the Method 1, two ventilation requirements were selected, for the first (C1) and fourth (C4) category of indoor air quality, which are characterized by the highest and lowest level of air quality, respectively. Both of these categories include simulations for all three levels of building pollution (Table 5).

Table 5. Simulation cases of kindergarten ventilation

Methods of ventilation	Category of air quality	People occupancy	Ventilation requirements (l/(s·person))
Method 1 (VLP) - M1, VLP	C1	Real occupancy Average yearly occupancy Maximum occupancy	11
	C4		4
Method 1 (LP) - M1, LP	C1		12
	C4		4
Method 1 (NLP) - M1, NLP	C1		14
	C4		4
Method 3 - M3	/		0.5 (ach)

According to this method, the operation of the ventilation system is conditioned by the people occupancy schedule. Three different schedules were used for each level of building pollution. For the real occupancy schedule, the amount of air that is introduced into the rooms corresponds to the current presence of children. In a certain room, when children occupancy is the highest, the flow rate of fresh air will be the highest and vice versa. The flow rate for the other two types of schedules corresponds to the average yearly and maximum possible people occupancy, and its value does not change during the heating season. The ventilation requirements of the Method 3 do not depend on the people occupancy. Their values, calculated on the basis of the volume of the ventilated room (0.5 ach), are also constant during the heating period. To simulate weather conditions of the city of Kragujevac (latitude of 44.02˚N, longitude of 20.92˚E) the EnergyPlus weather file was used.

5 Results and discussion

The values of the predicted heating consumption of the investigated kindergarten are presented in Fig. 3 and 4.

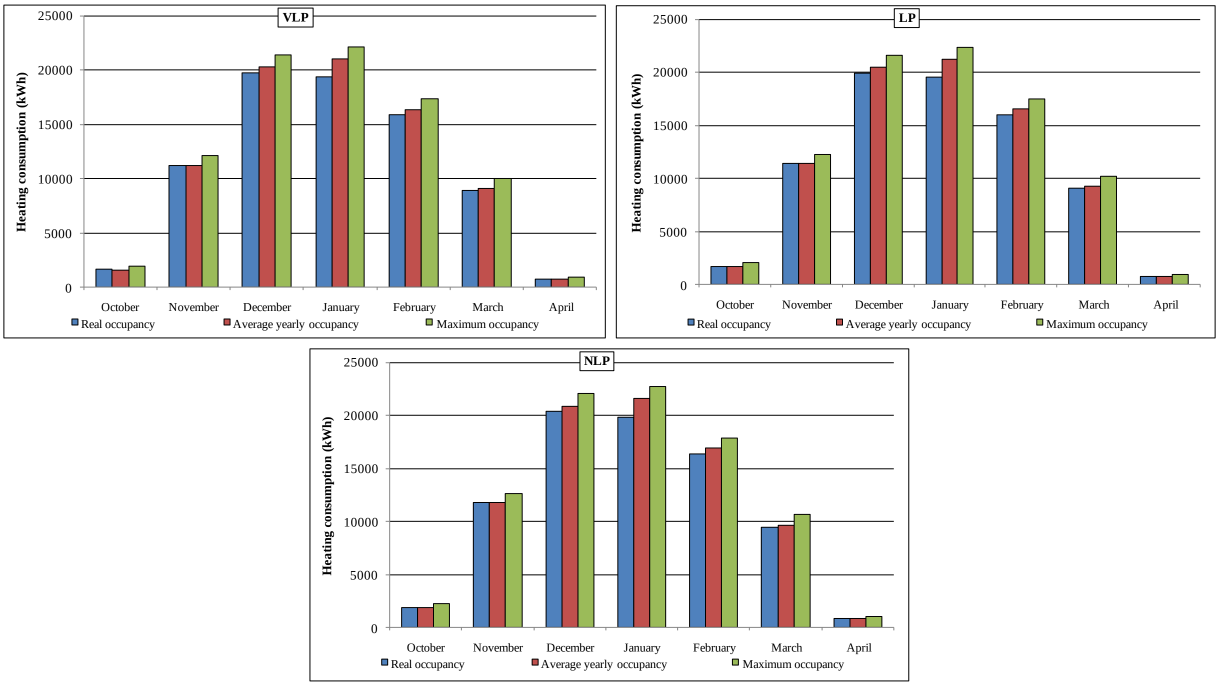

Figure 3. Heating consumption of the analyzed kindergarten for the ventilation Method 1, air quality C1 and different people occupancy schedules

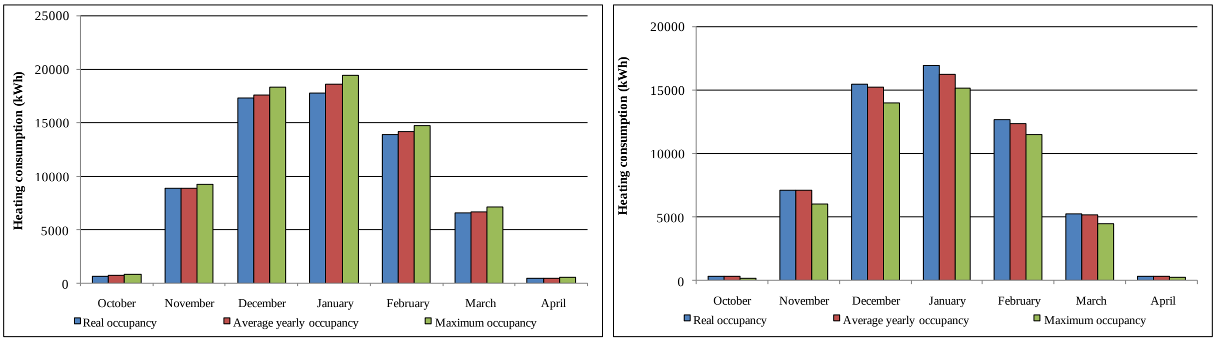

Figure 4. Heating consumption of the analyzed kindergarten for the ventilation Method 1, air quality C4 (left) and ventilation Method 3 (right), for different people occupancy schedules

The previous diagrams show that there are significant differences in terms of predicting the consumption of thermal energy for heating, both depending on the use of the people occupancy schedule, and on the differently applied ventilation methods. As expected, the energy consumption for heating increases with the increase in the amount of fresh air that is brought into the room. Its percentage increase does not correspond to the increase in the air flow rate, since not all heated rooms are ventilated and the ventilation takes place in the period from 8 am to 2 pm. If the ventilation of the building is performed according to the Method 1, the lowest energy consumption will be for the air quality category C4, when the air flow rate is equal to 4 l/(s·person). Compared to the Method 1, the energy consumption of the Method 3 is lower due to the lower fresh air flow rate (Table 6). As a reminder, the ventilation of a building according to this method does not depend on the people occupancy, but on the volume of the rooms that are being ventilated.

Table 6. Total heating consumption of the kindergarten for all simulation cases

	M1, VLP, C1	M1, LP, C1	M1, NLP, C1	M1, C4	M3
Real occupancy	77516.5	78517.60	80576.15	65447.17	58066.47
Average yearly occupancy	80373.06	81455.11	83664.01	66978.58	56795.18
Maximum occupancy	85888.52	86993.80	89257.64	70246.63	51458.66

The highest energy consumption, regardless of the occupancy schedule and ventilation method, occurs in the coldest months (January and December), and the lowest at the end and beginning of the heating season, in April and October, respectively. January is the month with the highest heating consumption, for all simulation cases except for the case of the Method 1 and category C1 for all three levels of building pollution and real occupancy schedule, when it was December. The reason for this result is the higher occupancy in December, which causes the higher amounts of fresh air and higher heating consumption. Although there is a difference in the children occupancy in the case of the Method 1, category C4, the heating consumption was higher in January. This can be explained by the minimum ventilation requirements which are approximately three times less than the requirements in the case of the Method 1 of category C1. Ventilation heat losses, in this case, had a smaller effect on the total heat losses than the transmission heat losses.

By applying the maximum occupancy schedules, the heating consumption will be higher in all cases where ventilation is linked to a number of people (Method 1). However, with the Method 3, the opposite effect occurs, energy consumption decreases with increasing people occupancy. The reason for that lies in the fact that the flow rates of fresh air are the same for all occupancy schedules, so with the increase in the number of people in the building, the people heat gains are higher. Due to the observed differences in heating consumption for different occupancy schedules, Table 7 shows the seasonal percentage deviations of the predicted heating consumption for the average yearly and maximum occupancy in relation to the real children occupancy, with different ventilation methods.

Table 7. Seasonal percentage deviations of the predicted heating consumption of the kindergarten for the average yearly and maximum occupancy schedules in relation to the real occupancy schedule, with different ventilation methods

People occupancy	Simulation case	Monthly absolute difference of consumed heat energy (kWh)							Total absolute difference of consumed heat energy (kWh)	Seasonal percentage difference (%)
		October	November	December	January	February	March	April		
Real vs average yearly occupancy	M1, VLP, C1	22	4	505	1618	539	212	2	2901	3.74
	M1, LP, C1	20	7	511	1671	549	217	2	2978	3.79
	M1, NLP, C1	28	8	522	1787	571	225	2	3143	3.90
	M1, C4	10	0	276	882	257	105	1	1531	2.34
	M3	18	43	274	707	273	74	3	1394	2.40
Real vs maximum occupancy	M1, VLP, C1	335	880	1628	2729	1489	1178	133	8372	10.80
	M1, LP, C1	348	862	1649	2801	1498	1177	142	8476	10.80
	M1, NLP, C1	373	819	1691	2946	1510	1181	161	8681	10.77
	M1, C4	141	411	1059	1681	843	621	42	4799	7.33
	M3	122	1033	1548	1825	1180	806	93	6608	11.38

Looking at Table 7, it can be seen that the values of the seasonal percentage deviations of the Method 1 and category C1 differ minimally, according to the levels of building pollution and both comparisons of the occupancy schedules. The results show that the smallest deviations of the predicted heating consumption occur when comparing the real and average yearly occupancy schedules. The maximum deviation for the Method 1 is 3.90%. Such small values of deviation indicate that the error in predicting the heating consumption would be negligible if the average yearly schedule was used instead of the real occupancy schedule.

The highest deviations occur when comparing the real and maximum occupancy schedules. When comparing these schedules, the deviations have a value of up to 10.80%, for the Method 1. It can easily be concluded that with the maximum occupancy schedule a significant error would be made in predicting energy consumption for heating. For that reason, the use of this schedule for the purpose of the mentioned predictions should be avoided.

The deviations of the consumed heat energy obtained for the ventilation Method 3 should be considered separately from the deviations for the Method 1. The air flow rate for this method is, during the season, always constant because it depends on the volume of the ventilated room. Therefore, the only influence on the value of seasonal deviations have people heat gains. Even with this method, the smallest error in prediction is given by the comparison of the real and average yearly occupancy, of 2.40%. On the other hand, the greatest impact of people heat gains is when comparing the real and maximum occupancy schedules where the error can reach a value of 11.38%.

In both comparisons of the occupancy schedules, the absolute differences of the consumed heat energy for the January have the greatest influence on the seasonal deviation, for which the difference in the number of present children according to the maximum and average yearly schedules in relation to the real occupancy schedule was the largest.

6 Conclusion

In this paper, two different ventilation methods for non-residential buildings defined according to the currently valid standard EN 16798 were considered. As a case study, a building intended for education, a kindergarten on the territory of the city of Kragujevac, was selected. The influence of ventilation methods on the predicted energy consumption for heating was examined. Ventilation requirements for one of the ventilation methods (Method 1) are based on people occupancy data. For that reason, the effect of different people occupancy schedules, real, average yearly and maximum occupancy schedules, on the prediction of the energy behavior of the selected building was analyzed. The Method 3 is characterized by a constant value of fresh air flow rate, determined by the volume of the ventilated room (0.5 ach). Although natural ventilation is performed in the analyzed building, it was assumed that the mechanical ventilation systems maintain the appropriate quality of indoor air in the rooms where children stay.

All simulations of energy consumption prediction were performed in the software EnergyPlus. The obtained results indicate that in the Method 1 the heating consumption increases with the increase of the air flow rate or the number of people in the building. In contrast, with a constant amount of fresh air (Method 3), heating consumption decreases with increasing number of people. However, it is to be expected that the Method 1 will always meet the quality requirements of the indoor environment. It has been shown that the use of the maximum occupancy schedule gives the largest error in predicting the heating consumption (up to 11.38%), regardless of the ventilation method. For the average yearly occupancy schedule, the prediction error ranges up to 3.90%. Although this error can be ignored, the question of the value of the error in predicting the electricity consumption of the ventilation system as well as the energy consumption of the cooling system remains open, especially bearing in mind that the presence of children during most of the summer is extremely low. This will be the subject of future research. Based on the presented results, in order to bring the predicted energy behavior of the building closer to its actual behavior, it is recommended to use the real occupancy schedule. The maximum occupancy schedule, in any case, should be avoided.

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