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Revitalization of Wooden Apartments as a Tool to Deal with Shrinkage – Case study from Valga

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Valga is a small shrinking town in South Estonia. The study focuses on the possibilities of solving the problems connected with apartment houses by using the disposition of apartments and improving energy efficiency to meet the contemporary standards of living space and getting buildings in public possession.

Keywords: shrinking cities, housing, urban brownfields, urban decline, post-soviet country, energy performance of buildings.

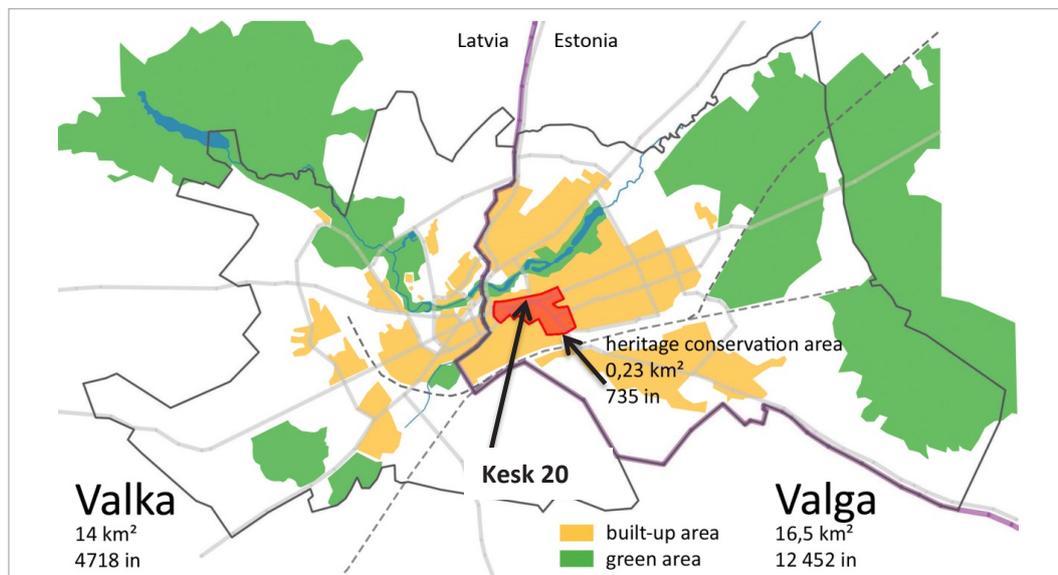
Introduction

Valga is a small shrinking town in South Estonia on the border of Latvia. Valga has lost 33% of its population since 1981 and 28% of the town territory is underused or abandoned.

There are 358 apartment buildings in Valga and 146 of them have wooden constructions. 22 wooden apartment buildings lie within the heritage conservation area (Fig. 1). Typical wooden apart-

Fig. 1

Schematic plan of
Valga-Valka
(Tintera et al. 2018)



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ment buildings have small apartments without bathrooms and with shared toilets in unheated areas. A large share of unused residential and business properties results in a fall in real estate prices. In 2017, the average price of a flat was less than 150 euros per square meter. A low price prevents owners from selling their properties and investment in housing is not lucrative for private sector. The result is the domination of low-quality living premises.

Six apartment buildings have been demolished in Valga during the last three years. The demolished buildings have been replaced with low-cost temporary public green areas. The residents would welcome even more rapid demolition works, however, this is delayed by the complicated ownership relations of the abandoned buildings. Still, not all the abandoned buildings should be demolished. The entirety of central Valga is a protected heritage site (Fig. 1) and it is complicated for demolition works to take place there. Also, abandoned buildings in other parts of the city are often of significant historic and architectural value and important elements of the urban landscape. To save at least some of these buildings from complete ruin, new uses must be found for them.

There are no high-quality rental flats on the market, even though there is no lack of demand. Both public institutions (the city government, the hospital, schools etc.) and entrepreneurs have been complaining about the lack of specialised labour. However, it is difficult to attract specialists to Valga because there are no high-quality living spaces on offer. To alleviate this problem that is hindering the city's development, the public sector – i.e. the local government with the help of the state – must interfere at least temporarily with the free market. From 2017 Ministry of Economic Affairs and Communications distributes investment for local governments to support housing development (Elamufondi arendamise investeringutoetus...; Kohaliku omavalitsuse üksuse....)

The support may be up to 50% of the total project cost and is applied to municipal rental apartments – either new buildings or reconstruction. In this case the building has to be completely owned by the local government. The project does not have to be totally cost effective, otherwise the private sector will deal with the problem. Benefit will be a uniform city centre on the area of cultural heritage value enabling the mobility of specialists necessary in the area. Of course, the houses must be self-acting during the exploitation later. That is an important aspect for getting support – documents have to be prepared.

The paper examines on the case study of Keskk 20 apartment housing technical possibilities of building conversion on high quality rental premise.

The phenomenon of shrinking cities has been recently widely examined by scholars. Researchers concentrate on different aspects of urban shrinkage: economic (Bogataj, et al. 2016), social (Hollander and Németh 2011; Großmann, et.al. 2015; Ročák, et.al. 2016), impacts of shrinking population on land use (Kroll and Haase 2010; Chengbin and Ma 2015), and the challenges of urban governance of shrinking cities (Wiechmann 2008, Rhodes and Russo 2013). The term “shrinking city” is used for a city which is losing its population together with its economic importance (Reckien and Martinez-Fenandez 2011; Martinez-Fernandez et al. 2012; Kotilainen et al. 2015; Bernt, 2014; Sousa and Pinho 2015; Wiechmann and Bontje 2016). The main drivers of shrinkage as such are economic decline with job losses and out-migration, suburbanisation and natural population decline (Reckien and Martinez-Fenandez 2011; Martinez-Fernandez et al. 2012; Großmann et al. 2015; Haase, et al. 2016).

Urban shrinkage results in falling property values, over-dimensioned and underused infrastructure, social problems, out-migration, and waning social life and public spaces (Sousa and Pinho 2015). Two of the most prominent symptoms of shrinkage are housing vacancies and urban brownfields (Wiechmann and Pallagst 2012; Haase et al. 2016). The overcapacity of houses and the outdated state of maintenance cause the decrease of real estate values (Elzerman and Bontje 2015; Bernt, et al. 2017). The private sector is not interested in investing in renovating properties

Causes and consequences of urban shrinkage

or building new apartment buildings. The result is the predominantly low quality of residential premises and the lack of quality apartments. When the quality of life in an apartment building continues deteriorating, those who can do so move out. Apartment owners with the lowest income remain in the building, but they cannot afford to pay for maintenance and the building becomes uninhabitable (Prada-Trigo 2015).

The main problem with the owners in Valga is that there are a lot of different owners, some of them live abroad. Some buildings are in a condition which is not safe for living – the apartments are unusable and their real value is negative (need expenses to demolition or repair). There is very little demand on real estate market at all and no demand for that kind apartments. In that case the owner can gift the apartment to the local government. Some apartments are burdened with mortgages. In that case they cannot just gift their property and the local government must find a way how to manage the loans and mortgages.

There is (in reality mostly theoretical) possibility that an owner wants to remain an owner and keep the apartment but in that case all the expenses must be covered by them and that part of building is not the subject for support.

The local government cannot massively buy the apartments unless the building has architectural or cultural heritage value. Some residents have been relocated to other apartments in buildings in a better condition.

Today buildings must meet energy requirements and offer comfortable indoor environment. If they are on heritage conservation area, it is most important to offer comfortable indoor environment.

Air tightness is the biggest problem in older wooden buildings. Studies carried out in Tallinn University of Technology (Kalamees, et.al. 2011) found that the average values of air leakage rates for wooden apartment buildings was $q_{50}=10 \text{ m}^3/(\text{hm}^2)$. Minimum and maximum values registered as 3.8 and $22 \text{ m}^3/(\text{hm}^2)$ accordingly. In brick and reinforced concrete panel buildings the average air leakage rate was only $4.0 \text{ m}^3/(\text{hm}^2)$. According to the minimum requirements for energy performance valid in 2018 (Hoone energiatõhususe miimumnõuded) the average leakage rate of a building envelope may not exceed one cubic metre per hour and per square metre of the building envelope ($\text{m}^3/(\text{hm}^2)$) and $1.5 \text{ m}^3/(\text{hm}^2)$ for energy calculations. In methodology for calculating the energy performance of buildings valid in 2018 (Hoone energiatõhususe arvutamise meetodika) base values (without measured air leakage rates) $3 \text{ m}^3/(\text{hm}^2)$ for new buildings and buildings after major renovation, and $6 \text{ m}^3/(\text{hm}^2)$ for existing and renovated buildings are given.

Material and methods

Fig. 2

View from North - backyard



The paper looks at the case study of Kesk 20 wooden apartment buildings which has the problems described above (Fig. 2). The building technical condition is unsatisfactory, and the layouts of apartments inside has morally depreciated. Following the used measures: 1) changes in room dispositions, 2) improving energy efficiency, 3) the ownerships constrains have been described.

Kesk 20 was built in 1917 and is situated in the town centre of Valga. Most of its structures are made of timber - log as wall bearing construction and beams for floor and ceiling. Most of the rooms in the building have originally been planned as walk-through rooms (Fig. 3). Toilets and bathrooms are missing as the building is not connected to water and sewage network. The building used to have ten apartments (5 on the first floor) (Fig. 3). The apartments are equipped with stove heating and wood cookers, and the staircases are in unheated area.

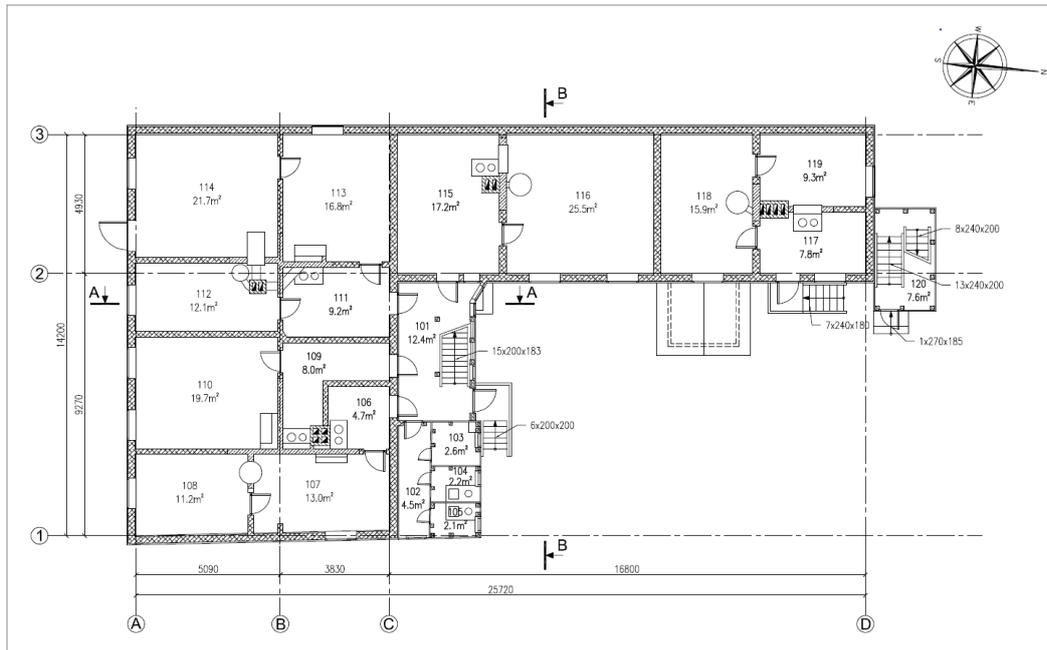


Fig. 3

Plan with initial planning of first floor (Pai 2015)

The building like other similar ones is inefficient in energy use. A log construction (240 mm) without insulation offers approx. value $U=0.5 \text{ W}/(\text{m}^2\text{K})$ (EVS 908-1:2016). The ceilings and floors in that kind of buildings are often in a condition which is hard to estimate. A ceiling without any insulation or filling has $U=1.36 \text{ W}/(\text{m}^2\text{K})$, with porous filler (sawdust, peat, $\lambda=0.116 \text{ W}/(\text{mK})=0.10 \text{ kcal}/\text{hm}^\circ\text{C}$, Jürgenson, 1949) $U=0.38 \text{ W}/(\text{m}^2\text{K})$. Floor is a timber floor on dry sand - $U=0.49 \text{ W}/(\text{m}^2\text{K})$ if to take into account the values of dry sand ($\lambda=0.86 \text{ W}/(\text{mK})=0.75 \text{ kcal}/\text{hm}^\circ\text{C}$; Jürgenson 1949) and $U=0.57 \text{ W}/(\text{m}^2\text{K})$ if to consider only ground $\lambda=2 \text{ W}/(\text{mK})$ (EVS-EN ISO 13370:2017).

The windows in the building need renovation or replacement. Minimum possibility is to repair the windows and improve the heat resistance by adding double glaze package and air tightness.

Energy simulation for whole building system energy performance was not performed because the idea was to concentrate on the borders and the building itself.

Total specific heat loss of the building envelope per square metre of heated area $\Sigma H/A_{\text{heated}} \text{ W}/(\text{m}^2\text{K})$ can be calculated by formula 1 (Liginullenergia eluhooned):

$$\Sigma H/A_{\text{heated}} = \frac{\sum U_i \cdot A_i + \sum \psi_j \cdot l_j + \sum \chi_p \cdot n_p + \rho_a \cdot c_a \cdot V_{\text{inf}}}{A_{\text{heated}}} \quad (1)$$

where: U_i is thermal transmittance of element of building envelope $\text{W}/(\text{m}^2\text{K})$; A_i is area of element of building envelope m^2 ; ψ_j is the thermal transmittance of the linear thermal bridge in $\text{W}/(\text{mK})$; l_j is the length of the linear thermal bridge in metres; χ_p is the thermal transmittance of the point thermal bridge in W/K ; n_p is the number of similar point thermal bridges in the building envelope; ρ_a – air density, $1.2 \text{ kg}/\text{m}^3$; c_a – specific heat of air, $1.005 \text{ kJ}/(\text{kgK})$; A_{heated} – heated area m^2 ;

The infiltration air flow rate \dot{V}_{inf} (m^3/s) is calculated by the means of the Formula 2:

$$\dot{V}_{\text{inf}} = \frac{q_{50} \cdot A}{3600 \cdot X} \quad (2)$$

where: q_{50} is the average air leakage rate in $\text{m}^3/(\text{h}\cdot\text{m}^2)$ of the building envelope; A is the area of the building envelope (including floors) in m^2 ; x is the factor which is 35 in the case of a single-storey building; 24 in the case of a two-storey building; 20 in the case of a three to five-storey building.

The apartments in the building are privately owned and often co-owned which means that the building has dozens of owners. Two of the apartments are mortgaged, part of an insolvent estate, some of the owners live abroad. All this requires time-consuming and complicated negotiations to get apartments in public property.

Results and Discussion

The paper focuses on the revitalization of apartment buildings lying within the heritage conservation area of Valga town. Also, the paper presents architectural (Fig. 4) and technical solutions for building reconstruction. The reconstruction project (Pai 2015) designs 8 apartments (4 on the first floor) (Fig. 5). There will be one one-room, two two-roomed and one three-roomed apartment. The staircase will be indoors. The cold toilets will be demolished. The disposition of apartments

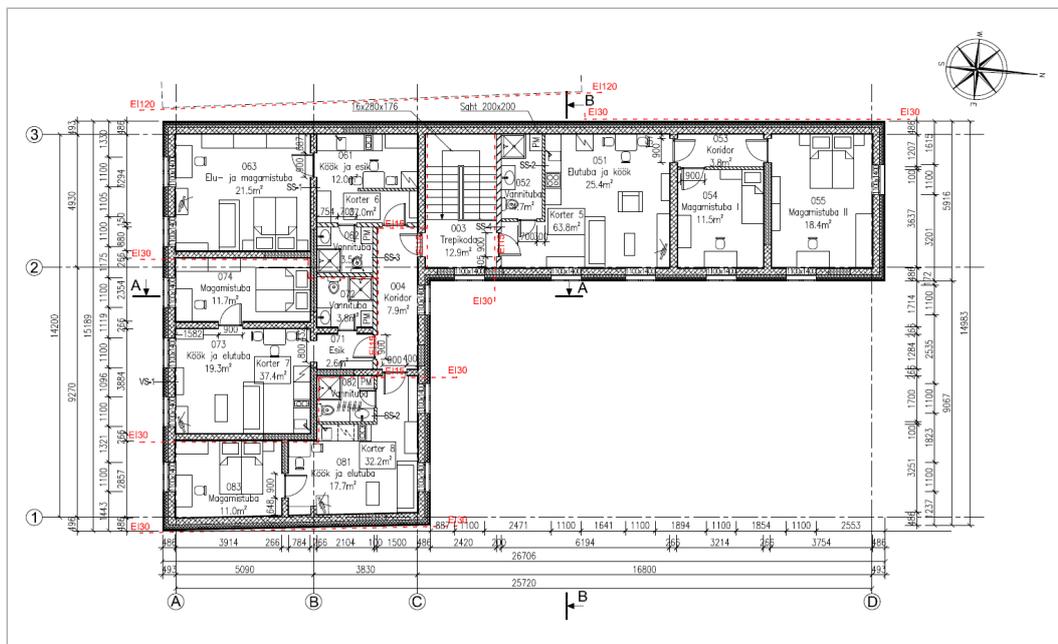
Fig. 4

Facade of the building – view from South (Pai 2015)



Fig. 5

Plan of the first floor after redesign (Pai 2015)



will be re-designed to meet the contemporary standards of living space. Additional exterior insulation is planned to be added (Fig. 6) and most importantly - the living environment will be modernized. There will be a comfortable private bathroom in every apartment.

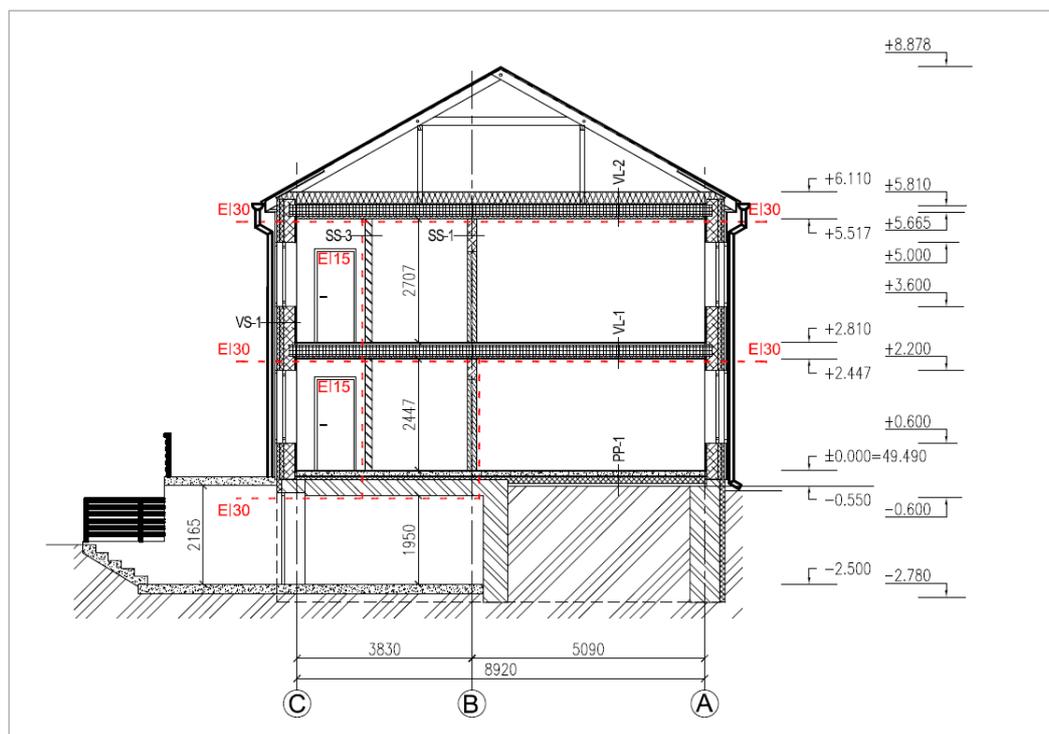


Fig. 6

Cross section of building (A-A on Fig. 5, Pai 2015)

Additional exterior insulation ($\lambda=0.33$ W/(mK), 150 mm) and wind retarder of 13 mm will make the thermal transmittance $U=0.15$ W/(m²K) for walls.

After the renovation of the floor (slab on ground) with insulation 150 mm XPS thermal transmittance will result in $U=0.17$ W/(m²K), which is not the best suggested value according to energy performance requirements, but the value is improved compared with the initial about three times. The attic floor can be quite easily improved by replacing the insulation between the beams (250 mm) and adding extra insulation of 250 mm, $U=0.07$ W/(m²K).

Specific heat loss for building ΣH , W/K was estimated (Table 1). Thermal transmittance values for linear thermal bridges are tabulated values from energy efficiency regulation.

Air tightness is an important component in energy efficiency: range of air leakage rate q_{50} from 1.5 to 10 m³/(hm²) will change the total specific heat loss of the building envelope 97.3 W/K. If the air leakage rate $q_{50}=1.5$, specific heat loss caused by infiltration $H_{\text{air leakage}}=17.2$ W/K and in case of $q_{50}=10$ m³/(hm²) $H_{\text{air leakage}}=114.5$ W/K. If base values 3 or 6 m³/(hm²) are used, 34.3 and 68.7 W/K will be the results of calculations.

Specific heat loss for the whole building at base value of air leakage 3 m³/(hm²) will be 300.5 W/K (Table 1) and delivered energy (Valga, balance temperature 15 C, 3617 degree days) and 67.9 kWh/(m²year). Variation in air tightness will change the values for specific heat loss from through the building envelope 283.3 to 380.6 W/K and delivered energy values from 64.1 to 86.1 kWh/(m²year).

Wooden building indicates that there is extra necessity to follow the fire safety requirements. Indoor wooden walls will be preserved and covered with gypsum board. Wooden or metal-stood partitions will be used instead of demolished brick wall and for new partitions.

Table 4

Specific heat loss of the building envelope

Heat loss through building envelope				Heat loss through thermal bridges			Heat loss through air leakage				
Item of envelope	g - W/(m ² ·K)	U_i , m ²	A_i , m ²	$H_{conduct}$ W/K	Thermal bridge	ψ_i , W/(m·K)	l_i , m	H_{linear} W/K	Item	Number	
Exterior wall	0.15	341.2	51.2		External corner of exterior wall	0.30	26.2	7,9	air-leakage rate q50, m ³ /(h·m ²)	3.0	
Attic floor	0.07	214.0	15.0		Exterior wall – ceiling	0.20	80.0	16.0	A_{vp} (building envelope), m ²	820.0	
Slab floor	0.17	214.0	36.4		Exterior wall – attic ceiling	0.20	80.0	16.0	Number of floors	2.0	
Door	1.00	4.8	4.8		Exterior wall – slab floor	0.30	80.0	24.0	\dot{V}_{inf} , m ³ /s	0.0285	
Windows	1.60	46.0	73.6		Junction window and exterior wall	0.10	145.2	14.5			
					Junction door and exterior wall	0.10	13.2	1.3			
					Exterior wall – interior wall	0.10	65.3	6.5			
					Interior corner of exterior wall	-0.20	5.2	-1.0			
Total	$H_{conductivity}$	W/K	180.9		$H_{linear\ thermal\ bridge}$	W/K	85.2		$H_{air\ leakage}$	W/K	34.3
Total specific heat loss of the building envelope					ΣH , W/K				300.5		
Average thermal transmittance of the envelope					$\Sigma H/A_{vp}$				0.4		
Heated area					A_{heated} , m ²				383.9		
Total specific heat loss of the building envelope per square metre of heated area					$\Sigma H/A_{koetav}$				0.78		

The building belongs to Fire Safety class TP3. Fire resistance class for fire protection construction is EI30 and will be achieved with using two layers of gypsum board for wooden or metal-stood partitions.

Conclusions

Shrinking population has several outcomes on urban areas. One of them is the prevalence of low quality and underfinanced maintenance housing stock. This results in housing vacancy and abandoned and underused apartment houses. The study shows that buildings can be quite easily revitalized. The main barrier of such revitalization is ownership constraints, not technical issues. Public investments in revitalization of wooden apartment building and creation of municipal apartment stock offer citizens high quality living space and helps or enables to stabilize the population of shrinking towns.

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