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## ENERGY EFFICIENCY TREND IN THE LATVIAN RESIDENTIAL PROPERTY MARKET

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**Abstract.** This research examines the influence of energy efficiency on the residential real estate market in Latvia, highlighting its environmental and socio-economic aspects. The impact of laws, regulations, and market dynamics on energy efficiency enhancements is also highlighted, outlining current trends, regulatory structures, and economic elements that facilitate or obstruct the implementation of energy-saving initiatives. Special emphasis is placed on the impact of these policies on residential property prices, market dynamics, and the relationship between supply and demand. This research analyzes energy-related regulations and identifies deficiencies in the regulatory framework, elucidating the intricate relationship among law, market dynamics, and consumer behavior. The research mainly relies on empirical study methods, outlining the basis for a well-defined approach to evaluation, performance, and energy-saving solutions in the Latvian residential sector. The data was acquired by circulating a detailed survey among industry experts and residents of Latvia. The data was thoroughly evaluated using multiple regression analysis to estimate the property values in Latvia, which is impacted by numerous variables. The IBM SPSS program was used for statistical analysis.

**Keywords:** *energy efficiency, residential property market, Latvia, multiple regression analysis.*

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### INTRODUCTION

Latvia still faces certain challenges in enhancing the energy efficiency of its real estate sector (Blumberga et al., 2021), namely, its residential segment. Residential real estate in Latvia accounts for around 30 % of overall energy consumption, with heating being the most major contributor due to the country's frigid environment. In terms of carbon dioxide emissions, the building industry accounts for around 25 % of the national total.

The residential real estate market in Latvia consists of three primary categories: Soviet-era multi-apartment buildings, freshly constructed multi-apartment complexes, and single-family homes. Each category embodies unique historical, economic, and socio-demographic patterns that influence housing market dynamics. Soviet-era multi-apartment edifices comprise a significant segment of

the housing inventory in Latvia, especially in metropolitan locales such as Riga, Daugavpils, and Liepaja. Residential buildings alone account for 44 % of the total building area and comprise a major proportion of the country's overall energy consumption (Kundziņa et al., 2023).

The construction of these buildings mostly occurred between 1965 and 1990, aimed at mitigating severe housing shortages during the socialist period of the Soviet Union. Constructed using conventional designs and materials, they often exhibit inadequate thermal insulation and run-down infrastructure. Research indicates that these structures are among the most significant users of heating energy, particularly in winter, owing to suboptimal heat transfer coefficients and deteriorating heating systems (Borodinecs et al., 2017). Notwithstanding their shortcomings, these structures are essential for offering inexpensive housing alternatives to a significant segment of the population. Enhancing these structures for energy efficiency and longevity has become imperative in accordance with Latvia's obligations to the EU energy regulations and sustainable development objectives (Borodinecs et al., 2015).

Renovation of Soviet-era residential buildings has been a major priority. These buildings, constructed with minimal regard for energy efficiency, account for a major part of Latvia's housing stock (LSM.lv, 2021). The Latvian government, with the help of EU funds, has launched programs to increase thermal insulation, upgrade heating systems, and install more energy-efficient windows and doors (Cilinskis et al., 2017). However, the current rate of energy-effective renovations in Soviet-era multistory apartment houses is insufficient to satisfy the EU's long-term energy efficiency objectives in the national context.

The research analyzes energy-related regulations and identifies deficiencies in the regulatory framework, elucidating the intricate relationship among law, market dynamics, and consumer behavior. The research mainly relies on empirical study methods, outlining the basis for a well-defined approach to evaluation, performance, and energy saving solutions in the Latvian residential sector. The data was acquired by circulating a detailed survey among industry experts and residents of Latvia. The data was thoroughly evaluated using multiple regression analysis to estimate the property values in Latvia, which is impacted by numerous variables. The IBM SPSS program was used for statistical analysis.

## **1. RESIDENTIAL SECTOR'S ENERGY CONSUMPTION IN LATVIA**

Latvia's residential energy consumption, measured in toe (tons of oil equivalent per dwelling), shows a noticeable trend when compared to other European countries. In 2000, Latvia had a consumption of approximately 1.4 toe/dwelling, which placed it in the mid-range among the EU countries. Over the years, Latvia experienced a modest decrease in energy consumption, reaching about 1.3 toe/dwelling in 2014 and 1.2 toe/dwelling in 2019. This declining trend suggests an improvement in energy efficiency or changes in energy usage patterns, aligning with broader European efforts to reduce energy consumption in residential sectors.

When compared to countries with initially higher energy consumption, such as Luxembourg and Belgium, Latvia's reduction is more consistent and significant.

For example, Luxembourg started with a notably high energy consumption of around 3.1 toe/dwelling in 2000, dropping to 2.6 toe/dwelling by 2019, yet it remains significantly above Latvia's levels.

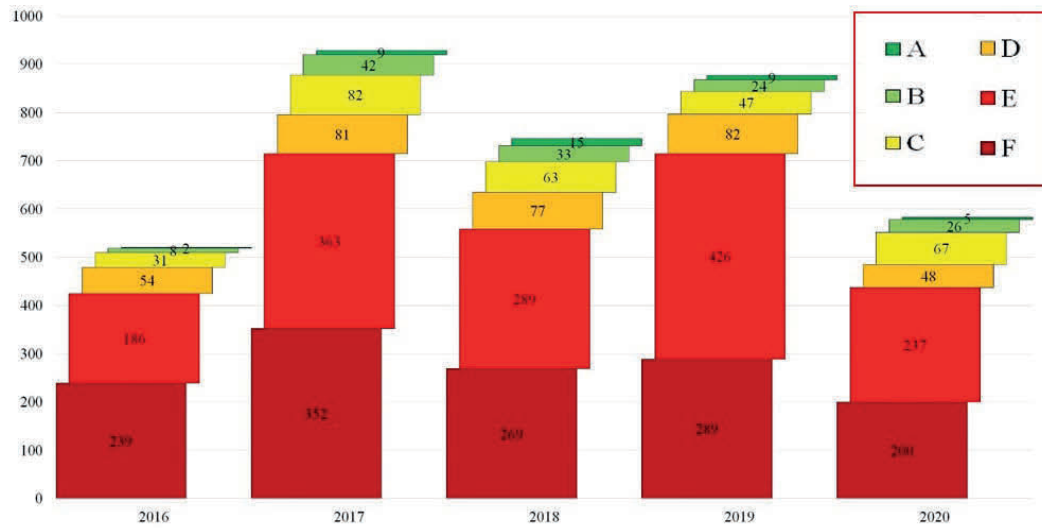
Similarly, Belgium reduced its consumption from around 2.0 toe/dwelling in 2000 to 1.7 toe/dwelling in 2019, which, although substantial, keeps it well above Latvia. On the other hand, countries with similar starting points, like Poland and the UK, have shown varying rates of reduction. Poland, which started with a consumption rate close to Latvia's in 2000, has decreased less sharply, maintaining slightly higher levels by 2019. The UK, despite starting at a higher level, also shows a decrease, but it remains consistently above Latvia's figures. This indicates that while Latvia's energy consumption reductions align with broader European trends, it has managed to achieve these reductions relatively more effectively than some other comparable nations. In contrast, countries with lower initial consumption, such as Malta and Portugal, have seen less dramatic changes over time.

The economic impediments to implementing energy-efficient measures further confuse consumer perceptions. Borodinecs et al. (2017) note that a major number of Latvian residential structures erected between 1965 and 1990 are energy inefficient and need extensive repair to meet current norms. The financial load connected with these modifications is a big impediment for many customers. The expenditure required in upgrading buildings to near-zero energy requirements typically surpasses the immediate financial gains seen by homeowners and renters. This economic problem impacts customer attitudes, since the high costs of rehabilitation might prevent investment in energy-efficient upgrades, despite their long-term advantages. The cost consequences of such modifications are key variables that drive consumer preferences and underline the need for supporting measures that help reduce these economic constraints.

Energy consumption in Latvian buildings is directly linked to many important criteria, including the overall size of the building, the construction materials employed, and the performance of heating and ventilation systems. Larger structures, such as multi-apartment complexes, tend to demonstrate greater absolute energy consumption owing to their wide surface areas and more complicated heating needs (Prozuments et al., 2023). However, the execution of full rehabilitation packages, including better insulation, facade enhancements, and the installation of energy-efficient heating systems, has shown considerable savings in energy usage.

For instance, in research assessing restoration projects in Latvia, completely renovated multi-apartment residential structures showed an average 50.59 % decrease in thermal energy consumption, with additional advantages found in enhanced interior air quality and comfort (Prozuments et al., 2023).

Figure 1 illustrates the distribution of energy performance levels (A, B, C, D, E, and F) in Latvia from 2016 to 2020, highlighting the prevalence of lower energy performance levels, especially levels E and F. Throughout all years, these two groups constitute the predominant share of instances, indicating a pervasive inefficiency in energy performance nationwide.



**Fig. 1.** The distribution of energy performance levels in Latvia from 2016 to 2020 (Doroņins, 2021).

In 2016, the aggregate number of cases was 521, with levels F and E accounting for 239 and 186 instances, respectively. Elevated energy performance levels (A, B, and C) were a mere fraction, with level A including just 2 instances, level B 9 instances, and level C 31 instances, underscoring a considerable disparity between low and high energy performance. In 2017, the overall number of cases surged to 850, propelled by a notable increase in levels F (352 cases) and E (363 cases). This year was the apex of supremacy for these two tiers. Levels D and C had modest rises to 81 and 42 instances, respectively, while levels A and B remained minimal, with 3 and 9 cases apiece. This distribution indicates that while the quantity of energy performance evaluations rose, the total energy efficiency did not exhibit substantial improvement. By 2018, the overall number of cases decreased to 746, with levels F and E remaining predominant at 269 and 289 instances, respectively. Notably, levels D and C saw a modest increase, reaching 77 and 63 instances, respectively.

Meanwhile, levels A and B observed minor increases to 15 and 33 instances, respectively, suggesting a tiny but inadequate move towards higher energy performance. In 2019, the total instances grew again to 877, the second highest throughout the studied period, with level E reaching its peak at 426 cases, while level F jumped to 289 cases. Levels D, C, B, and A showed small improvements, with D at 82 instances, C at 47, B at 24, and A at 9. Despite these slight advances, the dominance of levels E and F was maintained, representing the bulk of instances and underlining inadequate progress toward energy efficiency. In 2020, the overall number of instances declined dramatically to 583, suggesting a likely change in emphasis or lower energy performance reviews. Levels F and E also fell to 200 and 237 instances, respectively.

Levels D and C reached 67 and 48 instances, demonstrating steady but minor development. Similarly, levels B and A showed minor increases, with 26 and 5 instances, respectively. While this drop in levels F and E shows incremental gains,

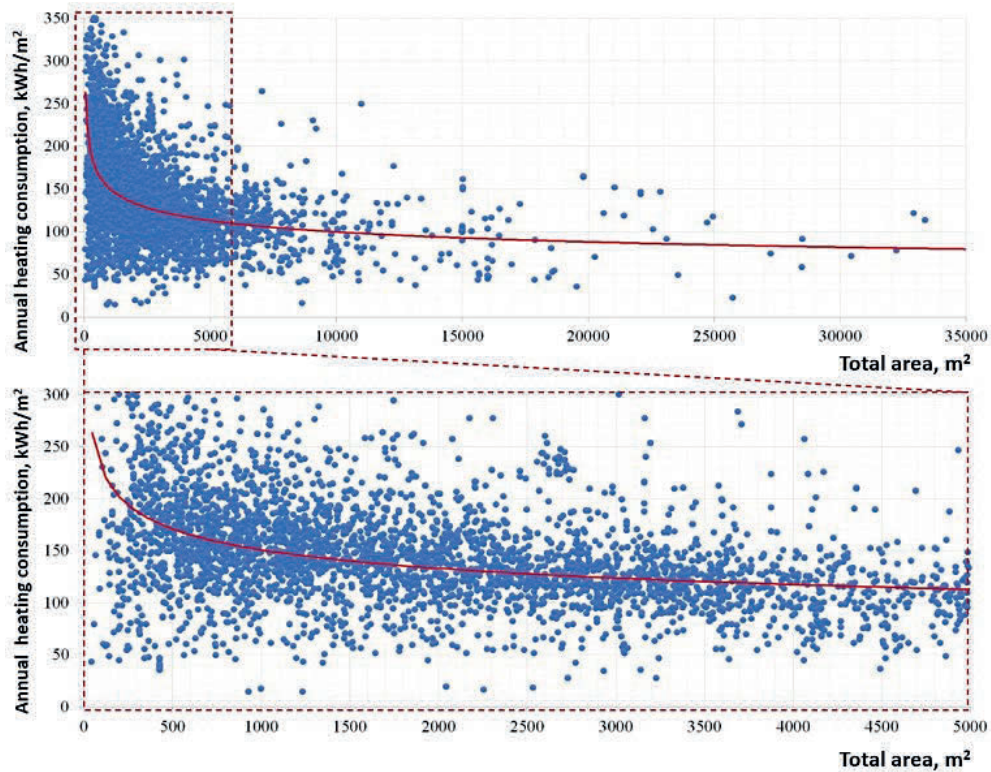
the fraction of high-performing levels (A, B, and C) remained relatively low, demonstrating the continued difficulty of attaining broad energy efficiency. Throughout time, levels E and F substantially dominate the distribution, demonstrating the great prevalence of poor energy performance in Latvia. The meager depiction of levels A, B, and C illustrates the inadequate progress toward implementing greater energy efficiency requirements. These trends underline the urgent need for regulatory interventions, greater investment in energy-efficient technology, and public awareness efforts to tip the balance toward better energy performance levels.

The surface area of a structure plays a vital role in determining its energy consumption and efficiency, especially in regions like Latvia, where protracted heating seasons require considerable energy inputs for sustaining interior comfort. Larger structures, such as multi-apartment residential complexes, often have significant external surface areas that contribute to increased heat losses via walls, roofs, and windows, particularly if the insulation is poor or obsolete. Studies have demonstrated that in multi-apartment buildings, thorough rehabilitation initiatives, including enhancements to facade insulation, have dramatically decreased heat losses and energy consumption (Prozuments et al., 2023). Additionally, the surface area-to-volume ratio of a structure affects its thermal performance, since buildings with greater ratios lose heat more quickly. For example, Latvian residential structures erected during the Soviet period generally display increased energy consumption owing to poor thermal characteristics of materials used during construction and vast surface areas exposed to external temperatures (Borodinecs et al., 2017). Addressing these difficulties demands not just enhancing insulation but also optimizing design elements to avoid excessive energy loss via exposed surfaces.

Figure 2 depicts the link between specific energy consumption (annual heating consumption, kWh/m<sup>2</sup>) and the overall area of buildings (m<sup>2</sup>). The data is shown as scatter plots with a substantial number of points, indicating the dispersion of energy consumption figures among buildings of varied sizes. A prominent red trend line has been introduced to reflect the general trend in the data. In the first plot, which encompasses a broad range of total building sizes (up to 35 000 m<sup>2</sup>), the data demonstrates a clear trend: as the overall area of the structure grows, the specific energy usage tends to decrease. This pattern shows that bigger structures are often more energy-efficient in terms of heating needs per unit of area. However, a great degree of dispersion is detected, particularly for smaller structures, suggesting significant variability in their energy usage. For big buildings (over about 10 000 m<sup>2</sup>), the variability in energy usage reduces, and the data points fit more closely with the trend line, showing more consistency in their energy efficiency.

The second plot zooms in on smaller structures, concentrating on areas up to 5000 m<sup>2</sup>. Here, the large variety of energy consumption levels is considerably more obvious. While smaller structures demonstrate a greater range of heating consumption values, from below 50 kWh/m<sup>2</sup> to far beyond 250 kWh/m<sup>2</sup>, the general decreasing trend in energy consumption with increasing building size is maintained. This suggests that building design, construction quality, and insulation may considerably impact energy efficiency in smaller buildings. The data illustrates

a notable trend: bigger buildings tend to be more energy-efficient on a per-square-meter basis compared to smaller ones. The lower variability in energy usage for bigger structures reflects a more consistent approach to their construction and energy use. Conversely, the significant dispersion in smaller buildings implies variability in their energy efficiency, possibly driven by variables such as construction materials, insulation quality, and heating systems.



**Fig. 2.** Specific energy consumption depending on the total area of the building (Doroņins, 2021).

In addition to building size and design, climatic conditions in Latvia have a vital impact on energy efficiency. The country's lengthy and frigid heating seasons demand good thermal insulation to reduce heat loss. Buildings with inadequate insulation or low thermal inertia generally demonstrate significant energy demand for heating, especially during peak winter months (Jakovičs et al., 2015). Meanwhile, summer months pose the dangers of overheating in structures with little thermal mass, particularly in metropolitan locations where heat retention is compounded by dense construction. Addressing these difficulties demands incorporating creative solutions such as the utilization of renewable energy sources, high-performance insulation materials, and smart heating and cooling systems that react to seasonal swings (Sakipova et al., 2015). Furthermore, indoor air quality has emerged as an essential factor, since poorly designed ventilation systems may damage occupant health even in energy-efficient buildings (Prozuments et al., 2023). National regulations and EU efforts have been essential in encouraging

improvements in energy efficiency throughout Latvia's building base. The Energy Performance of Buildings Directive requires high energy performance criteria for both new constructions and restorations, driving building owners and stakeholders toward adopting more sustainable methods (Remeikienė et al., 2021). These methods have been backed by financial incentives and government initiatives, supporting the implementation of Energy Performance Contracting (EPC) and other creative models to finance large-scale repairs. Notably, EPC projects in Latvia have produced energy savings of up to 65 % in rebuilt multi-family residential structures, demonstrating the efficiency of these measures (Rochas et al., 2014). By continuing to use such regulatory frameworks and investing in cutting-edge technology, Latvia is well-positioned to lower its energy consumption and carbon footprint, contributing to larger EU sustainability ambitions.

## 2. METHODOLOGY

This study uses a structured technique to examine the effects of different property attributes on economic results and energy use. The key statistical method used in the research is multiple regression analysis, which is used to find and quantify the correlations between independent factors (such as property attributes) and dependent variables (such as purchase price and energy use). The study starts with data collecting, which generates a dataset of 51 properties to represent realistic and varied property qualities.

Variables (see Table 1) are purchasing price (EUR), rental price (EUR), floor space (m<sup>2</sup>), property age (years), number of floors, and energy usage (kWh/year). The data is preprocessed to correct any missing values, eliminate outliers, and standardize the range of variables to ensure consistency.

**Table 1.** Dependent and Independent Variables Used in the Analysis  
(developed by the authors)

Dependent variable(s)	Independent variable(s)
Purchasing price	Energy usage
	Rental price
	Floor space
	Number of floors
	Age of the building

After the dataset has been created, a multiple regression analysis is used to investigate the impact of independent factors on dependent variables. The general form of the regression equation is represented by Formula (1).

To measure the relevance and strength of each predictor, performance metrics such as the coefficient of determination ( $R^2$ ), p-values, and standardized coefficients are applied to the regression findings. Finally, the results are evaluated using residual analysis and diagnostic tests to verify that the regression models are reliable. The findings of this research will help stakeholders optimize property

development and investment plans while encouraging energy-efficient practices in the real estate industry.

$$P_i = \alpha + \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3 + \dots + \beta_n A_n + \varphi_i, \tag{1}$$

where

$P_i$  – the price of property  $i$  (dependent variable);

$\alpha$  – the intercept term;

$\beta_1, \beta_2, \dots, \beta_n$  – the coefficients of independent variables;

$A_1, A_2, \dots, A_n$  – the independent variables;

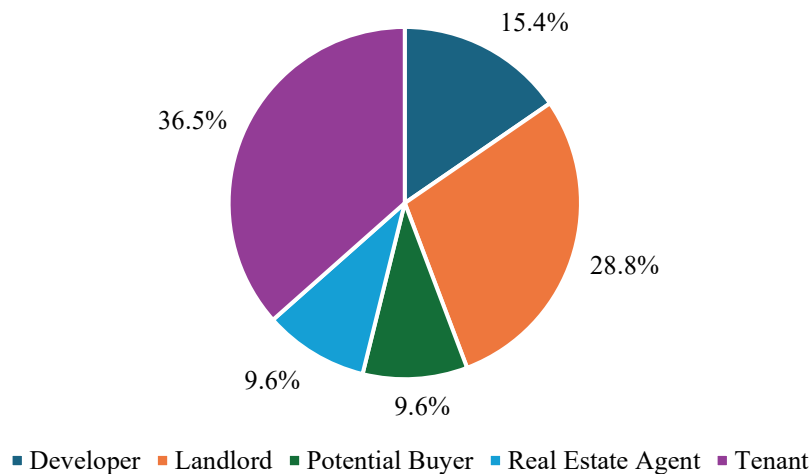
$\varphi_i$  – the error term capturing the unobserved factors affecting the property price.

The coefficients ( $\beta$ ) of the independent variables will be calculated using ordinary least.

### 3. RESULTS

The real estate industry is a dynamic and multidimensional sector, including many players that play unique but interwoven roles in defining its environment. The distribution of these professions reflects the different demands and activities within the market, ranging from property development and management to buying, selling, and renting. Understanding the proportionate representation of various stakeholders gives vital insights into the market’s structure and its driving factors.

Figure 3 demonstrates the distribution of respondents within the real estate market, highlighting the variety and contributions to the real estate market. The biggest group, comprising 36.5 % of the market, is formed of renters, showing their major position as end-users and beneficiaries of the real estate business.

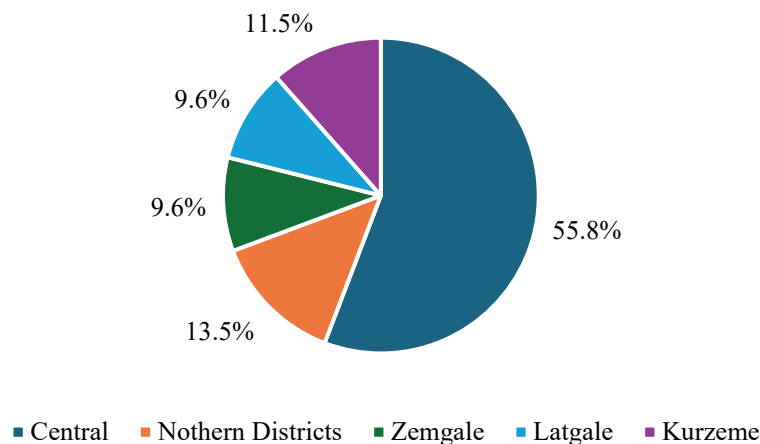


**Fig. 3.** Responders’ occupational background (developed by the authors based on survey results).

This substantial percentage demonstrates the dependence of housing markets on rental demand, fueled by urbanization and population expansion. Following renters, homeowners and landlords make up 28.8 % of the market. This group stresses the dual function of providing homes and contributing to the property management industry. Their impact extends to the larger real estate market via investment, maintenance, and leasing operations. Developers account for 15.4 % of the market, showing their vital role in constructing new residential, commercial, and mixed-use areas. Their effect is particularly evident in urban development, construction trends, and sustainable building techniques. Real estate brokers and prospective buyers each contribute 9.6 % of the market. Real estate agents function as middlemen, enabling transactions and guaranteeing market fluidity, while prospective purchasers create demand, affecting market trends and pricing.

This research emphasizes the numerous and interrelated functions within the real estate market, showing the vital contributions of each stakeholder group to housing and property management dynamics. It highlights the necessity of balancing tenant requirements, property ownership, and environmental development to build a healthy and fair market.

The distribution of survey respondents (see Fig. 4) throughout Latvia’s administrative divisions gives insights into regional representation within the research.

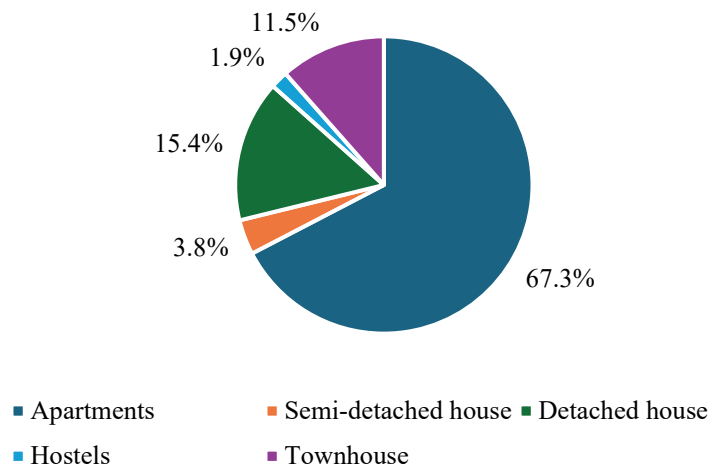


**Fig. 4.** Distribution of survey respondents throughout Latvia’s administrative divisions (developed by the authors based on survey results).

The findings indicate tremendous variety, with some places being more strongly displayed than others. A vast majority of responders, representing 55.8 %, come from the Central area. This significant proportion shows that the Central area, presumably containing the capital city or other large metropolitan centers, is a focal point of activity or population in Latvia. The high percentage can also imply a more substantial involvement or accessibility to the survey in this location. The Northern Districts account for 13.5 % of the respondents, making it the second most represented area. Although less in percentage compared to the Central area, this share still demonstrates considerable engagement and implies a moderate

demographic base or interest from this part of Latvia. Kurzeme provides 11.5 % to the entire respondent pool, establishing it as the third-largest category in the poll. This statistic represents a balanced level of involvement, possibly indicative of a populated or active location in the context of the research. Both Latgale and Zemgale constitute 9.6 % of the respondents each, establishing them as the least represented areas. Their equal contribution reveals a lower level of involvement, which might be attributable to smaller populations, poorer survey outreach, or decreased interest in these regions. The findings emphasize a strong concentration of respondents from the Central area, with comparably smaller yet important contributions from other regions of the nation. This distribution presumably represents population density, geographical accessibility, or specific emphasis regions of the study within Latvia.

The distribution of property types where people live (see Fig. 5) gives useful insights into housing choices and lifestyle patterns within a community.



**Fig. 5.** Types of property respondents live in Latvia (developed by the authors).

In the case of Latvia, the examination of respondents' living arrangements indicates a strong dominance of particular property types, reflecting the country's urbanization tendencies, housing supply, and cultural preferences. A considerable fraction of the population, 67.3 %, dwells in apartments, showing their position as the most frequent housing choice. Apartments are generally valued in metropolitan locations for their affordability, accessibility, and convenience, coinciding with the lives of individuals living in cities. Detached homes follow as the second most popular option, with 15.4 % of the respondents. This choice indicates a desire for bigger, more private living spaces, generally seen in suburban or rural locations. Townhouses, which account for 11.5 % of the replies, offer a compromise between communal life and seclusion, appealing to a smaller part of the population. Meanwhile, semi-detached homes, at 3.8 %, are quite rare, indicating limited supply or demand. Hostels make up only 1.9 % of the replies, possibly catering to certain populations such as students or transitory workers. This distribution demonstrates a strong preference for urban housing options in Latvia, with

flats dominating the landscape, while other property types cater to varied demands and lifestyles. These patterns present crucial implications for housing policy, urban planning, and real estate development plans in the nation.

### 3.1. Regression Analysis

The descriptive statistics reported in Table 2 offer insights into the qualities and variability of the data analyzed. For Property Price, the broad range (34 760.00 to 325 980.00) and a high mean value of 79 815.53 show great variety in property prices, possibly driven by variables such as location and amenities. The substantial standard deviation (7345.78) and variance (2 536 141 963.30) further underline this variability, suggesting varied market situations.

Similarly, Rental Price has a range of 250.00 to 980.00, with a mean of 502.87, demonstrating considerable variance in rental prices among properties. However, the standard deviation (180.10) refers to considerable variances in rental pricing tactics or property demand. For Floor Area, the range extends from 35.70 to 214.50, with a mean of 94.34, suggesting a large variance in property sizes.

The standard deviation (43.30) illustrates the variation in floor areas, which might relate to differing property kinds or intended purposes. Property Age indicates minimal variety, with a range of 3.00 to 24.00 and a mean of 12.81, showing that most properties are somewhat elderly, but the standard deviation (6.61) implies that there are some outliers, probably older or younger builds. Floor Numbers, with a range of 1.00 to 12.00 and a mean of 4.32, demonstrate that most properties are mid-rise structures. However, the greater skewness (1.14) suggests a predominance of low-rise structures with fewer stories. In comparison, Energy Consumption, with a range of 110.65 to 250.73 and a mean of 174.83, demonstrates a modest variability. The standard deviation (33.84) illustrates the variability in energy efficiency between properties, which could be impacted by the design or energy-saving measures employed. Table 2 illustrates the descriptive data collected from the study.

**Table 2.** Descriptive Statistics (developed by the authors based on SPSS analysis)

N	N	Minimum	Maximum	Mean		Std. deviation	Variance	Skewness	
	N	Statistic	Statistic	Statistic	Std. error	Statistic	Statistic	Statistic	Std. error
Property Price	51	34 760.00	325 980.00	79 815.5319	7345.778 88	50 360.122 75	2 536 141 963.298	3.073	0.347
Rental Price	51	250.00	980.00	502.8723	26.27012	180.098 84	32 435.592	0.790	0.347
Floor Area	51	35.70	214.50	94.3447	6.31633	43.302 59	1875.115	0.826	0.347
Property Age	51	3.00	24.00	12.8085	0.96451	6.612 37	43.723	0.122	0.347
Floor Numbers	51	1.00	12.00	4.3191	0.32347	2.217 58	4.918	1.139	0.347
Energy Consumption	51	110.65	250.73	174.8262	4.936 27	33.841 38	1145.239	0.185	0.347

The model summary, see Table 3, offers an overview of the regression model’s effectiveness in predicting Property Price. The *R* value of 0.868 shows a good association between the dependent variable (Property Price) and the independent variables (Rental Price, Floor Area, Property Age, Floor Numbers, and Energy Consumption).

**Table 3.** Model Summary (developed by the authors based on SPSS analysis)

Model	<i>R</i>	<i>R</i> square	Adjust ed <i>R</i> square	Std. error of the estimate	Change statistics					Durbin – Watson
					<i>R</i> square change	<i>F</i> change	df1	df2	Sig. <i>F</i> change	
1	0.868 <sup>a</sup>	0.754	0.724	26 443.529 61	0.754	25.167	5	41	0.000	1.733
<sup>a</sup> Predictors: (Constant), Energy Consumption, Property Age, Floor Area, Rental Price, Floor Numbers										

This shows that the model captures a considerable fraction of the variance in the data. The *R* Square score, at 0.754, demonstrates that 75.4 % of the variability in Property Price is explained by the model, while the Adjusted *R* square value of 0.724 accounts for the number of variables included, demonstrating a robust model fit even after correcting for possible overfitting. The standard error of the estimate (26 443.53) quantifies the average departure of actual property prices from the projected values, giving a measure of the model’s prediction accuracy. Additionally, the Durbin–Watson statistic (1.733) is near the ideal value of 2, suggesting that the residuals display little to no autocorrelation, hence validating the assumption of independence in the regression model.

The ANOVA table (Table 4) assesses the statistical significance of the regression model. The regression sum of squares (87 992 859 714.53) represents the variation in Property Price explained by the model, while the residual sum of squares (28 669 670 597.18) corresponds to the unexplained variability in the data. Together, these contribute to the total variability (116 662 530 311.70). The mean square for regression (17 598 571 942.91) compared to the mean square for residuals (699 260 258.47) yields an *F*-statistic of 25.167, which is highly significant ( $p < 0.001$ ). This result confirms that the predictors collectively provide a statistically significant explanation of the variability in Property Price, validating the overall model fit.

**Table 4.** ANOVA (developed by the authors based on SPSS analysis)

Model		Sum of squares	df	Mean square	<i>F</i>	Sig.
1	Regression	87 992 859 714.525	5	17 598 571 942.905	25.167	0.000 <sup>b</sup>
	Residual	28 669 670 597.177	41	699 260 258.468		
	Total	116 662 530 311.702	46			
<sup>b</sup> Predictors: (Constant), Energy Consumption, Property Age, Floor Area, Rental Price, Floor Numbers						

The coefficients' table (Table 5) provides detailed insights into the contributions of each predictor to Property Price. The constant term (1202.41) represents the baseline Property Price when all predictors are set to zero, although its significance level ( $p = 0.964$ ) indicates it is not meaningful in isolation.

**Table 5.** Coefficients (developed by the authors based on SPSS analysis)

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.	Collinearity statistics	
	<i>B</i>	Std. error	Beta			Tolerance	<i>VIF</i>
(Constant)	1202.413	26 152.488		0.046	0.964		
Rental Price	112.540	35.288	0.402	3.189	0.003	0.376	2.657
Floor Area	-372.782	166.665	-0.321	-2.237	0.031	0.292	3.426
Property Age	-1396.529	826.358	-0.183	-1.690	0.099	0.509	1.964
Floor Numbers	19 128.610	3198.880	0.842	5.980	0.000	0.302	3.310
Energy Consumption	-43.141	288.944	-0.029	-0.15	0.882	0.159	6.290

<sup>a</sup> Dependent variable: Property Price

Rental Price has a positive and significant effect on Property Price ( $\beta = 112.54$ ,  $p = 0.003$ ), meaning that a unit increase in Rental Price corresponds to an increase of approximately 112.54 in Property Price, holding all else constant. Floor Area and Property Age exhibit negative coefficients, with Floor Area ( $\beta = -372.78$ ,  $p = 0.031$ ) being statistically significant, implying that larger properties might decrease the price per square meter in some contexts. Floor Numbers has the most substantial positive impact ( $\beta = 19,128.61$ ,  $p < 0.001$ ), suggesting that higher buildings are associated with significantly higher Property Prices. Energy Consumption shows a negative coefficient ( $\beta = -43.14$ ) but is not statistically significant ( $p = 0.882$ ). Collinearity statistics, including tolerance and variance inflation factor (*VIF*), confirm that multicollinearity is not severe, though higher *VIF* values for some variables (e.g., Energy Consumption,  $VIF = 6.290$ ) suggest a potential area for further investigation.

The correlations and covariances among predictors give insights into their linkages and possible interdependencies. Strong negative correlations are discovered between Energy Consumption and other variables, such as Property Age (-0.673) and Floor Area (-0.492), showing that older and smaller houses tend to consume more energy. Positive correlations, such as between Rental Price and Property Age (0.394), show that older homes may attract higher rental costs in certain situations. Floor Numbers exhibits poor connections with most other variables, emphasizing its largely independent influence on Property Price. The covariance values supplement the correlation matrix by measuring the degree to which pairs of variables vary together. For example, the correlation between Energy Consumption and Floor Area (-23 717.11) demonstrates that bigger homes are often more energy efficient. Table 6 illustrates the coefficient correlations from the analysis.

**Table 6.** Coefficient Correlations (developed by the authors based on SPSS analysis)

Model		Energy Consumption	Property Age	Floor Area	Rental Price	Floor Numbers	
1	Correlations	Energy Consumption	1.000	-0.673	-0.492	-0.629	-0.151
		Property Age	-0.673	1.000	0.365	0.394	-0.015
		Floor Area	-0.492	0.365	1.000	0.295	-0.528
		Rental Price	-0.629	0.394	0.295	1.000	-0.220
		Floor Numbers	-0.151	-0.015	-0.528	-0.220	1.000
	Covariances	Energy Consumption	83 488.598	-160 799.290	-23 717.14	-6412.719	-139 406.005
		Property Age	-160 799.290	682 868.088	50 264.043	11 484.882	-38 759.445
		Floor Area	-23 717.114	50 264.043	27 777.379	1737.636	-281 463.798
		Rental Price	-6412.719	11 484.882	1737.636	1245.213	-24 810.185
		Floor Numbers	-139 406.005	-38 759.445	-281 463.8	-24 810.185	10 232 834.763
<sup>a</sup> Dependent variable: Property Price							

Collinearity diagnostics (see Table 7) assesses the multicollinearity among predictors, which could undermine the reliability of the regression coefficients.

**Table 7.** Coefficient Correlations (developed by the authors based on SPSS analysis)

Model	Dimension	Eigenvalue	Condition index	Variance proportions					
				(Constant)	Rental Price	Floor Area	Property Age	Floor Numbers	Energy Consumption
1	1	5.593	1.000	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.200	5.282	0.00	0.00	0.04	0.30	0.06	0.00
	3	0.111	7.114	0.07	0.04	0.03	0.23	0.11	0.00
	4	0.059	9.739	0.05	0.36	0.24	0.00	0.06	0.00
	5	0.032	13.150	0.10	0.21	0.44	0.03	0.76	0.00
	6	0.004	35.960	0.77	0.39	0.24	0.43	0.02	1.00
<sup>a</sup> Dependent variable: Property Price									

The eigenvalues and condition indices provide a breakdown of the dimensional structure of the predictors. The condition index, which measures the level of collinearity, reaches a maximum value of 35.960, indicating some potential multicollinearity concerns. Variance proportions for Energy Consumption are concentrated in the last dimension, suggesting it may contribute to collinearity issues, as reflected by its high VIF in the coefficients table. Despite this, the diagnostics overall suggest that the model remains stable and interpretable, though careful attention to predictor relationships is warranted.

The residual statistics (see Table 8) measure the accuracy and dependability of the model’s predictions. The anticipated Property Prices vary from 9590.03 to

252 329.64, with a mean value (79 815.53) nearly matching the observed mean. Residuals, which indicate the difference between actual and anticipated values, vary from -43 183.73 to 73 650.35, with a mean of zero, showing no consistent bias in the predictions.

**Table 8.** Residuals Statistics (developed by the authors based on SPSS analysis)

	Minimum	Maximum	Mean	Std. deviation	N
Predicted Value	9590.0264	252 329.6406	79 815.5319	43 736.577 99	51
Residual	-43 183.734 38	73 650.351 56	0.000	24 965.049 74	51
Std. predicted value	-1.606	3.944	0.000	1.000	51
Std. residual	-1.633	2.785	0.000	0.944	51
<sup>a</sup> Dependent variable: Property Price					

The standard deviation of residuals (24 965.05) shows a considerable amount of dispersion around the projected values. The standardized predicted values range from -1.606 to 3.944, while the standardized residuals lie within the range of -1.633 to 2.785, suggesting that the conditions of normality and homoscedasticity are met. This supports the conclusion that the model gives a solid fit to the data and properly predicts Property Price within the range of observed values.

## CONCLUSIONS

The results of the research reveal the interplay of energy efficiency and residential market dynamics, adding to the wider debate on sustainable development. Below is a list of the most important conclusions:

- Latvia has achieved success in energy efficiency improvements, backed by national plans and EU funding. However, gaps continue in improving energy efficiency in older residential buildings.
- The Latvian residential market increasingly appreciates energy-efficient homes, which fit with customer desires and legal regulations. This transition has pushed increased property prices and market competitiveness for energy-efficient buildings.
- Policies and regulatory frameworks in Latvia and the EU play a significant role in promoting energy efficiency, with financial incentives, construction rules, and long-term initiatives pushing sectoral gains.
- Data analysis indicated that knowledge of energy-efficient solutions among people in Latvia is expanding, but cost remains a key barrier to adoption.
- Energy-efficient buildings ensure higher property prices, proving that market demand matches sustainability aims, motivating developers to embrace more sustainable construction practices.
- The research reveals that various independent factors, such as rental price, floor area, and floor numbers, have a substantial effect on influencing property prices.

- Floor numbers have the biggest positive effect on property prices, demonstrating the premium associated with high-rise constructions. The rental price also has a strong positive influence, demonstrating a tight link between rental returns and market worth.

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