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CREATION OF MODULAR LOG KINDERGARTEN FOR RUSSIAN MARKETS

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ABSTRACT

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The customer of this project is Kontio company - a Finnish construction company specialized in the creating and building of individual wooden houses and administrative wooden buildings. A big part of their sales come from the Russian market. The goal of this project is creating of modular wooden kindergarten for sale in Russia.

Research in the thesis is carried out in two directions. The first of them is an analysis of Russian fire resistance regulations, energy efficiency norms and soundproofing usage rules and also observing laminated wood as main building material for a kindergarten. The second part is design of a building. The drawings and a 3D model of the building were created with ArchCad and AutoCad programs.

During the work, three types of modules for the building were designed. One version of the building is shown in the thesis. The plan of the floor, the facades, the sections and a 3D model were designed for this version.

The customer company can use these modules in the future to create a building of different sizes and forms.

Keywords:

Kindergarten

Fire resistance

Thermal-technical calculation

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1 INTRODUCTION

The customer of this project is Kontio company. This is a Finnish construction company specialized in creating and building individual houses in their own projects. Recently Kontio has started to create administrative buildings. Lately one of Kontio designs was used for building of a kindergarten in Pudasjärvi. The main construction material used by this company is wooden log. Kontio is one of the leading manufacturers of log houses and leisure homes. This company exports buildings to more than 20 countries. Russia is one of the biggest export countries.

The individual wooden houses by Kontio are popular in Russia. Now the company starts to promote wooden administrative buildings to the Russian market. One of Kontio's ideas is to create a wooden modular kindergarten for sale in Russia.

Recently the construction of kindergartens has actively developed in Russia due to the increased birth rate. The first preschool educational institutions for children opened in Russia in late 19th century. In three decades there were already several dozen of free and paid kindergartens in Russia. By the mid of the 20th century more than two million children started to visit the preschool institutions. At the beginning of the 21th century there are more than 45 thousand kindergartens in Russia (<http://edu.glavsprav.ru> 20014). Today the most popular kindergartens are the ones for children of ages 3 to 7 years old. There are two types of kindergartens in Russia: municipal and private. There are not enough spaces in public preschool institutions so the private ones became popular as well.

The customer company plans to develop series of kindergartens for Russia. Kontio's idea is creation of modular building. Buildings of different forms and sizes can be designed by various combinations of simple modules.

Finland and Russia have different concepts for inside premises of kindergartens. The customer company requested to design the building according to Russian regulations and norms. Thereby, mainly Russian documents were used for this project. The customer company was interested in not only creating a design of the building, but also in a possibility of building a wooden kindergarten from laminated logs. In order to answer this question, it is necessary to check if laminated wood is an appropriate construction material for an administrative building. Besides

that, it was decided to compare the fire resistance regulation and energy efficiency standards of both countries.

The necessity of the technical analysis part arose due to the lack of certificates of quality for laminated logs according to Russian system of certification.

Besides it, a 3D model of the kindergarten was created. Nowadays 3D modeling is an important part of the design in the construction area. 3D visualization helps to imagine a future building better, which is important for the sales of the project to a buyer. Two main programs were used for creation of the building plan. AutoCad program was used for the graphical part of the thesis. After an approval of the plan of the floor, all drawings were imported to ArchiCad program for creating of a 3D model.

2 ANALYSIS OF TECHNICAL NORMATIVE DOCUMENTS

2.1 Fire resistance regulations

According to the fire safety regulations of buildings, presented in section E1 of National Building Code of Finland, all construction materials are divided into classes based on their impact on fire ignition, spreading and smoke generation. Laminated wooden log falls into the category D-s2, d0. Notation D means that the contribution of material on fire is within acceptable limits, s2 means the smoke generation is minimal, d0 means that burning droplets or separate parts do not occur (Design principles for log buildings 2010, 8).

During the fire resistance tests the following characteristics of material are measured: R = Load-bearing capacity in fire; E = Tightness; I = Insulation capacity. Tests show how much time the testing material can hold those characteristics.

The second system of classification divides the buildings into seven types based on the way of exploitation: 1) residential houses, 2) buildings for temporary living as hotels, 3) care facilities as hospitals and nursing homes, 4) meeting and business facilities, such as restaurants, schools, kindergartens, swimming pools (RakMK E1 2011, 3).

Meeting and business facilities are classified into P3 building fire class, in which it is allowed to use material D-s2, d0 class as the main construction without any special safety products. In this case the kindergarten in Finland can be built from laminated wooden log. The possibility to build a kindergarten using the same materials in Russia, is described below.

According to the federal law № 123-FS “Technical regulations for fire safety requirements”, fire regulation system in Russia has three kind of classifications for buildings (№ 123-FS Technical regulations for fire safety requirements 2008, article 29-32):

2.1.1 Degree of fire resistance

The degree of fire resistance is characteristic of buildings and determined by the fire resistance class of materials that are used for construction of these buildings. This characteristic is divided into I, II, III, IV and V classes in accordance with the load-bearing capacity, tightness and insulation capacity of material.

The degree of fire resistance of the building depends on the number of the floors, the functional fire hazard class and fire hazard of the functional processes inside the building. The fire resistance class of the structures must satisfy the given degree of fire resistance of the building. (№ 123-FS Technical regulations for fire safety requirements 2008, article 87.) Conformity to the fire resistance class of structures used in building is shown in table 1.

TABLE 1. Conformity of degree of fire resistance of building with fire resistance class of structures used in the building (№ 123-FS, 2008)

Degree of fire resistance of building	Fire resistance class of structures						
	Bearing core elements (walls, columns, beams, trusses)	External not load-bearing walls	Inter floor overlap (including attic and cellars over)	Constructions of overlaps without attics		Building construction of staircases	
				Decking (including insulation)	Trusses, beams, etc.	Inside walls	Stair flights and landings
I	R 120	E 30	REI 60	RE 30	R 30	REI 120	R 60
II	R 90	E 15	REI 45	RE 15	R 15	REI 90	R 60
III	R 45	E 15	REI 45	RE 15	R 15	REI 60	R 45
IV	R 15	E 15	REI 15	RE 15	R 15	REI 45	R 15
V	not regulated	not regulated	not regulated	not regulated	not regulated	not regulated	not regulated

2.1.2 Structural fire hazard class of buildings

This characteristic of buildings is determined by a degree of participation in the development of fire and occurrence of dangerous factors of fire. According to the fire hazard classes, the structural building classes are C0, C1, C2, and C3.

The structural fire hazard class of the building depends on the number of the floors, the functional fire hazard class and fire hazard of the functional processes inside the building. The structural fire hazard class of the structures must satisfy to the given structural fire resistance class of the building (№ 123-FS Technical regulations for fire safety requirements 2008, article 87.). (see table 2)

TABLE 2. Conformity of structural fire resistance class of building with fire danger class of constructions (№ 123-FS, 2008)

Structural fire hazard class of building	Fire hazard class of building structures				
	Bearing core elements (columns, beams, trusses)	Outside walls from the outer side	Walls, partitions, overlaps, and roof without loft	Walls stairwells and fire barriers	Stair flights and landings in the stairwells
C0	K0	K0	K0	K0	K0
C1	K1	K2	K1	K0	K0
C2	K3	K3	K2	K1	K1
C3	not regulated	not regulated	not regulated	K1	K3

K0 = no fire risk; K1 = little fire risk; K2 = moderately fire risk; K3 = fire risk.

The fire hazard class of the structural material is determined by sample analysis. During the test a sample is slowly heated in a special oven and certain factors are controlled. The results of the tests are compared with data in table 3 and the fire hazard class of the material is identified. (№ 123-FS Technical regulations for fire safety requirements 2008, table 6.)

TABLE 3. Procedure for determining fire hazard class of materials (№ 123-FS, 2008)

Fire hazard class of material	Permissible size of structural damage of construction, cm.		Presence of		Permitted fire danger characteristics of the damaged material +		
	vertical	horizontal	thermal effect	combustion	Group of		
					combustibility	flammability	Smoke generation
K0	0	0	absent	absent	absent	absent	absent
K1	not more than 40	not more than 25	not regulated	absent	not more than G2+ (Г2 +)	not more than V2+ (B2 +)	not more than D2+ (Д2 +)
K2	more than 40 but, not more than 80	more than 25 but, not more than 50	not regulated	absent	not more than G3+ (Г3 +)	not more than V3+ (B3 +)	not more than D2+ (Д2 +)
K3	not regulated						

Note:

The sign "+" indicates that in the absence of the thermal effect, it is not regulated.

G2 (Г2) - moderate combustible has the following characteristics:

- flue gas temperature not more than $235\text{ }^{\circ}\text{C}$;
- degree of damage along the length of the test sample is not more than 85%;
- degree of damage to the test sample by mass is not more than 50%;
- independent burning duration less than 30 seconds.

G3 (Г3) - normally combustible has the following characteristics:

- flue gas temperature not more than $450\text{ }^{\circ}\text{C}$;
- degree of damage along the length of the test sample is not more than 85%;
- degree of damage to the test sample by mass is not more than 50%;
- independent burning duration less than 300 seconds.

For the materials related to groups' combustibility G1-G3 (Г 1 - Г 3) are not allowed to have burning or melting droplets during the test.

V2 (B 2) - moderate inflammable materials have a value of critical surface heat flux density between 20 and 35 kW/m^2 ;

V3 (B3) - flammable materials have a value of critical surface heat flux density of less than 20 kW/m^2 .

D2 (Д2) - moderate smoke generation capacity is a ratio of smoke formation of not less than 50 but not greater than 500 kW/m^2 (№ 123-FS Technical regulations for fire safety requirements 2008, article 13.)

2.1.3 Class of functional fire hazard

This characteristic of the building is determined according to the way of exploitation of the buildings; the age and amount of people using the building. The functional fire hazard class of the kindergartens is F1.1 (Ф1.1)

When the class of the functional fire hazard is known, it is possible to determine the rest of fire regulations classes for the kindergarten (see table 4). (SNIP 31-06-2009 Public buildings and works 2011, 22). Table 4 determines limitations for location of rooms and number of children in the kindergarten in accordance with the structural fire hazard class of the building.

TABLE 4. Correlation between number of seats and limitation of floors in kindergarten (SNIP 31-06-2009, 2011)

Number of seats	Numbers of floors	Structural fire hazard class
to 50	1 floor	C1-C3
	2 floor	C1
from 51 to 100	1 floor	C1
from 101 to 150	2 floor	C1
from 151 to 350	3 floor	C0, C1

The degree of fire resistance, structural fire hazard class and maximum height of the building with the functional fire hazard class F1.1 should be chosen according to table 5. All this indexes depend on the amount of the children in the kindergarten. (SP 2.13130.2012 Systems of fire protection Fire-resistance security of protecting units 2012, item 6.7.10, table 6.12)

TABLE 5. Correlation between degree of fire resistance, structural fire hazard class, maximum height of building and the amount of children (SP 2.13130.2012, 2012)

Number of seats	Fire resistance class not less, than	Structural fire hazard class	Maximum height of buildings, m (stories)
to 50	not standardized	not standardized	3 (1)
	III	C1	3(1)
to 100	III	C0	3(1)
to 150	II	C1	6(2)
to 350	II	C0	6(2)
	I	C0,C1	9(3)

Based on the data from two previous tables a kindergarten for 100 children has the following classes: III - C0 or II-C1.

The next step is determination of fire hazard class of used material. It is necessary to compare the Russian and Finnish systems of classification of materials by their fire hazard class (see table 6).

TABLE 6. Comparison of Russian and Finnish fire hazard classes of materials

Fire hazard of structure		Russian classification	Finish classification
non - ignitable		NG (НГ);	A1; A2-s1,d0
ignitable	low ignitable	G1(Г1)	A2-s1,d1; A2-s1,d2; A2-s2,d0; A2-s2,d1; A2-s2,d2; A2-s3,d0; A2-s3,d1; A2-s3,d2; B-s1,d0; B-s1,d1; B-s1,d2; B-s2,d0; B-s2,d1; B-s2,d2; B-s3,d0; B-s3,d1; B-s3,d2
	moderately ignitable	G2(Г2)	C-s1,d0; C-s1,d1; C-s1,d2; C-s2,d0; C-s2,d1; C-s2,d2; C-s3,d0; C-s3,d1; C-s3,d2
	normally ignitable	G3(Г3)	D-s1,d0; D-s1,d1; D-s1,d2; D-s2,d0; D-s2,d1; D-s2,d2; D-s3,d0; D-s3,d1; D-s3,d2
	extremely ignitable	G4(Г4)	E; E-d2; F
No flaming droplets		G1-G2(Г1-Г2)	Except classes E and F, have additional classification d0
	low smoke	D1 (Д1)	have additional classification s1
	moderately smoke	D2(Д2)	have additional classification s2
	High smoke	D3(Д3)	have additional classification s3
	low flammability	V1(B1)	No data
	moderately flammability	V2(B2)	No data
	easily flammability	V3(B3)	No data

As a result, the D-s2, d0 fire hazard class of material in Finland has G3-D2 characteristics in Russia. According to table 3, the fire hazard class of structural material is K2. This way the laminated wooden log can be used as material for outside walls (see table 2). The other constructions should be made out of class K1 materials. The laminated wood log should be treated with fire-retardant agent in order to have class K1. Thereby it is possible to create a wooden kindergarten with structural fire hazard class of C1. To ensure the fire resistance class II of the building the log 180xh has to be used. Laminated logs with sizes like this or greater has the load-bearing capacity R90 in fire (Design principles for log buildings. Finnish log house industry association (HTT) 3/2010, 8.). According to customer requirements, the laminated log 275x275 mm was chosen.

2.2 Thermal-technical calculation

First, it is necessary to make the thermal calculation of exterior walls for determination of the thickness of the walls. The calculation from SNiP 23-02-2003 “Thermal performance of the building” should be used. The main formula for calculation is formula 1:

$$R_0 \geq R_{req} \quad (1),$$

where

R_0 = Calculation value of thermal resistance of construction ($m^2 \cdot K/W$)

R_{req} = Normalized values of thermal resistance, $m^2 \cdot K/W$ (SNiP 23-02-2003 Thermal performance of the building 2003, item 5.3.)

Finnish R -value corresponds to the value of Russian R_0 thermal resistance. The R -value is the reciprocal U -value. The U -value is a measure of heat loss in a building element such as a wall, floor or roof. The R_0 is calculated using formula 2:

$$R_0 = \frac{1}{U - value} = \frac{d}{\lambda} \quad (2),$$

where

d = Thickness of material (m)

λ = Lambda value/ thermal conductivity of material ($W/m \cdot K$)

According to customer requirements a laminated log of the size 275x275 mm was chosen.

The value of λ for laminated wood is $0,12W/m \cdot K$ (SNiP II-3-79 "Construction heat engineering" 1995, appendix 3*)

Thereby, for wooden exterior walls with thickness of 275 mm:

$$R_0 = \frac{0,275}{0,12} = 2,292 \text{ (} m^2 \cdot K/W \text{)}$$

The next step is the determination of the value of R_{req} . According to the SNiP 23-02-2003 "Thermal performance of the building", the value of R_{req} is determined by table 4 of this SNiP and depends on D_d (Heating degree-day period) of a building's area. R_{req} for intermediate values of D_d is determined by formula 3:

$$R_{req} = a \cdot D_d + b \quad (3),$$

where

D_d = Heating degree-day period ($C^\circ \cdot day$)

a, b = Coefficients whose values should be taken according to the table 4 of SNiP 23-02-2003 "Thermal performance of the building" for the respective groups of buildings. For kindergartens they are: $a = 0,00035$, $b = 1,4$

This way, the value of heating degree-day period is calculated by formula 4:

$$D_d = (t_{int} - t_{ht}) \cdot z_{ht} \quad (4),$$

where

t_{int} = Estimated average indoor air temperature in the building (C°),

t_{ht} = Average outdoor temperature heating season (C°),

z_{ht} = Duration of the heating period, days (SNiP 23-02-2003 Thermal performance of the building 2003, item 5.3.)

Values of these parameters are given in table 1 of SNiP 23-01-99 "Building Climatology". According to this table, for Saint- Petersburg's area:

$$t_{ht} = -0,9 C^{\circ}$$

$$z_{ht} = 239 \text{ day}$$

For kindergartens:

$$t_{int} = 23 C^{\circ}$$

Using the data above, the following equation is obtained:

$$D_d = (t_{int} - t_{ht}) \cdot z_{ht} = (23 - (-0,9)) \cdot 239 = 5712,1 (C^{\circ} \cdot \text{days})$$

This value of D_d is intermediate between 5000 and 6000 therefore, calculation is continued by formula 3:

$$R_{req} = a \cdot D_d + b = 0,00035 \cdot 5712,1 + 1,4 = 3,399 (m^2 \cdot K/W)$$

All data is received for the main formula calculations:

$$R_0 = 2,292 (m^2 \cdot K/W) \leq R_{req} = 3,399 (m^2 \cdot K/W)$$

R_0 is below R_{req} which means that insulation has to be used. In this situation it is not allowed to use only log material. The customer company wished to save a wooden structure in the building anyway. So, they decided to use the following structure of the walls: log, insulation outside of the building and wooden panel. This system of walls allows to use log as the main construction material anyway and to visually save the wooden structure of the building. The structure of the new wall includes:

- Wooden log 160x275 mm, $\lambda = 0,12(W / m \cdot K)$
- Homatherm HDPQ standard 140 mm, $\lambda = 0,038(W / m \cdot K)$
- Thermal insulation "Ts-levy Homatherm UD" 22 mm, $\lambda = 0,043(W / m \cdot K)$
- Rail system for fastening of wooden panels 25 mm
- Wooden panel 20 mm, $\lambda = 0,12(W / m \cdot K)$

The next step is to check the thermal characteristic of this wall structure. The "TeremOK" program (Thermal calculation of multilayer walling) can be used for this purpose. This program is based on the requirements and procedures given by SNIP 23-02-2003 "Thermal protection of buildings", SP 23-101-2004 "Design of thermal protection of buildings" and snip 23-01-99 "Building Climatology."

Baseline data for calculation given by "TeremOK" program are presented below:

Construction area - St. Petersburg

Zone humidity - wet

Normal humidity mode operation walling - B

n = Coefficient taking into accounts the dependence of the position of the outer surface of the building envelope in relation to the outside air - 1

α_{ext} = Heat transfer coefficient of the outer surface of the enclosing structure - $23 W / (m^2 \cdot C^0)$

α_{int} = Heat transfer coefficient of the inter surface of the enclosing structure - $8.7 W / (m^2 \cdot C^0)$

Δt_n = Normalized temperature difference - $4 C^0$ (TeremOK 2014)

The remaining data is the same as in the previous calculations.

According to calculation $R_0 = 5,854 (m^2 \cdot K / W) \leq R_{req} = 3,399 (m^2 \cdot K / W)$, the structure of the outside wall represented by Kontio company satisfies the Russian thermal-technical norms.

The technical module that includes food unit and laundry areas, has exterior walls with another structure:

- Brick masonry 380 mm , $\lambda = 0,87(W / m \cdot K)$ (TeremOK 2014)
- Thermal insulation "Homatherm HDPQ standard insulation, $\lambda = 0,038(W / m \cdot K)$
- Thermal insulation "Ts-levy Homatherm UD" 22 mm, $\lambda = 0,043(W / m \cdot K)$
- Rail system for fastening of wooden panels 25 mm
- Wooden panel 20 mm, $\lambda = 0,12(W / m \cdot K)$

The thickness of the thermal insulation for this structure is unknown. "TeremOK" program can also be used for determination of thickness for one unknown layer in the composite structure of a wall. According to the calculations, the thickness of insulation is $79mm$. So, it is agreed to use the Homatherm HDPQ standard 80 mm (HDP-Q11 Standard. 2013).

2.3 Sound proofing

The noise negatively affects the health of children. The kindergartens are located away from the roads and behind other buildings (SanPin 2.4.1.3049-13 Sanitary and epidemiological requirements to the device, the content and organization mode of preschool educational institutions 2013). Also, the building should have sound proofing inside the walls and overlaps.

Normalized parameters of internal insulation of building envelopes are indexes of airborne sound insulation walling $R_w(dB)$ and reduced level of noise impact, $L_{nw}(dB)$ (for overlaps).

Index of airborne sound insulation R_w - is the value that serves the barrier's ability to reduce sound transmission. R_w is determined by comparison of the frequency characteristics of an airborne sound insulation with a special assessment curve in dB .

Index of reduced level of impact noise L_{nw} - is the value that assesses the ability of the insulating covering relatively to impact noise. L_{nw} is determined by comparison of the frequency response of the reduced level of impact noise under the ceiling with a special assessment curve in dB . (SNiP 23-03-2003 Noise protection 2004, item 9.1.)

The values $R_w(dB)$ and $L_{nw}(dB)$ for kindergarten are shown in table 7 (SNiP 23-03-2003 Noise protection 2004, Table 6):

TABLE 7. Index of airborne sound insulation and index of reduced level of impact noise for the kindergarten (SNiP 23-03-2003, 2004)

Name and location of the enclosing structure	$R_w(dB)$	$L_{nw}(dB)$
Overlap between the group rooms, bedrooms	47	63
Overlap, separating group rooms, bedrooms from kitchens	51	63 ²
Walls and partitions between the group rooms, bedrooms and between other children's rooms	47	-
Walls and partitions separating group rooms, bedrooms from kitchens	51	-

Based on data from table 7 and table (6-10) from "Design principles for log buildings Finnish log house industry association (HTT) 3/2010" the following structures for the inside walls were chosen: rectangular log 135 mm, wooden rails k 600 and mineral wool 45 mm, single extra-hard plasterboard 13 mm.

2.4 Ventilation system

There are two ventilation systems in this kindergarten:

- natural ventilation by windows;
- mechanical ventilation by ventilation ducts.

Ventilation ducts are installed in all premises without windows such as: bathrooms, food unit and laundry. Also the attics of every module of the building have a place for ventilation pipes and ventilation chamber. A standard ventilation duct has the measurements of 140x270 mm and is built in a brick wall or attached to a wooden wall. Air flow from bedrooms of kindergarten is permitted through the windows of playrooms (SNiP 41-01-2003 Heating, ventilation and conditioning 2003, item 7.1.3.)

2.5 Heating system

A central heating system is also provided in the kindergarten. The surface temperature of the parts of heaters and heating pipes that people have access to should not exceed $70C^{\circ}$. The temperature of pipes protected by special screen can increase up to $75C^{\circ}$. (SNiP 31-06-2009 Public buildings and works 2011, item 6.38). There are heated floors with a maximum temperature of $23C^{\circ}$ provided in the rooms for children (SNiP 31-06-2009 Public buildings and works 2011, item 8.4).

There are technical rooms in each module of the building provided for the engineering systems. These rooms are located near the exterior walls of the building with direct access outside. The equipment in the technical rooms is located 2,2 m above the floor (SNiP 31-06-2009 Public buildings and works 2011, item 8.2). Thereby the height of these rooms is equal to the height of the building.

3 CREATION BUILDING CONCEPT FOR KINDERGARTEN

The customer company gave drawings of modular kindergarten as a basic idea (Appendix 1); at the beginning the goal of the design part of the thesis was to keep the outward face of the building, but to change the inside planning. Since the set-up of inside premises are different in Russian and Finnish kindergartens the first step was to research the normative documents about kindergartens in Russia. The main document for the creation plan of kindergarten is SNiP 31-06-2009 "Public buildings and works". Common norms about the height of the premises, width of the corridors, and number of floors of the building are presented in this document. SanPin 2.4.1.3049-13 "Sanitary and epidemiological requirements to the device, the content and organization mode of preschool educational institutions" was the next document used in the process of collecting information for the research.

One of the conditions of the customer company was the geographical location of the future kindergarten. As the company actively conducts business in Saint Petersburg, it was agreed to create the building for this city. A regional normative document of creating and building of kindergartens in Saint Petersburg area is RMD 31-07-2009 "Design guide preschool educational institutions in Saint Petersburg". The RMD 31-07-2009 collects data of set-up of the kindergarten, its contents, and principle of disposition of premises from one another.

3.1 Description of the groups of premises in the kindergarten

There are five groups of premises in the kindergarten:

- Entrance premises
- Cells of the groups
- Specialized rooms for working with children
- Additional premises
- Service premises (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 7).

3.1.1 Entrance premises

This group of premises includes all vestibules and corridors and distributes traffic between other premises. All entrances of the kindergarden include vestibules with a minimal depth of 1.6 m. The main entrance is also connected to the big hall with an area of at least 18 m². The hall is used for exhibitions of children's art works. All administrative premises and a medical unit are located close to the main entrance. (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 7).

3.1.2 Cells of the groups

These are the spaces designed specifically for the children and include a playroom, a bedroom, a dressing room, a bathroom, a scullery and an office for the work with the subgroups of the children. The rooms of this group should be located proximately to each other and have a good system of the communication with the other groups of the premises.

When the children arrive at the kindergarden in the morning, first of all they go to the dressing room where the clothes are being changed and they are left by their parents. Next, they go to the playroom, where the children spend the most part of the day. The playroom is the center of the cell of the group and the doors of all other rooms and corridor are located in this room.

For the children of all ages a postprandial nap is provided; for this reason the cell of the group include a bedroom equipped with individual beds. Each bedroom has a direct access to the bathroom as well.

The bathroom is divided into a washroom and a toilet zone separated for the girls and boys. The cell of the group also includes a room for activities, which is used for teaching lessons and activities in subgroups.

The scullery is intended for washing and storing dinnerware and to prepare for the distribution of the food coming from the food unit. Each scullery has an entrance from the corridor and the shortest connection with a service hatch of the food unit. This room is equipped with a kitchen sink, a desk and wall cabinets for dishware storage. (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 8.) The system of the cell of the group is presented in the picture below (Figure 1.)

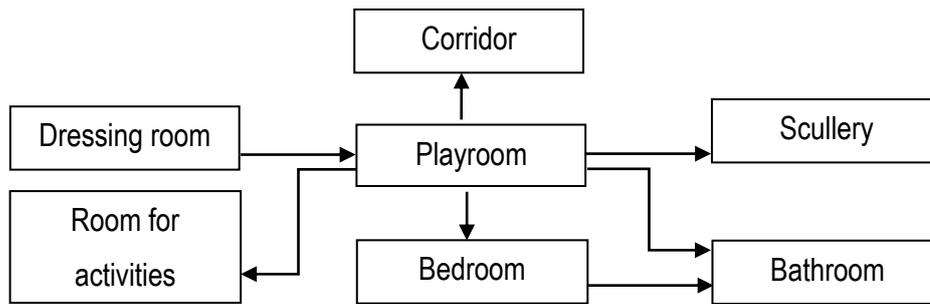


FIGURE 1. Plan of functionality of cell of group

3.1.3 Specialized rooms for working with children

This group includes: 1) a hall for physical education and the music lessons, 2) a clubroom, 3) a classroom of the children from 5 to 7 years and 4) a swimming pool.

The hall for music lessons has one wall without any windows or doorway. This wall can be used for decoration for the children's matinees, performances and festivals. There are two storages for sports and musical equipment next to the hall, 6,0 m² each. The height of the hall for physical education and musical classes is 3,9m from floor to ceiling. The height of the rest of the premises is 3,0m. The Arts and interests rooms are intended for the classes of the children, where the children have the ability to be creative and develop better skills by training drawing, painting, etc. Lessons mainly are carried out with a group of children not more than 10. The classroom is designed for the preschool children from 5 to 7 years old to have their literacy studies.

3.1.3.1 Swimming pool

Kindergarten can also include swimming pool but this is optional. In this case, the swimming pool consist of the following areas: 1) room with bath for swimming, 2) dressing rooms of the boys and girls, 3) coach room, 4) nursing unit, 5) laboratory of analysis of water, 6) node of basin management, 7) storage of inventory. The swimming pool is provided for health-promoting activities and swimming lessons for children. The structure of the swimming pool is presented in a picture below (Figure 2.)

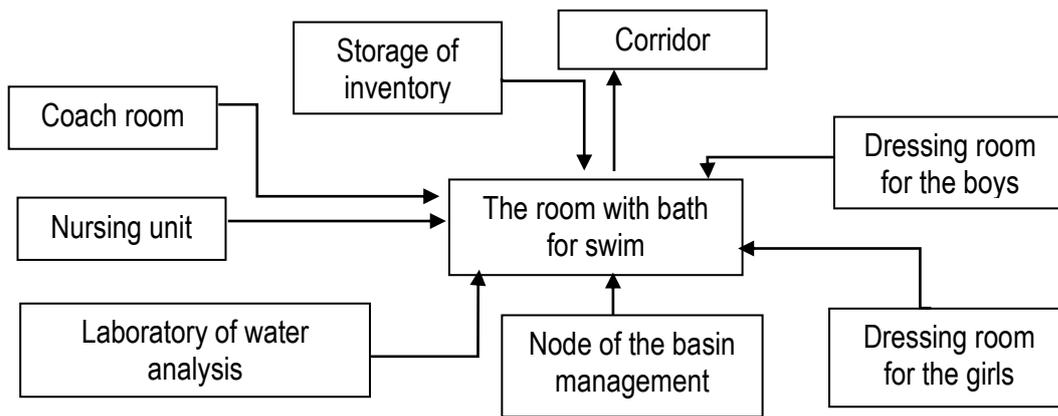


FIGURE 2. Plan of functionality of swimming pool

The coach room includes the bathroom and dressing room. This room has two entrances; one to corridor, second to the room with a basin for swimming. The nurse explores the children before swimming lesson and looks after them during the training. The laboratory of water analysis is also used for the preparation of decontamination solutions. The node of the basin management is the technical room with equipment. Entrances from the dressing rooms are provided through the showers.

3.1.4 Additional and service premises

This group of premises is necessary for kindergarten. The additional and service premises include: 1) a medical unit, 2) a food unit, 3) a laundry. The medical unit should be located near one of the entrances of the kindergarten. The food unit and laundry are technical premises and should be located close to each other.

3.1.4.1 The medical unit

The structure of the medical unit includes: 1) a medical office of doctor, 2) a room for medical procedures and 3) an isolator. There are a reception hall, two patients' rooms and a bathroom in the isolator. The reception hall of the isolator is intended for registration of ill children. It is also used like a scullery to prepare for the distribution of the food. The reception hall is equipped with a kitchen sink, a wall cabinet for dishes and a serving desk. The nutrition of the sick children is organized in the patients' rooms. The bathroom is equipped with a toilet for the kids, a wash basin and a shower tray. This bathroom is also used for the preparation of the disinfecting solutions. The doctor's office and the room for medical procedures have a connection with the reception hall

of the isolator and also with a corridor of kindergarten. The doctor's office is located next to one of the patient's rooms of the isolator. A viewing window is provided between the medical office of the doctor and one of the patients' rooms at a height of 1.2 m above the floor to look after the sick children. The system of the medical unit is presented in the picture below (Figure 3.)

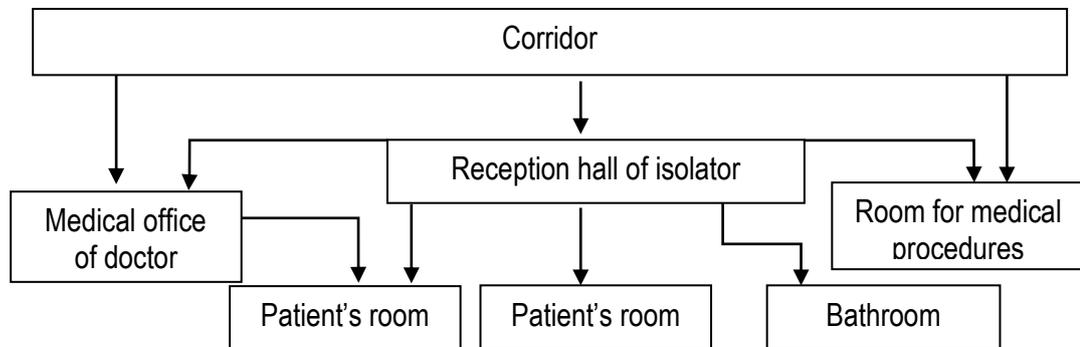


FIGURE 3. Plan of functionality of medical unit

3.1.4.2 Food unit

The food unit provided in the future kindergarten is designed to work with raw materials. The composition of the food unit includes: 1) a hot shop, 2) a cold shop, 3) a vegetable shop, 4) a food preparation station, 5) a meat and fish shop, 6) a shop for primary processing of vegetables, 7) a service hatch, 8) a washing place of kitchen utensils, 9) a dry food pantry, 10) a vegetable pantry, 11) a refrigeration room (meat, fish, dairy and fatty foods, fruits, herbs, vegetables - semi-finished products), 12) a charging room, 13) a washing place of returnable containers, 14) a staff room with dressing area and bathroom. All shops can be combined into one large room (SanPin 2.4.1.3049-13 Sanitary and epidemiological requirements to the device, the content and organization mode of preschool educational institutions 2013, item 4.25). Food preparation is done with electrical equipment. The food unit has a private entrance for staff, equipped with vestibule. The scheme of the food unit is presented in the picture below (Figure 4.)

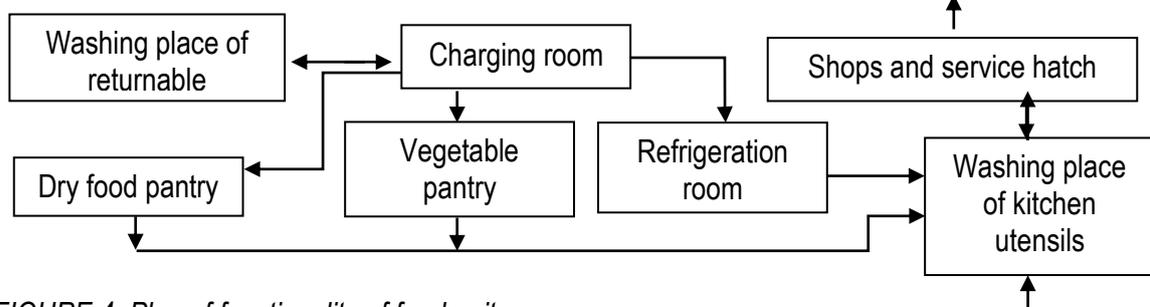


FIGURE 4. Plan of functionality of food unit

3.1.4.3 Laundry

The building provides a laundry wash designated for no more than one third of the total amount of the soiled linen. The rest goes to the specialized laundries of the city. The laundry includes: a washroom, an ironing room and a room for sorting of the soiled linen with a separate external entrance. Entrances into the washroom and the ironing room are individual. The washroom and the ironing room are placed adjacent and connected by a door. The scheme of the laundry is presented in the picture below (Figure 5.)

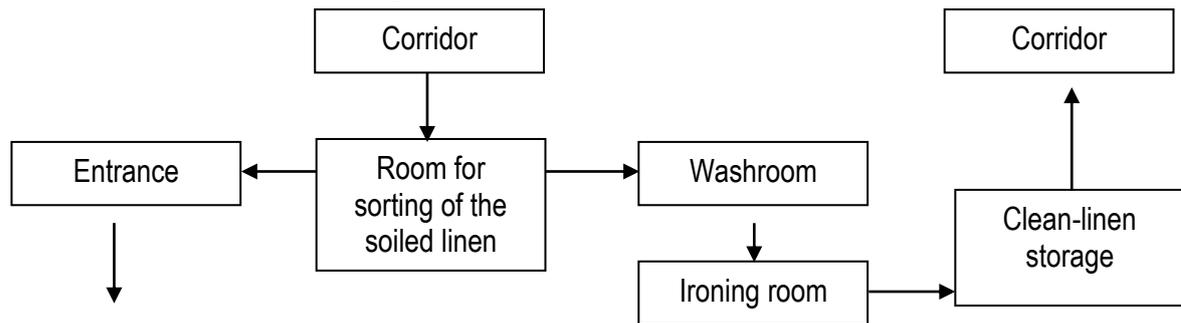


FIGURE 5. Plan of functionality of laundry

3.1.5 Service premises

The structure of the service premises of the kindergarten includes a director's office, an office of administrative manager, a methodic department, a teacher's room, a staff room, a cleaning tools storeroom, a room for personal hygiene of women, a staff bathroom and utility storeroom (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 12.)

3.2 Modules of kindergarten

The next step after collecting of the information was creation of the building plan. A modular system for the kindergarten was chosen due to several reasons. First of them is the log system where the length of the structural parts is limited to 10300 mm (Critical measures of logs 2012, 1). The modules can be combined in different ways. It gives an opportunity to create a new building in every individual situation without extra effort. Finally, modular system of the building makes it visually smaller. Also, keeping a smaller scale will help children to accommodate easily to the building's size in accordance with their mental scale.

3.2.1 Group modules

It was decided to start from the cell of the group module, because this group of premises must be approximated to each other. The set-up and spaces of a module have been designed in accordance with RMD 31-07-2009 "Design guide preschool educational institutions in Saint Petersburg" (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, appendix A, tables A2, A4, A5). The translation in English of these tables is presented in Appendix 2. It emerged that the total area of the group cell is bigger than the size of basic module given by the customer company, so it was decided to increase the measures of the module. As a result, four option types of modules were created. Every module has two fire exits. All modules have the same structure of premises with the same sizes, but different variants of the zoning. This way the customer can choose the most suitable for them or use all of the options. The modules are compacted; three of them do not have the corridors which save space. The options of the modules of the group cell are presented in the pictures below (Figure 6 and 7).

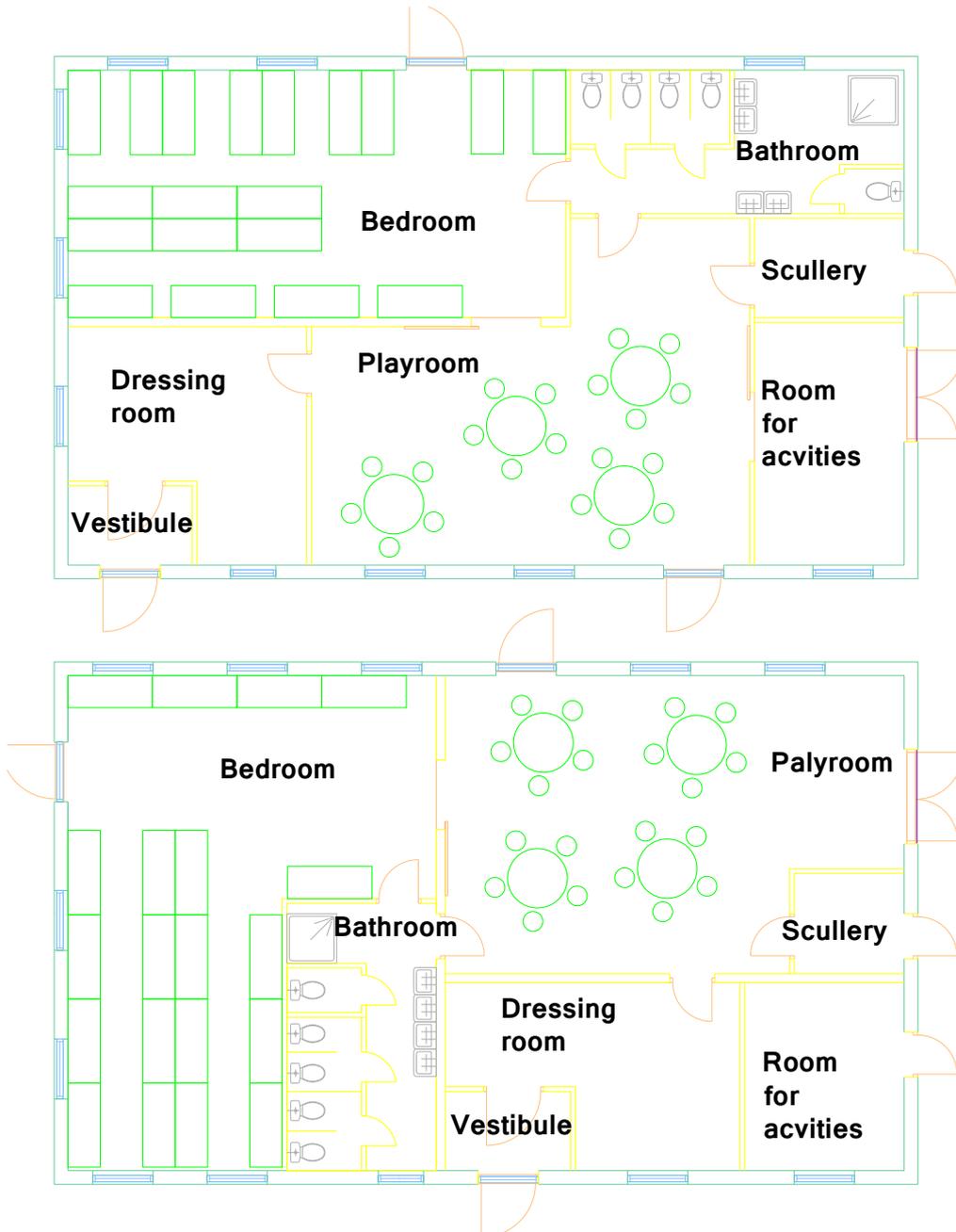


FIGURE 6. First variant of modules of group cells (options 1-2)

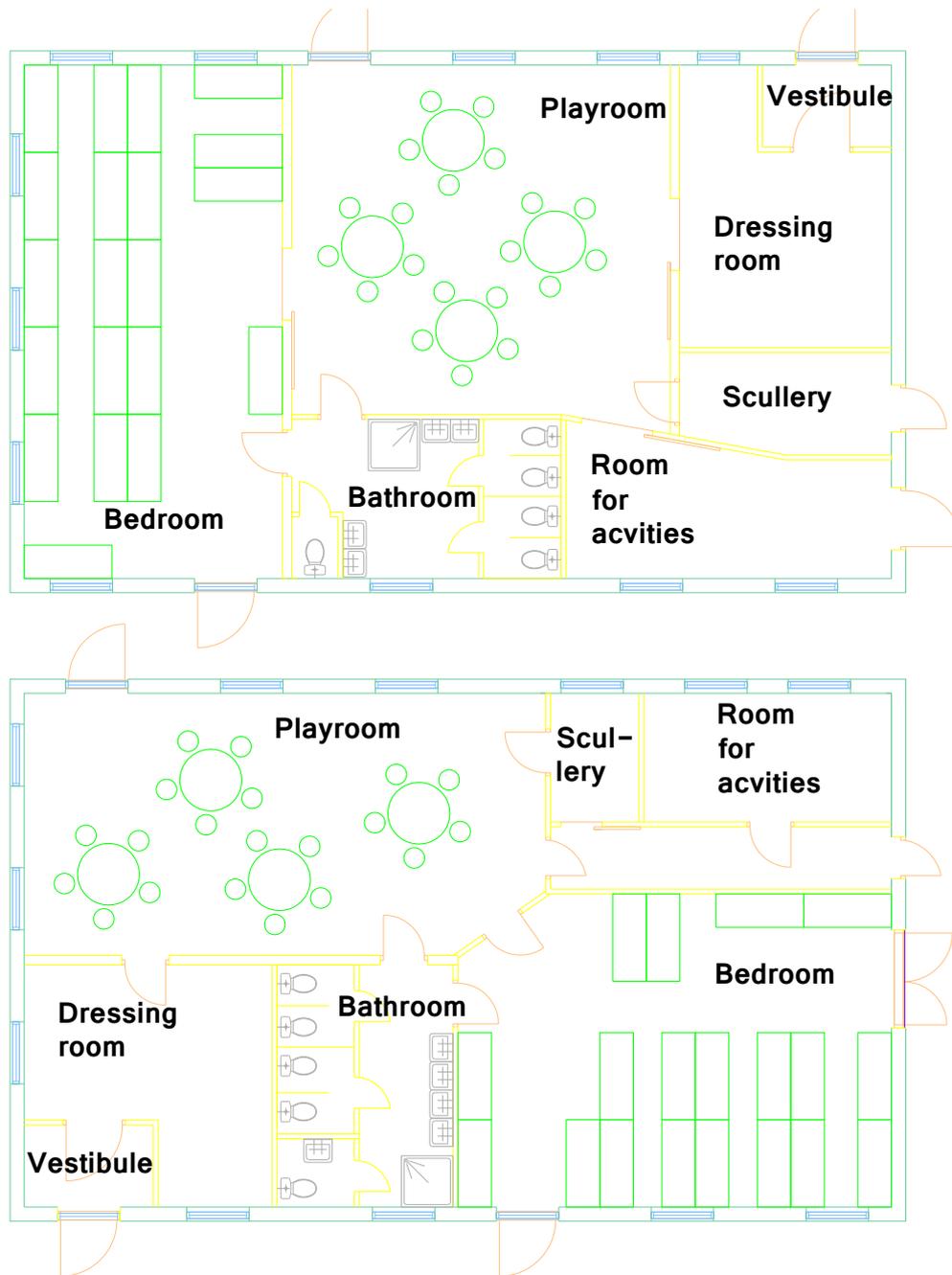


FIGURE 7. First variant of modules of group cells (options 3-4)

3.2.2 Additional modules

Next, the other premises were created. External contour of the module obtained in the previous step was saved for the rest. For the convenience, the remaining premises were divided into four modules: administrative, food, sport, and also swimming pool modules. The administrative module combines the laundry and medical unit. Other areas of this module are occupied by

director's office, a staff room, an office of administrative manager, storage, a bathroom and a hygiene room. The food module includes three zones: pantry, zone for cooking, and staff room. After allocation of the food unit, there was some free space left in this module, thereby it was suitable for modeling technical premises in this space. The sports module also includes Arts and interests rooms.

The classroom for the preschool children, methodical room and teachers' storage room are missing in these modules. It was decided that these premises will be added when the modules are combined in one building. The picture below (Figure 8 and 9.) represents the modules described above.

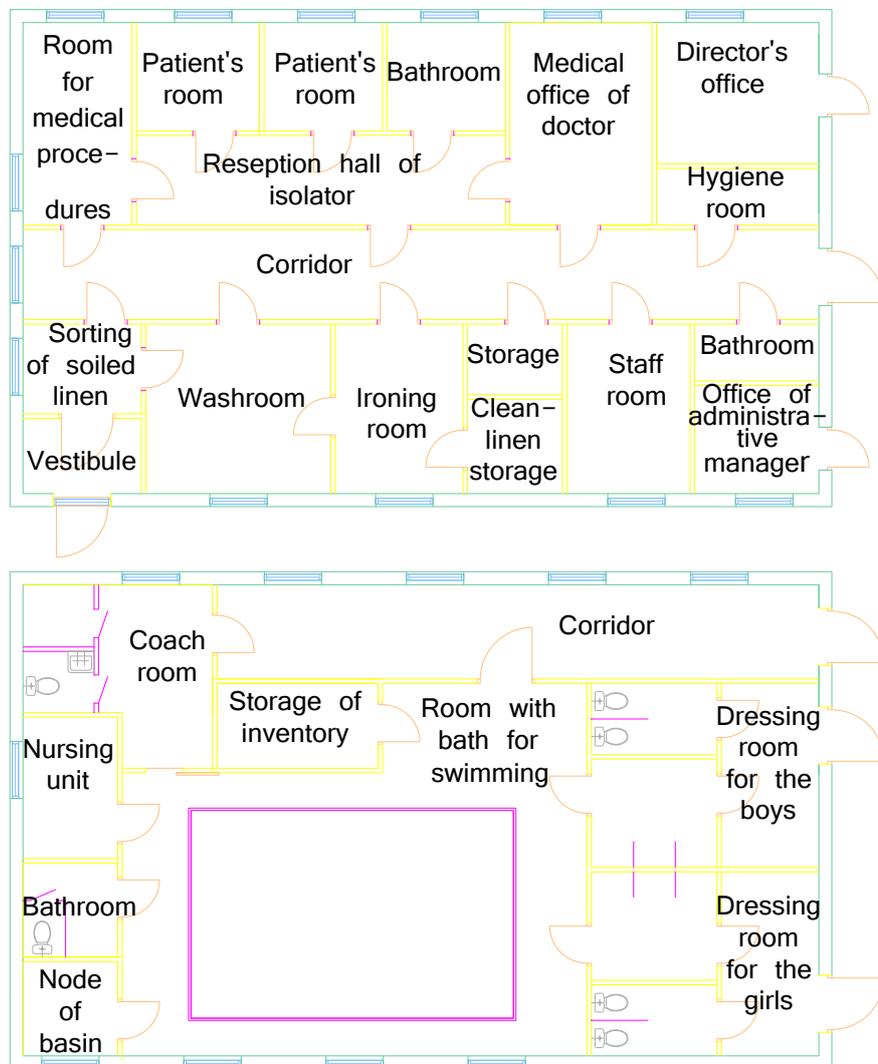


FIGURE 8. Administrative module and swimming pool

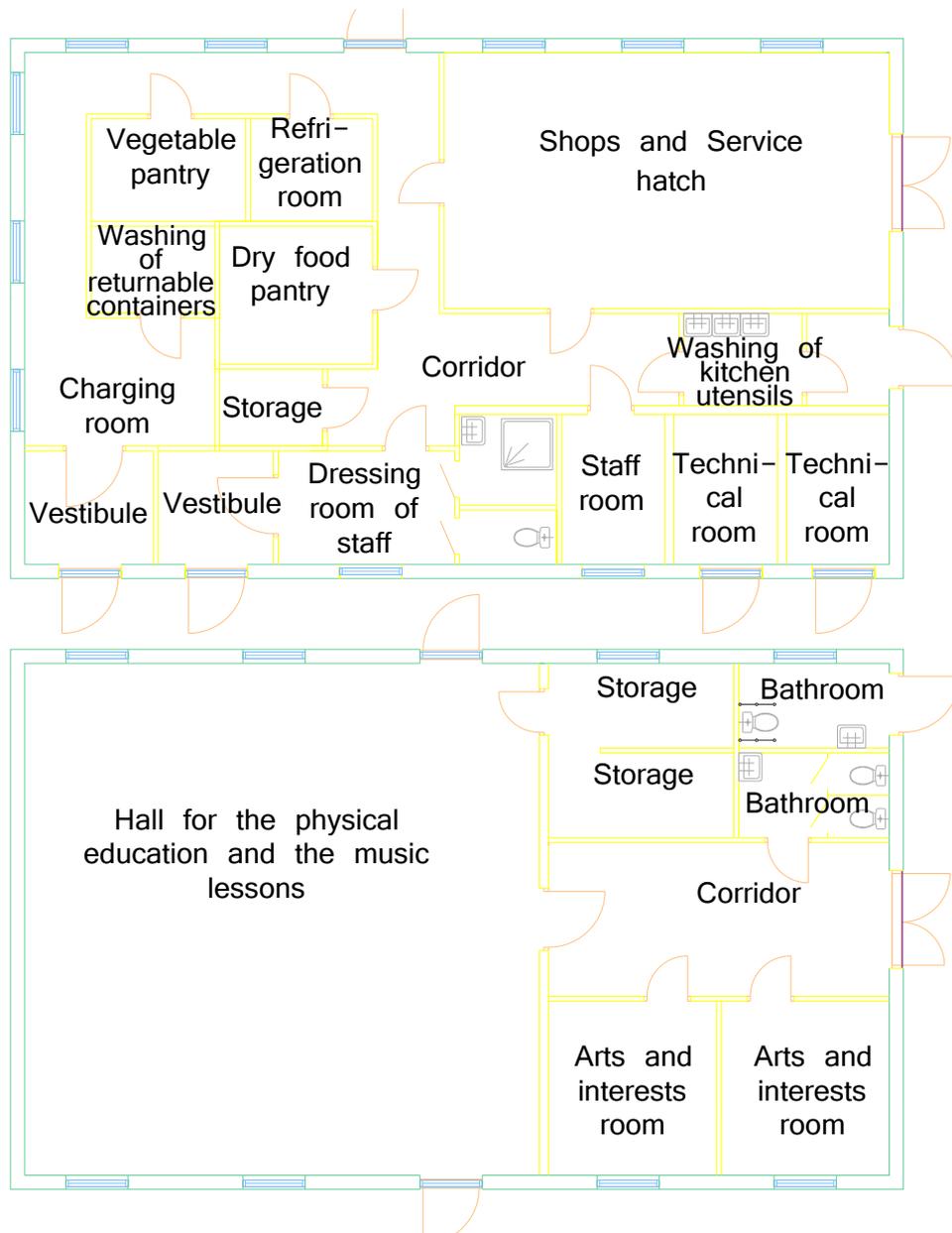


FIGURE 9. Food module and sport module

3.3 Combination of modules

Thus, the result was eight modules. Several options of the building can be obtained by different combination of these modules. In the process of the combination of the modules the location of the premises should be considered relative to each other. There must be enough distance for insolation between two modules with parallel location. It is not allowed to locate the windows of the food unit, the laundry and the bathrooms under the windows of cell of the group (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 12.) The food

module should be located approximately at the same distance from the group cells modules. The building should be maximally compact with short corridors to create a comfortable system of communication that can allow people with limited mobility to visit it. The process of combination of the modules in one building is proven to be more difficult than it seemed in the beginning.

3.3.1 The first combination proposal

The building turned out to be too long with a big hall in the middle. The modular conception of kindergarten with same sizes of modules was rejected. The first combination proposal of all modules in one building is presented in figure 10.



FIGURE 10. Variant of combination modules in one building

3.3.2 Further development of module combinations

Next, a second concept of the building was proposed. The group cells modules were saved and additionally a central module was created which includes all the specialized rooms for working with children and other service premises. The customer company decided to exclude the swimming pool from the project plan. Also, it was decided to create the central module with two storeys (Figure 11 and 12). According to the norms, it is recommended to locate the laundry, food and medical units on the first floor (RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, 11-12). As a result of the changes the new building has a lot of free space on the second floor, which is marked by hatching in a picture. A ventilation room or other technical premises can be located there. There is a long corridor located throughout the building on the first floor. Two ends of this corridor connect the modules of the cell of the group and the central module by the specially created wooden-glass tunnels (Figure 13). According to a new plan this building also appeared to be extremely lengthened which is too long of a distance for children to walk from their groups to the central module.

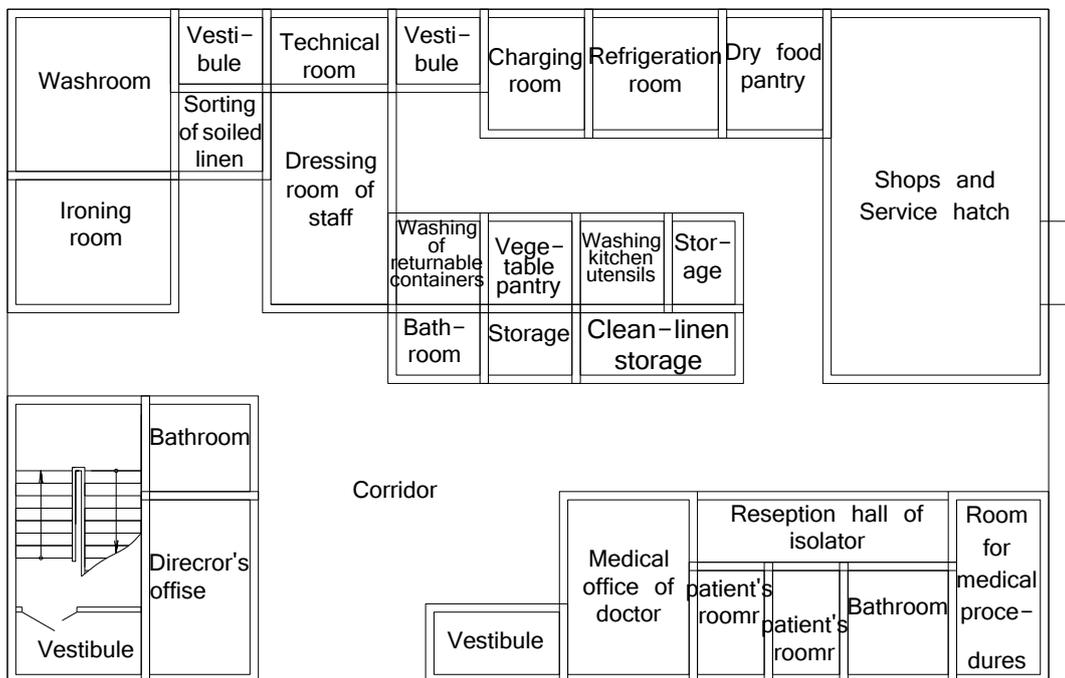


FIGURE 11. First floor of central module

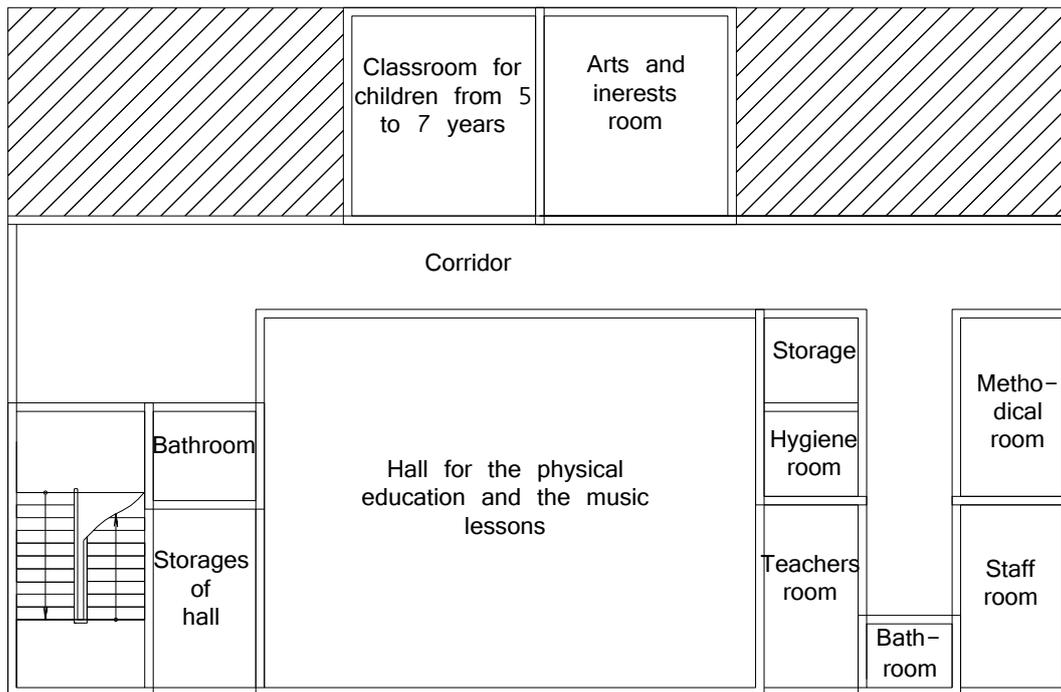


FIGURE 12. Second floor of central module



FIGURE 13. Wooden-glass tunnels created by Kontio company

Besides long corridors there are two other problems found in this building's plan. First, the limited accessibility of the building for people with limited mobility who would like to attend children's music lessons, matinees and celebration parties. The second one is the lack of emergency exits from the second floor where the wooden stairs are not considered as an appropriate emergency exit. The building is supposed to be wooden, however, the laundry and food unit are areas with high humidity level so it was decided to use brick as a building material for these.

Plan of the floor



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Duis University of Applied Science	
Institute: A	
Date: 08/20	
Project: 8020	
Job title: Kindergarten for Kontio company	
Prepared by: A	
Date: 08/20	
Drawing name: Plan of Facades	
Drawing title: Thesis	Date:
Drawn by: Margareta Danekova	Date:
Checked by: Margareta Danekova	Date:
Drawing scale: 1:100	Date:
Layer ID: A.01.2	Status: Revision

FIGURE 15. Final plan of the kindergarten

4 RESULTS

During this research a comparative analysis of the Finnish and Russian fire resistance regulations was made. A table of correspondence of the fire danger classes of structural materials was created. The class of fire hazard for the glued log structure was successfully identified. Thereby, the kindergarten has the functional fire hazard class F1.1, the structural fire hazard class of building C1 and the fire resistance class II. The building created from glued laminated wooden log corresponds to these classes after treatment by fire-retardant agent.

The building was created in accordance with soundproofing regulation. The load bearing walls of the building provide the index of airborne sound insulation $R_w = 47$ dB.

The system of central heating is recommended. There are technical rooms in the building for the equipment of this system. Natural system of ventilation through windows is used in most premises of the kindergarten and mechanical ventilation through ventilation ducts is used in the food unit, bathrooms and laundry.

The result of the architectural part of the thesis is an example of building of kindergarten for 100 children. This building includes two groups' modules, the administrative and technical modules. The group module includes two similar cells of the groups. If necessary, the customer company can create new modules by including one, three or more cells of the groups of this type.

The load bearing walls of the administrative and the groups' modules are built from wooden log of 135 mm with soundproofing of 45 mm. The partitions of these modules are made from gypsum plasterboard. The technical module is built from brick and has exterior finish of wooden panels. The partitions of this module are made from bricks of 120 mm thickness.

The final version of the building is the most compact. The modules are located maximally close to each other and all of them are connected by one corridor. The connection part of the building has wooden bearing columns and beams and metal-glass structure of walls. For better visual effect this part of the building is higher than the rest of the building, a table of the areas is presented below:

TABLE 8. Areas of premises of kindergarten

Name of premises	№ in the build.	Total area (m2)	Name of premises	№ in the build.	Total area (m2)
Playroom	4	200,9	Washroom	1	14
Bedroom	4	207,36	Ironing room	1	10,18
Room for activities	4	41,44	Sorting of soiled linen	1	4,1
Dressing room for children	4	74,3	Storage of clean-linen	1	4,84
Bathroom for the children	4	65,57	Hall for physical education and the music lessons	1	100,19
Scullery	4	24,84	Storage of sport equipment	1	6,3
Medical office	1	12,1	Storage of musical instruments	1	6,3
Patient's room	2	8,17	Room for studies children age from 5 to 7	1	20,16
Room for the medical procedures	1	8,31	Arts and interests room	1	20,16
Isolator	1	9,4	Teachers room	1	8,4
Staff room	2	23,86	Methodical office	1	10,05
Shops and Service hatch	1	43,03	Director's office	1	10,35
Charging room	1	6,07	Office of administrative manager	1	6,3
Vegetable pantry	1	4,82	Hygiene room	1	3,24
Dry food pantry	1	8,8	Bathroom	7	27,87
Refrigeration room	1	7	Storage	6	35,28
Washing of kitchen utensils	1	4	Corridor	4	348,26
Washing of returnable containers	1	4,1	Vestibule	8	32,93
Dressing room of staff	1	6,1	Technical room	4	32,89
Total area of the building				1461,97	

The facades of the building are designed in one style. The following materials were chosen for finishing: light gray wooden panel for exterior walls and blue soft tile for roofing (Figure 16). The ArchiCad program does not show the materials in the final preservation of 3D model. The group modules have a system of round windows. It makes the building funnier and children friendly.



FIGURE 16. Structure and color of wooden panel and soft tile of roof

All cells of the groups have individual entrances. The territory of the kindergarten is divided into two zones: the technical zone and the children's zone. The technical zone is used for delivery of food to technical module. The children's zone is equipped with playgrounds and a sport field. These two zones are separated from each other by a hedgerow. The road around the kindergarten provides access to the building in case of an emergency. The plan of territory is presented below (Figure 17).

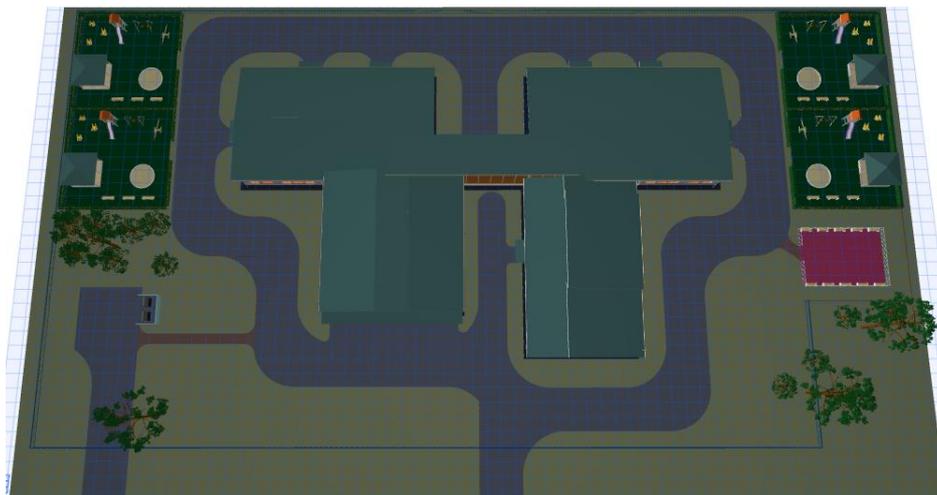


FIGURE 17. Plan of territory of kindergarten

5 DISCUSSION

Building from glue laminated wooden log is a new technology for Russia. The glue laminated wooden log is often used in individual house's construction area. In this case it does not need to have Russian certificate of quality for construction materials. So, it means that individual wooden houses in Russia are built according to Finnish certificates. However, when it comes to administrative buildings the Russian regulations have to be followed. The customer company does not have Russian certificates of quality for their material, that is why the research was done.

Currently, Russian government supports the construction of kindergartens, and this field is well financed. A wooden kindergarten is an absolutely new idea for Russia. This construction market is not occupied by other companies. The Kontio company has a good chance to promote their product to the Russian market.

The created building is a result of the research; it corresponds to today's Russian norms and regulations. It has modern design, concise form, comfortable planning and can be successfully sold.

The AutoCad program is a really useful graphic design program. It is convenient for working in 2D mode, when the plan of building is being created. AutoCad is like an electronic drawing paper and pencil. After the plan has been done, it is better to use 3D Graphic Design Program to create a 3D model of the building.

The ArchiCad program was chosen for creating of the 3D model. The interface and visual perception of the basic shell are informative and understandable. The program allows to design the building fast and easy. The data for any structure is introduced in options and the program delineates them. The program creates the section and facades by itself. The model was created in ArchiCad and can be saved in different formats.

To conclude, this research showed that it is possible to build a wooden building as a kindergarten using Finnish technologies and Russian norms. Before the construction begins, it is recommended to receive an approval for laminated wooden log from Russian certification system of quality.

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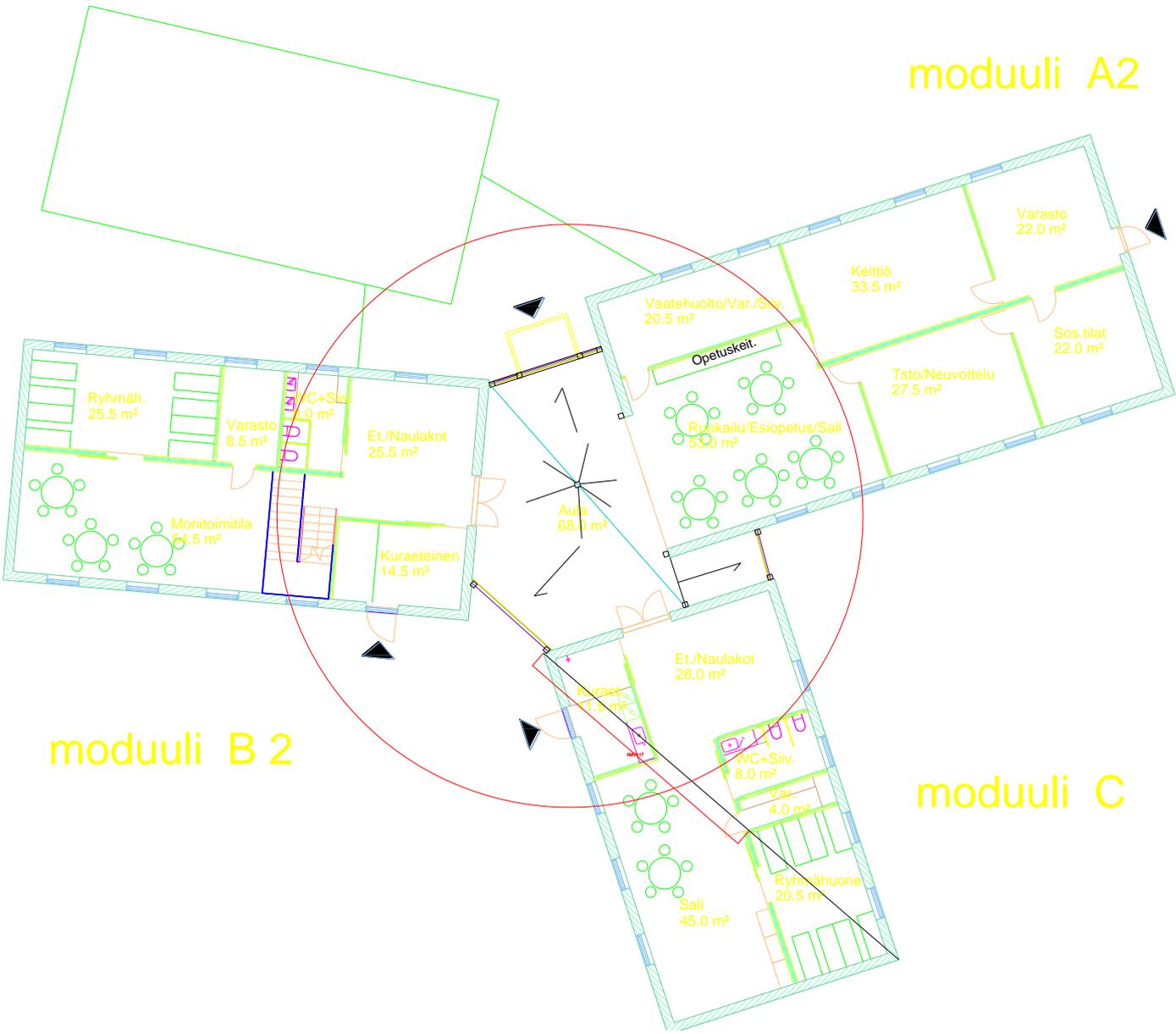
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APPENDICES

- APPENDIX 1 The plan of Kindergarten in Pudasjärvi by Kontio company
- APPENDIX 2 RMD 31-07-2009 Design guide preschool educational institutions in
Saint Petersburg 2010, appendix A, tables A2, A4, A5
- APPENDIX 3 Drawings by Margarita Borisova

The plan of Kindergarten in Pudasjärvi by Kontio company

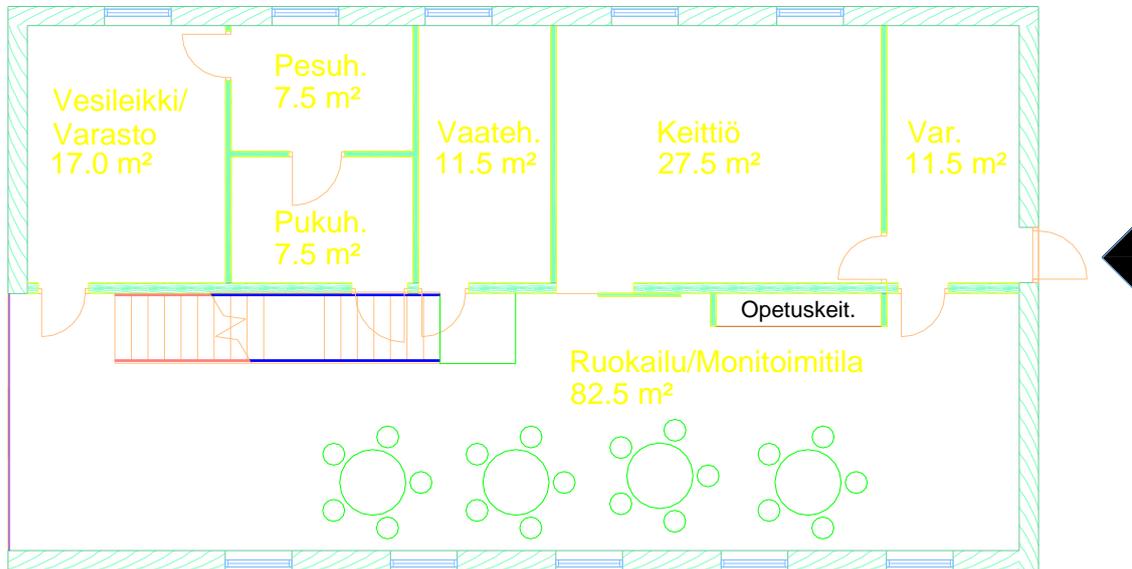


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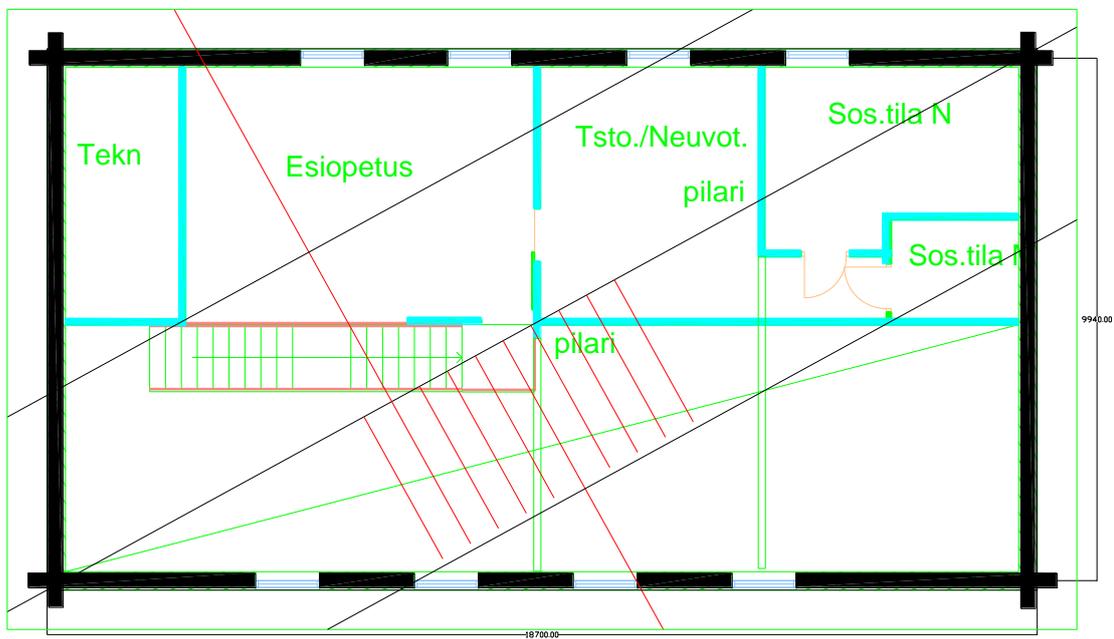
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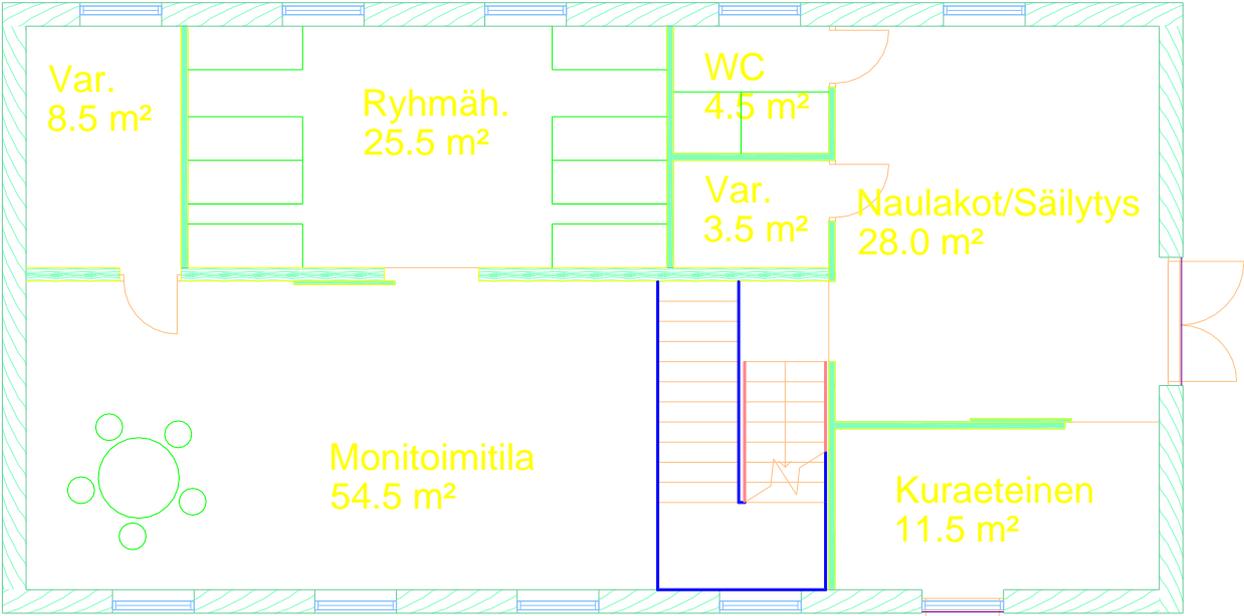
Module A by Kontio company, first floor



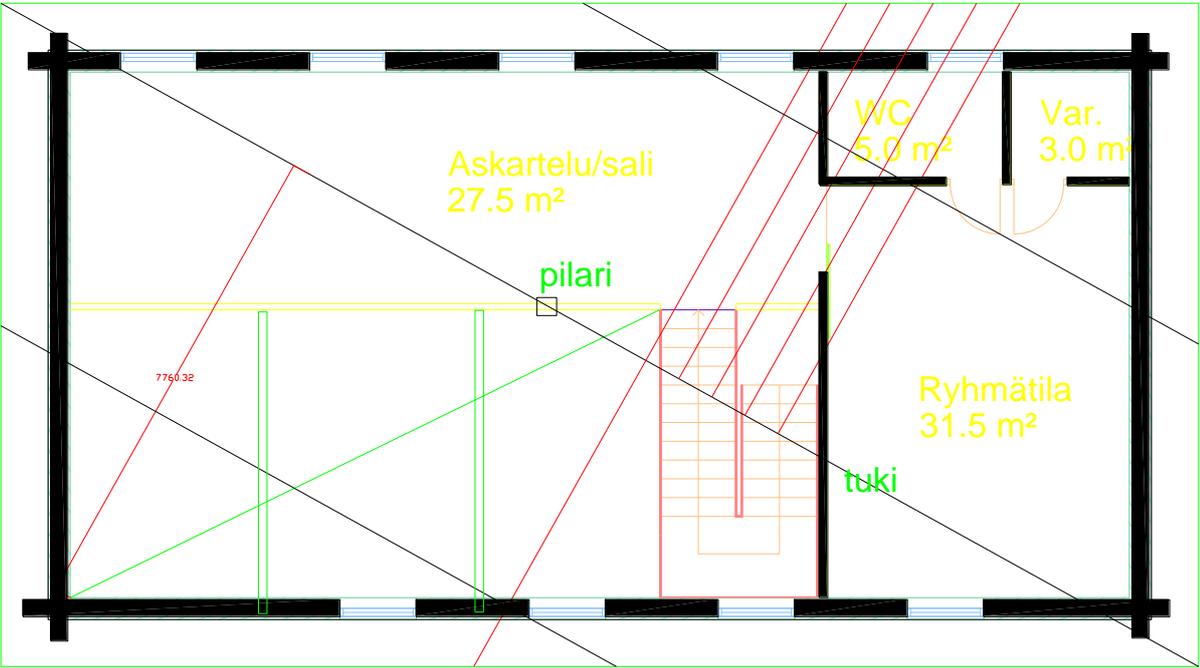
Module A by Kontio company, second floor



Module B by Kontio company, first floor



Module B, second floor



Reference:

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RMD 31-07-2009 Design guide preschool educational institutions in Saint Petersburg 2010, appendix A, tables A2, A4, A5

Table A.2 – Composition space groups' cells: basic elements

Type of groups of the children	Basic elements					
	Dressing room	Playroom	Room for activities	Bedroom	Scullery	Bathroom
1	2	3	4	5	6	7
Group of children's age from 1,5 to 3 years old (universal nursery group)	n	n	r	n	n	n
Uneven aged group of children aged from 1 year to 3 years	n	n	r	n	n	n
Uneven aged group of children aged from 3 to 7 years (universal preschool group)	n	n	n	n	n	N
Uneven aged group of children aged from 3 to 7 years	n	n	n	n	n	n
Group of children from 5 to 7 years	n	n	n	n	n	n

Legend:

n – premises, necessarily involve;

r – premises recommended for selection.

Table A.4 – Area of the basic premises of groups' cells

Basic premises of groups' cells	Area of the basic premises, m ² (not less than)
1	2
Playroom	50
Bedroom	50
Dressing room	18
Scullery	3,8
Bathroom	16

Table A.5 – Area is recommended for additional premises of the cell of the group

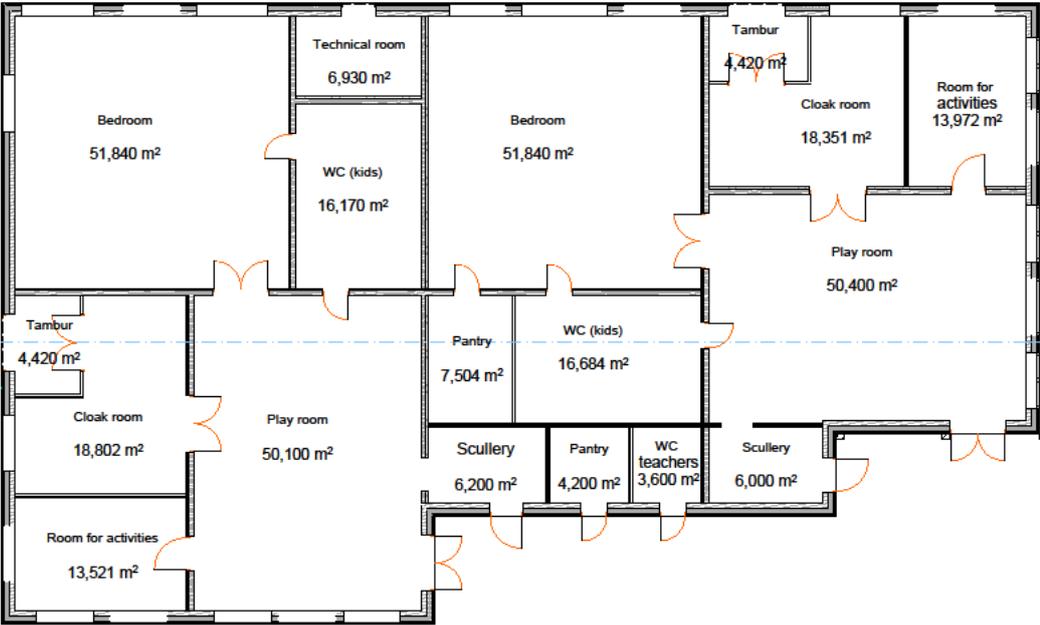
Names of additional premises	Area of premises , m ²
1	2
Rooms for activities	12
Room of psychological relaxation and individual work with child ("Home Area")	6
Spatial module sports game equipment	4
Area of fine arts, sculpture, games with clay, water, paint	4
Spatial module replacement game equipment	4-6
Staff room with bathroom	6
Glass-covered veranda or open terrace	According to the design task or project
Notes: 1 Spatial Module - a planning element of gaming space group's cell area of 4.0-10.0 m ² , specialized by type of role-playing games, or creativity and properly equipped. 2 Room for games and activities children can be used as a room for psychological relief.	

Reference:

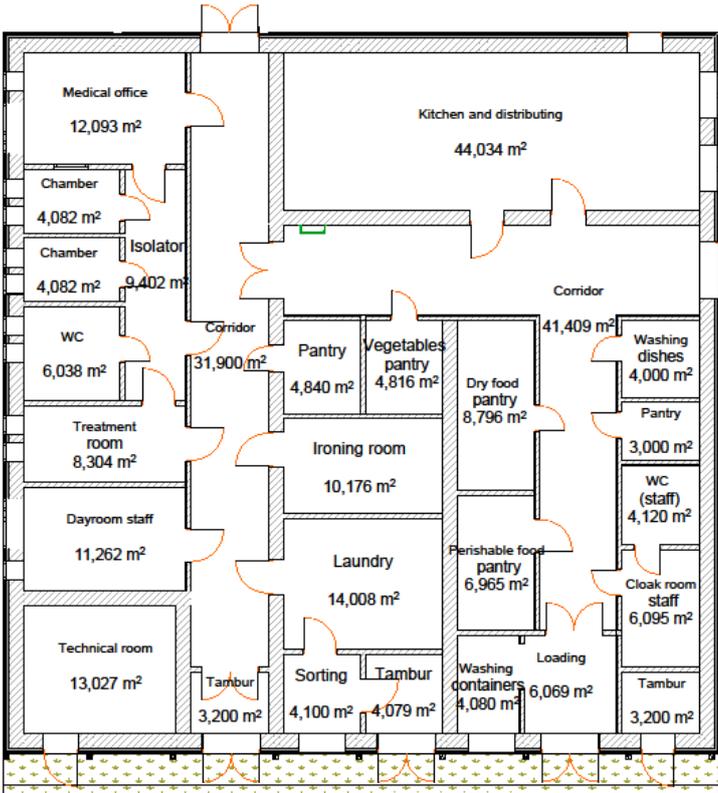
RMD 31-07-2009 "Design guide preschool educational institutions in Saint Petersburg"

Drawings by Margarita Borisova

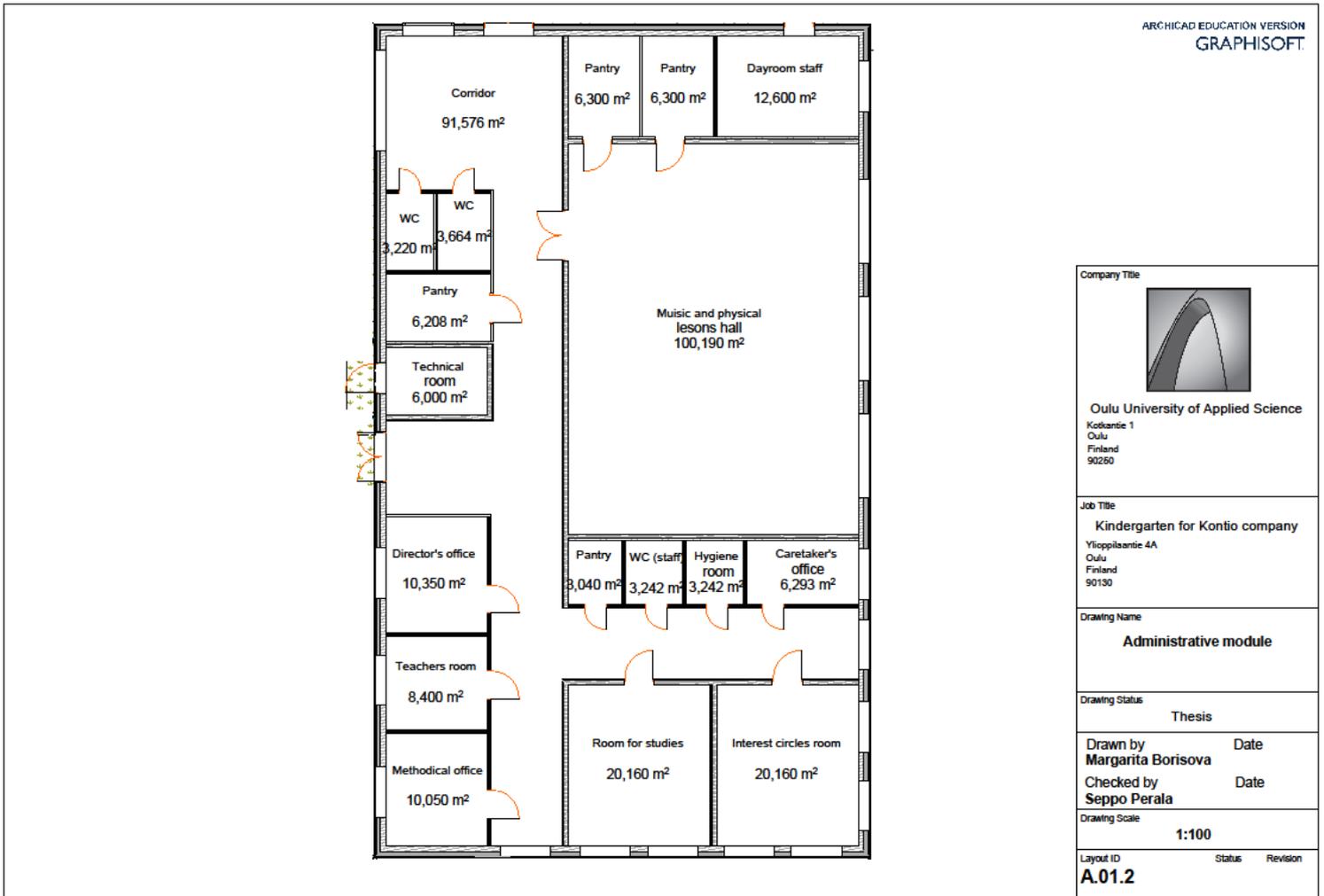
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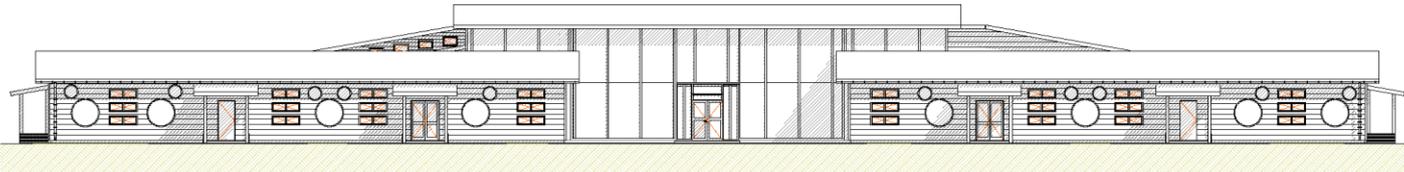
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Oulu University of Applied Science Kotkan tie 1 Oulu Finland 90260	
Job Title	
Kindergarten for Kontio company Ylioppilaskatu 4A Oulu Finland 90130	
Drawing Name	
Group module	
Drawing Status	
Thesis	
Drawn by	Date
Margarita Borisova	
Checked by	Date
Seppo Perala	
Drawing Scale	
1:100	
Layout ID	Status Revision
A.01.2	



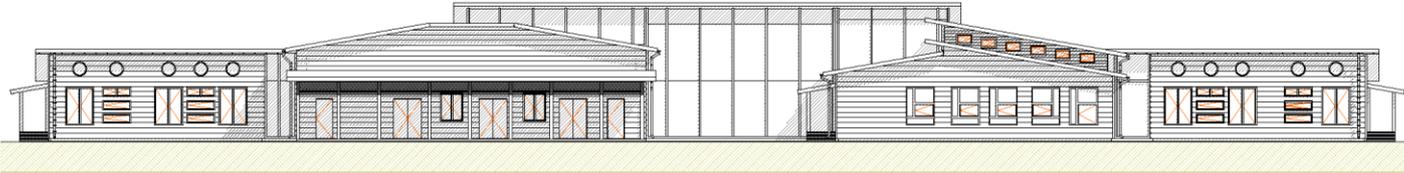
Company Title	
	
Oulu University of Applied Science Kotkanie 1 Oulu Finland 90260	
Job Title	
Kindergarten for Kontio company Ylioppilantie 4A Oulu Finland 90130	
Drawing Name	
Technical module	
Drawing Status	
Thesis	
Drawn by	Date
Margarita Borisova	
Checked by	Date
Seppo Perala	
Drawing Scale	
1:100	
Layout ID	Status Revision
A.01.2	



North Facade



South Facade



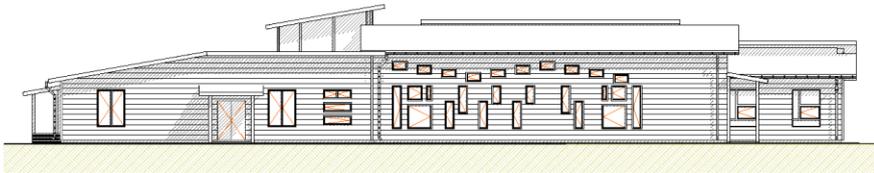
East Facade



East Elevation

1:100

West Facade



Company file



Oulu University of Applied Science
Bachelor's 1
Faculty
Faculty
Faculty

Job file
Kindergarten for Kontio company

Project file
Project
Project

Drawing name
Plan of Facades (second variant)

Drawing status
Thesis

Client by
Mergelä Architects

Client
Date

Checked by
Mergelä Architects

Checked
Date

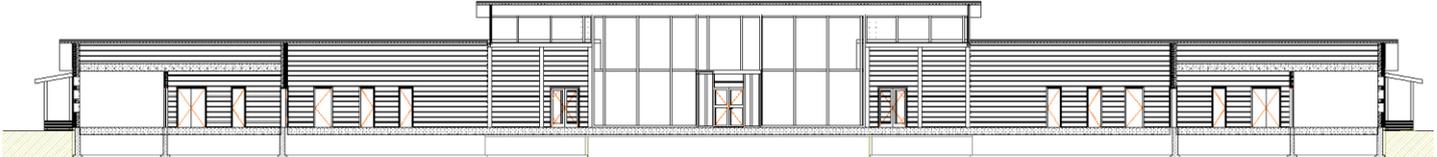
Drawing scale
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Drawing ID
A.02.1

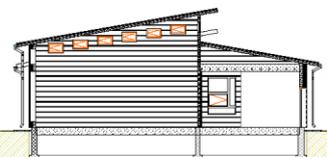
Status Revision



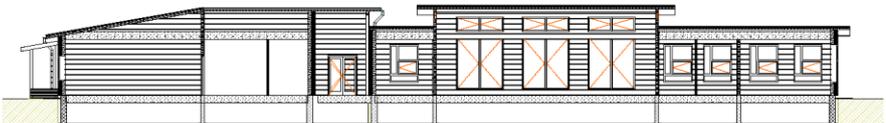
S-01 Building Section 1:100



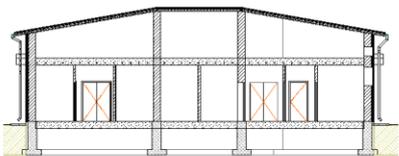
S-07 Building Section 1:100



S-04 Building Section 1:100



Building Section 1:100



S-05 Building Section 1:100



S-06 Building Section 1:100

 <p>Oulu University of Applied Science</p>	
Institute 1 Date: 10/2010 Project: 82510	
Job Title: Kindergarten for Kontio company Date: 10/2010 Project: 82510	
Drawing name: Sections	
Drawing State: Thesis	
Created by: Margareta Mattsson	Date:
Checked by: Sappi Purtila	Date:
Drawing Scale: 1:100	
Layout ID: A.03.1	State: Revision:









