Ekonomikas ministrija

Research on annual costs

dynamics forecasts and overheating risks

in the construction industry of Latvia

REPORT

2022 | INNOMATRIX RESEARCH & INNOVATION

Research client: Ministry of Economics of the Republic of Latvia. Study ID. No. EM 2022/19

Researcher: InnoMatrix | LLC | Reg. no. 40103264228

The study was completed in August 2022. The expert survey was conducted in June 2022.

The study is based on the methodology developed in 2018 and supplemented in 2022, which is included in the Research Report.

Neither the Ministry of Economics nor any other person is responsible for the further use of this information.

For more information, please visit: https://www.em.gov.lv/lv/buvnieciba

The research report has included information obtained from several sources of information, both primary and secondary, including the Ministry of Finance of the Republic of Latvia (FM), the Ministry of Environmental Protection and Regional Development (VARAM), the Central Finance and Contracting Agency (CFLA) and the Central Statistical Bureau (CSB). The quality and relevance of the data received from the FM, VARAM, CFLA and CSP has been accepted as optimal, without the authors checking the sources of origin of the data. The range of experts of the study was represented by organizations and companies of the Latvian construction non-governmental sector, public administration, academic and industrial fields, as well as experts in the field of macroeconomics. A detailed list of experts and the organisations and companies they represent is available in the Annex to the Study. The number of experts, the specialisations and the sample of organisations they represent correspond to a statistically presentable set.

Within the framework of the study, the authors take responsibility for the assessment of data quality and their use in the analysis, performing the necessary data selection and excluding possible inappropriate observations and data from the data set to be analyzed as a result of insufficient data quality. When performing the quality check of the received data, restrictions on the availability of data have been identified, which apply to both incomplete questionnaires filled out by experts and statistically missing observations.

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Contents

Abbreviations and terms used

Abbreviation	Explanation
CAGR	Calculated compound multi-year growth
CSP	Central Statistical Bureau
Experts	Latvian macroeconomics and construction experts who expressed their opinion within the framework of the study and who represent both public administration, civic and academic environments, and industry. A detailed list of experts can be found at the end of the report (see table of contents)
EM	Ministry of Economics of the Republic of Latvia
EU	European Union
Eurostat	Eurostat of the European Commission
FM	Ministry of Finance of the Republic of Latvia
GDP	Gross domestic product
Researcher	Socio-economic market process research company „InnoMatrix“, LLC
LR	Republic of Latvia
Research client	Ministry of Economics of the Republic of Latvia
Research	Study on projected changes in labour and building materials costs in construction sector in Latvia in 2022-2026.

The purpose and tasks of the study

The aim of the study is to carry out cost dynamics forecasts and overheating risk assessment in the Latvian construction sector and to provide recommendations for promoting the stability and competitiveness of the industry, taking into account the factors affecting the development of the construction industry and the processes taking place in the world. Several work tasks were set to achieve the goal:

1) to update the methodology for forecasting construction cost trends and to develop a methodology for forecasting overheating risks, as well as to develop recommendations for the improvement of methodologies as necessary;
2) based on the updated methodology for forecasting construction cost trends and the developed methodology for forecasting overheating risks, to carry out an assessment of construction cost trends for 2011-2021 and to develop a model for forecasting overheating risks for 2022-2026;
3) model situations and provide a reasoned assessment of whether there are circumstances indicating a possible "overheating" of the construction sector in 2022-2023 (quarterly/semi-annual) and possible causes thereof, as well as recommendations to reduce the risks of "overheating";
4) based on the conclusions made to make recommendations for the promotion of stability and competitiveness of the Latvian construction industry.

Summary

For more efficient planning of public construction procurements and assessment of potential changes in costs in the coming years, the Ministry of Economics (EM) has been carrying out an assessment of the projected changes in the costs of labour and building materials in the construction sector and their impact on the national economy every year since 2018, providing proposals for the necessary further action.

For the determination of forecasts, a unique multivariate methodology has been scientifically developed, which covers complex both statistical and expert assessments. Reports from previous years show that EM has obtained forecasts with high reliability annually, despite cardinal fluctuations in the construction field. The forecasts obtained in 2021, despite the pronounced uncertainty in the economy and the emergency situation in the country, differed in the forecasts of changes in total construction costs by only 0.1 percentage points.

Within the framework of the 2022 study, **83 experts expressed their views**, representing organizations from both public administration, civic initiative (NGOs) and academia, as well as construction companies. A detailed list of experts and the organisations they represent can be found at the end of the report (see Annex 1 – Experts involved in the research).

According **to the results of the study, a significant increase in costs is predicted in 2022 and 2023, mainly in the field of maintenance and operation of building materials and machinery and mechanisms.** Total construction costs in 2022 could increase between **+14.9%** (combined forecast) and 20.5% (expert forecast), while in 2023 costs could increase +9.4% according to experts' forecasts. In previous years (2020 and 2021), the combined forecast based on the methodology showed a highly accurate estimate. Cost growth in 2024-2026 is projected to average 8.7% per annum according to the combined forecast and +4.5% per annum according to expert forecasts (see table 1).

Table 1. Summary of forecasts of construction production costs

Changes in construction costs compared to the previous year				
2020	*2021*	*2022*	*2023*	*2024-2026*
+1.3%	**+6.7%**			
	Combined forecast →	**+14.9%**	**+9.9%**	**On average +8.7% per annum**
	Expert forecasts →	**+20.5%**	**+9.4%**	**On average +4.5% per annum**

Source: CSB data, expert evaluations obtained in the study, authors' calculations

The total volume of construction output in 2022 is projected to grow slightly by 1.1% according to the combined forecast or 0.9% according to the expert forecast. In 2023, a negative growth of the construction volume is predicted in the amount of -1.4% in the experts' assessment or -0.2% in the assessment of the combined forecast (see Table 2).

Table 2. Summary of forecasts of changes in construction costs

Changes in construction output compared to the previous year				
2020	*2021*	*2022*	*2023*	*2024-2026*
+2.7%	**-6.2%**			
Combined forecast →		**+1.1%**	**-0.2%**	**On average +2.0% per annum**
Expert forecasts →		**+0.9%**	**-1.4%**	**On average +3.8% per annum**

Source: CSB data, expert evaluations obtained in the study, authors' calculations

For the second year in a row, a further increase in the price of building materials is predicted, the most significant jump is planned for timber, bitumen products and metal products. In these groups of materials in 2022, the cost increase is estimated at around 30%, but in 2023 it could reach an annual increase closer to the mark of 20-25%.

Factors affecting costs. Labour costs primarily depend on the volume of construction in Latvia. Pressure from other construction sectors in EU countries is also significant– both wages and labour demand in other EU construction sectors have an impact.

The prices of metal, timber and energy resources have had the greatest impact on the cost of building materials. Maintenance and operational costs of machinery and equipment in the construction sector are particularly affected by the current higher prices of fuel and energy resources, as well as the low level of competition in the market of machinery and equipment in Latvia. The problem arises with the availability of spare parts and the availability of machines of individual brands.

Construction of buildings. In the construction of residential buildings in 2022 and subsequent years, the most significant increase in production volumes from all sub-sectors is forecast at 8.2% in 2022 and 3.8% in 2023. Cost growth is also projected to be significant, at 25.1% in 2022 and 14.3% in 2023. For the construction of non-residential buildings in 2022, a 5.6% increase in construction volume is forecast, which could fall to a 1.4% annual increase in volume in 2023. Cost growth in 2022 is projected at 26.6% and 15.3 in 2023.

Construction of roads and railways. In the sub-sector of construction of roads, highways, bridges and tunnels, according to the experts' assessment, a decrease in the volume of construction is predicted by about 3%, and in the construction of railways an increase of 1.5%. Construction of all roads and railroads is projected to grow more rapidly in 2025-2026. Cost growth in the construction of roads and railroads is mainly projected in the range of 23-25% in 2022 and in the range of 10-13% in 2023.

Urban management infrastructures and specialized construction. In the construction of urban facilities in 2022, stagnant development is predicted, while cost growth is forecast at 21% in 2022 and 19% in 2023. In the sub-sector of specialized construction works, the change in volumes in 2022 is projected with insignificant growth, but in 2023-2026 could increase by 5-8% per annum. Costs in the subsector could increase by 18% in 2022.

Architectural and engineering services, technical inspection and analysis. In the field of architectural and engineering services, technical inspection and analysis, a sharp increase in volume is projected in 2022 at 10%, which could fall to 2.4% growth in 2023.

Construction resources. The most cost in the construction industry will increase for building materials, for which an overall increase of 21% is forecast in 2022 according to expert assessments. They will grow faster in the construction of buildings, where an increase of 28-30% is forecast in 2022 and in the construction of roads and railroads in the amount of 32%. A second significant increase in input costs

is expected for the maintenance and operation of machinery and equipment of 14.5% in 2022. Higher cost growth is forecast for the construction of buildings, roads and railroads and urban infrastructure around 20%, but lower in the field of specialized construction.

The increase in wages and salaries in the construction sector is projected to be 7.8% in 2022. No significant differences by subsector have been observed.

Combating the shadow economy. Measures taken by public authorities to combat the shadow economy do not have a significant impact on construction costs. The impact on the cost of building materials is negligible, while the labour costs are average. Labour costs were mostly affected by the general agreement on minimum wages and salaries in the construction sector.

Global events. If in 2020-2021 the increase in costs in construction could be attributed to the impact of the COVID-19 pandemic and related epidemiological measures, then in 2022 the Russo-Ukrainian war and related sanctions play a significant role.

Risks of overheating of construction. In the context of overheating of the construction sector, the Construction Overheating Risk Index has been created, the value of which, based on the data at the time of the study, is 0.66 for medium risk and 0.45 for high risk, which means that out of all seven indicators included, their weighted average actual value is 66% of the limit of medium overheating risk and 45% of high limit.

Of the seven indicators considered, three are close to the overheating limit assessed by experts - the amount of housing loans, capital investments of budget institutions in buildings and constructions and the GDP growth rate. The other four indicators are currently at a safe level or with a trend towards reduced risk. In general, there is no significant impact of internal processes on the imbalance of the construction industry, the main problem situation in 2022 is the disruptions in the supply of construction materials caused by the Russia-Ukraine war and the increase in the prices of energy resources, which indirectly affects the construction industry and various indicators that characterize it.

1. Methodology for forecasting construction cost trends and overheating risks

1.1. Updated methodology for forecasting construction cost trends

Necessity and justification of the methodology

For the purpose of carrying out the study, the forecasting methodology developed and subsequently supplemented in 2018 for the study "Study on projected changes in labour and building materials costs in the construction sector in Latvia" was used for the acquisition and analysis of data and evaluations, which allows to achieve the task necessary for the current research to update the methodology for forecasting trends in construction costs. The methodology is based on well-established quantitative and qualitative methods [21, 22, 23, 24, 25, 33] approved by previous studies, selected according to the specifics and objectives of the Study. In 2022, the methodology has been repeatedly tested, identifying the latest scientific achievements in the field of construction forecasting carried out by scientists from other countries [26, 27, 28, 29, 31, 32] with the aim of applying the most current and latest approaches in construction forecasting.

The tasks to be achieved by the methodology are:

1. to define the indicators on which statistical information is to be compiled;
2. determine the indicators for which it is necessary to obtain evaluations from experts;
3. to choose calculation methods to be used in the statistical processing of the obtained data and estimates;
4. to select quantitative methods to be used in identifying development trends and assessing the quality of the models obtained;
5. create a combined method for the development of forecasts of changes in construction costs of various types;
6. to determine the method for identifying internal and external factors affecting changes in construction costs and assessing their impact.

The research steps provide for the acquisition of data and expert survey in general in the construction industry, as well as in subgroups by type of objects and by types of resources (see Annex 2 – Object groups and resource types).

As part of the methodology, cross-compliance of concepts is assumed.

1. Construction sub-sectors, sectors and sub-sectors are considered as groups of objects according to the terminology used by the CSB and NACE Rev.2. Classification.
2. Changes in construction costs by segment are considered as changes by type of resources, according to the terminology used by the CSB.
3. Cost changes are considered as construction cost indices (CCI), according to the terminology used by the CSB.

Statistical information to be compiled for the study

The research data array consists of statistical data, which are obtained using statistical information on the construction sector from various aspects available in public sources and special databases created by state and non-governmental organizations. Primary information is indicators of changes in the volume of construction and construction costs, t.sk. by subsector and type of resource. This information

is intended for forecasting trends in construction costs. It can be used for the development of both statistical and expert forecasts, from which combined forecasts may result. The main source of this information is static data published by the CSB.

As additional statistical information to be compiled, there are data related to the construction sector, which allow to assess the development of the situation, the influence of internal and external factors, potential risks of overheating, provide signals of an anticipatory nature, etc.

The information to be obtained from the CSB data covers data illustrating the dynamics of construction cost indices in different breakdowns (see Table 3). Within the framework of the study, the necessary cuts include cost dynamics by type of resources (building materials, labour remuneration of workers, maintenance and operation of machinery and equipment), by sub-sectors, sectors and sub-sectors (construction of buildings, civil engineering, specialized construction works, services related to construction). Data with the periodicity of years are used to forecast overall trends, data with a more detailed periodicity – quarterly and monthly – are used to achieve individual tasks.

Table 3. Data table characterising construction costs to be retrieved from the CSB

Code	Name	Periodicity and time period
RCB010	Construction cost indices by resource type	Years, 1992-2021.
RCB020c	Construction cost indices (2015=100)	Quarters, 1991-2022
RCB010m	Construction cost indices by resource type (2015=100)	Months, 2009-2022
RCB030c	Construction cost indices and changes by object group	Quarters, 2010-2022
RCB030m	Construction cost indices and changes by object group	Months, 2010-2022.
RCB040c	Construction cost indices by object group and type of resource (2015=100)	Quarters, 2010-2022
RCB050m	Construction cost index for capital road reconstruction and new construction	Months, 2010-2022.
RCB060c	Construction cost index for new residential buildings (2015=100)	Quarters, 2006-2021
RCP010	Services producer price indices (2015=100)	Years, 2006-2021.
RCP010c	Services producer price indices and changes by service sector	Quarters, 2006-2021

Source: CSB data tables, authors' summary

In addition to forecasting construction costs, forecasting of the volume of construction is also carried out, which is an important indicator of potential construction costs, as well as a component in the assessment of overheating of the industry. Indicators characterising the volume of construction production itself and its indicators in different breakdowns (sub-sectors, by types of structures), as well as related indicators are compiled from the CSB data (see Table 4) illustrating developments in certain sectors of construction or constituting indicative indicators (new buildings, building permits, commissioning, housing stock, etc.).

Table 4. Data tables characterising the volume of construction output and related indicators to be extracted from the CSB

Code	Name	Periodicity and time period
BUP010	Volume indices and changes in construction production	2000 – 2021
BUP010c	Volume indices of construction production and changes by sector	Q1 2000 - Q4 2021
BUP020c	Volume of construction production by sector, at current prices, thousand euro	Q1 2015 - Q4 2021
BUP030c	Construction of buildings by type of structure, at current prices, thsd. euro	Q1 2018 - Q4 2021
BUP040	Number of new buildings index (2015=100)	2003 – 2021
BUP040c	Number of new buildings index (2015=100)	Q1 2003 - Q4 2021
BUE011	Number of building permits issued and estimated area by type of building in regions and cities of the country (after the administrative-territorial reform in 2021)	2021 – 2021
BUE010	Number of building permits issued and estimated area by type of building in regions and cities under state jurisdiction	2010 – 2021
BUE011c	Number of building permits issued and estimated area by type of building in regions and cities of the country (after the administrative-territorial reform in 2021)	Q1 2021 - Q4 2021
BUE010c	Number of building permits issued and estimated area by type of building in regions and cities under state jurisdiction	Q1 2010 - Q4 2021
BUE021c	Number and area of new apartments accepted for operation in regions, cities and counties (after the administrative-territorial reform in 2021)	Q1 2021 - Q4 2021
BUE020	Number and area of new apartments accepted for operation in regions, cities under state jurisdiction and counties	2010 – 2021
BUE021	Number and area of new apartments accepted for operation in regions, cities and counties (after the administrative-territorial reform in 2021)	2021 – 2021
BUE020c	Number and area of new apartments accepted for operation in regions, cities under state jurisdiction and counties	Q1 2010 - Q4 2021
BUE031	Buildings accepted for operation in regions and cities of the country, thousand m2 (after the administrative-territorial reform in 2021)	2021 – 2021

BUE030	Buildings accepted for operation in regions and cities under state jurisdiction, thousand m2	2010 – 2021
BUE030c	Buildings accepted for operation in regions and cities under state jurisdiction, thousand m2	Q1 2010 - Q4 2021
BUE031c	Buildings accepted for operation in regions and cities of the country, thousand m2 (after the administrative-territorial reform in 2021)	Q1 2021 - Q4 2021
BUF010	Housing stock in the regions at the end of the year	2010 – 2020
BUF020	Management fee calculated by the housing stock on average per month in regions (euro cents per 1 m²)	2000 – 2020
BUN010c	Indices of hours worked, number of employed persons and wages and salaries and changes thereof in construction	Q1 2000 - Q4 2021

Source: CSB data tables, authors' summary

The listed statistical data can be used both in the development of forecasts of the necessary indicators and as data to illustrate the development of the industry. Recalculation of previous dynamics into different units (absolute, relative), visualization and interpretation are intended to outline general trends and evaluate the development of the industry. The presence of data in the methodology does not mean that they must necessarily be used in the analysis process. Use depends on established relationships, degree of impact and usefulness in the context of the situation.

As additional data, information is used, which is available in various databases and registers of the Construction Information System (see Table 5). This information can be used as anticipatory indicators, influencing factors and indicative indicators for the development of the situation.

Table 5. Data tables describing the construction sector to be retrieved from the BIS

Category	**Name**	**Periodicity**
Register of construction merchants		
	Number of economically active construction merchants	Months, years
	Number of registered and re-registered construction merchants	Months, years
	Suspension and renewal of the registration of construction merchants	Months, years
	Number of annual updates	Months, years
	Number of excluded construction merchants	Months, years
	Number of registered and excluded construction merchants	Months, years
	Number of changes in information in the register of construction merchants	Months, years

	Number of construction workers	Years
	Number of active construction merchants by country of residence, administrative territory of Latvia and form of business	Years
	Total volume of construction services provided and volume of own account construction services	Years
Register of construction specialists		
	Number of certificates (active, issued)	Years
Construction intentions		
	Construction applications	Years
	Number of construction cases	Months, quarters, years

Source: BIS data tables, authors' compendium

When performing data collection and analysis, as far as possible, data can be obtained in breakdown by the types of objects and types of resources required for the study (see Annex 2 –).

In situations where a sufficient amount of data is not available or data are not counted, an assessment of a specific subsector, sector or sub-sector and type of resources, as well as a combination thereof, shall be carried out using an expert assessment. As part of the expertise, missing past values can be assessed for intrapolation.

Indicators to be assessed in the expert evaluation

The main purpose of applying expert methods is to raise the professional level of decisions. Expert evaluations In the context of the study is evaluated as essential information for making balanced, reasoned decisions in difficult, non-standard situations, as well as in making very important decisions that are important for society.

In forecasting trends of changes in construction costs, expert methods will be used in the following cases:

1) to obtain expert forecasts for the trends required within the framework of the study;
2) to assess the degree of influence of internal and external factors on the growth of costs and construction volume of the construction industry;
3) to assess the level of acceptable profitability under different scenarios of the development of the industry;
4) to assess the impact of measures affecting the sector;
5) to evaluate other factors, trends and situations according to the specifics of the current Research period.

Within the framework of the Research, the task of experts is to predict the indicator of interest as the growth rate. In the context of the study, there are positions in which the level of detail of information is higher than is compiled in national statistics. Thus, cases are manifested when statistical information on a certain subgroup has not been accumulated.

Expert assessments from the corresponding groups of objects were used to assess the extent of the change in costs. First of all, expert assessment is necessary for dynamics rows without a pronounced development trend, will also be covered within the framework of the study, if any of the statistical indicators are without a pronounced development trend. Experts will be provided with questions of a closed form with the indicators to be studied in certain groups of objects and by type of resource. Experts will give their assessment of the rate of change in costs for the time periods specified in each position, thereby forming an expert forecast.

In a general expert interview , experts from the construction industry are attracted, without their division into groups of objects. As well as in the general expert interview, macroeconomic experts will be attracted to the assessment, whose area of competence includes the assessment of the impact of construction on the economy. The task of the experts of this group is to identify factors that have a significant impact on changes in construction costs, as well as to make a general assessment of trends in the development of the construction industry and cost changes.

This group shall be composed of experts representing:

1) professional associations and associations of construction;
2) construction boards and expert groups;
3) construction-related vocational and higher education institutions and a research institute;
4) non-governmental organisations involved in the construction sector;
5) state bodies that manage, supervise and otherwise professionally interact with the construction industry;
6) public and private sector bodies competent to assess the overall development of the economy, from a construction perspective, Bank of Latvia and Ministry of Finance.

The recruitment and selection of the expert group will take place in several stages.

1) Identification of organizations whose activities correspond to one of the above groups;
2) establishment of lists of experts representing the organization;
3) Coordination of the list of organizations and their representative experts with the customer, in which experts or organizations may be supplemented or excluded;
4) Contacting organizations and coordinating the conduct of the expert interview of persons nominated for expert opinion.

In the expert interview, experts from each group of objects will be attracted to the object groups, and interviews-surveys will be conducted for each group separately, as they will evaluate the changes in the construction costs of a particular group of objects.

This group will involve experts representing companies whose type of activity is related to the following sub-sectors:

1) construction of residential and non-residential buildings,
2) construction of roads and railroads,
3) construction of urban infrastructure facilities,
4) other civil engineering.

The recruitment and selection of the expert group shall take place in several grades.

1) Identification of enterprises whose activities correspond to a group of objects.
2) Ranking of enterprises by turnover rank, main region of activity.

3) Ranking of companies by level of competence based on diversification according to 2nd degree criteria.
4) Coordination of the list with the customer, in which the ranks of competence can be changed, companies are supplemented and companies to be excluded are determined.
5) Contacting the company and identifying the persons nominated for the expert's opinion and coordinating the course of the expert interview.

For expert groups, a distinction is made between the issues to be studied. The general group carries out the identification of factors affecting changes in construction costs from the proposed list and supplementing with its own factors, as well as provides a general forecast of changes in the construction industry and costs during the period under study. In an expert interview in object groups, the general expert group is assessed as the degree of influence of the most important selected factors on a ball scale, as well as forecasting of changes in construction costs in groups of objects and by types of resources is carried out.

Methods of statistical processing of data and estimates

Different methods of analysis will be used for the analysis of the obtained statistical data and expert evaluations, according to the task being studied, data development trends and the scale of expert evaluations. To determine the further development of cost changes, various types of models will be used that characterize the further development over time of the underlying trends of the dynamics rows, based on the extrapolation of previous trends. The resulting models will undergo a quality assessment with variance indicators.

In the processing of expert assessments, depending on the shape and scale of the questions used, the calculations of the total averages, structural mean, scattering and variation indicators will be used. In addition to a separate analysis of statistical information and expert estimates, combined forecasts that combine the different sources of information will be used as a final forecasting tool. This will provide an opportunity in the Study to compensate for errors and improve the reliability of the final forecast.

As part of the research, expert assessments of external and internal factors affecting cost changes will be obtained. The degree of influence of factors will be assessed on the scales of ranks, scores and direct ratings.

The ranking scale score will be used to identify the most important influencing factors. For the proposed list of factors, experts will perform a rank of factors in a certain order from 1 to *n*, where *n* is the number of factors in the group. For factors, several groups will be distinguished, for example, external and internal factors, or additional groups, depending on the specifics of the group of objects under study. The indicated factor rank 1 indicates the factor with the highest impact on cost changes.

The score will use the most important influencing factor to assess the degree of impact. In the list of factors, experts will provide an estimate on a 10-point scale, where a higher score indicates a greater influence of the factor under consideration on changes in construction costs in the relevant group of objects and/or type of resources.

There are two main stages of expert evaluation – general expert interview and expert interview in object groups. Each of the expert groups has a different approach to identifying a set of experts.

When performing analysis of the considered data, if necessary, the data shall be transformed into comparable indicators. Depending on the source and type of data, possible indicators of development are:

1) index against the base period;
2) index against the previous period;
3) interest from the previous period;
4) percentage change from the previous period.

When visualizing the data to be analyzed, it is recommended to display the data as an index against the base period or as a percentage change from the previous year. In the case of the first option, medium and long-term trends are more successfully depicted and there is an opportunity to assess growth more objectively without taking into account fluctuations in the shorter term. The choice of the second option should be preferred to the assessment of short-term trends and the dissemination of information to the public, since percentage changes are easier to perceive without prior knowledge of statistical analysis.

When evaluating development trends, the average annual growth rate (*AAGR*) and compound annual growth rate (*CAGR*) for a time period that is contextually relevant in each individual case. For consistency purposes, default indicators for the period from 2012 onwards.

Compound growth rate:

$$T = \prod_{t=1}^{n} T_t = \frac{T_n}{T_1}$$

(Formula 1)

where T_t – growth rate in period *t*,
t – period number in succession,
n – number of observations (periods).

Average growth rate:

$$\bar{T} = \sqrt[n]{\prod_{t=1}^{n} T_t}$$

(Formula 2)

where $\bar{T}$ – average growth rate,
T_t – growth rate in period *t*,
t – period number in succession,
n – number of observations (periods).

By analysing the expert evaluations, it will be possible to calculate indicators for those expert evaluations that will be provided using a closed form with a rank, ball or direct scoring scales, which will allow the rating to be divided as a single indicator characterizing the average opinion, or a scattering of opinions. For the processing of expert assessments, aggregate averages, structure averages and variations will be used for direct forecasting.

Mean expert evaluation:

$$\bar{v}_j = \frac{\sum_{i=1}^{k} v_{ij}}{k}$$

(Formula 3)

where k – number of experts,
j – number of problem,
v_{ij} – i-th experts evaluation of the j-th question.

Normed mean expert evaluation:

$$\bar{v}_{j(n)} = \frac{\sum_{i=1}^{k} v_{ij}}{\sum_{i=1}^{k}\sum_{j=1}^{m} v_{ij}}$$

(Formula 4)

where k – number of experts,
j – number of the problem,
v_{ij} – i-th experts evaluation of the j-th question.

The average expert rating of the structure – median and mode – will be used.

Standard deviation of expert evaluations:

$$S_{v_j} = \sqrt{\frac{\sum_{i=1}^{k}\left(v_{ij} - \bar{v}_j\right)^2}{k}}$$

(Formula 5)

For those that are aggregated as rank values, the weight or significance of the factors will be calculated:

$$\beta_j = \frac{1/R_j}{\sum_{j=1}^{m}\left(1/R_j\right)} \times 100$$

(Formula 6)

The obtained indicators characterizing the opinion of experts were compiled in a graphical form to facilitate their perception, and their interpretation was also given. If necessary, recalculation of indicators will be carried out in order to facilitate their interpretation and assimilate them to other indicators that do not coincide in the unit of measurement with the indicator under study.

Methods for determining development trends and assessing quality

The main purpose of the analysis of dynamics rows is to determine the regularity of the development of the phenomenon under study. The study will carry out an analysis of the dynamics of changes and volume of construction costs in order to assess the current development trend and possible further progress in the future.

Analysis of dynamics rows within the framework of the study provides an opportunity to solve the following tasks:

1) to study the nature of the dynamics of the process – to determine the main development trend and assess random fluctuations;
2) identify and analyze periodic, for example, seasonal, fluctuations;
3) to study the causal relationships between the processes and phenomena that will appear in the form of correlative relationships between the rows of dynamics;
4) develop a model for the development of the studied process;
5) predict the development of an object, process or phenomenon in the future.

The object of study, which are socio-economic processes, is characterized by the main trend, for which a certain constant change in nature is observed over a certain period of time. Analytical approach of the method The study is based on the assumption that it is possible to find a type of function that describes the regular, determined component of the dynamics row. For example, in the implementation of visual and economic analysis of the dynamics row, it will be assumed that the main trend can be described by some pattern. Then, at the next stage of the Research, the parameters of the model will be statistically evaluated and theoretical values, which are already aligned values, will be calculated.

As models for extrapolating dynamics rows, autoregressive models will be used. In statistics and econometrics, and especially in the analysis of dynamics rows, the ARIMA (*autoregressive integrated moving average*) model is used, which is a generalization of the ARMA *autoregressive moving average*) model. Both of these models are adapted to the dynamics row data to predict future points. ARIMA models are used in individual cases where data indicate non-stationaryness in the mean, where an initial differentiation step (corresponding to the "integrated" part of the model) can be applied one or more times to eliminate the non-stationaryness of the mean function (i.e. the trend). If seasonality in the dynamics row is observed seasonality, a seasonal difference can be applied to eliminate the seasonal component.

The abbreviation ARIMA is divided into three parts AR, I and MA. The AR part indicates that the variable of interest is regressed based on the values shifted during it. The MA part indicates that a regression error is a linear combination of terms whose values arose simultaneously and at different times in the past. I ("integrated") indicates that the data values have been replaced by the difference between their values and the previous values. The differentiation process can take place in several rounds. The goal of each of these components is to make the model fit the data as closely as possible.

Non-seasonal ARIMA models are usually denoted by $ARIMA\ (p, d, q)$ where the parameters p, d and q are non-negative integers, p is the sequence of the autoregressive model (the number of time offsets), d is the differentiation (how many times the data is deprived of past values), and q is the sequence of the variable average model. Seasonal ARIMA models are usually denoted by where m denotes the number of periods in each season, while the capital letters $ARIMA\ (p, d, q)(P, D, Q)_m P$, D, Q indicate the auto-regressive, differentiating, and moving average term for the seasonal part of the ARIMA model.

ARIMA models can be evaluated using the *Box – Jenkins* approach.

As a rule, several variations of the ARIMA model are used. Given that many indicators related to construction have a pronounced seasonal component, it is considered better to use the SARIMA (seasonal ARIMA) model than to increase the order of the AR or MA parts of the model.

In a practical implementation of the ARIMA and SARIMA models in the first iteration of the implementation of these models, the study will be approbated using the Python programming environment and, if necessary, others. Data import for forecasting purposes should be performed using CSV format files or creating an API connection to databases that have the appropriate plug-in compatibility capabilities.

The quality of the resulting forecasts can be based on two evaluation approaches.

1) The sum of the squares of deviations and subordinate indicators – the sum of the actual deviations of the dynamics row from the quadratic value of the modeled values in the past and their sum as an indicator indicates the quality of the model, where a smaller total value indicates a higher coincidence of the model and the data.

2) Relevance of learning and approbation data – using automation capabilities, part of the past data is determined as learning data for calibration of model parameters and part (smaller) is used to assess model errors. Parameter calibration occurs by minimizing errors.

Within the framework of the study, different combinations of these methods are used (e.g. to adapt to the latest data trends), determining the most suitable solution for each situation and combination of indicators with the highest quality of the model and, in other words, the smallest errors. Predictions are obtained by further extrapolation of the model for the required periods.

Combined forecasting method

Taking into account the division of the studied changes in construction costs into groups by types of objects and types of resources, in different sections it becomes necessary to combine statistical information and expert assessments for the development of forecasts. At aggregated levels, when analyzing changes in the cost of a group of common objects or types of common resources, a combined indicator will be used. It combines the forecasts obtained in the analysis of statistical data with the assessment provided by experts.

Three types of cost change forecasts will be offered as the final product, depending on the principle of their acquisition (see Fig. 1).

Option I – extrapolating forecast of statistical data.

The forecast will be obtained on the basis of statistical data modelling the possible further development, if the previous trends were maintained. The forecast for this variant was intended for cases where there will be no possibility to obtain a forecast of another variant in the required time frames and an operational solution is required.

Option II – combined (expert-statistical) forecast.

The forecast will be developed on the basis of an extrapolation of the dynamics rows, which will be adjusted by the resulting average expertly estimated future values. The adjusted forecast will be constructed as a weighted average expert and model forecast. The forecast for this variant is intended as the final forecast for groups of objects and types of resources where statistical information is available.

Option III – expert forecasts.

The expert forecast as the final forecast will be used for cases when statistical data will not be available in certain groups of studied indicators. In this case, average expert forecasts with their standard deviations will be used (see fig. 1).

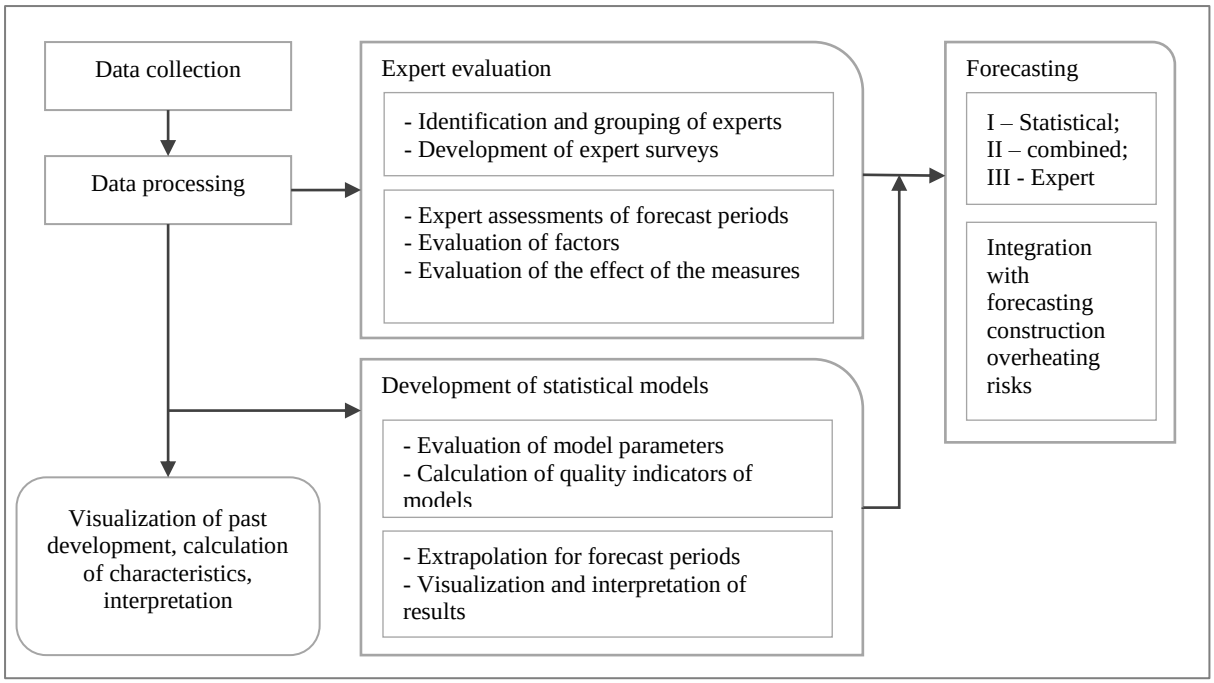


Fig. 1. Diagram of data collection, processing, modelling, expertise and development of forecast options. Source: author-created

When conducting repeated studies, it is necessary to re-assemble an array of available information in order to identify the amount of new information. In the event that new data that has not been compiled so far is publicly available, then it is possible to transfer the forecasts of certain groups of objects and types of resources to another variant group. It is possible to calibrate statistical forecasts and expert forecast weight coefficients in an equivalent manner if new arguments have arisen in favour of modifying certain weights.

In the development of all three forecast options, it is possible to extend the forecast horizon for additional years if a certain period of time has changed, which requires the development of a forecast.

Identification and impact assessment of factors affecting changes in construction costs

When evaluating the impact of various internal and external factors on changes in construction costs, expert assessments are used in the study. With the help of expert opinion, the most significant factors will be identified and the degree of influence of factors will be determined.

Within the framework of the research, the list of internal and external factors affecting the indicators to be studied will be submitted to the experts for evaluation. When assessing the influence of factors, their ranking and evaluation on a ball scale will be carried out. The advantage of ranking within the framework of the study is the identification of the most important factors. Unlike the usual scoring or selection of key factors, ranking avoids a number of potential problems:

- the determination of ranks ruled out a situation where individual factor are not evaluated;
- ranking allows to evaluate the sequence of influence of factors, not allowing several factors to be evaluated with equal force.

After identification of the most important factors in the initial phase, statistical processing of the obtained results will be carried out and the factor weights or significance will be calculated. Guided by

the resultant indicator, the most relevant factors will be selected, which will be used in the next phase. The key factors selected in the second phase will be evaluated with a ball scale. In this case, the task is to determine the degree of influence of factors.

Separately, factors will be distinguished for which a significant impact on changes in construction costs has been determined. Of these factors, those that are quantifiable and have access to dynamics rows with the nature of the changes in the period corresponding to the period of change in construction costs will be selected. If such information is not available, the correlative relationship of all selected factors with the corresponding changes in construction costs will be assessed.

Within the framework of the study, approbation of influencing factors is required. When conducting an expert-examination, it will be determined which factors are considered by experts to be significant factors affecting changes in construction costs. After approbation of the factors in the expert-examination, it is possible to supplement the methodology by including already those factors that have been recognized as the most important.

1.2. Methodology for forecasting overheating risks

Necessity and justification of the methodology

As part of the study, it is planned to assess the risks of overheating in the construction sector and predict their possible degree by quarter. Consequently, it is essential to determine the concept of overheating of the construction industry, its understanding in the context of this study. Overheating of the economy is an economic situation in which growth occurs so quickly that there is a significant risk of inflation rising [8, 9]. Such a situation may arise when producers are unable to produce enough goods and services to meet increasing demand and instead increase prices [10, 11, 12]. Based on this classical principle of economics, a simplified overheating indicator may be a sharper increase in costs than an increase in construction volumes. There are a number of considerations that make the concept of overheating look at from other angles as well.

1. The increase in costs may arise not due to the actions of manufacturers. In a situation where significant inflation arises as a result of conditions beyond the competence of producers, which are not caused by an increase in the prices of domestic producers, there can be no talk of overheating in its classic manifestation, and the shock in the sector can be attributed to regional or global events.
2. The increase in costs may not be due to an increase in demand. Overheating is associated with a sharp increase in market demand, however, disruption of the balance of costs and volumes can also be caused by changes in demand outside the borders of the national market.

The above factors make it necessary to look at overheating as a shock in an industry whose causes and manifestations can be quite diverse and different at different periods. Therefore, it is proposed to use a wider range of indicators to cover various potential signals that could indicate increasing risks to the industry.

As part of the study, it is proposed to use the Construction Overheating Risk Index (BPRI), which is a combined indicator and includes several sub-indicators. The selected sub-indicators are various economic indicators, the specific nature of the change of which may be one of the signs of an increasing risk of overheating of the construction industry. Index components need to assess their critical values

at which there is an increased risk. In turn, rationed values of sub-indicators are combined into the total Construction Overheating Risk Index using weight coefficients.

Some of the indicators of overheating of the economy are:

- labour and capital shortages and an increase in their workload, which is reflected in statistical indicators such as the capacity utilisation rate, unemployment and vacancy rates and their dynamics.

- A situation in which the volume of goods and services demanded significantly exceeds that offered also leads to an increase in their prices, which can be measured by an inflation indicator, and a deterioration in the current account balance, which is satisfied by an increase in imports.

In the case of Latvia, signs of economic overheating were most noticeable in the real estate and construction sectors. Loans in banks were very readily available, they were taken out a lot and this, in turn, led to a demand for construction services that could not be provided at a sufficient level.

1.3. Assessment of overheating indicators and critical limits

For the selection of overheating indicators, a potential list of indicators is offered, which within the framework of the study must be initially approved in a pilot-survey with experts - macroeconomic specialists (see Table 6). After the pilot-survey, correction, replenishment of the list of indicators is possible.

Table 6. Initial indicative indicators of the risk of overheating of construction

Internal indicators	
	Number of applications for construction intentions
	Share of job vacancies in construction sector
	Ratio of construction cost index to volume index of construction output
	The ratio of wages and salaries per employee to productivity in construction
External indicators	
	Planned gross capital investment in construction by the state
	Household disposable income
	Total turnover of enterprises
	Mortgage interest rate
	Volume of newly issued loans for the purchase, reconstruction, repair of a dwelling
	GDP growth rate
	Construction cost index by building materials group
	Electricity price on the stock exchange
	Average prices of petrol and diesel fuel for final consumers
	Forecast of state budget expenditures/revenues for the period of EU funds

Source: author-created

The resulting list of indicators is initially approbated in the pilot-survey and, after corrections and assessment of critical limits, is transferred to the expert-survey of macroeconomic experts with a more detailed assessment.

Initial approbation

As part of the approbation of the risks of overheating of the initial construction, the initial list of overheating indicators is evaluated (see Table 6). Up to six macroeconomic experts are involved in the evaluation and the evaluation is carried out by the researchers involved in the study.

The purpose of approbation is to evaluate the list of indicators in order to identify possible shortcomings in the definition of indicators, to assess their usefulness within the framework of the study, to supplement the list with indicators that were not identified in the initial heuristic analysis of the situation. As part of the approbation, the indicators are ranked from the most significant to the least significant.

In order to assess the approximate critical limits, the approbation experts involved in each indicator shall indicate the discrete value of the indicator in the specified unit of measurement, which is considered to be the critical limit at which there is reason to believe that there is an increased risk of overheating of the construction industry. The arithmetic mean, median mean, and standard deviation values of the obtained discrete critical limits are used to develop the assessment intervals for the next round of expertise.

Expert assessment of indicators and their critical limits

In the second round of expertise, the list of indicators adjusted in the approbation shall be transferred to a wider group of macroeconomic experts for evaluation, ranking, determination of weight coefficients and assessment of critical limits.

For the list of indicators within the framework of the expert-assessment, the following actions shall be performed:

1. Assessment of the significance of overheating indicators on the provided scale, on the basis of which the coefficients of indicator weights for the calculation of the index will be developed;
2. Determination of critical values of overheating indicators using intervals, indicating the boundaries at which there is a moderate, medium and high risk of overheating in the construction industry;
3. Identification of additional overheating indicators to supplement the list or further study in repeated iterations of the study.

The obtained estimates of weight coefficients, critical limits and scales shall be compiled with arithmetic mean, median and standard deviation statistical indicators and shall be used in the next stage in the calculation of the Overheating Risk Index for Construction.

1.4. Development of the construction overheating risk index and assessment of the degree of risk

To assess the risks of overheating of construction, it is proposed to use the Construction Overheating Risk Index (BPRI), which is the weighted average index of normalized overheating indicators. The use of BPRI would provide for two types of approach – the calculation of the total value of the index for past periods, as well as the forecasting of the value of the index by forecasting the values of its components using extrapolation or predictions of their values made by other public studies.

The normalized value of overheating indicators is expressed in a normalized index of their values with a value between 0 and 1, so that the combination of indicators in the overall indicator of overheating risk of construction is possible. Such a transformation is necessary in order to be able to compare with each other different indicators that have different units of measurement.

$$nPI_t^i = \frac{PI_t^i - min\{PI_t^i\}_{t=n-5}^{n}}{kPI^i - min\{PI_t^i\}_{t=n-5}^{n}}$$

(Formula 7)

where nPI_t^i – value of i-th overhating indicators normalized value in period t,
PI_t^i – actual value of i-th overheating indicator in period t,
kPI^i – mean expert evaluated critical value of i-th overheating indicator.

The indicator of the risk of overheating of construction is determined as the weighted average index of the normalized values of all overheating indicators.

$$BPRI_t = \frac{\sum_{i=1}^{n}(nPI_t^i \cdot \beta^i)}{\sum_{i=1}^{n}\beta^i}$$

(8. formula)

where $BPRI_t$ – construction overheating risk index in period t,
i – sequence number of the overheating indicator,
nPI_t^i – normalized value of the i-th overheating indicator in the period t,
β^i – average significance weight assessment of the i-th overheating indicator.

The resulting BPRI index allows you to assess the overall trend and the degree of risk of overheating. In addition to a direct interpretation of the index, the proportion of components in the total components has reached the critical limit of its components (see fig. 2).

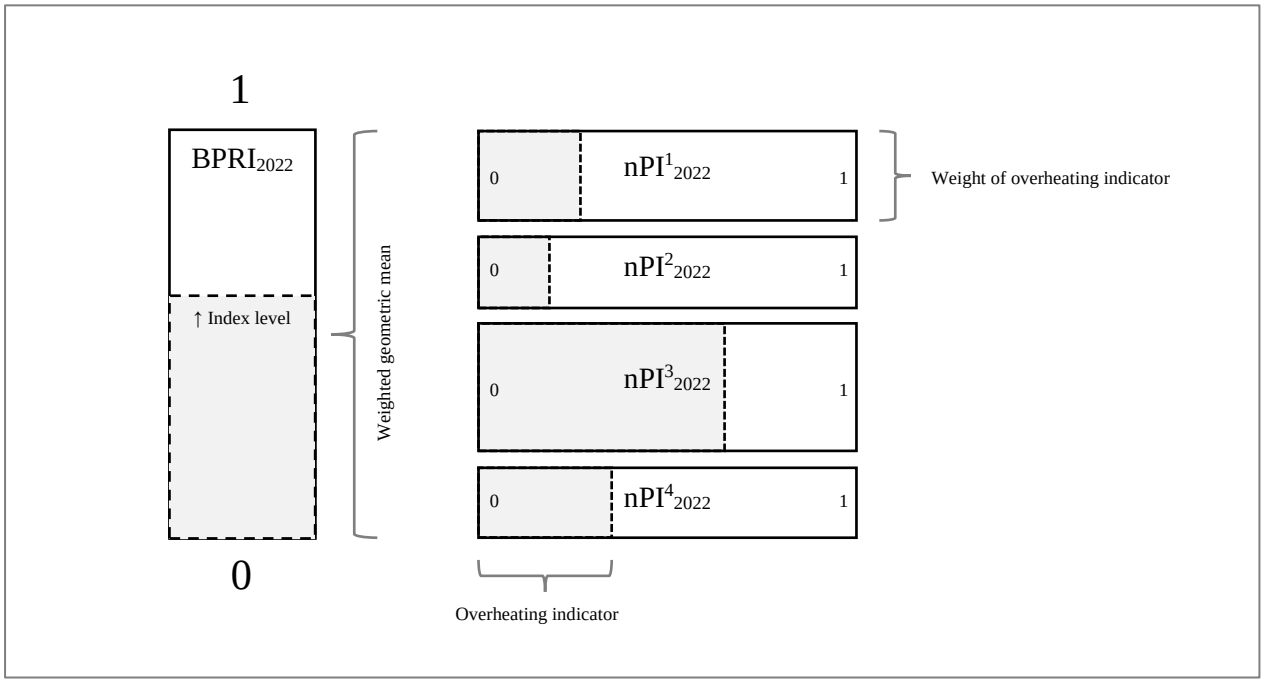


Fig. 2. Conceptual scheme of the construction overheating risk index. Source: author-created

The index value ranges from 0 (low) to 1 (high) risk of overheating. The normalized value of each overheating indicator also fluctuates in the same amplitude, which allows identifying those indicators whose value is closer to critical or higher.

Overheating assessment limitations

The use of the construction overheating risk index within the framework of the study is in the first iteration phase, therefore the researchers set limitations that must be taken into account when using and interpreting the BPRI in the context of the Latvian construction industry.

The construction industry in the national economy of Latvia has experienced only one full-fledged overheating episode in 2008-2010. within the framework of the financial and administrative crisis of Latvia. Due to this circumstance, a sufficient empirical database is not available to be able to identify critical indicators that could signal the approach of a new overheating situation.

The economic situation both in Latvia and in the world in 2020-2022 faced regional and global shocks during the period. As a result of these events, global logistics chains, international economic and political relations, and national strategies have changed significantly. The results of these changes are unique in the 21st century, and their consequences and impact on the Latvian construction industry have not yet been fully realized.

For the reasons mentioned above, any assessments and forecasts about the risks of overheating in the construction industry should be taken with caution and must be considered not only in a direct, quantitative interpretation, but also considered in the context of the events of the relevant period and evaluated with caution.

Looking at the risks of overheating in terms of sub-sectors, it is not possible to fully implement the BPRI methodology. This is justified by the fact that more detailed data on overheating indicators and their applicability to each subsector are not available. Therefore, a separate analysis of the ratio of construction costs and production volume is performed in the section of sub-sectors. To achieve this task, sub-sectors of construction of residential and non-residential buildings, roads and railways and urban economy infrastructure should be considered. The choice of these sub-sectors is justified by the availability of data covering quarterly changes in the volume of construction output and construction costs. Trends in the growth of construction costs in the sub-sector, which exceed the trends in the growth of construction output, are considered an indicator of a higher risk of construction overheating.

2. Forecasts of changes in construction costs and production volume

2.1. Analysis of factors affecting construction

Factors affecting changes in labour costs

In order to assess the influence of various factors on labor costs, a compilation of the opinions of experts from both general and sub-sectors was carried out. The list of factors affecting the previous years served as the basis for the list of influencing factors, which was updated in coordination with the Customer and guided by the trends in the Latvian and international situation in the context of the construction industry. The obtained results were summarized with an average expert assessment and allow to assess the degree of influence of 16 factors affecting labour costs on a 10-point scale (see Table 7).

Table 7. Average e-expert assessments of factors affecting labour costs (number, points)

Rank	Factors affecting labour costs	Number of expert ratings	Average expert rating
1	Construction volume in Latvia	66	7.33
2	Level of wages and salaries in the construction sector in EU countries	68	7.29
3	EU labour demand in the construction sector	68	6.94
4	Labour tax level in Latvia	67	6.85
5	Scope of construction intentions implemented with public funds	67	6.24
6	Net labour migration in Latvia	68	6.00
7	Level of wages and salaries in the EU in other sectors	66	6.00
8	Number of students in construction-related education programmes in Latvia	67	5.70
9	The global impact of COVID-19	69	5.41
10	Scope of measures to combat the shadow economy in Latvia	68	5.34
11	Implementation of sustainability principles in construction (energy efficiency, eco-construction, etc.)	69	5.19
12	Intensity of digitization of construction processes	69	5.00
13	Construction of the Rail Baltica project	69	4.84
14	Unemployment rate in Latvia	68	4.31
15	Planned mandatory involvement of the engineering consultant in public procurement	64	3.97
16	Unemployment rate in Latvia in non-construction sectors	67	3.55

Note: Expert ratings are given on a 10-point scale, where 10 points is the highest impact assessment and 0 points is a non-existent impact assessment.

Source: expert evaluations obtained in the study [7], authors' calculations

The main factors affecting labour costs were identified as the **volume of construction in Latvia, the level of labour remuneration in the EU countries in the construction sector and the demand for labour in the construction sector in the EU**. Compared to the previous period, equivalent studies show a stable leadership of these three factors – they maintain the position of the most important factors in the same order.

The level of taxes on labour in Latvia is also indicated as an important factor, and in the expert assessment this factor has become more significant than in 2021. From the 5th position and the 6.73-point rating, the labor tax level has risen to the 4th position with 6.85 points. While the increase is not large, it could be a signal that the industry is beginning to perceive the tax burden on labor as a growing burden.

By analysing factors that are not universal, but characterise current events in a certain period of time (COVID-19, the Rail Baltica project, digitalisation, etc.), it can be observed that in the expert assessment these types of factors have a mediocre impact on labour costs. If the epidemiological safety measures for 2021were assessed as a weak factor (4.28 points), then they were not included as outdated in the 2022 Study, as these measures are no longer implemented. Instead, the global impact of COVID-19 was assessed, as the pandemic has had a strong impact on global logistics chains that directly affect the construction sector. However, even in this broader interpretation, the impact of COVID-19 on labour costs is assessed as mediocre (5.41 points) and is not among the leading factors. Similarly, the construction of the Rail Baltica project is not assessed as a significant factor affecting labour costs, and over the year the average expert rating has even decreased from 5.16 to 4.84 points. It can be concluded that in the increase in labor costs in construction, it is not individual projects that matter, but the total volume of construction.

As part of the study, the research was also carried out by collecting the opinion of construction experts in various sub-sectors. This provides an opportunity to identify differences between subsectors and identify factors that have a higher impact on labor costs in certain sections. Factors that are more pronounced in certain subsectors were identified (see Table 8).

Table 8. Breakdown of the most significant factors affecting changes in labour costs by sub-sectors of construction sector represented by experts

Sub-sector	**Construction of buildings**	**Construction of roads and railroads**	**Construction of urban-farm infrastructure facilities**	**Specialized construction work**	**Architectural and engineering-technical services**
Key factors in the subsector	1. Construction volume in Latvia	1. EU labour demand in the construction sector	1. Construction volume in Latvia	1. Labour tax level in Latvia	1. Construction volume in Latvia
	2. Level of wages and salaries in the construction sector in EU countries	2. Level of wages and salaries in the construction sector in EU countries	2. EU labour demand in the construction sector	2. Number of students in construction-related education programmes in Latvia	2. Level of wages and salaries in the construction sector in EU countries
	3. Labour tax level in Latvia			3. Construction volume in Latvia	3. Scope of construction intentions implemented with public funds

Source: Expert assessments obtained in the study [7]

If in the assessment of factors affecting the increase in labour costs the most significant factor was the volume of construction in Latvia, it is the specific leader in the sub-sector of roads and railroads and specialized construction works. In the case of the construction of roads and railroads, the most pronounced factor is the demand for labour in the EU and the payment of labour in other EU countries. It can be concluded that the construction of roads and railroads is more competitive in the labour market with the EU's neighbouring countries than in other sub-sectors. In turn, in the sub-sector of specialized construction, the differences are manifested in the greater importance of the level of taxes on labor and the number of learners in construction education programs. So, in this sub-sector, there is a greater sensitivity to taxes and, perhaps, a greater deficit of young specialists.

Looking at the factors indicated by experts that were not included in the overall list of factors to be assessed, it is possible to identify individual unique factors and these are:

- shortage of specialists in certain construction professions, especially in mid-level managerial positions;
- the complexity of the process of attracting guest workers;
- the cyclical nature of the order for construction products;
- increase in the volume of requirements (certification, education, further training, etc.).

Factors affecting changes in the cost of building materials

As equal to factors affecting wages and salaries, factors affecting the cost of building materials were analysed. The methodological approach was used in the same way as for labor costs. The experts carried out an assessment of the factors affecting the cost of the proposed building materials and compiled using average expert assessments, which made it possible to determine the degree of influence of 19 factors on a 10-point scale (see Table 9).

Table 9. Average expert assessments of factors affecting the cost of building materials (number, points)

Rank	Factors affecting the cost of building materials	Number of expert ratings	Average expert rating
1	Average annual price of metal products in Latvia	57	8.51
2	Average annual timber price in Latvia	57	8.07
3	Average annual price of energy resources in Latvia	57	8.00
4	Average fuel price in Latvia	58	7.90
5	The global impact of COVID-19	57	7.44
6	Construction volume in Latvia	58	6.86
7	EU total demand for the construction market	57	6.39
8	Competition concentration indicators in the building materials market in Latvia	58	6.09
9	Scope of construction intentions implemented with public funds	58	6.02
10	Real estate lending volumes in Latvia	57	5.79
11	Implementation of sustainability principles in construction (energy efficiency, eco-construction, etc.)	58	5.74
12	Number of construction intentions in Latvia	58	5.50
13	Technical requirements for the construction quality of EU buildings	57	5.44

14	Natural resources tax rate in Latvia	56	5.43
15	Growth rates of the EU economy	56	5.16
16	Construction of the Rail Baltica project	57	4.77
17	Changes of Gross Domestic Product in Latvia	55	4.55
18	Intensity of digitization of construction processes	58	3.86
19	Scope of measures to combat the shadow economy in Latvia	58	3.76

Note: Expert ratings are given on a 10-point scale, where 10 points is the highest impact assessment and 0 points is a non-existent impact assessment.
Source: expert evaluations obtained in the study [7], authors' calculations

Taking into account the current increase in the costs and availability of the supply of materials and energy resources both nationally and globally during the development of the study, which took place from May to July 2022, the **prices of metal products, timber, energy resources and fuel in Latvia** were identified as the most important four factors contributing to the cost of building materials. Compared to the previous year, the influence of prices of metal products (from 7.91 to 8.51 points) and timber (from 7.21 to 8.07 points) on construction costs has increased. It can be concluded that the situation regarding these resources has escalated.

A significant jump in costs is observed in the energy component. If in the 2021 edition the price of fuel and electricity was not even in the list of the most important 10 factors, then in 2022 these two factors have become two of the five most important factors affecting the price of building materials. In general, these factors are evaluated even more significantly than the volume of construction in Latvia, which for several years was one of the most important factors, but in the 2022 Study has lost its position as a leader. On this basis, the authors interpret that the cost of building materials has lost a significant connection with the demand of the Latvian internal market, but becomes primarily dependent on the global situation. This reduces the chances of influencing the influence of these factors with the help of measures at the state level, since the complexes do not allow to eliminate the causes of the problem.

Looking at the differences in different sub-sectors in the context of factors affecting the cost of building materials, it is possible to identify those factors that have a higher impact on the specific sub-sectors (see Table 10).

Table 10. Breakdown of the most significant factors affecting changes in the cost of building materials by sub-sectors of the construction industry represented by experts

Sub-sector	**Construction of buildings**	**Construction of roads and railroads**	**Construction of urban-farm infrastructure facilities**	**Specialized construction work**	**Architectural and engineering-technical services**
Key factors in the subsector	1. Average annual price of metal products in Latvia	1. Average annual price of energy resources in Latvia	1. Average annual price of metal products in Latvia	1. Average annual price of metal products in Latvia	1. Average fuel price in Latvia
	2. Average annual price of energy resources in Latvia	2. Average annual price of metal products in Latvia	2. The global impact of COVID-19	2. Average annual timber price in Latvia	2. Average annual price of metal products in Latvia

	3. Average annual timber price in Latvia	3. Average fuel price in Latvia		3. Average annual price of energy resources in Latvia	3. Average annual timber price in Latvia

Source: Expert assessments obtained in the study [7]

In contrast to the factors affecting labour costs, where differences in expert assessments were observed in different sub-sectors, such differences are not particularly observed in the breakdown of building materials. In all subsectors, material and energy prices remain key factors in the various combinations. The only sub-sector in which minor changes are observed is the construction of urban infrastructure facilities. In this sector, the global impact of COVID-19 could be eliminated with a high impact. Given that this subsector might need specific building materials that are less typical of other industries, the cost of building urban infrastructure facilities could be more dependent on disruptions to global supply chains caused by COVID-19.

Experts in the subsectors indicated factors that were not included in the range of factors proposed and evaluated by the Study:

- The impact of the Russo-Ukraine war and related sanctions;
- the need to look for new supply routes;
- lack of long-term construction planning.

Considering that the main challenge for the surveyed experts is the search for new delivery routes, then in this aspect, state support would be supported. Current offers for business support are focused on export activities but not on import activities. Therefore, assistance to replace import sources would contribute to a faster increase in the supply of building materials and, accordingly, a reduction in costs.

Building materials cost assessments were also conducted by experts representing the architectural and engineering services subsector, and a large proportion of these experts were unable to identify building material costs relevant to their subsector. Based on this observation, the researchers believe that in the coming years, conducting an equivalent study, it would be useful to reduce the number of questions to architectural and engineering service experts about factors that are outside the specifics of their activity.

Factors affecting changes in maintenance and operating costs of machinery and equipment

One of the novelties of the 2022 Research is to supplement the assessment of factors affecting changes in construction costs with an expert assessment of factors affecting the maintenance and operating costs of machinery and equipment (see Table 11). The range of factors to be evaluated includes both internal and external factors and is based on the factors identified in other sections, selected based on the specifics of machines and mechanisms. Given the novelty of the analysis of the influence of these factors, it is not possible for it to make a comparative analysis with the results of other years.

Table 11. Average expert assessments of factors affecting maintenance and operational costs of machinery and equipment on a 10-point scale, where 10 is the highest impact assessment and 0 is the assessment of non-existent effects

Rank	Factors affecting the maintenance and operational costs of machinery and equipment	Number of expert ratings	Average expert rating
1	Average fuel price in Latvia	49	8.33
2	Average annual price of energy resources in Latvia	48	7.92
3	Competition concentration indicators in the machinery and equipment market in Latvia	49	6.22
4	Construction volume in Latvia	49	6.06
5	The global impact of COVID-19	50	5.50
6	EU total demand for the construction market	46	5.33
7	Scope of construction intentions implemented with public funds	49	5.31
8	Number of construction intentions in Latvia	49	5.00
9	Growth rates of the EU economy	48	4.88
10	Construction of the Rail Baltica project	49	4.47
11	Implementation of sustainability principles in construction (energy efficiency, eco-construction, etc.)	49	4.43
12	Real estate lending volumes in Latvia	48	4.42
13	Changes of Gross Domestic Product in Latvia	46	4.15
14	Scope of measures to combat the shadow economy in Latvia	49	3.78
15	Intensity of digitization of construction processes	48	3.50

Source: expert evaluations obtained in the study [7], authors' calculations

The main factors affecting the maintenance and operational expenses of machinery and equipment are the average price of fuel and energy resources in Latvia. Both of these factors are rated high with 8.33 and 7.92 points. Consequently, changes in operating costs can be considered to be more dependent on their daily running costs. The third most important factor is competition in the respective machinery and equipment market in Latvia (assessed with 6.22 points), which on the one hand should be interpreted as a moderately significant factor. On the other hand, it is assessed that among the three most important factors, one is related to the concentration of competition in the hands of some market participants, which indicates a potentially problematic situation. with a large, there is a situation that many dealers who offer a specific range of machines or mechanisms used in construction are not able to operate successfully. This situation could be one of the reasons for the higher prices, so that measures to promote competition would allow costs to be reduced in the construction sector.

Looking at the ranks of factors in different sub-sectors, no significant differences were found. In fact, in all sub-sectors, the most significant factors coincided, with only their ratings changing.

In the sub-sector of maintenance and operation of construction machinery and equipment, specific factors which were not included in the overall assessment but which were identified as significant by individual experts were:

- availability of spare parts and delivery terms;
- offer of machines and mechanisms of certain brands;
- the degree of depreciation of existing machines and mechanisms;

- The impact of the Russo-Ukrainian war and related sanctions.

Given that the competition aspect was also mentioned in the unaccounted factors, only this time in terms of specific brands, the need to monitor competition in this aspect has repeatedly crystallised.

2.2. Assessment of the impact of the fight against the shadow economy, COVID-19 and the Russo-Ukrainian war

Within the framework of the study, experts carried out an assessment of the impact of the measures planned and implemented by public administrations to combat the shadow economy on the labor and building materials costs of the construction industry. By analyzing the obtained answers of experts from both general and sub-sectors, the average expert assessment was calculated. The impact of measures to combat the shadow economy on construction costs was assessed on a ball scale from -10 to +10 points, where a higher score means that the factor of combating the shadow economy increases or decreases significantly the cost of labor or building materials in construction.

An analysis of the obtained expert assessments concludes that, in general, experts representing the construction sector see a greater impact of measures to combat the shadow economy on labour costs than on the costs of building materials (see Fig. 3). Overall, there are also moderately positive ratings, indicating that these measures lead mainly to cost increases rather than savings.

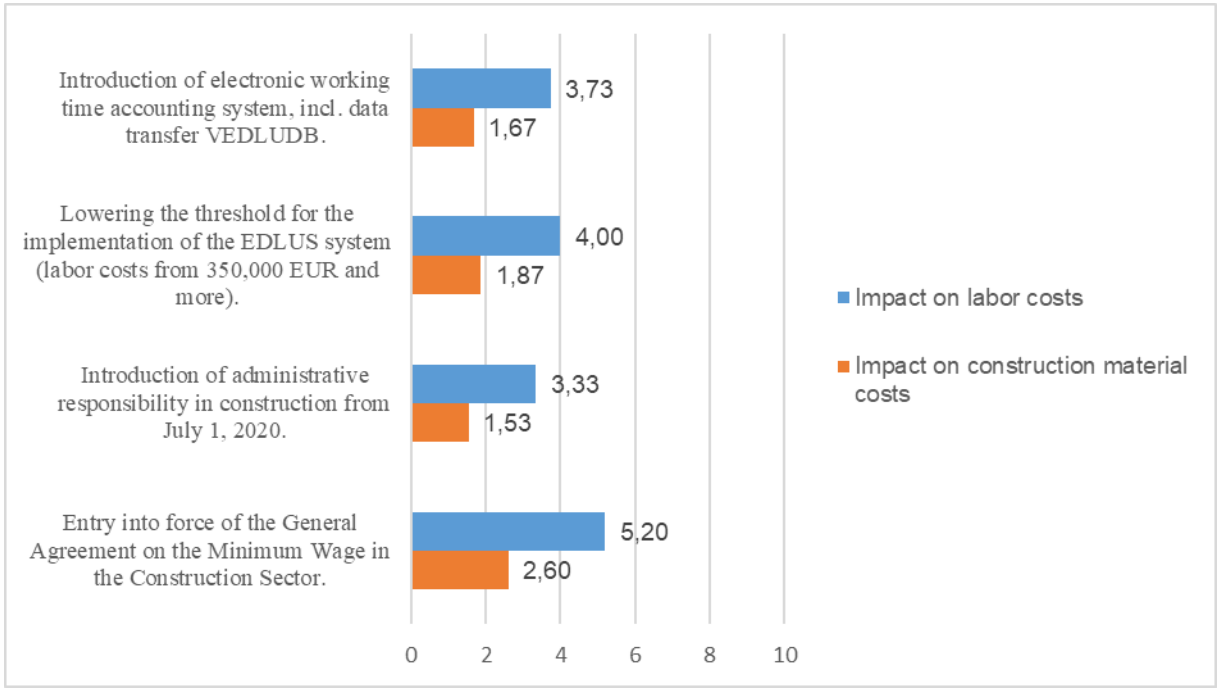


Fig. 3. Expert assessment of the impact of measures to combat the shadow economy on the cost of labor and building materials. Source: expert evaluations obtained in the study [7], authors' calculations

The most significant impact on labour costs is the entry into force of the general agreement on minimum wages in the sector in the construction sector and the reduction of the threshold for the introduction of the EDLUS system. In both cases, the impact of these measures has been assessed as mediocre. On the other hand, in the case of the impact of the cost of building materials, all valuations are low and in the range between 1.35 out of 10 points for the implementation of the EDLUS system and 1.89 out of 10

points in the case of a general agreement on the minimum wage. From this it can be concluded that measures to combat the shadow economy have a negligible impact on the cost of building materials, but in general the impact is estimated slightly higher than in the Research of previous years.

During the study, the COVID-19 pandemic continued for the third year, but epidemiological measures to combat it have decreased. However, on a global scale, the pandemic remains relevant and has a negative impact on supply chains. Consequently, there is reason to believe that these measures, and the pandemic itself, continue to affect the construction sector. In order to assess the degree of impact, the impact on both changes in labour costs and changes in the cost of building materials was assessed.

Ratings were carried out on a 10-point scale, with the possibility of indicating both positive and negative degrees of influence. In general, the impact of Covid-19 on the part of experts was assessed with a positive assessment, which means that it increases, not reduces, construction costs (see Fig. 4). The cost of building materials is more affected than labor costs. The average expert assessment of the impact of Covid-19 on the cost of building materials is 6.13 out of 10 points, which indicates an average impact. At the same time, the average impact on labour costs is 4.25 out of 10 points, which indicates a weak impact (see fig. 4).

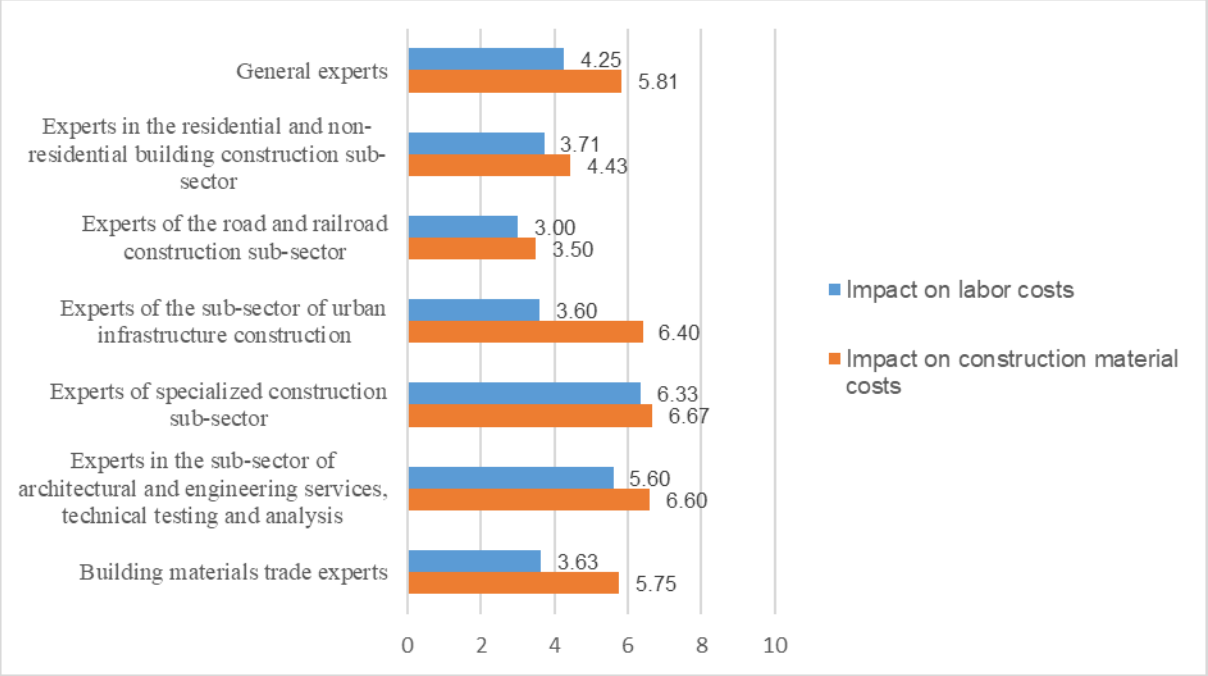


Fig. 4. COVID-19 impact assessment by different expert groups. Source: expert evaluations obtained in the study [7], authors' calculations

The greatest impact on the cost of building materials under the influence of COVID-19 is felt in the field of specialized construction works and architectural and engineering services, in other sub-sectors they are relatively less significant. At the same time, the impact on labor costs is most strongly estimated in the sub-sector of specialized construction work.

Taking into account the Russian invasion of Ukraine in 2022, for the first time, the effect of the Russo-Ukrainian war and related sanctions is also assessed (see fig. 5).

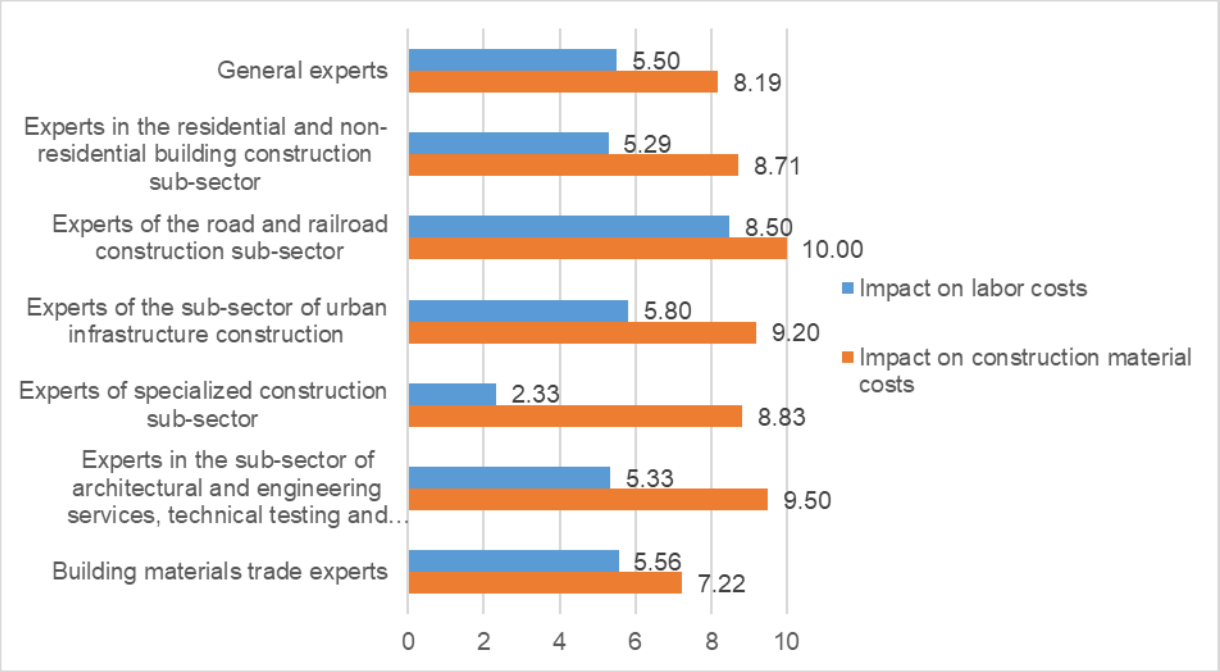


Fig. 5. Expert assessment of the impact of the Russo-Ukrainian war on the costs of the construction industry. Source: expert evaluations obtained in the study [7], authors' calculations

It can be concluded that in the construction sector, the impact of the Russian-Ukrainian war has surpassed the impact of the COVID-19 pandemic assessed in 2020-2022 (see Fig. 5). Most of all, the war has affected the cost of building materials and is especially critical in the construction of roads and railroads. Labour costs have also been significantly affected, most notably in the construction of roads and railroads, which could be related to specific materials and labour imported from war or sanctions-affected areas.

2.3. Assessment of the dynamics of the most significant costs of building materials

For the assessment of trends in the estimated cost of building materials for 2022 and subsequent years, manufacturers of building materials, traders and their representatives were surveyed with the aim of evaluating forecasts of changes in the costs of the most important construction materials, finishing materials and systems.

Based on the materials of the international research in the field of construction, within the framework of the study, a classification of building materials was created, dividing them into three basic groups:

1. Basic building materials;
2. Finishing materials;
3. Main system equipment.

Expert evaluations of the group of basic building materials show that there is still (as in 2021) timber leadership for the increase in costs (see Fig. 6). A 32.5% increase in timber prices is forecast. Unlike the observed situation in 2021, when only two positions were dominant – timber and metal products, the forecasts for 2022 indicate a significant increase in costs in almost all groups of basic building materials. Bitumen products with a 31.3% cost growth forecast in 2022 have come in second place, which is related to the increase in the cost of construction of roads and railroads considered in other sections. Forecasts of price growth of metal products are close to the assessment for 2021, and in 2022 are estimated at 28.8%. Glassware is also projected to see a significant cost increase of 28.3%, while in a preliminary study, the forecast for 2022 was only a 4.0% increase in costs (see fig. 6).

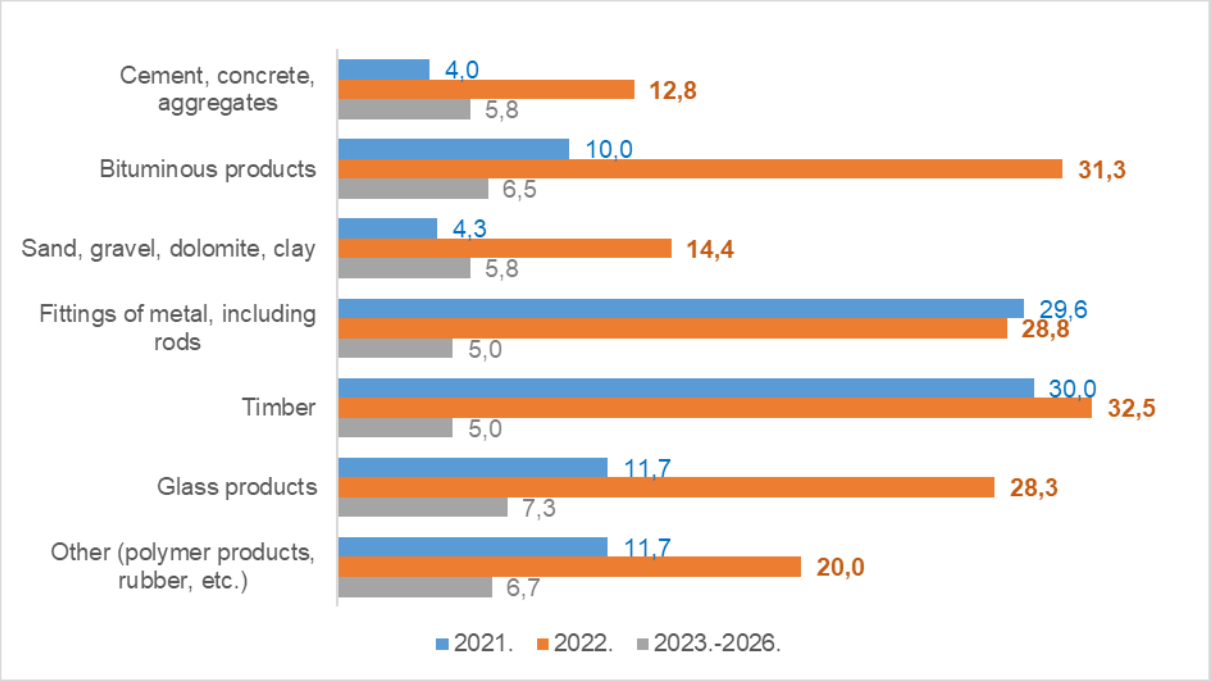


Fig. 6. Percentage of changes in the cost of basic building materials compared to the previous year expert assessment for 2021-2026 Source: expert evaluations obtained in the study [14], authors' calculations

The positions in which relatively moderate cost growth forecasts for 2022 are observed are only cement, concrete and fillers, as well as sand, gravel, dolomite and clay. Looking at the situation in a more distant perspective, it is characteristic that experts predict a decrease in the increase in costs in the period of 2023-2026 in all positions. It should be noted that the same view in perspective was observed by experts in the 2021 Study, which makes it necessary to be cautious about the reliability of forecasts over a longer period of time. The inadequacy of the forecasts of previous years with the situation can also be justified by the occurrence of unforeseen circumstances related to the Russo-Ukrainian war, which in 2021 were not foreseen by any expert either within the framework of the Research or in the wider scientific and expert community.

The second group of building materials that is analyzed within the framework of the study is finishing materials. The main positions in this group are interior and exterior finishing materials. For exterior finishing materials, an increase in costs of 29.3% in 2022 is predicted, which is five times higher growth than predicted a year earlier. The increase in the cost of interior finishing materials in 2022 is projected to be 15.0% (see Fig. 7). Attention is drawn to the fact that in the previous year there were higher price forecasts for interior finishing materials, as they are more related to high prices for timber.

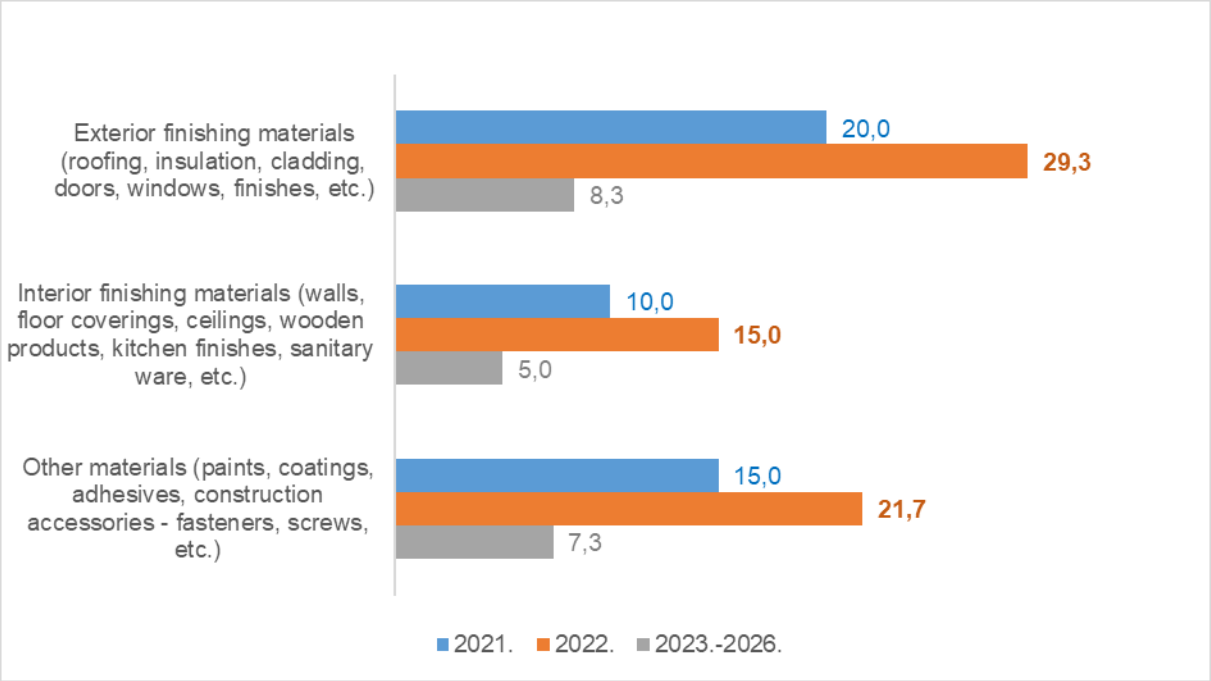


Fig. 7. Percentage of changes in the cost of finishing materials compared to the previous year expert assessment for 2021-2026 Source: expert evaluations obtained in the study [14], authors' calculations

In the division of main system equipment, high-cost growth forecasts can also be observed in all groups where expert assessments have been obtained (see Fig. 8). The highest cost increase is foreseen for plumbing systems with an annual growth rate of 35.0%. The second most significant growth is for heating and cooling systems with an increase of 33.3% in 2022. The lowest cost increase is projected for automation systems with 17.5%, which could be explained by the lower material consumption for these systems. No assessments have been obtained for fire-fighting and safety management systems because the experts did not provide a sufficient number of assessments for reliable results (see fig. 8).

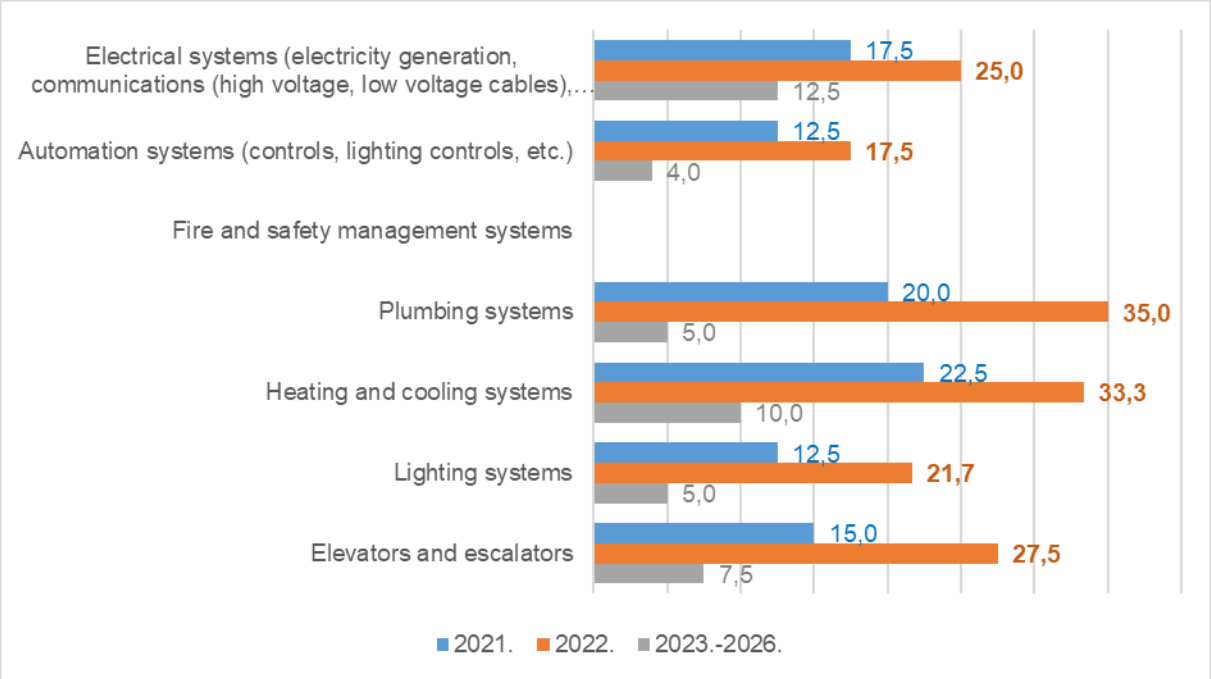


Fig. 8. Percentage of changes in the cost of main system equipment compared to the previous year expert assessment for 2021-2026 Source: expert evaluations obtained in the study [14], authors' calculations.

For the second year in a row, the study evaluates the structure of the sale of building materials in the Latvian market. However, the compilation of assessments by experts in the trade sector allows to obtain a relatively reliable view of market demand (see Fig. 9).

According to the obtained structure, 20% of the sales volume of building materials consists of cement, concrete, fillers, sand, gravel, etc. equivalent materials, 13% of the market is occupied by bitumen mixtures, 14.6% is made up of metal products. Timber and finishing materials (both internal and external) each account for 15.8% of the total sales of building materials, while the main system equipment accounts for 10%. The remaining 10.8% are various other building materials that do not fall into the above categories.

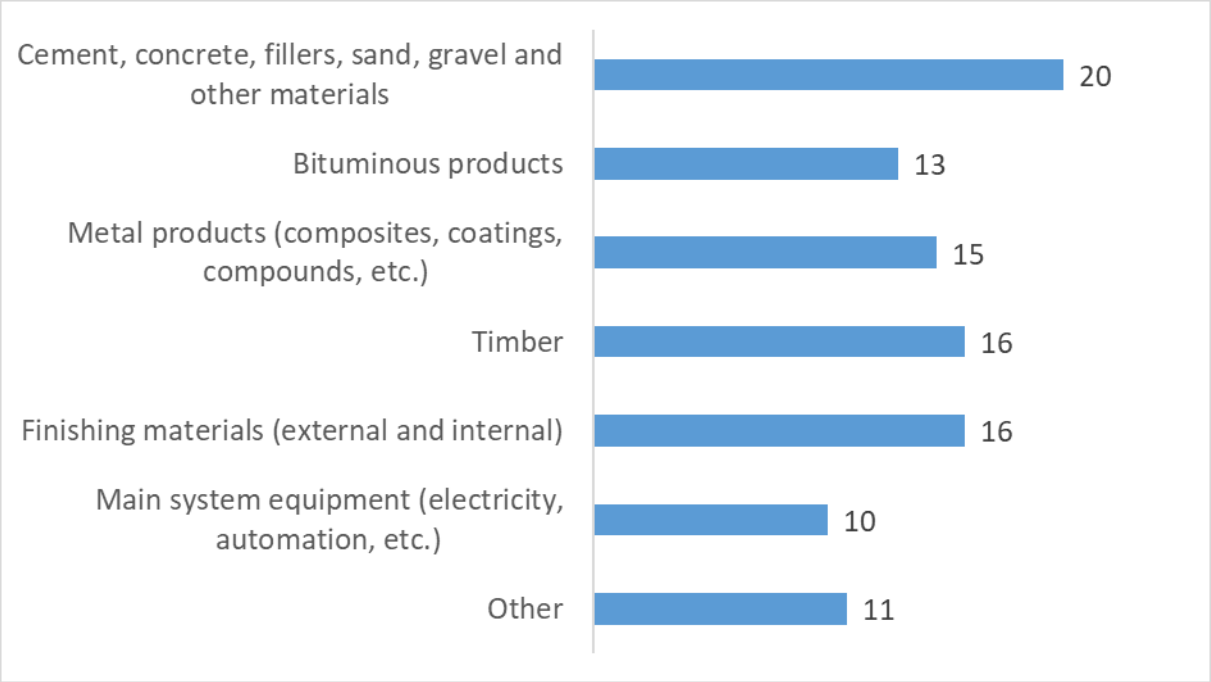


Fig. 9. Average estimates of experts in the trade in building materials for the structure of the sale of building materials as a percentage. Source: expert evaluations obtained in the study [14], authors' calculations

The considered categories are characterized by certain groups of goods, but separately the study analyzed previous trends in the field of prices of building materials, using CSB data specially compiled for the Study on the dynamics of prices of various goods from 2015 to 2021 for the category of timber and metal products.

In the category of metal products, data were collected on such metal products as rolled steel, metal structures, products, reinforcing and meshes, frames, various steel tubes, etc. Over the period from 2015 onwards, cost changes in these different categories were observed in the range from -12.2% to +40.5% compared to the previous year, so it can be concluded that no price stability has been observed over the period considered.

In the field of metal products, the year 2021 was marked by a significant increase in the costs of various metal products (see Figure 10). The most significant price increase was actually observed for steel pipes in the amount of 40.5%, as well as for bars, reinforcement meshes, frames in the amount of 33.1%. The lowest cost increase was for industrially insulated steel pipes with an internal diameter of 200 mm at 10.7%. The situation in 2021 is characterized by both the actual data on individual goods and the experts' assessment with a 29.6% increase. Considering that there is no comparable public data that would allow us to know the average price increase of metal products, expert assessment serves as a measure of reliability of expert assessments. Taking into account that the obtained assessment of the costs of metal

products in 2021 corresponds on average to the actual values of the prices of individual goods in the CSB data, the expert assessments are considered reliable.

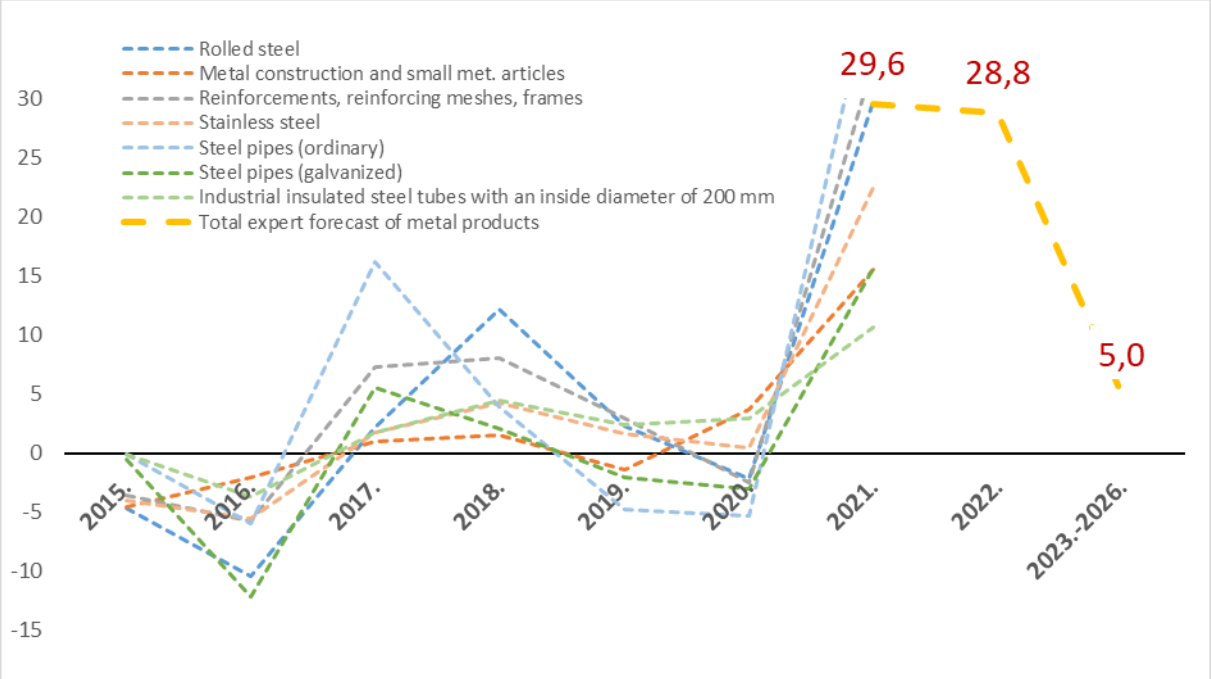


Fig. 10. Price dynamics of individual metal products 2015-2021. for 2021, trade experts' assessment for 2021 and forecast for 2022-2026 (% compared to the previous year). Source: CSB data, evaluations of trade experts obtained in the study [14], authors' calculations

Within the framework of the study, an expert survey was conducted on the prices of metal products and expert assessment of them in 2021, which indicated an increase of 29.6%. The expert assessment obtained within the framework of the study is included in the CSB data on individual metal products and corresponds to the overall trend, which allows to judge the high reliability of the forecast for 2022. Accordingly, in 2022, the expert assessment indicates an increase in the price of medium-sized metal products in the amount of 28.8%.

In the timber category, the available data on positions such as logs, beams, unplanned boards, parquet, plywood, fibreboard and chipboard were considered (see Fig. 11). Unlike metal products, this group has a lower amplitude of fluctuations and an increase in the price of individual products, thus the average trend is generally lower. The change in the cost of the positions considered can be observed in the range from -11.4% compared to the previous year to an increase of +36.4%. The forecasts, which were made in 2021, predicted a 30.0% increase in the timber group, based on the assessments of experts in the trade in building materials. The data obtained confirm these forecasts, since on average prices for the positions considered increased by 24%, not counting on the structure of demand for materials, which is not available. Further forecasts for 2022 predict the same price increase by 32.5% (see fig. 11).

The situation in 2021 is characterized by both actual data on individual timbers and expert assessment with a 30.0% increase. Similar to the situation with metal products, there is also no comparable public data for timber that would allow us to know the increase in the average price of timber, the expert assessment serves as a measure of the reliability of expert assessments. Taking into account that the obtained assessment of timber costs in 2021 corresponds on average to the actual values of the prices of individual goods in the CSB data, even in this situation expert assessments are considered reliable.

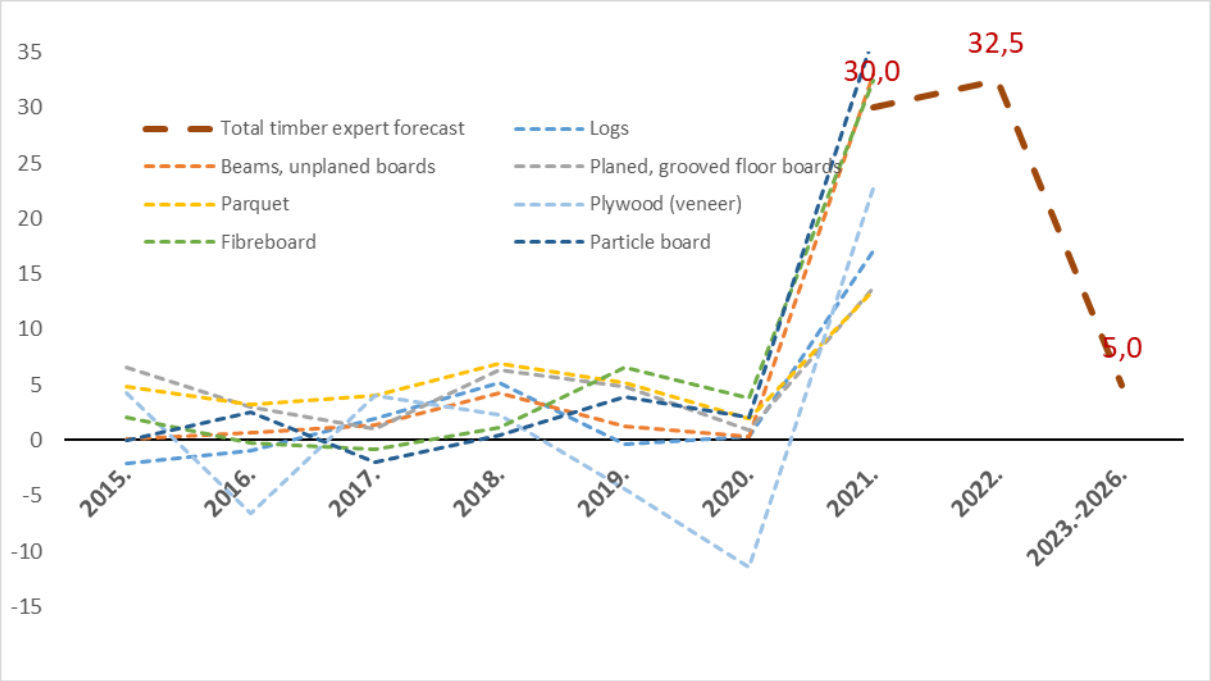


Fig. 11. Price dynamics of individual timber 2015-2021. year, trade experts' assessment for 2021 and forecast for 2022-2026 (% compared to the previous year). Source: CSB data, evaluations of trade experts obtained in the study [14], authors' calculations

Looking at the current trends based on CSP data for individual types of co-materials, in 2021 the most significant increase was for fiberboards and chipboards by 32.5% and 36.4%, respectively. In the period since 2015, this was the highest price jump recorded in official statistics. A significant price increase can also be observed for sanders and unplaned boards in the amount of 33.1% in 2021. The lowest increase is 13.5% for parquet, which is also considered a significant price jump. Also, the assessment made by trade experts on the average growth of timber costs in 2021 with a volume of 30.0% roughly corresponds to the average trend in various timber positions. Considering that the CSB does not have an average indicator of timber price cost growth, the expert assessment for the year 2021 can be used as a measure of the overall trend. In the further perspective, in 2022, experts also predict an increase in costs for timber by 32.5%, but in 2023-2026. price stabilization and a moderate price increase are predicted for the period of the year.

2.4. Changes in volume and costs of construction production and their forecasts

Forecast of changes in total construction output and construction costs

Within the framework of the study, a forecast of changes in the volume and cost of construction production in Latvia was carried out for the period from 2022 to 2026. The forecast was based on three approaches – statistical forecast, expert forecast and combined forecast. The expert evaluations were provided by experts professionally related to the construction sector who are not specialised in a particular sub-sector in order to prevent the possible presence of stereotypical evaluations in the results obtained. The purpose of the combined forecast is to obtain a balanced forecast that would give a balanced average view of the dynamics of the development of the industry between the average estimates of experts and statistically extrapolated development of the situation (see fig. 12).

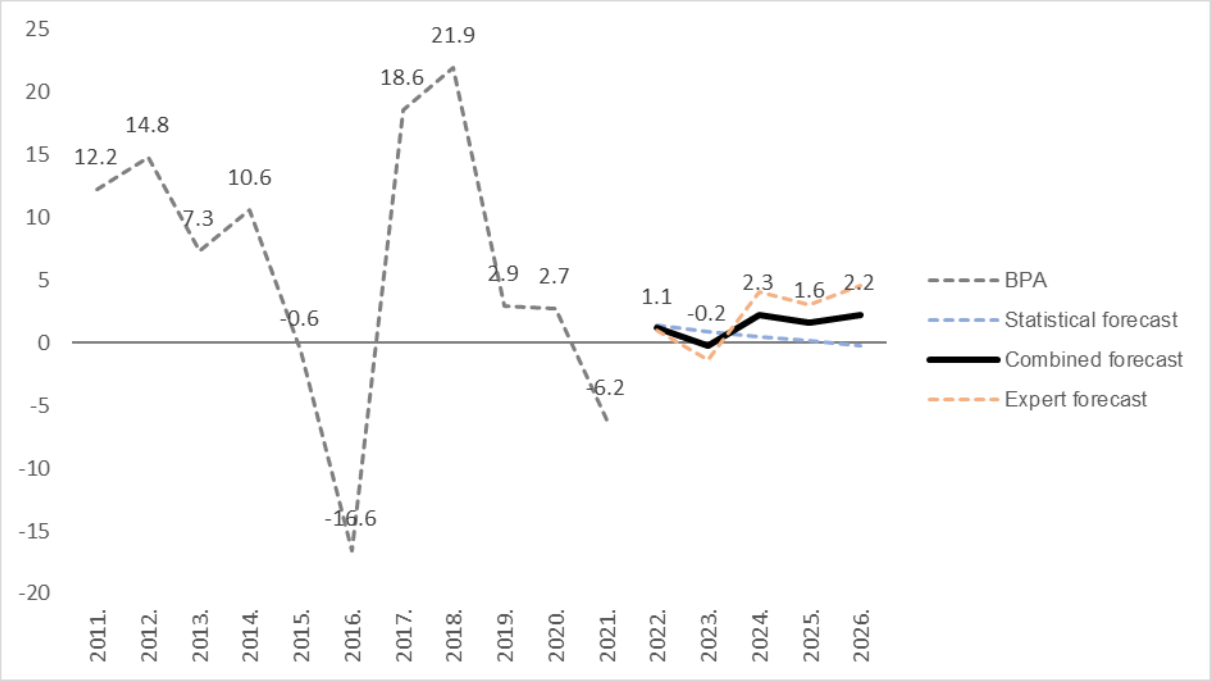


Fig. 12. Forecasts of changes in the volume of production of construction for 2022-2026 as a percentage of the previous year, where BPA is the actual historical indicators of the volume of construction production. Source: CSB data, expert evaluations obtained in the study [8, 14], authors' calculations

The obtained results indicate relatively low differences (compared to the cost assessment) between the rate of market development estimated by experts and the obtained results of statistical extrapolation (see Fig. 12). Forecasting the situation in 2022, the experts' average assessment is that the volume of construction production will increase by 0.9%, while the statistical forecast indicates a 1.3% increase in volume, which makes a combined forecast of 1.1% growth.

The differences between statistical and expert forecasts become larger starting from 2023. The statistical forecast, guided by general trends, is aimed at a gradual decrease, reaching a forecast of 0.9% annual growth in 2023 and a forecast of 0.5% growth in 2024. Expert forecasts point to the rest of the growth cycle from 2024 with 4.0% growth. Comparing retrospectively obtained forecasts in previous years' Studies, a high difference in results can be observed. In fact, in 2021, construction output fell by 6.2%, while the expert forecast for 2021 indicated an 11.4% increase, while the combined forecast indicated an expected 6.6% increase. In absolute terms, the combined forecast had a lower error, but in both cases no reduction in construction volume was expected. Potential reasons could be the severe and significant operational problems of global logistics chains in the industry, which caused delays in deliveries. These delays created an avalanche response in various industries and a significant increase in raw material prices.

Looking at the operational information from CSB, which was published after the expert survey and was not included in the research calculations, preliminary conclusions can be drawn. In the 2nd quarter of 2022, the volume of construction output has fallen by 13.8% compared to the corresponding period of the previous year. The obtained forecasts show that in 2022 the total volume will stagnate or could increase by a few percent. Researchers interpret that the moderate optimism of construction industry experts may be related to the state of shock in the industry in the first half of the year as a result of the Russia-Ukraine war. Due to the subsequent rapid increase in costs and disruption of supply channels, many construction projects were frozen. Therefore, in fact, the delay in the supply of materials and the recovery of logistics in the industry would allow the delayed projects to be completed in the second half of the year, which would allow to increase the total volume of construction output and compensate for

the fall in the first half of the year. The construction sector is also characterized by a higher volume of construction output in the 2nd and 3rd quarters, which, taking into account the above-mentioned shift in 2022, could manifest itself as a higher volume of output in the second half of the year

When forecasting changes in construction costs, the same forecasting methodology was used as when forecasting changes in construction production volumes for 2022-2026. The results obtained with a statistical forecast are significantly different from the expert assessment (see Fig. 13).

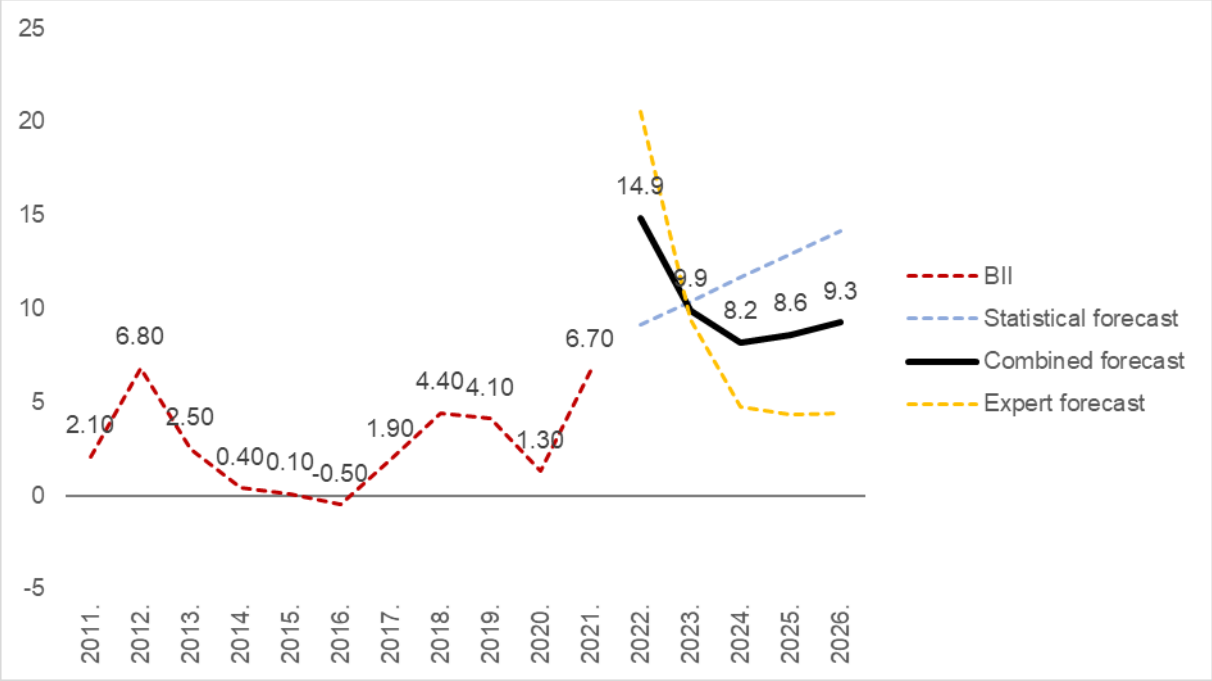


Fig. 13. Forecasts of changes in construction costs for 2022-2026 as a percentage of the previous year, where the BII is the actual historical indicators of changes in construction costs. Source: CSB data, expert evaluations obtained in the study [8, 14], authors' calculations

The same situation was observed in the previous 2021 Study, but with a smaller amplitude. According to the experts' assessment, construction costs in 2022 together could increase on average by 20.5% compared to 2021. Such a high increase in costs in the Latvian construction industry has not been observed for at least ten years and is a very important signal from experts. The statistical forecast for this period shows a cost increase of 9.2%, but the researchers consider this forecast unlikely. The low statistical forecast is justified by the increase in average costs over the past ten years, which has not exceeded 7% per annum. Taking into account the situation in the world in 2022 (Russo-Ukrainian war, continuation of the COVID-19 pandemic, etc.), it can be considered that the development of the situation according to the principle of extrapolation is not expected, therefore, an expert assessment that takes into account these events that have a strong impact on the industry (see table 12) would be more reliable.

Table 12.Forecasts of changes in construction production and costs for 2022-2026

Changes **in construction output** compared to the previous year						
2020	2021	2022	2023	2024	2025	2026
+2.7%	-6.2%					
Statistical forecast →		+1.3%	+0.9%	+0.5%	+0.1%	-0.2%
Combined forecast →		+1.1%	-0.2%	+2.3%	+1.6%	+2.2%
Expert forecast →		+0.9%	-1.4%	+4.0%	+3.0%	+4.6%
Changes **in construction costs** compared to the previous year						
2020	2021	2022	2023	2024	2025	2026
+1.3%	+6.7%					
Statistical forecast →		+9.2%	+10.4%	+11.6%	+12.9%	+14.1%
Combined forecast →		**+14.9%**	+9.9%	+8.2%	+8.6%	+9.3%
Expert forecast →		+20.5%	+9.4%	+4.7%	+4.4%	+4.4%

Source: CSB data, expert evaluations obtained in the study, authors' calculations.

For the volume of construction production in 2022, experts predict a slight growth of 0.9% compared to 2021, but in 2023, a decrease of -1.4% is expected. Experts foresee the highest increase in construction costs by 20.5% in 2022, but the forecasts decrease in all the following years and already in the period of 2024-2026 they could represent an average increase of 4.5% per year.

Operational data from CSB, which were not known at the time of the Research, show that in July 2022 construction costs increased by 21.3% compared to the previous year. This actual figure is very close to the 20.5% increase in 2022 estimated by experts. These periods are not identical, but indicate trends close to expert assessments made earlier on the data published by the CSB. Based on the assumption that construction material supply chains could be improved in the second half of 2022, this could reduce the pressure on construction material costs and also achieve a slightly lower level of cost growth on an annual basis. This may be overshadowed by the non-reduction of energy resource prices at the start of the heating season and the increase in demand. The state's stabilizing policy for compensating the costs of energy resources could reduce this effect.

Changes in volume and costs of construction production in sub-sectors and sectors

As part of the study, representatives of various construction sub-sectors provided expert assessments to assess in detail the forecasts of changes in the volume and cost of construction production of each sub-sector for the period from 2022 to 2026. Predictions were obtained for the following objects (see Table 13):

1) residential buildings;
2) non-residential buildings;
3) roads and highways;
4) railways and metros;
5) bridges and tunnels;
6) urban management infrastructure;

7) specialized structures;
8) changes in the volume of production architectural and engineering services, of technical inspection and analysis.

From the point of view of the growth of construction output, the highest growth is expected in the sub-sectors related to building construction. This significantly contrasts with the trends of the previous year. Over a longer period of time, this increase coincides with the trend of cyclical building construction. In 2022, experts predict an increase in the construction of residential buildings (8.2% in 2022) and an increase in the construction of non-residential buildings (5.6% in 2022). In the following years, expert assessments indicate lower market activity, but growth is still predicted. The combined forecast for building construction is 14.5% in 2022 and 11.3% in 2023. Given that the combined forecast is obtained by combining expert forecasts and statistical forecasts, they are higher than expert forecasts due to fluctuations in historical statistical data. In the period from 2011 to 2021, the production volume of building construction fluctuated from -10.5% to +28.2%, which makes it difficult to use statistical models.

In the construction of roads and railroads, experts predict low activity in the short term, but increased activity in the period until 2026. Expert-examinations show a decrease in the volume of construction of roads and highways in 2022 by 3.3% and reductions in construction of bridges and tunnels by 3.5%. At the same time, an increase of 1.5% is predicted in the volume of construction of railways and metros. In general, in the period of 2022-2026, the largest increase from the forecasts of experts without negative periods is predicted specifically for the railway sub-sector, while other sectors have separate periods of negative growth.

In the specialized construction sector in 2022, experts predict a slight decrease in production volume by 0.7%, however, in other periods up to 2026, an increase of between 3.8% and 8.6% per annum is forecast.

Significant growth is predicted in the field of architectural and engineering services, where experts see a 10.0% increase in 2022, and a subsequent decline to a 2.4% increase in 2023. In further periods up to 2026, an increase of between 8.0% and 9.6% per annum is forecast (see Table 13).

Table 13. Forecasts of changes in the volume of construction production as a percentage compared to the previous year in sub-sectors according to the average expert evaluations of experts for 2022-2026

	2022	**2023**	**2024**	**2025**	**2026**
Building construction volumes					
Expert-examination of changes in the volume of output of residential construction	+8.2%	+3.8%	+5.0%	+10.5%	+7.8%
Expert forecast of changes in the volume of production of construction of non-residential buildings	+5.6%	+1.4%	+2.0%	+8.4%	+8.6%
Combined forecast of changes in the volume of output of the construction of buildings	+14.5%	+11.29%	+10.9%	+15.2%	+15.2%
Volumes of construction of roads and railroads					
Expert forecast of changes in the volume of road and highway construction production	-3.3%	+1.3%	+4.0%	+9.0%	+15.7%

Combined forecast of changes in the volume of production of road and highway construction	-3.1%	+3.9%	+0.2%	+7.0%	+6.6%
Expert forecast of changes in the volume of construction of railways and metros*	+1.5%	+4.0%	+2.5%	+10.0%	+17.5%
Expert forecast of changes in the volume of construction of bridges and tunnels*	-3.5%	-1.0%	+1.0%	+6.0%	+16.0%
Combined forecast of changes in the volume of production of bridges and tunnel construction*	+7.3%	+20.2%	+11.6%	+23.3%	+20.2%
Construction volumes of urban management infrastructure facilities					
Expert-examination of changes in the volume of production of construction of urban management infrastructure objects	-0.8%	-0.8%	+1.8%	+5.0%	+3.5%
Combined forecast of changes in the volume of production of construction of urban management infrastructure objects	-0.4%	+3.8%	-0.9%	+5.7%	-0.9%
Volumes of specialized construction work					
Expert-examination of changes in the volume of production of specialized construction works	-0.7%	+3.8%	+8.6%	+6.0%	+4.2%
Combined forecast of changes in the volume of output of specialized construction works	+2.9%	+5.1%	+7.4%	+6.0%	+5.1%
Volumes of architectural and engineering services. technical inspection and analysis					
Expert-forecast of changes in the volume of production of architectural and engineering services, technical inspection and analysis	+10.0%	+2.4%	+8.0%	+9.0%	+9.6%

Source: sub-sector expert evaluations obtained in the study [9, 10, 11, 12, 13], authors' calculations

Equivalent to construction production volumes by sub-sectors, experts also assessed construction costs by sub-sectors according to their competence (see Table 14). Comparing the obtained results, it can be concluded that in the forecasts for 2022 there are no pronounced relationships between the volume of construction production and costs. If the trends in output volumes vary significantly between subsectors, then costs consistently increase in all sub-sectors. To some extent, this confirms the pressure of headline inflation on all sectors and subsectors and the fact that price increases are largely imported and are not justified by an increase in demand.

Table 14. Forecasts of changes in construction costs as a percentage of the previous year according to the average assessment of experts of subsectors for 2022-2026

	2022	2023	2024	2025	2026
Expert forecast of changes in construction costs of residential buildings	+25.1%	+14.3%	+8.7%	+8.6%	+7.8%
Expert-examination of changes in construction costs of non-residential buildings	+26.6%	+15.3%	+9.0%	+8.6%	+8.2%
Expert forecast of changes in construction costs of roads and highways	+23.3%	+9.7%	+6.7%	+6.0%	+4.7%
Expert forecast of changes in construction costs of railways and metros	+25.0%	+12.5%	+8.5%	+5.0%	+3.5%
Expert forecast of changes in the cost of construction of bridges and tunnels	+25.0%	+11.0%	+7.5%	+5.0%	+3.5%
Expert-examination of changes in the construction costs of urban management infrastructure objects	+21.3%	+18.8%	+8.0%	+5.8%	+4.5%
Expert-examination of changes in the cost of specialized construction works	+17.5%	+12.0%	+9.3%	+5.3%	+4.7%
Expert forecast of changes in the cost of architectural and engineering services, technical inspection and analysis	+14.0%	+7.6%	+8.8%	+6.4%	+7.6%

Source: sub-sector expert evaluations obtained in the study [9, 10,11, 12, 13], authors' calculations

Experts predict the most significant cost increase in the construction of residential and non-residential buildings, where in 2022 cost growth is forecast at 35.8% and 37.0%, respectively. In the coming years, cost growth is projected to be lower and lower, decreasing to the lowest level in 2024 with 17.4% in construction of residential buildings and 19.1% in construction of non-residential buildings.

In the roads and railroads construction subsector, cost increases are predicted to be similarly high in all subsectors. In 2022, an increase of 23.3% was forecast in the construction of roads and highways, in the construction of railways - by 25.0% and in the construction of bridges and tunnels - by 25.0%. In subsequent years, in all areas of roads and railroads construction, the increase in costs is expected to be lower and lower until 2026, in which growth is forecast in the range of 3.5-4.5%.

The relatively lowest cost increase is forecast in the field of architectural and engineering services, technical inspection and analysis, where in 2022 costs could increase by 14.0% according to expert estimates and in subsequent years the growth could fluctuate between 6.4% and 8.8% annually.

Changes of construction costs by kind of resources

In each of the sub-sectors, changes in construction costs by type of resource were assessed. As part of the study, the following division into types of resources was analyzed:

1. Changes in the cost of building materials;
2. Changes in labour remuneration costs of workers;
3. Changes in maintenance and operating costs of machinery and equipment;

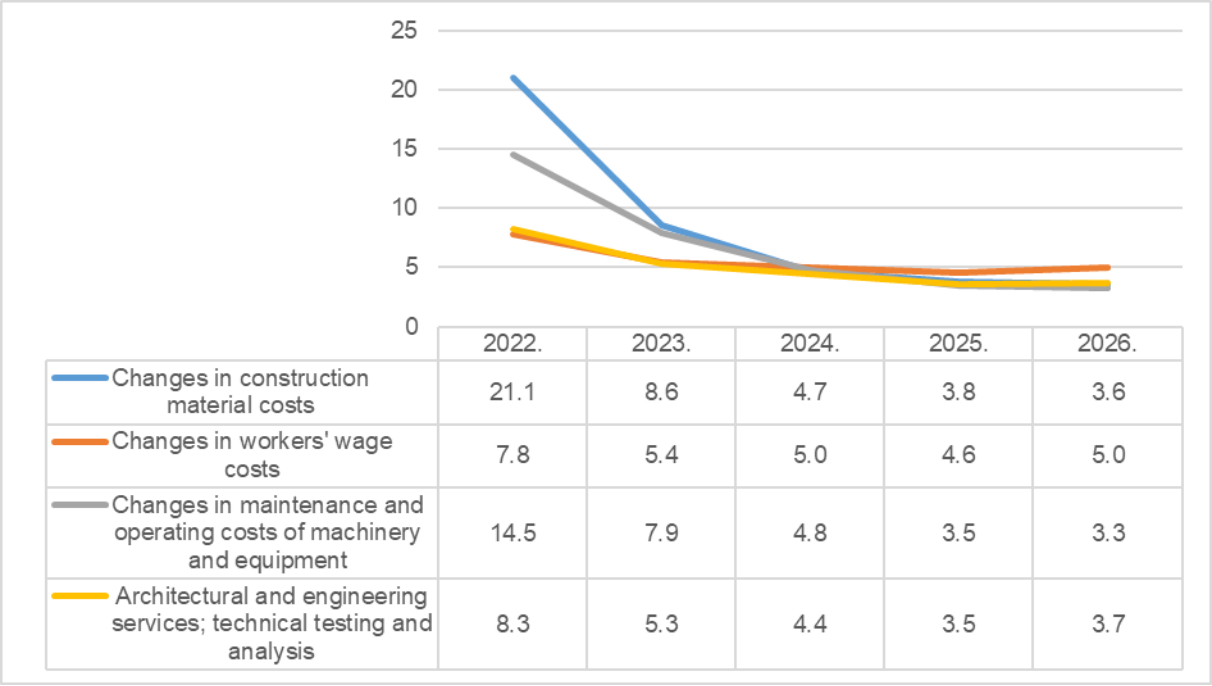
4. Architectural and engineering services; technical inspection and analysis.

In addition to the overall breakdown of cost types, changes in costs were also considered in combination with the subsector breakdown.

For the second year in a row, the largest increase is forecast for the cost of building materials, which is ahead of the leading position in the wages of workers prevailing in previous years. In comparison with the forecasts for 2021, it should be noted that in the context of building materials they have not been justified (see Fig. 14).

From the perspective of 2021, experts assessed the increase in prices of building materials as a unique event, which should be followed by a correction and a drop in growth. However, in 2021, forecasts were not expected to affect international trade by the events of the Russo-Ukrainian war and the associated disruptions in import flows of building materials. Thus, the cost of building materials in 2022 was also projected to increase by 21.1%. In the expert assessment, the increase in the cost of building materials in 2021 was a phenomenon of 2021, because in the forecasts for 2022 the change in the cost of building materials slipped to the second position classically putting the change in wages and salaries of workers in the first place. Until 2025, an increasingly small increase in the cost of building materials was predicted.

Similar to the forecasts of previous studies, experts also predict a decreasing increase in the cost of building materials in 2022 on an annual basis, where an 8.6% increase in costs is forecast in 2023 and an average of 4.0% annually in 2024-2026 (see fig. 14).



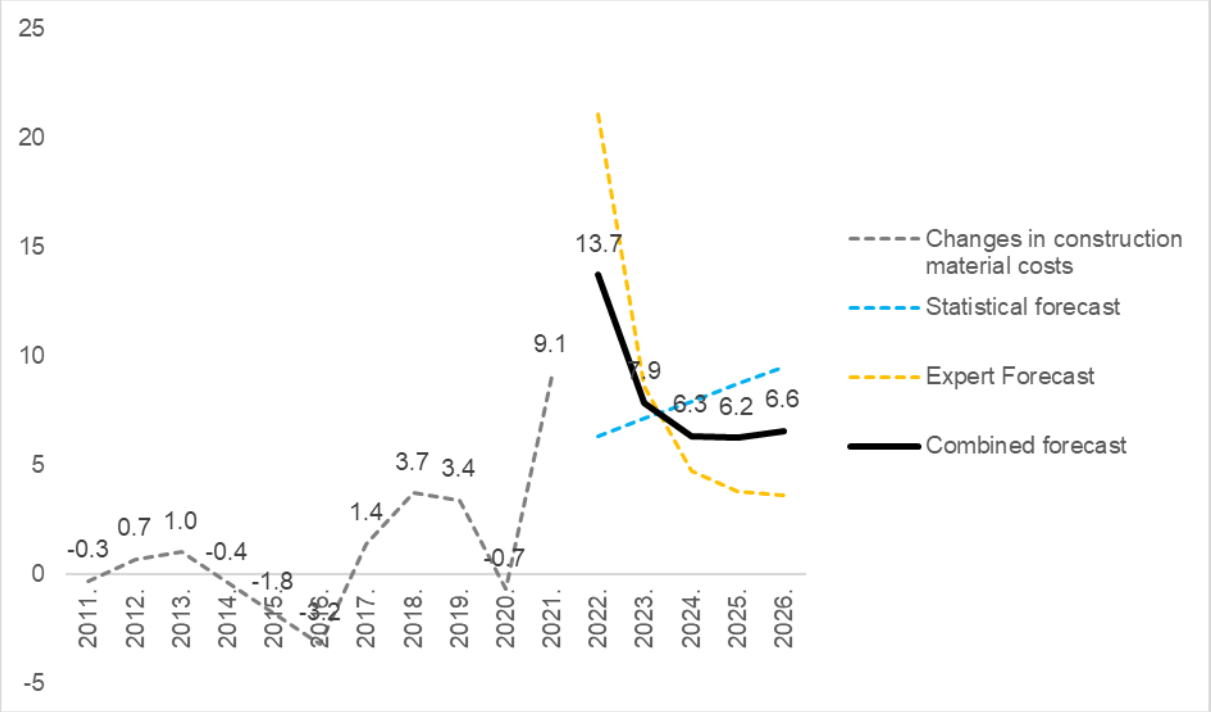
	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	21.1	8.6	4.7	3.8	3.6
Changes in workers' wage costs	7.8	5.4	5.0	4.6	5.0
Changes in maintenance and operating costs of machinery and equipment	14.5	7.9	4.8	3.5	3.3
Architectural and engineering services; technical testing and analysis	8.3	5.3	4.4	3.5	3.7

Fig. 14. Expert forecasts of changes in costs of resource types for 2022-2026 as a percentage of the previous year. Source: expert evaluations obtained in the study [8], authors' calculations

The maintenance and operational costs of machinery and equipment for the first time in forecast observations, according to expert estimates, exceeded the increase in wages and salaries of workers. For the past periods in this resource group, growth was always within a few percent per year, but in 2022, for the first time, expert forecasts reach double digits and a cost increase of 14.5% is forecast. In

the following years, this increase is projected to be lower, respectively, 7.9% in 2023 will approach the annual growth rate of 3% in the coming years. A secondary factor may be the lack of competition in the machinery and equipment market in Latvia, which is reflected as a result of the analysis of factors affecting the costs of machinery and equipment.

Forecasting the dynamics of the cost of building materials by statistical methods provides a relatively low forecast, for example, 6.3% in 2022 (see Fig. 15).

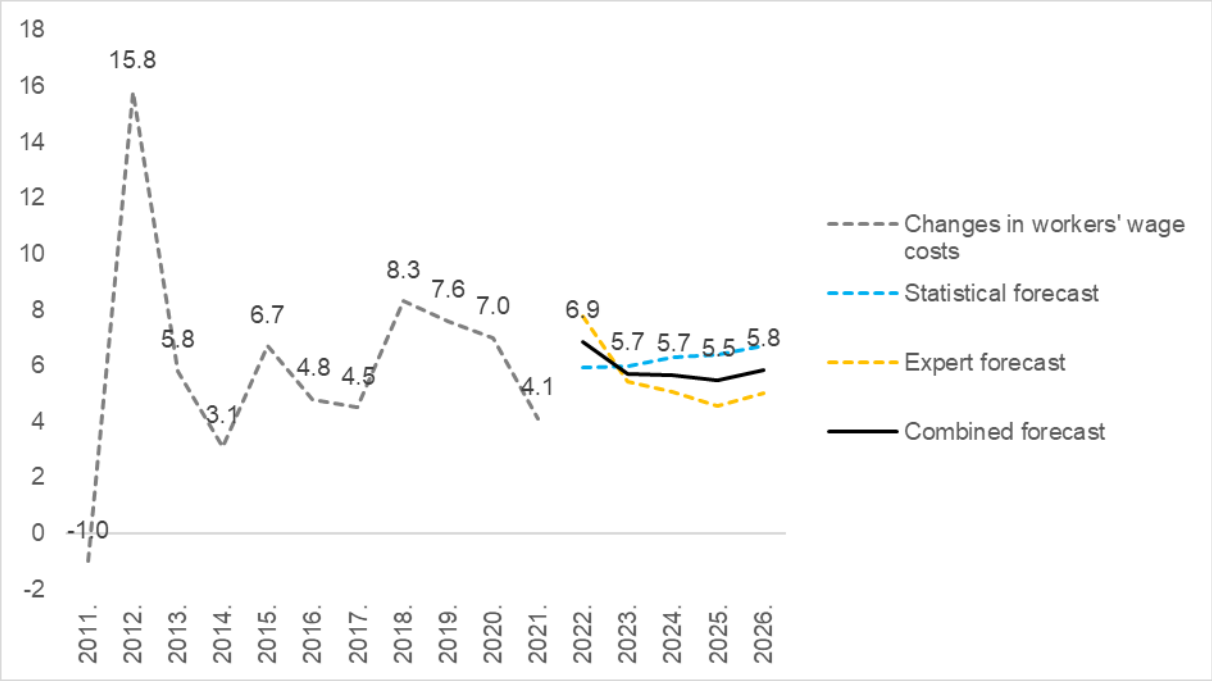


	2022	2023	2024	2025	2026
Statistical forecast	6.3	7.1	7.9	8.7	9.5
Combined forecast	13.7	7.9	6.3	6.2	6.6
Expert forecast	21.1	8.6	4.7	3.8	3.6

Fig. 15. Changes in the cost of building materials as a percentage of the previous year and forecasts for 2022-2026. Source: CSB data, expert evaluations obtained in the study [8], authors' calculations

The statistical forecast is based on extrapolation, therefore it does not include the effects caused by external shocks and depicts the situation on the condition that the situation develops according to past trends. Thus, in the context of this resource, higher reliability should be paid to the forecasts of experts, since experts were guided by the current situation in the market, which is characterized by a significant shortage of building materials due to a decrease in its supply. Thus, researchers consider the forecast of experts to be more reliable in 2022, and the combined forecast in 2024-2026 (see Fig. 15).

In 2021, labour remuneration costs of workers had the lowest increase since 2015, however, forecasts for 2022 already show a faster increase in costs again (see Fig. 16).

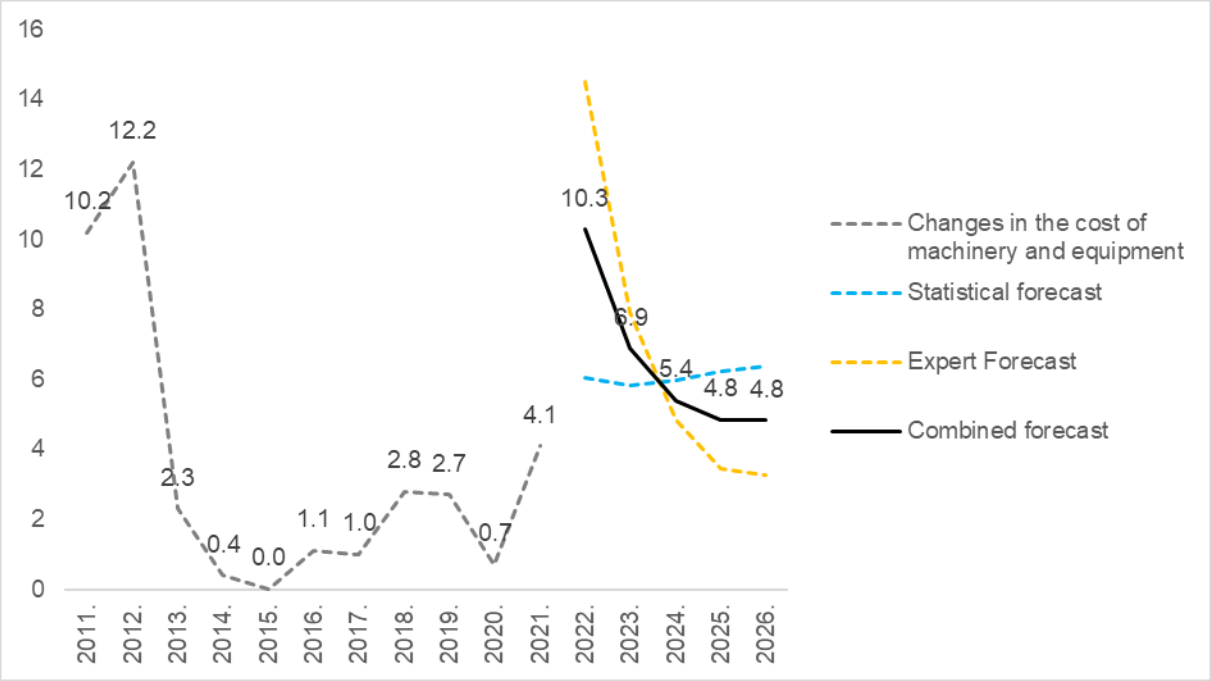


	2021	2022	2023	2024	2025
Statistical forecast	5.9	6.0	6.3	6.4	6.7
Combined forecast	6.9	5.7	5.7	5.5	5.8
Expert forecast	7.8	5.4	5.0	4.6	5.0

Fig. 16. Changes in labour remuneration costs of workers as a percentage of the previous year and forecasts for 2022-2026. Source: CSB data, expert evaluations obtained in the study [8], authors' calculations

Researchers are guided by the combined forecast, which is considered more reliable in the context of this indicator, and predict a 6.9% increase in costs in 2022 and an increase of 5.5-5.8% on average per year in 2023-2026. It can be concluded that during the foreseeable period the cost of labour remuneration of workers will result in much lower pressure and total construction costs than the costs of building materials, machinery and equipment. It also confirms once again that the cost pressure in the sector is more imported than created in Latvia.

Maintenance and operational costs of machinery and equipment since 2015 have grown relatively insignificantly, where in 2021 the highest increase of 4.1% was observed. However, already in 2022, experts predict an increase in costs by 14.5% (see fig. 17).

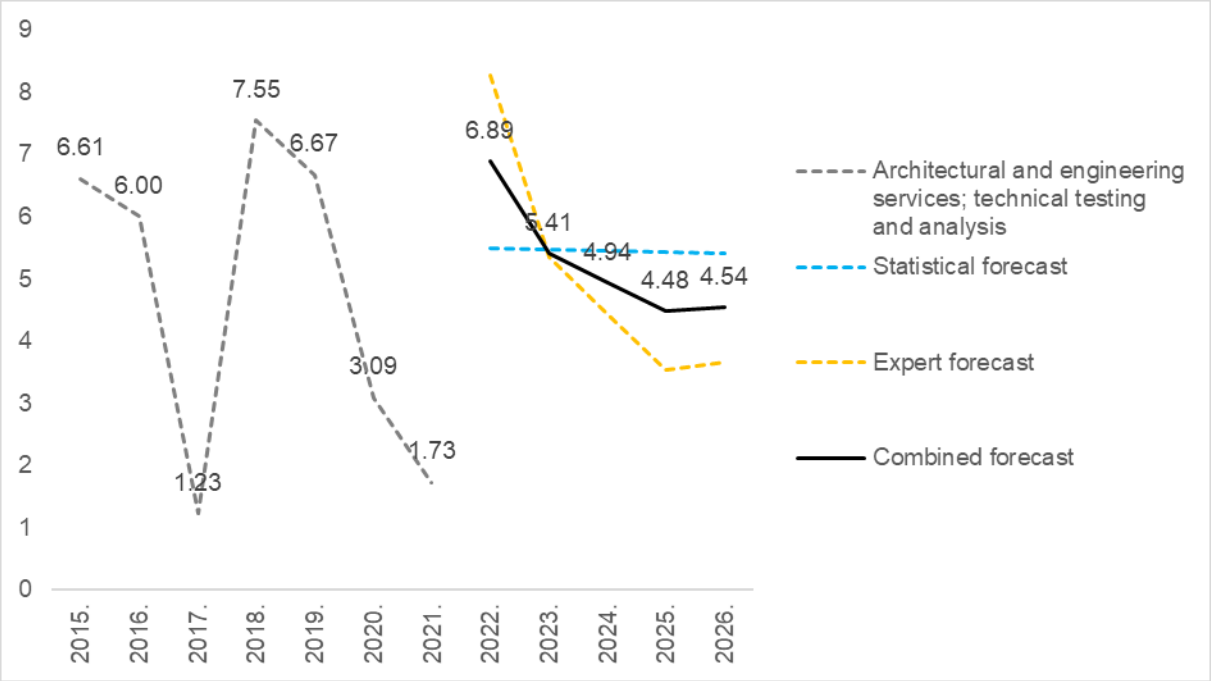


	2021	2022	2023	2024	2025
Statistical forecast	6.1	5.8	6.0	6.2	6.4
Combined forecast	10.3	6.9	5.4	4.8	4.8
Expert forecast	14.5	7.9	4.8	3.5	3.3

Fig. 17. Changes in maintenance and operation costs of machinery and equipment as a percentage of the previous year and forecasts for 2022-2026. Source: CSB data, expert evaluations obtained in the study [8], authors' calculations

This forecast differs significantly from the statistical forecast of 6.1% growth, which, similar to the context of building materials, is explained by the unorthodox situation in 2022, which does not obey the current trend.

In the cost of architectural and engineering services, cyclical development is observed. The peaks of the cycle so far were in 2015 with a 6.6% increase in costs per year and in 2018 with a 7.6% annual increase (see Fig. 18). The opposite points of the cycle were 2017 with only a 1.2% increase in costs and 2021 with only a 1.7% increase in costs (see fig. 18).

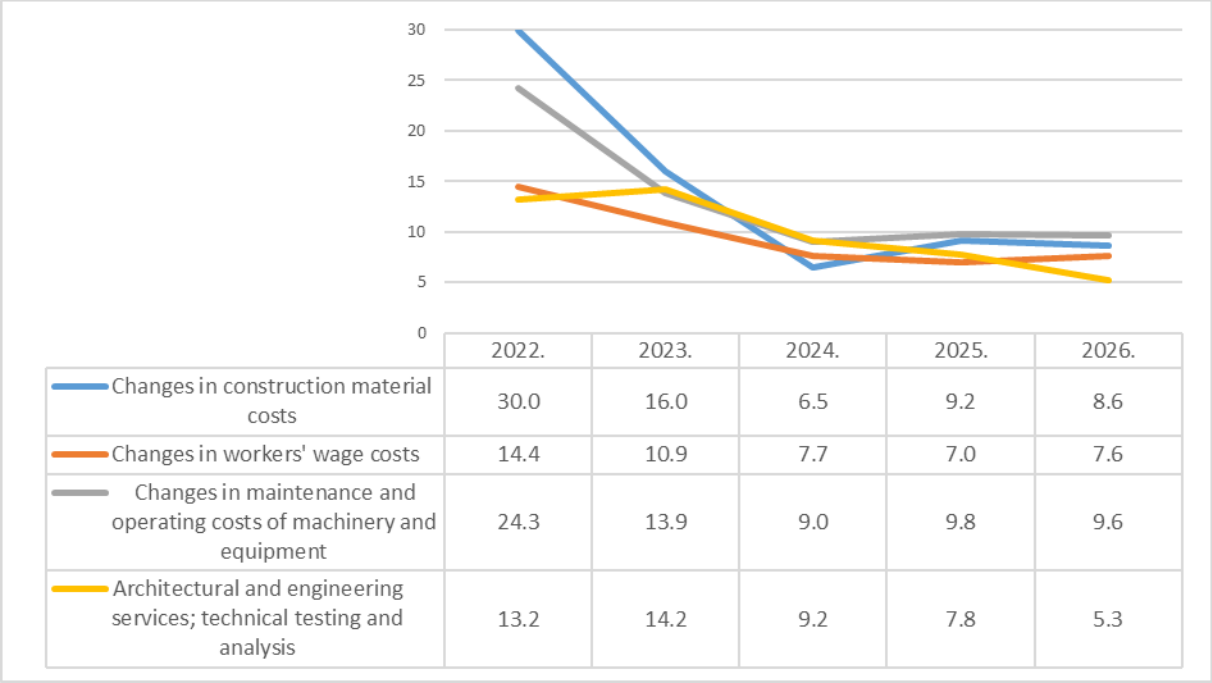


	2021	2022	2023	2024	2025
Statistical forecast	5.5	5.5	5.4	5.4	5.4
Combined forecast	6.9	5.4	4.9	4.5	4.5
Expert forecast	8.3	5.3	4.4	3.5	3.7

Fig. 18. Changes in the cost of architectural and engineering services, technical inspection and analysis as a percentage of the previous year and forecasts for 2022-2026. Source: CSB data, expert evaluations obtained in the study [8], authors' calculations

Consequently, in the context of cyclical development, researchers consider a combined forecast that repeats this cycle of cyclical oscillation as relatively plausible. In this context, the costs of architectural and engineering services could increase by 6.9% in 2022, by 5.4% in 2023 and by an average of 4.7% per year in the subsequent period in 2024-2026.

The study also evaluates the combinations between construction subsectors and resource types, obtaining forecasts of several subsector resource types. In the construction of residential buildings, the costs of building materials are predicted to be higher than in the overall assessment and experts estimate that in 2022 they could increase by 30.0% (see Fig. 19).

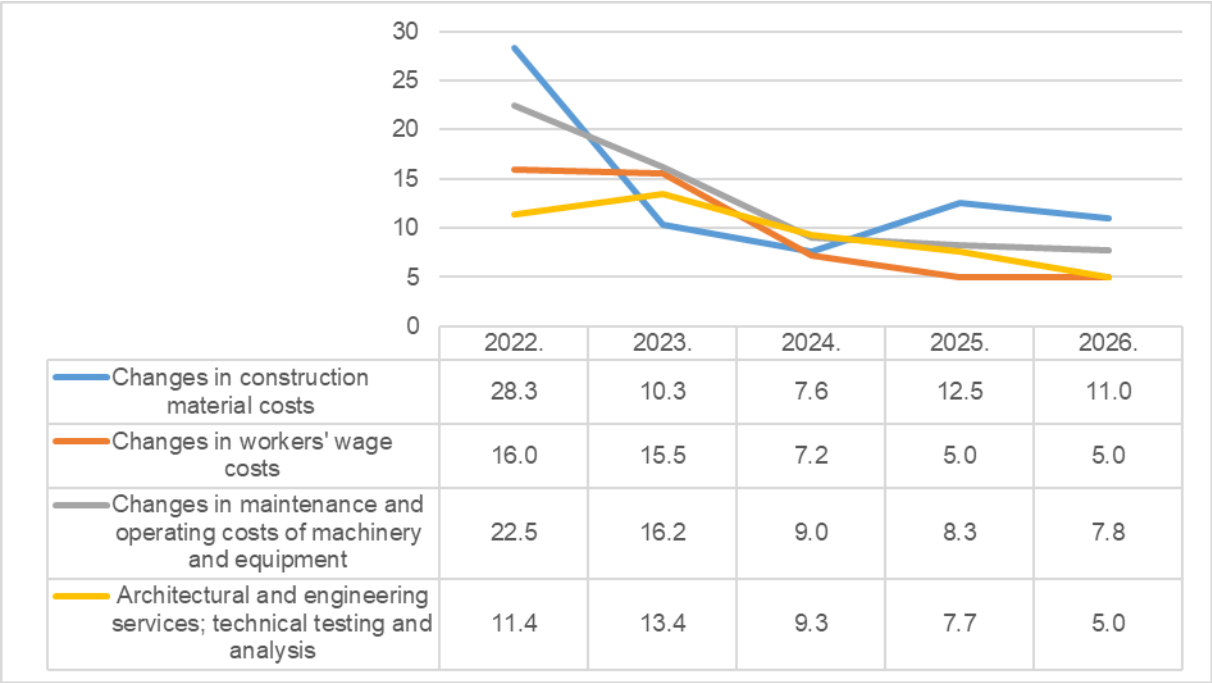


	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	30.0	16.0	6.5	9.2	8.6
Changes in workers' wage costs	14.4	10.9	7.7	7.0	7.6
Changes in maintenance and operating costs of machinery and equipment	24.3	13.9	9.0	9.8	9.6
Architectural and engineering services; technical testing and analysis	13.2	14.2	9.2	7.8	5.3

Fig. 19. Forecasts of changes in the cost of residential buildings for 2022-2026 by type of resources as a percentage of the previous year. Source: building construction expert evaluations obtained in the study [9], authors' calculations

Similarly, the cost of labour remuneration of workers is projected to be 14.4% higher, which is twice as much growth as the overall forecast in the construction sector. The cost of maintaining and operating machinery and equipment is projected to be 24.3% higher, which is in line with the overall trend that this will be the second fastest growing type of resource in terms of cost. In turn, the increase in the cost of architectural and engineering services is projected by 13.2%.

In the construction of non-residential buildings, the cost of building materials is projected to be higher than in the overall ranking and experts estimate that in 2022 they could increase by 28.3% (see fig. 20).

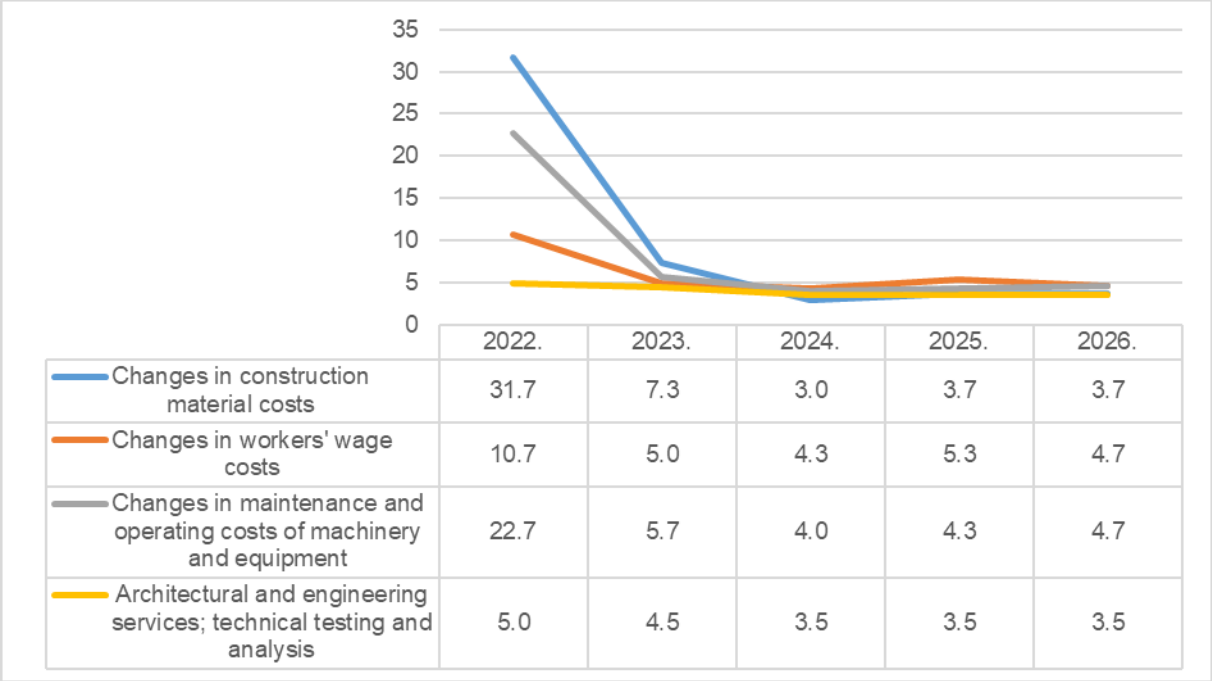


	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	28.3	10.3	7.6	12.5	11.0
Changes in workers' wage costs	16.0	15.5	7.2	5.0	5.0
Changes in maintenance and operating costs of machinery and equipment	22.5	16.2	9.0	8.3	7.8
Architectural and engineering services; technical testing and analysis	11.4	13.4	9.3	7.7	5.0

Fig. 20. Forecasts of changes in the cost of non-residential buildings for 2022-2026 by type of resources as a percentage of the previous year. Source: building construction expert evaluations obtained in the study [9], authors' calculations

Similarly, the cost of labour remuneration of workers is projected to be 16.0% higher, which is a significantly higher growth than the overall forecast in the construction sector. The cost of maintaining and operating machinery and equipment is projected to be 22.5% higher, which is in line with the overall trend that this will be the second fastest growing type of resource in terms of cost. In turn, the increase in the cost of architectural and engineering services is projected by 11%.

In the construction of roads and railroads, the cost of building materials is forecast with a significant increase in costs, which in 2022 could increase by 31.7% (see Fig. 21).

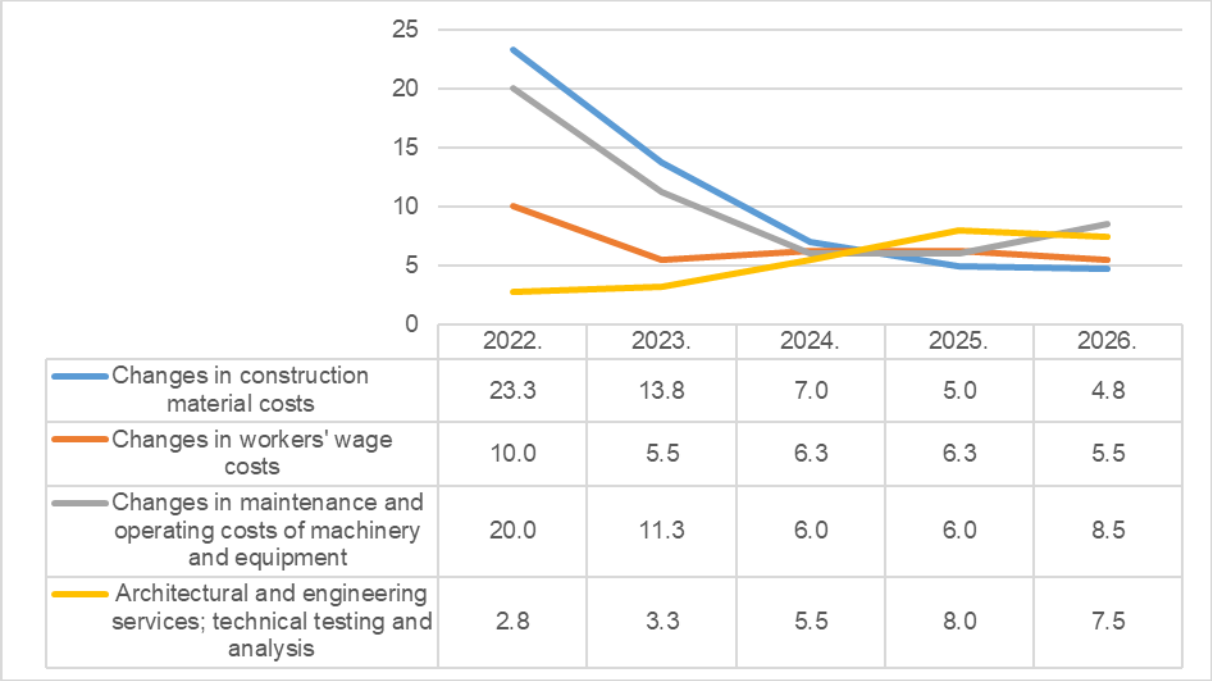


	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	31.7	7.3	3.0	3.7	3.7
Changes in workers' wage costs	10.7	5.0	4.3	5.3	4.7
Changes in maintenance and operating costs of machinery and equipment	22.7	5.7	4.0	4.3	4.7
Architectural and engineering services; technical testing and analysis	5.0	4.5	3.5	3.5	3.5

Fig. 21. Forecasts of changes in construction costs of roads and railroads for 2022-2026 by type of resources as a percentage of the previous year. Source: road and railroad construction expert evaluations obtained in the study [10], authors' calculations

In subsequent years, experts predict a rather low increase in the cost of building materials for the construction of roads and railroads with the lowest forecast of 3.0% in 2024. The cost of labour remuneration of workers is projected to be 10.7% higher, which is actually a high increase in costs, but comparatively significantly lower than in the construction of buildings. The cost of maintenance and operation of machinery and equipment is projected to be 22.7% higher, which is relatively similar to other sub-sectors. In turn, the increase in the cost of architectural and engineering services is projected by 5.0%.

In the construction of urban management infrastructure facilities, the cost of building materials is projected with a significant increase in costs, which in 2022 could be 23.3% (see Fig. 22).

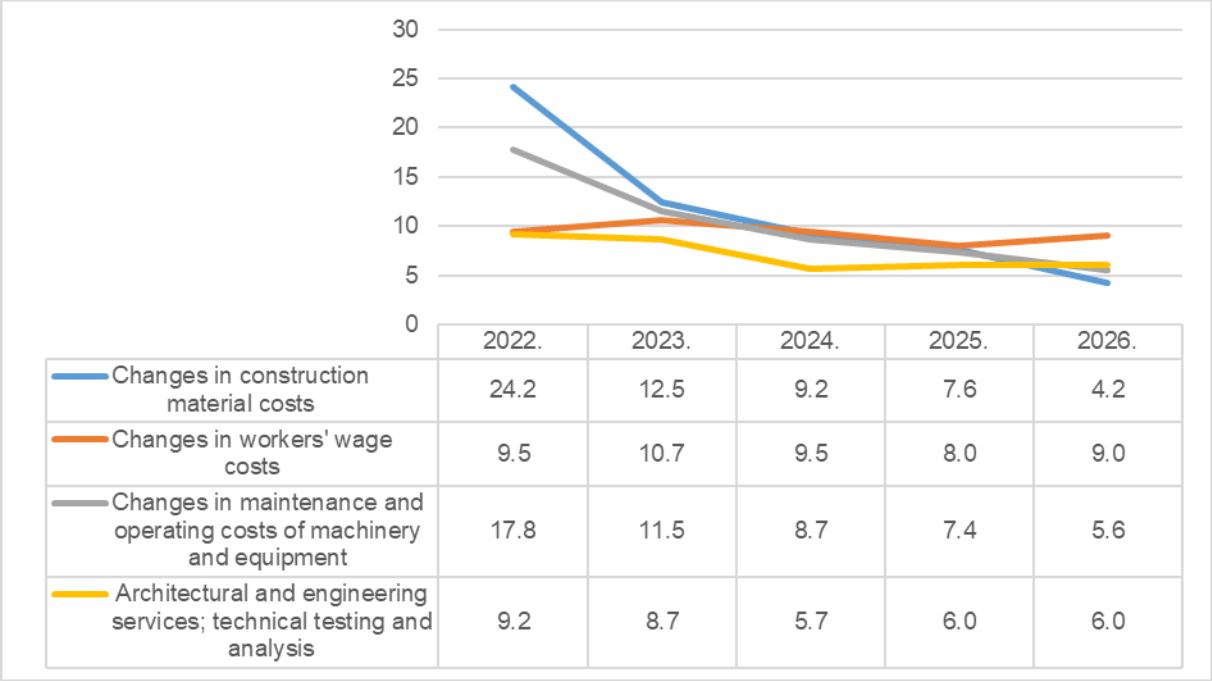


	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	23.3	13.8	7.0	5.0	4.8
Changes in workers' wage costs	10.0	5.5	6.3	6.3	5.5
Changes in maintenance and operating costs of machinery and equipment	20.0	11.3	6.0	6.0	8.5
Architectural and engineering services; technical testing and analysis	2.8	3.3	5.5	8.0	7.5

Fig. 22. Forecasts of changes in construction costs of agricultural infrastructure for 2022-2026 by type of resources as a percentage of the previous year. Source: urban infrastructure construction expert evaluations obtained in the study [11], authors' calculations

In further years, experts predict a gradual increase in the cost of building materials for the construction of urban infrastructure facilities with the lowest forecast of 4.8% in 2026. The labor costs of workers are projected to be 10.0% higher in 2022. The cost of maintenance and operation of machinery and equipment is projected to be 20.0% higher, which is at a relatively similar level with other sub-sectors. In turn, the increase in the cost of architectural and engineering services is projected by 2.8% - lower than in other sub-sectors.

The cost of building materials for specialized construction works is forecast with a significant increase in costs, which in 2022 could increase by 24.2% (see Fig. 23).



	2022.	2023.	2024.	2025.	2026.
Changes in construction material costs	24.2	12.5	9.2	7.6	4.2
Changes in workers' wage costs	9.5	10.7	9.5	8.0	9.0
Changes in maintenance and operating costs of machinery and equipment	17.8	11.5	8.7	7.4	5.6
Architectural and engineering services; technical testing and analysis	9.2	8.7	5.7	6.0	6.0

Fig. 23. Forecasts of changes in costs of specialized construction works for 2022-2026 by types of resources as a percentage of the previous year. Source: specialized construction works expert evaluations obtained in the study [12], authors' calculations

In further years, experts predict a gradually lower increase in the cost of building materials for specialized construction works with the lowest forecast of 4.2% in 2026. The cost of labour remuneration of workers is projected to be 9.5% higher. The cost of maintenance and operation of machinery and equipment is projected to be 17.8% higher, which is at a relatively similar level with other sub-sectors. In turn, the increase in the cost of architectural and engineering services is projected by 9.2%.

2.5. Impact of construction output on average profit margin

The construction sector is characterised by cyclical development, with large stages of the sector's growth likely to be followed by significant downturns. Such cyclicality can be attributed both to the cyclical nature of the availability of structural funds and to long-term projects, as well as to the general cyclical development of the economy. In the event of a downturn, it is important for companies in the construction sector to be able to survive the reduced demand, which often also means giving up normal profits.

Within the framework of the study, an expert assessment was carried out on what the profit margin would be, with which Latvian construction industry companies would be willing to work on various market development scenarios. Five scenarios were considered, ranging from a 20% reduction in construction volume to a 30% increase in construction volume. Each scenario looks at the profit margin, which is assessed as acceptable for construction companies in Latvia as a whole and also in individual sub-sectors (see Table 15).

Table 15. Changes in construction costs and industry acceptable profit margins for different scenarios of changes in construction output assessed by experts

Scenarios of changes in the volume of construction	Changes in construction costs	Profit margin* %, which would be acceptable for Latv. construction companies.
-20% to -10%	7.99	6.26
-10% to -0%	6.80	6.74
0% to +10%	7.81	7.90
+10% to +20%	12.41	10.65
+20% to +30%	15.32	12.21

Note: Profit margin in this case is considered as a percentage of profit after tax as a percentage of turnover.
Source: expert evaluations obtained in the study [7], authors' calculations

Compared to the results obtained in 2021, it can be concluded that experts see a higher increase in costs under identical scenarios, also in cases where the market growth is negative. If in 2021 experts estimated that a decrease in the volume of construction production by 10-20% will lead to an increase in costs by only 3.21 percent, then in 2022 experts estimate that under the same scenario the costs will increase by 7.99%. The situation is similar in the example of a scenario where construction output would fall to 10%, then costs would increase by 6.80%, which is more than the previously forecasted 4.30%. With positive growth scenarios for the construction sector, cost growth forecasts are only about 1-2 percentage points higher.

Such an expert assessment can be interpreted as another signal that more and more cost increases are caused not by an increase in demand in the Latvian market, but by external factors affecting costs on a regional and global scale.

Based on the expert assessments of the subsectors, there is a relatively significant difference in the resulting evaluations (see Table 16). There are no full ratings available in the building construction subsector group due to the unwillingness of experts from the sub-sector to provide assessments on this sensitive issue. In the other subsectors, assessments are available, but the ratings obtained in the architectural and engineering services, technical inspection and analysis subsection are not considered reliable due to the low number of responses of respondents. The results obtained in the other subsectors considered are to some extent consistent with the results of studies from previous forecast periods, which confirm their reliability.

Table 16. Profit margin expert assessment that would be acceptable to Latvian entrepreneurs in various sub-sectors under certain construction output growth scenarios

Scenarios of changes in the volume of construction	Building construction sub-sector	Construction of roads and railroads	Townspeople. construction of infrastructure facilities	Specialized constructions	Construction of architectural and engineering services, technical inspection and analysis
-20% to -10%	n.a.	1.3	4.3	11.0	12.5
-10% to -0%	n.a.	1.8	4.7	11.7	12.5

0% to +10%	7.5	4.0	5.0	12.3	15.0
+10% to +20%	10.0	7.0	7.7	12.3	12.5
+20% to +30%	n.a.	10.0	8.3	13.3	15.0

Notes: n.a. – insufficient ratings

Source: evaluations by sub-sector experts obtained in the study [9, 10, 11, 12, 13], authors' calculations

The roads and railroads construction industry is regularly the one that is characterized by a greater readiness to live with a lower profit margin than in other sub-sectors. With a negative volume of construction production, this industry is ready to work with a profit margin of 1.3-1.8%, while in the urban infrastructure sector a profit margin of at least 4.3-4.7% is expected and in the specialized construction sector by 11.0-11.7%. It is also typical for the specialty construction industry to work with a high profit margin, i.e. more than 12%.

3. Assessment of the risks of overheating of the Latvian construction industry

3.1. The essence of the risk of overheating and restrictions on interpretation

One of the main tasks of the study is the assessment of overheating risks in the Latvian construction industry. Looking back at the financial and administrative crisis of Latvia in 2008-2010, such risk assessment is considered to be a topical state obligation in order to prevent a repetition of an equivalent situation. The situation in the construction sector within the framework of the above-mentioned crisis was characterized by a significant increase in construction volumes, which was facilitated by the inflow of easily accessible loans into the Latvian market, which led to a sharp increase in demand, which exceeded the ability of the construction industry to meet this demand. This led to an imbalance in the market with an imbalance between supply and demand, which led to a sharp increase in costs, followed by a sharp fall in construction output, with high unemployment and economic declines underlying it.

In the context of the study, it is essential to understand how the concept of overheating is perceived. The classical understanding, which was also used in previous annual cost evaluation Studies, is a situation where economic growth occurs so quickly that it leads to a significant increase in costs. In the context of the construction sector, this would take the form of a significant increase in demand for new construction products, which the existing construction capacities in the country would not be able to meet, or the increase in supply would lag behind the growth in demand. In situations where demand exceeds demand, price increases occur. In the context of the construction industry, if the industry is not able to meet the growing demand, it raises the price of construction products. Consequently, the proportion of construction costs and production volume could be used as a simplified indicator of the risk of overheating. However, the researchers believe that this indicator may be an insufficient risk indicator, which is discussed more broadly in the methodology chapter (see chapter 1). The reason for this is both that the increase in costs can be detached both from the decisions of enterprises in the construction sector and from the growth of demand.

Given the different ways in which overheating can occur in the industry, in the context of this study, researchers analyze overheating of the industry more as an economic shock that can take many forms. Thus, various indicators are evaluated, which can be potential indicators of the risks of overheating of the industry. As part of the study, the authors identified indicators that characterize or are related to the development of the construction sector and for which statistical data are available. Based on the theoretical approach of evaluating scientific references, the researchers carried out an analysis of the creation of a list of indicators and identified 12 indicators that are considered the most significant indicators of overheating risk in the scientific evaluations of economic processes. Anticipating the risk of overheating, as well as their numerical boundary values, at which it would be considered that a medium and high risk of overheating should be identified.

3.2. Assessment of the significance of the indicative indicators of overheating in the construction sector

During the approbation phase of the indicative indicators of overheating, the researchers identified 12 indicators that were considered relevant for further analysis. Latvian macro-economic experts were asked to carry out validation and ranking of indicators in order to identify the most important of them in the context of overheating of the construction sector (see table 17).

Table 17. Expert ranking of experts in the risk of overheating of the construction sector in the initial approbation

Indicators in approbation, starting with the most important	**Rank**
The ratio of wages and salaries per employee to productivity in construction	1
Number of applications for construction intentions	2.5
Volume of newly issued loans for the purchase, reconstruction, repair of a dwelling	2.5
Share of job vacancies in construction sector	4.5
State planned gross capital investment in construction	4.5
Ratio of construction cost index to volume index of construction output	6
Mortgage interest rate	7
Construction cost index by building materials group	8
Growth rate of household disposable income	9
GDP growth rate	10
Average prices of petrol and diesel fuel for final consumers	11
Electricity price on the stock exchange	12

Source: macroeconomics expert evaluations obtained in the study [15], authors' calculations

In the first round of expertise, the main three indicators that can be used in the assessment of the risk of overheating of the construction sector, the ratio of remuneration and productivity in the construction sector, the number of construction intentions and the amount of loans issued for new housing, reconstruction and repairs are considered. The share of job vacancies in the construction sector and the planned gross capital investment in construction by the State are assessed as the next most important with equal positions (see Table 17).

Experts assessed the price of electricity and the price of gasoline and diesel as relatively insignificant factors. These factors certainly have a significant impact on the construction cost index, especially in the dimension of operation and use of building materials and equipment, but are obviously not evaluated as a suitable indicator for the identification of overheating and, in essence, duplicate the construction cost index in the group of building materials, which is an argument for excluding them from the list of indicators in further analysis.

After approbation of the indicators, two indicators were excluded from their range, which in the overall assessment of macroeconomic experts were indicated as the most unsustainable for the potential overheating of the construction sector, namely – the average prices of gasoline and diesel for final consumers and the price of electricity on the stock exchange. Consequently, 10 indicators remained in the set of indicators for further analysis. The remaining indicators were subject toa detailed expert evaluation involving a wider range of macroeconomic experts, as well as listing in the results the initial approbation expert evaluations, adjusting them to take into account the transition of ranks from 12 to 10 positions in order to maintain a fixed sum of ratings (see table 18).

Table 18. Expert ranking of indicative indicators of overheating risk in the construction sector

Indicative indicators of overheating risk in the construction sector, starting with the most important	**Rank**	**Weight or significance of the indicator**
Number of applications for construction intentions	1	15%
Ratio of construction cost index to volume index of construction output	2	12%
Volume of newly issued loans for the purchase, reconstruction, repair of a dwelling	3	11%
The ratio of wages and salaries per employee to productivity in construction	4	11%
Planned gross capital investment in construction by the state	5	10%
Share of job vacancies in construction sector	6	9%
Growth rate of household disposable income	7	9%
Mortgage interest rate	8.5	8%
Construction cost index by building materials group	8.5	8%
GDP growth rate	10	7%
		Total: 100%

Source: macroeconomics expert evaluations obtained in the study [15], authors' calculations

As a result, the ranking of potential indicators of overheating of the construction industry was obtained, as well as the weight or significance of each indicator (see Table 18). The latter is an indirectly usable measure that allows you to express the importance of a given indicator as a percentage, based on the proportion of ranks in their total sum (inverse). The following were identified as the three most important indicators – the number of construction intentions, the ratio of construction costs and production volume indices, as well as the number of loans for housing and their repair. The ratio of wages and productivity of the construction sector and the amount of capital investment planned by the state in construction were also indicated as important indicators.

Experts assessed household disposable income, mortgage rates, the cost of building materials and the growth rate of GDP as relatively minor indicators of overheating in the construction sector.

3.3. Assessment of the dynamics and risk limits of potential indicators of overheating in the construction sector

Risk assessment of the number of construction intentions

The number of construction intentions that have been registered in the BIS has been constantly increasing in recent years. In the period from 2016 to 2021, the number of plans has increased from 13 thousand to more than 31 thousand. In general, this should be assessed as an increasing activity of the construction industry, however, at the same time, these data are not directly related to the volume of construction, since the published BIS data do not provide information on the volume and cost of each idea. Based on the results of the approbation expert-evaluation, the average risk of overheating in the construction sector could be achieved at 33.7 thousand construction intentions, while high risk at 39.5 thousand construction intentions (see Fig. 24).

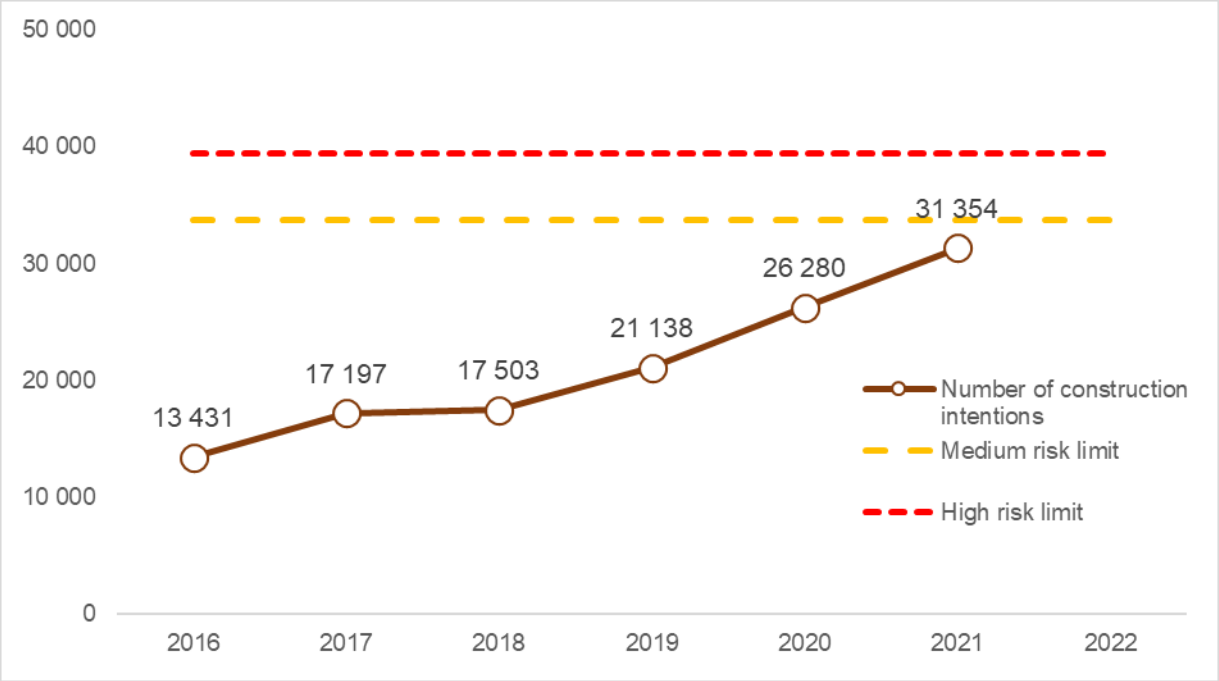


Fig. 24. Dynamics of the number of construction intentions registered in the Construction Information System in 2016-2021 and expert assessments of risk limits. Source: BIS, macroeconomics expert assessments obtained in the study [15], authors' calculations

Guided by these assumptions, there has been no reason to worry about overheating during the period considered, however, the overall trend makes it necessary to be careful about the future. Taking into account the previous development trends in the period 2016-2021, the number of construction intentions increased on average by 3.4-3.6 thousand (depending on the calculation method) per year and the average growth rate index was 1.185, or on average per year by 18.5% Taking into account stable growth, it can be assumed that the medium risk limit, while maintaining the previous trends, could be reached in 2022, but the limit of high overheating risk in 2023-2024. The pessimistic value of the forecast is in the event that the number of construction intentions will be characterized by an accelerated increase.

The number of construction intentions has a significant drawback – the procedure for accounting for this indicator. Upon closer examination, it was found that the available data do not reflect all actual construction intentions, since their registration in the BIS in full is carried out only from 2020. Also, the comments of individual competent experts indicate that this indicator is not objective enough. Also, researchers believe that the number of intentions themselves does not indicate the nature and quantitative scale of the intentions. A growing number of plans may indicate more cheap planning, which can be lower in total than at low expectations. Based on these considerations, the researchers plan not to use this indicator in assessing the risks of overheating, but offer to continue monitoring construction intentions in future studies.

Risk limits for the number of vacancies

In a situation where the demand for construction products begins to significantly exceed supply, it is expected that a lot of vacancies appear on the labor market. If enterprises in the construction sector are not able to meet the needs of construction volumes with their existing capacities, as a rule, new workers are attracted, which should be reflected in this indicator. Since the crisis of 2008, Latvia has been characterised by a steadily low number of vacancies in construction with a seasonal nature. Until 2016,

this level fluctuated in the range between 269 and 2594 vacancies. However, since 2017, the observation has taken a significant leap – more and more jobs are unfilled. The peak was reached in Q2 2019 with 8328 vacancies (see Fig. 25).

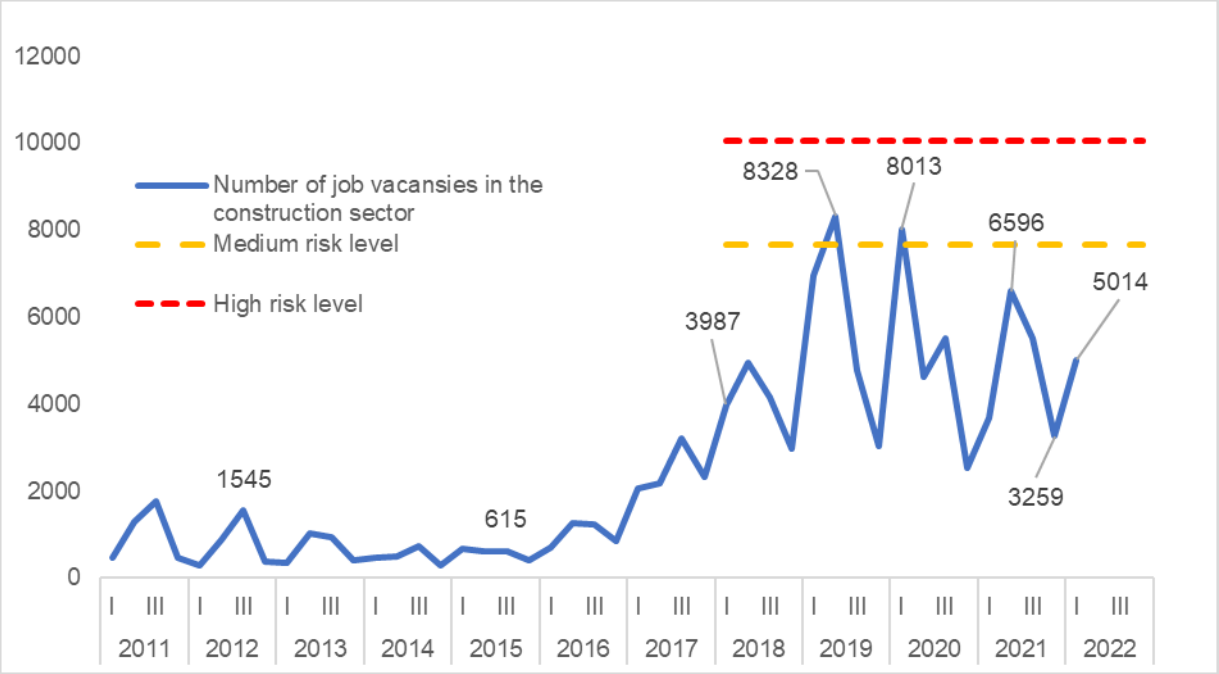


Fig. 25. Dynamics of the number of job vacancies in the construction sector in 2011-2022 by quarter and risk limit expert assessments. Source: CSB, macroeconomics expert assessments obtained in the study [15], authors' calculations

Since 2019, it has become more difficult for the construction sector to fill the demanded job vacancies and, although the situation is seasonally volatile, it indicates a high need to attract labor, so it can be concluded that there is an unmet demand for labor. According to the assessment of experts, the medium risk limit is 7.7 thousand. vacancies in the construction sector, but the high risk limit is 10.1 thousand vacancies. Overall, in 2019-2020, the industry was the closest to overheating by these indicators, but there was still a relatively high amplitude of permissible growth. Looking at the trends of 2021-2022, the number of vacancies has a common downward trend, which could indicate a departure from risky levels and a lower risk of overheating.

Risk limits of the ratio of construction costs and construction production indices

The ratio between the construction cost index and the construction output volume index is an indicator that has already been used in previous years as a possible signal for overheating of the construction sector. This indicator was once chosen because it very closely corresponds to the symptoms that are indicated as a state of overheating – a sharp increase in costs at a lower increase in production volumes. Looking at the situation in 2005-2021, the highest ratio value was in the period 2009-2010, when the cost index was 17-35% higher than the production index, and in 2016, when for a short time the cost index grew 19% faster than the production index. For the rest of the period until 2022, there has been a relatively stable ratio of indices.

The critical levels assessed by experts have been exceeded for three years. The medium risk limit was rated at a ratio of 1.17 and at a high limit of 1.37 (see Fig. 26).

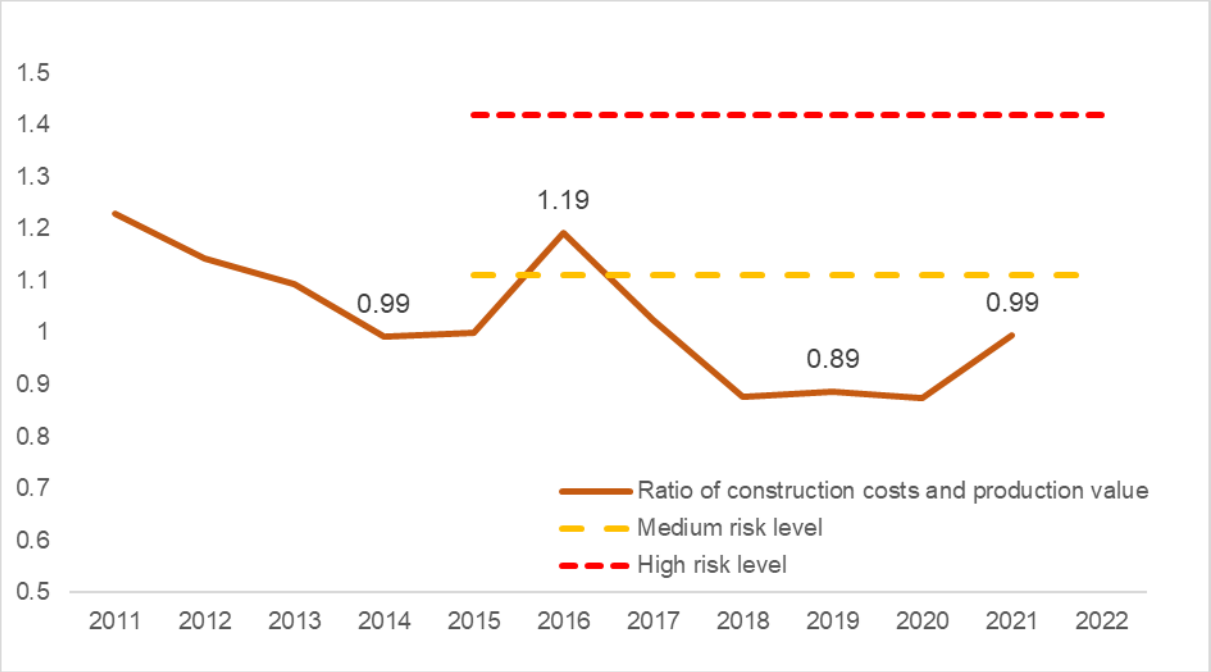


Fig. 26. Dynamics of the ratio of construction costs and production volume indices in 2011-2021 and expert assessments of risk limits. Source: CSB, macroeconomics expert assessments obtained in the study [15], authors' calculations

Previously, the ratio of construction costs and production indices for 2009 and 2016 exceeded the average risk threshold and in 2010 was actually equal to the high-risk limit, which is to some extent comparable to the real situation in the industry. The latest available data for 2021 indicate a relatively optimistic situation with a low index. Based on short-term trends, the market situation and the overall forecasts of the experts of the Study 2022, the risk of overheating has an increasing trend, as a result of which in 2022-2023 it could reach the limit of average risk if the situation develops with a similar trend as in 2019-2021.

The ratio of wages and productivity in the construction sector is at the limit of the risk of overheating

Looking in more detail at the various components of construction costs, the most important item is labor expenses. When paying for construction labour, it is essential for companies to be able to produce products that have a higher value than the funds spent. One way to assess this relationship is to compare the relative changes in labour productivity and wages. Based on the dynamics of 2012-2020 and using 2015 as the base year, wages and salaries are characterised by faster growth than labour productivity. If in ten years the salary has approximately doubled, then labor productivity has increased by only about 10%.

The researchers in the Research are careful in the interpretation of this growth, since the output of wages in the construction sector from the shadow economy is also an important aspect, which may mean that, in fact, the increase in wages for jobs is lower than shown in the official data.

When analyzing expert estimates, the medium-risk limit for the difference between wage and productivity growth indices is 33.4 percentage points, while the high-risk limit is 50.6 percentage points (see Fig. 27).

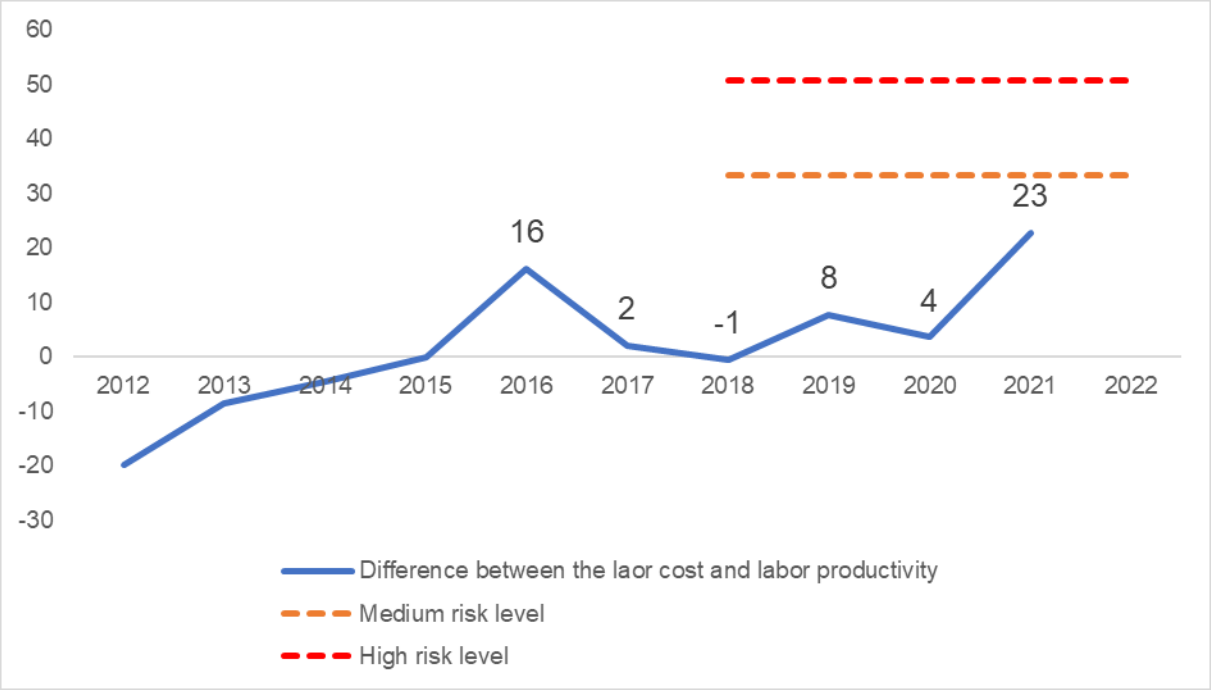


Fig. 27. The dynamics of the difference between the labor cost and labor productivity growth indices (2015-100) in 2012-2020. Source: Eurostat data, macroeconomics expert evaluations obtained in the study [15], authors' calculations

In the context of the data considered, both relationships are true, indicating a high risk of overheating. In 2021, a significant divergence between productivity and labour costs has been observed, with the second growing relatively faster. If such a jump continues, the average risk limit will be exceeded already in 2022 and a high-risk limit may be reached in 2023. However, looking at past trends, it is characteristic that after a great moment of drift in labour costs and productivity, correction and convergence follow.

Risk limits for gross capital investment in buildings and structures by budgetary authorities

The demand of the construction industry consists of private and public demand. It is impossible to manage private demand directly. There are instruments to influence it, such as monetary and fiscal policy, laws and regulations or state aid programmes. The way in which public bodies can directly influence both stimulating and discouraging the demand of the construction sector is through public order adjustments. In this section, the authors of the study made an adjustment to the indicator to address the shortcomings identified in the approbation examination in the valuation of gross capital investment in construction. CSB data on gross capital investment of budget institutions in buildings and structures, which since 2015 have ranged from the lowest level of EUR 319 million to the highest level of EUR 1051 million.

Based on the limits of the risk of overheating assessed by experts, the average level is estimated at 1191 mil. eur, corresponding to a 13% increase compared to the actual level of 2020 (see Fig. 28).

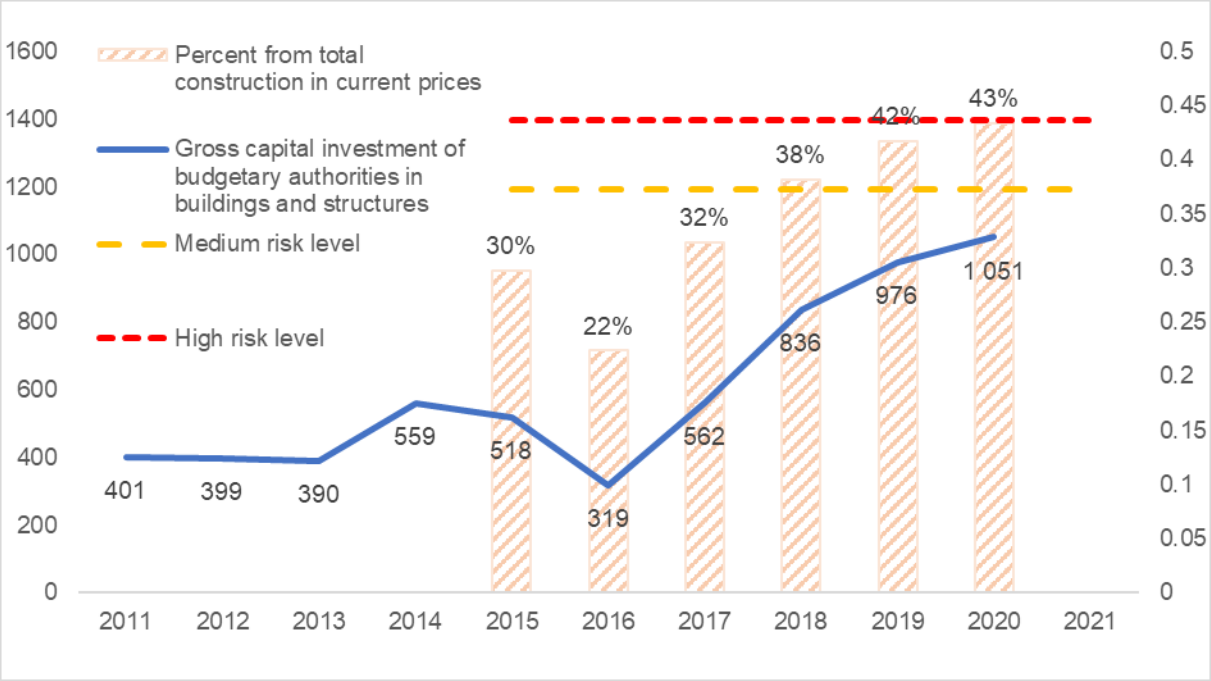


Fig. 28. Gross capital investment of budgetary authorities in buildings and structures in 2011-2020 and assessment of overheating risk limits. Source: CSB data, macroeconomics expert evaluations obtained in the study [15], authors' calculations

With past trends, the average could be reached in 2022. The high overheating risk limit is estimated at EUR 1396 million, which could be achieved in 2024-2025 at the current trends. However, within such a timeframe, it would not be correct to use the values of the 2022 Study - an up-to-date assessment of them would be required according to the specific situation at the time and the influencing circumstances that will be in 2024-2025.

Risk limits for household disposable income growth rate

The classic primary cause of overheating in the construction industry is the growing demand for construction services. A large part of this demand is based on the demand of households for living space. Accordingly, it is assumed that with a sharp increase in household disposable income, growth after the construction of buildings is also expected (see Fig. 29).

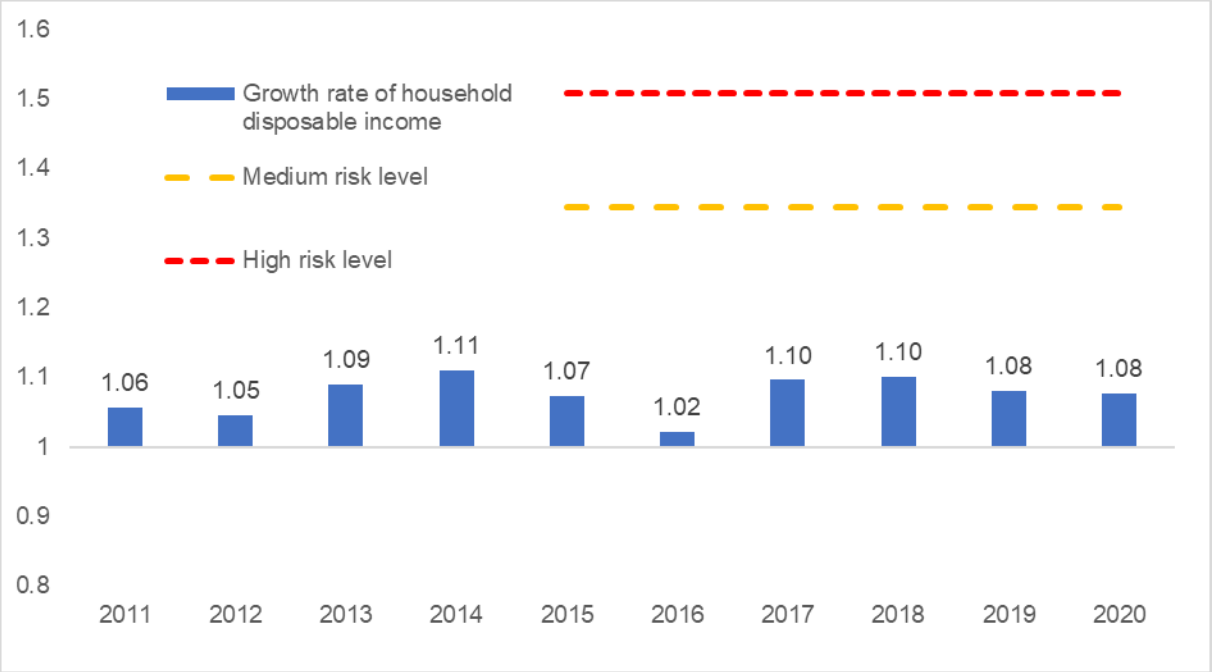


Fig. 29. Dynamics of the growth rate of household disposable income compared to the previous period in 2011-2020 and expert assessments of risk limits. Source: CSB data, macroeconomics expert evaluations obtained in the study [15], authors' calculations

Over the period from 2011 to 2020, there is a moderate and relatively stable growth in household disposable income. Each year, the increase has ranged from 2 to 11 percent per annum versus the previous period. The approbation examination determined an annual increase of 35% as the average risk limit, and an increase of 51% per annum as a high-risk limit. At the moment, household income growth is significantly below both medium and high overheating risk thresholds and there are no indications that it could approach any of these limits in 2022-2024. Consequently, in this segment, signs of overheating risks are not observed in the context of the assessment methodological approach.

Interest rate risk limits on home loans

The overheating of the construction industry in the past has been closely related to the demand for real estate by private individuals. The situation in 2006-2008 is characterised by the purchase of active residential areas through credit and one of the indicators characterising this market is the interest rates on housing loans. Before and during the 2008 crisis, interest rates fluctuated in the range of 5.5-7 percent and reached a peak of 9.6% in 2008 (see Fig. 30). In the period up to 2022, they have been generally downward and were around 2.5% in 2022.

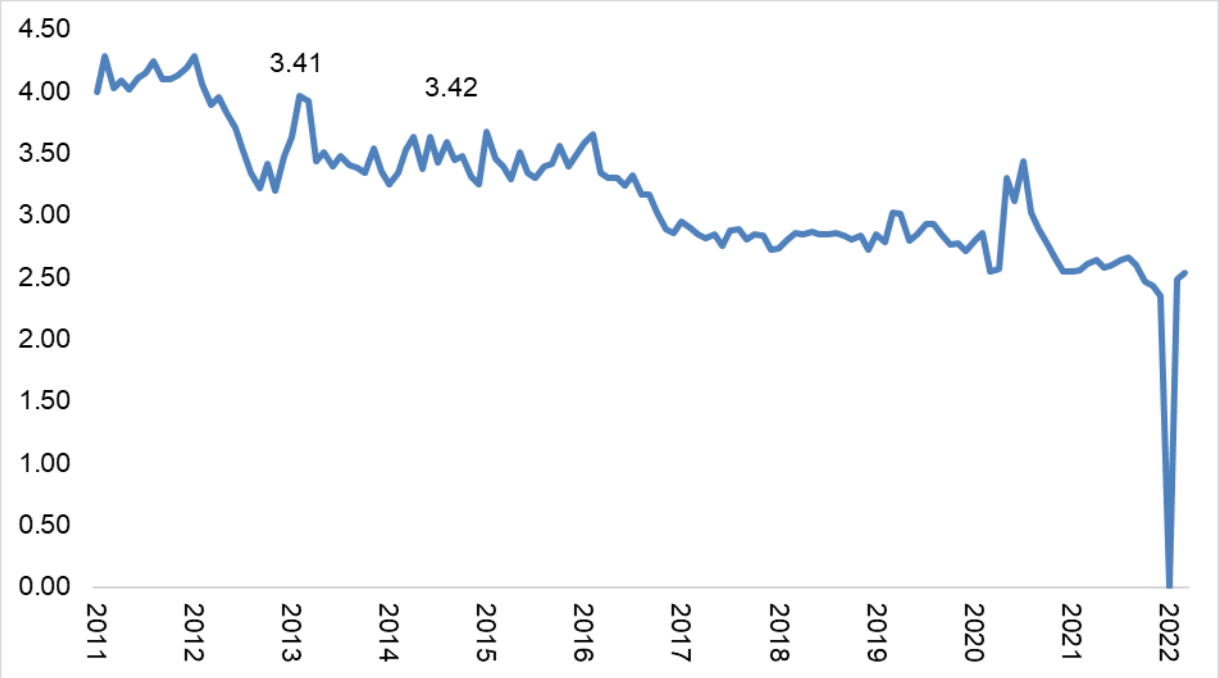


Fig. 30. The evolution of the interest rate on loans for the purchase of housing in 2011-2022. Source: Bank of Latvia

In the expert's assessment, the average risk of overheating was the interest rate of 0.35% per annum and the high-risk limit of 0.10% per annum. In this case, the expert assessment can be interpreted as the threat of very low rates to significantly stimulate demand for home loans, which, in turn, can lead to overheating of the market. Rates in 2022 are generally the lowest over a ten-year period. It should be noted that during the overheating of construction in 2008, the rates were exactly very high, which can be an indicator that the market's response to interest rates can be very different. Interpreting expert judgements, there is no high risk of overheating from the perspective of this indicator in 2022 at rates above 2%. The European Central Bank's monetary policy also plays an important role in the rate movement, which in 2022 is likely to focus on raising interest rates to slow inflation, thereby further reducing the role of this indicator in anticipating overheating.

Risk limits for the volume of newly issued home purchase loans

The volume of loans issued for the purchase of housing is part of the demand indicator of the construction industry. The weakness of this indicator is that this is not a pre-emptive indicator and shows trends that are already actually taking place in the real estate market. However, its trends can be a useful indicator for assessing changes in the situation. Looking at the 2018-2021 period as a whole, there is an observation of an increase in the volume of loans issued, which indicates a trajectory towards overheating risks (see Fig. 31).

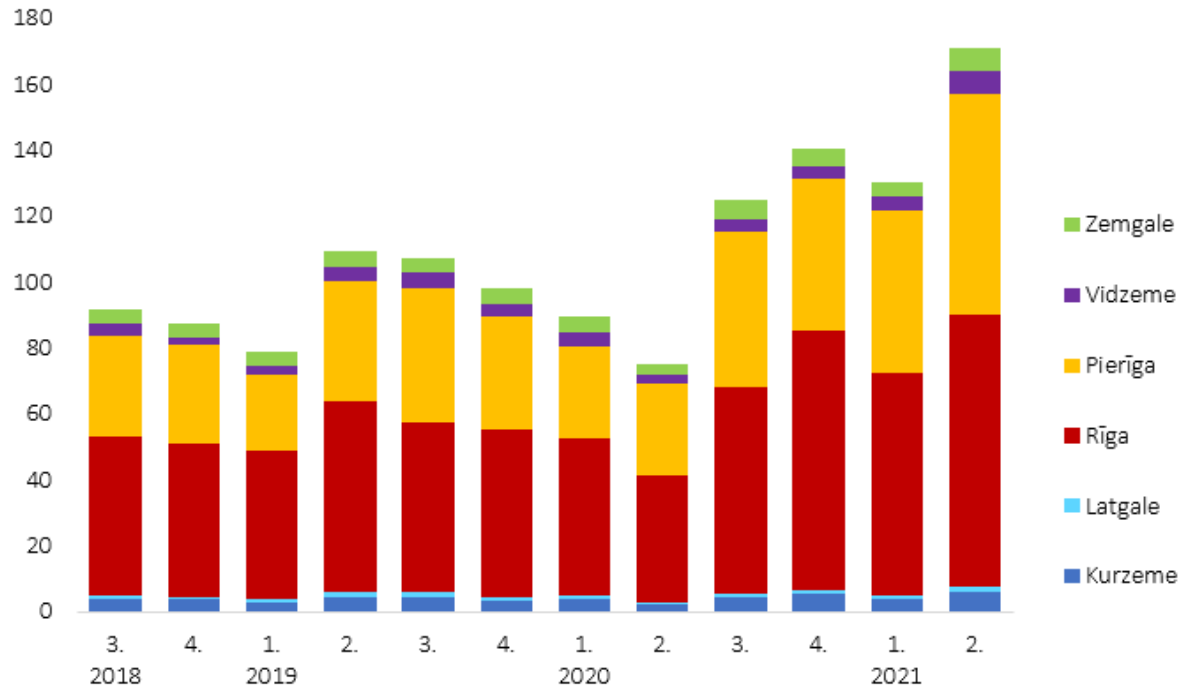


Fig. 31. Dynamics of the volume of newly issued loans for house purchase in 2018-2021. Source: Andrejs Kurbatskis, Nadežda Siņenko, Hipotekārā kreditēšana – kas notiek Latvijas reģionos? www.makroekoomika.lv [Viewed 25.05.2022.]

According to the results of the approbation of overheating indicators, the average risk limit for overheating construction is EUR 186.2 million worth of loans issued per quarter and the high-risk limit is EUR 251.3 million for loans issued per quarter. Actual data in the 2nd quarter of 2021 were the highest in recent years and amounted to around EUR 170 million. euro-based loans, which are significantly below critical limits for the time being. However, the overall trend is upwards, which raises some concerns. Exceeding 200 mil. the amount of euro per quarter would be justified in considering the need to limit the volume of lending in order not to reach EUR 245.5 million. the euro border. At the same time, taking into account the large heterogeneity of the regional distribution, it would be appropriate to promote the issuance of loans or to maintain volumes outside Riga and Pierīga.

Risk limits for the growth rate of gross domestic product

Overall economic growth is usually linked to the growth of all sectors. The growth of the country's total gross domestic product (hereinafter also referred to as GDP) also contributes to the demand for the production of the construction sector and vice versa. It is expected that not only thanks to the development of the private sector, but also to a potentially growing tax base, public procurement would be promoted. Changes in gross domestic product compared to the previous year in the period from 2015 to 2021 have been in the range between -3.8% and +4.5%, and only in 2020 they were negative (see Fig. 32).

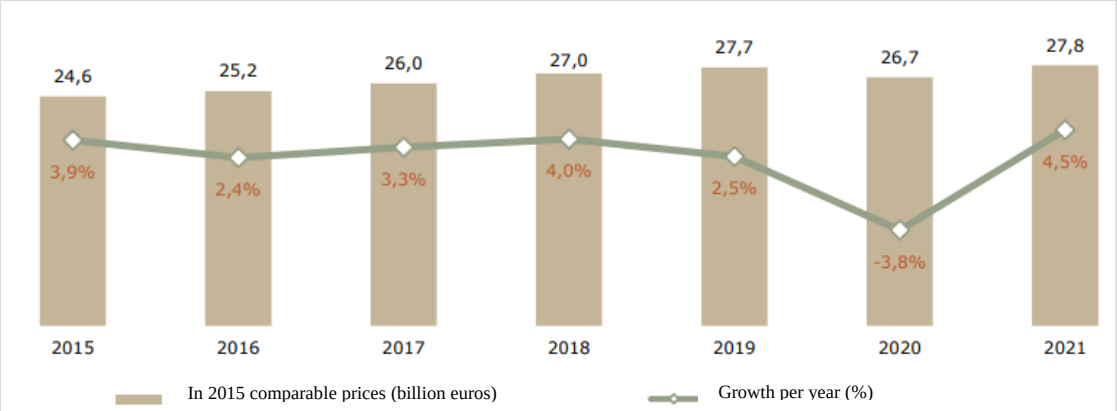


Fig. 32. Dynamics of gross domestic product at constant prices and changes compared to the previous year in 2015-2021. Source: Latvija. Galvenie statistikas rādītāji 2022, CSP

In turn, the limits of the average risk of overheating estimated by experts are 6.5% GDP growth and the high-risk limit is 9.3% GDP growth. Based on the forecasts of state institutions, the Bank of Latvia and research institutions, such a level is not expected in 2022. According to the economic barometer of the think tank "LV PEAK" of the University of Latvia in 2022, the forecasts of various institutions for GDP growth in 2022 range from 1.0 to 2.4 percent with a consensus forecast of 2.0 percent, which is more than three times lower than the average limit of overheating of construction risk.

Risk limits of the cost index of building materials

Although construction costs are included in the indicator characterising the ratio of construction costs to production volume, an isolated examination of this indicator is also important. When distinguishing between construction costs, attention is paid precisely to the dynamics of the cost of building materials. The labor force effect is valued in the ratio of productivity and wages, and building materials are usually the second most important position that affects costs. In the period from 2015 to 2020, no significant fluctuations were observed and for at least two years the cost of building materials tended to decrease (see Fig. 33). However, the situation began to change significantly in 2021, when a global rise in the prices of building materials (in particular timber and metal products) was observed. The increase in the cost of building materials compared to the corresponding quarter of the previous year in the 1st quarter of 2022 reached the level of 30%, which is the highest level in the foreseeable past.

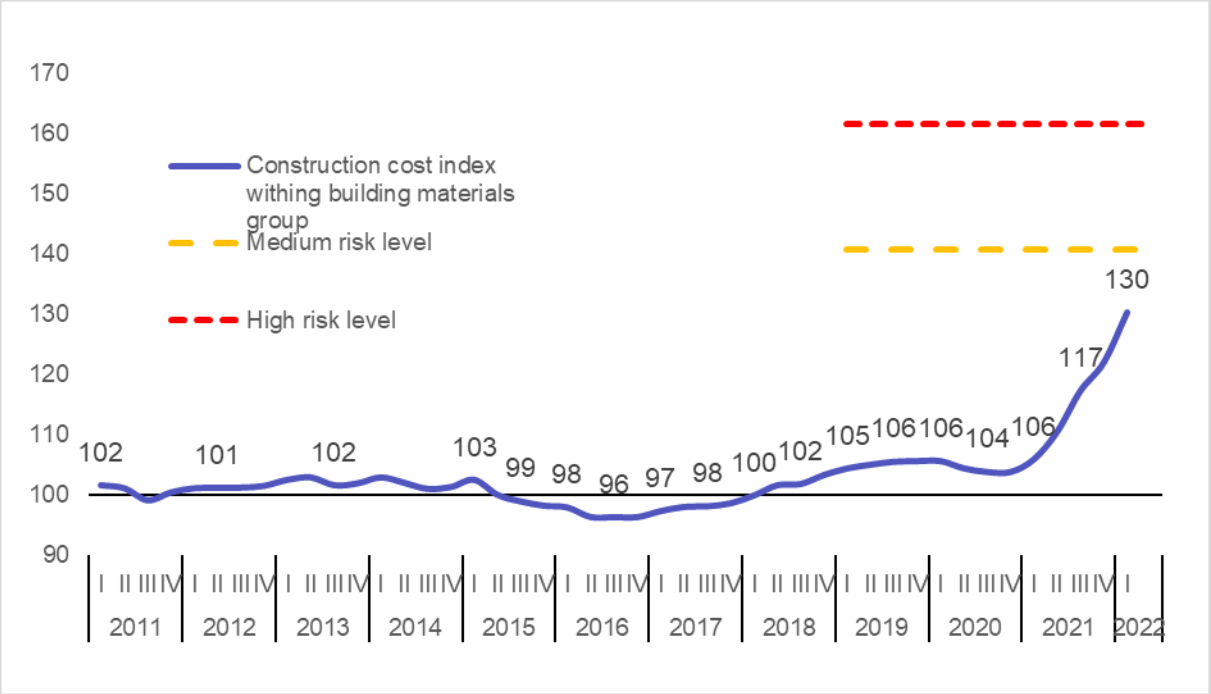


Fig. 33. Dynamics of the construction cost index within the group of building materials in 2011-2022 and risk limits. Source: CSB, macroeconomic expert assessments obtained in the study [15], authors' calculations

Approbation experts estimated the average construction overheating risk limit of the construction cost index at 141 and the high-risk limit at 162. Current trends are approaching this indicator relatively rapidly, creating a potential risk of overheating in 2022-2023, provided that the cost rates of building materials continue to increase. Such a scenario is highly plausible, as evidenced by the cost projections for building materials in this Research.

Average electricity price risk limits

For the construction sector, the current and now prolonged jump in electricity prices since mid-2021 has led to significant additional costs not only for households, but also for entrepreneurs. Although the construction sector is not comparatively energy-intensive with other sectors, as the higher costs are made up of personnel and building materials, electricity prices, both directly and indirectly, have an impact on the level of costs.

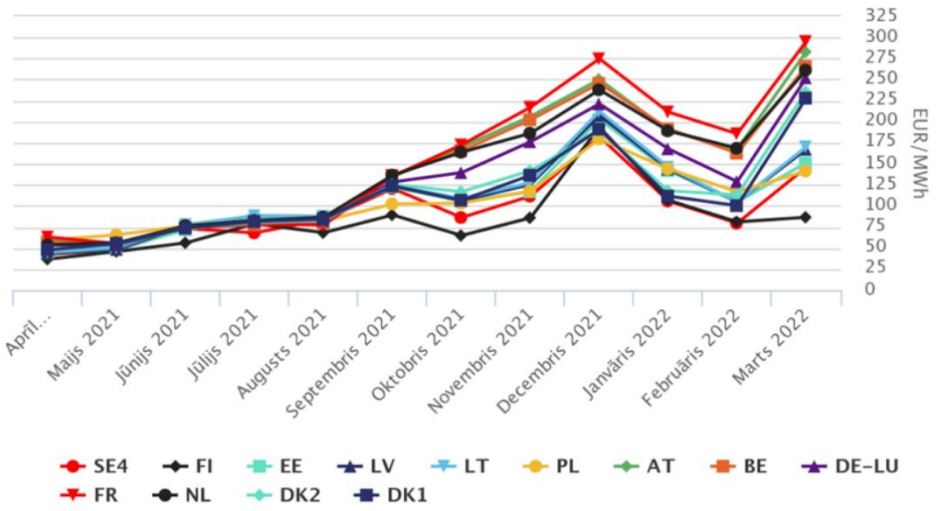


Fig. 34. Evolution of electricity prices in Europe from April 2021 to March 2022. Source: NordPool.

According to the approbation experts' assessment, the medium risk limit at which electricity-energy prices would cause overheating risks is 345.5 EUR/MWh and the high-risk limit is 375 EUR/MWh. In fact, in 2021-2022, this price in Latvia fluctuated in the range of 150-200 MWh and is currently far from identified critical limits (see Fig. 34). However, in a situation where in France the price level has reached a level of 300 EUR/MWh in Q1 2022, which is very close to a critical limit, the situation may change rapidly, which will be reflected in the operating costs of building materials and machinery and equipment.

As the Study found, electro-energy prices are included in other evaluations of overheating indicators, so in further phases of the Study, the authors excluded this indicator from the list of indicators to be considered in detail in order to eliminate the overlap of indicators.

Risk limits for average prices of petrol and diesel for final consumers

As in the case of electricity, fuel costs also have an impact on the costs of the construction sector. Again, they mainly have a proxy effect on the cost of building materials, which may depend on the price of fuel, and a direct impact on the operating costs of machinery and equipment. Fuel prices in general are rising for almost the entire period under consideration, which is due to both the increase in global oil prices and the dynamics of excise duties on fuel.

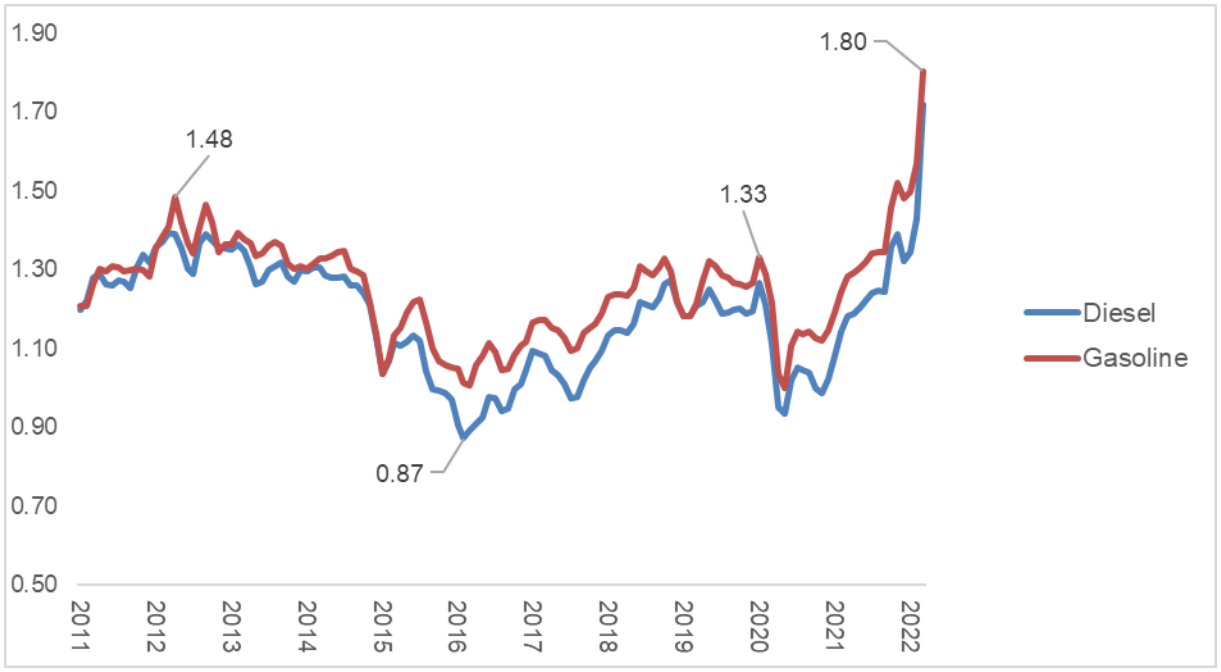


Fig. 35. The dynamics of the average price of gasoline and diesel fuel in Jan.2011-Mar.2022 in euros. Source: CSB

The critical limit of the risk of overheating of construction according to the assessment of approbation experts is 2.15-2.20 euros per liter of fuel. During the first expert-examination, the price of fuel in Latvia was below the limit of EUR 2, but in later periods it exceeded the limit of EUR 2, and in June 2022 the price already occasionally corresponded to the overheating limit (see Fig. 35). As in the case of electro-energy costs, in the further phases of the study, the authors excluded this indicator from the list of indicators to be considered in detail, since fuel costs and their dynamics are included in the construction cost index by proxy and in the assessment of macroeconomic experts this is an indicator of the relatively lowest degree of materiality in the assessment of the risk of overheating of construction.

3.4. Assessment of components of the Construction Overheating Risk Index

Based on the obtained preliminary assessments of experts on the critical limits of each of the indicators considered and the actual values of the indicators, the rationed degrees of risk were obtained. In this case, the risk levels are expressed as a percentage, where 100% would mean that the actual last known level of the indicator coincides with the level at which the limit of a given risk is averaged.

Table 19. Estimated normed risk levels of the indicative indicators of overheating of construction

Indicators	Weight	Proportion of medium risk level	Proportion of the high-risk level
Share of job vacancies in construction sector	13%	40%	26%
Ratio of construction cost index to volume index of construction output	18%	48%	20%
The ratio of wages and salaries per employee to productivity in construction	16%	69%	46%
Gross capital investment of budgetary authorities in buildings and structures	15%	84%	68%
Volume of newly issued loans for the purchase, reconstruction, repair of a dwelling	16%	86%	55%
GDP growth rate	11%	80%	63%
Construction cost index by building materials group	11%	74%	49%

Source: CSB, Eurostat, Bank of Latvia, macroeconomic expert evaluations obtained in the study [15], authors' calculations

When analyzing the results obtained, indicators such as the volume of newly issued loans for housing, gross capital investment in construction by budgetary institutions and the growth rate of GDP have the highest risk rating.

The number of applications for construction intentions was assessed as an important indicator, however, it should be used with caution. The number of applications does not reflect the scale of the intended construction projects, therefore it is possible that there are more applications for a smaller volume. However, this is an anticipatory indicator that can be a good signal for an increase in activity in the industry.

When interpreting the results obtained, the relevance of the indicators should also be taken into account. As GDP growth in 2022, operational data for 2022 and forecasts of public authorities indicate that GDP growth will be closer to the 2% level, which means that the expected degree of overheating risk will be lower than actually estimated.

Gross capital investment in buildings and structures in Latvia is regularly increasing. Of the three most important indicators, this is the one that is easier to control. It is recommended to keep the increase in capital investment balanced with the volume of private sector construction.

Based on the latest available data for each indicator, the Construction Overheating Risk Index (BPRI) was created Based on the average risk assessment and the assessment of the materiality of each indicator, the BPRI for 2022 forecasts is 0.66 and the high risk BPRI is 0.45. Taking into account that the index is expressed in the range from 0 to 1, where a higher index value means a situation closer to a position for a higher risk of overheating, actual data indicate a relatively average risk of overheating of construction. However, the situation may change if one of the indicators changes rapidly, for example, by transferring uneven gross capital formation between different periods.

3.5. Assessment of the risk of overheating of construction by sub-sectors and quarters

The analysis carried out on the basis of indicative indicators allows to obtain a detailed assessment of the risks of overheating of the construction industry. The construction overheating risk index and its components provide insights into potential sectors that are the first to signal the possible approach of overheating. However, taking into account the availability of data for these indicators mostly on a yearly basis, they also make it possible to identify trends in a year-on-year perspective. In situations where the construction sector is already located in a high-risk area, it may be necessary to assess the situation also in terms of shorter periods of time – quarters.

The indicators used in the overheating index of construction were selected in the context of the entire construction industry. Such broad indicators are useful for assessing the risks of overheating of the construction sector, but were not used in the assessment of overheating of individual sub-sectors of the construction industry. To achieve this task, the sub-sectors of construction of residential and non-residential buildings, roads and railroads and urban management infrastructure were considered. It is the choice of these sub-sectors that is based on the availability of data that covers the changes in the volume of construction production and construction costs on a quarterly basis.

In the sub-sector of construction of residential and non-residential buildings, the period from 2015 to 2017 was marked by an increase in costs higher than the increase in production volume compared to 2015 as a base year (see fig. 36). In turn, in the period from 2017 to mid-2021, the situation was the opposite – construction production volumes were higher than cost changes. Consequently, the latter period is characterized as a period with a low risk of overheating. However, starting from the 3rd quarter of 2021, trends indicate an increase in costs in the construction of buildings faster than the volume of production, which is one of the signs of overheating.

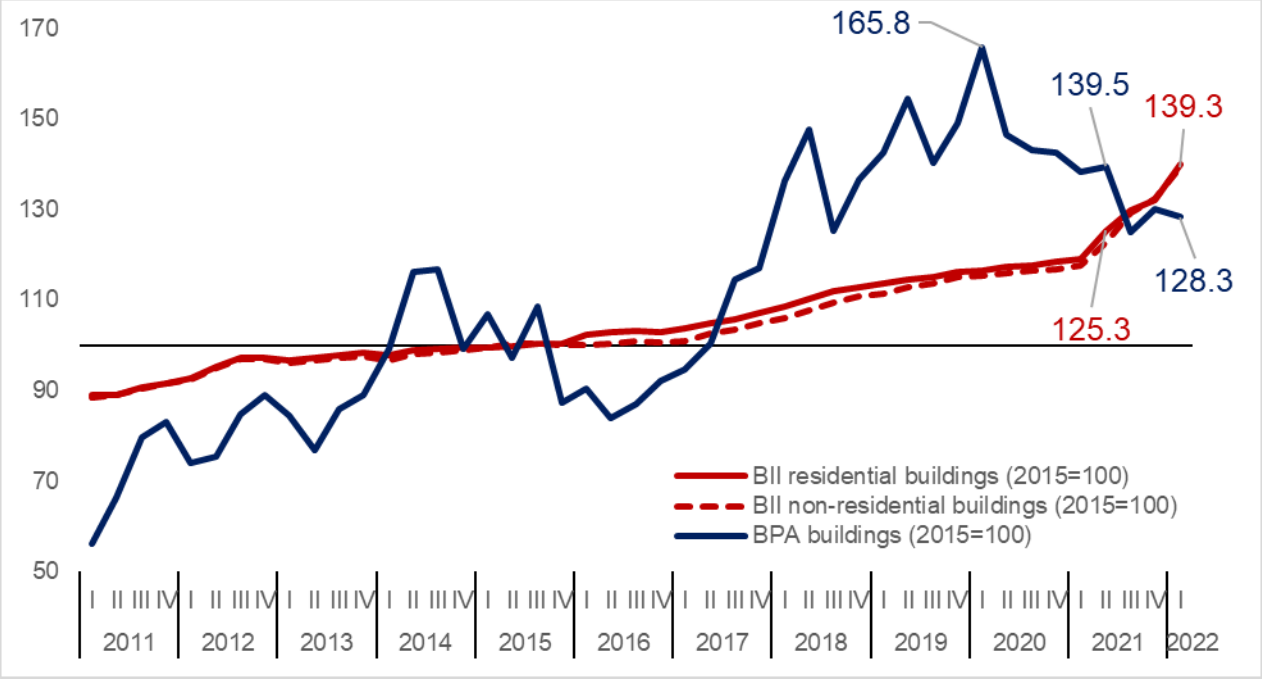


Fig. 36. Development dynamics of construction cost index (BII) of residential and non-residential buildings and construction output of buildings (BPA) in 2011-2022 by quarter, index compared to 2015. Source: CSB

Based on the relationship between construction cost index and construction output volume index, in the 4th quarter of 2021 it was a ratio of 132.1 to 130.2 or 1.02, but already in the 1st quarter of 2022 it reached a ratio of 139.3 to 128.3 or 1.09. In the 1st quarter of absolute units of measurement, the cost index exceeds the production index by 11 percentage points.

In the sub-sector of construction of roads and railroads, the period from 2015 to 2018 was marked by an increase in costs higher than the increase in production volume compared to 2015 as a base year (see fig. 37). In turn, in the period from 2018 to mid-2021, the situation was relatively stable – construction production volumes in most periods were higher than cost changes, but in some quarters lower. Such cyclicality would be explained by the greater dependence of the construction of roads and railroads on seasonality and public order. Starting from the 2nd quarter of 2021, trends indicate an increase in costs in roads and railroads construction faster than the volume of production, therefore, classic signs of overheating are observed.

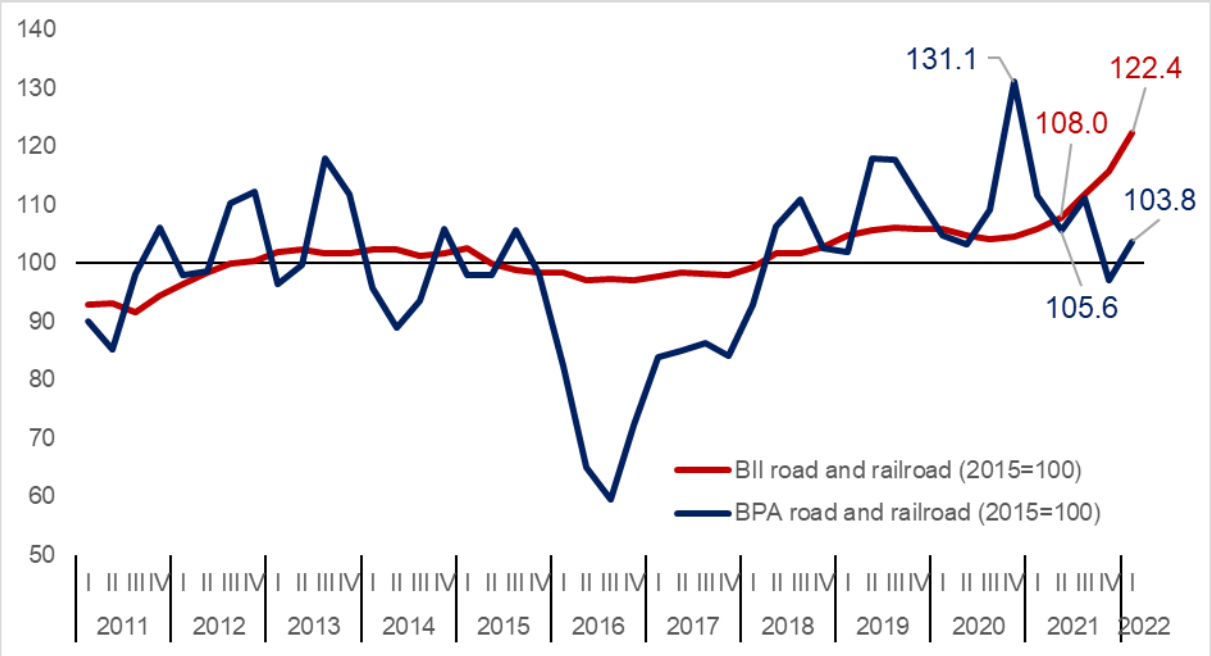


Fig. 37. Development dynamics of construction cost index (BII) of roads and railroads and volume of construction of buildings (BPA) in 2011-2022 by quarter, index compared to 2015. Source: CSB

Based on the relationship between the construction cost index and the volume index of construction production, in the construction of roads and railroads in the 3rd quarter of 2021 it was a ratio of 111.9 to 111.2 or 1.01, but already in the 1st quarter of 2022 it reached a ratio of 122.4 to 103.8 or 1.18. In the 1st quarter of absolute units of measurement, cost index exceeds production index by 19 percentage points. In general, it can be estimated that in the construction of roads and railroads the jump in costs against the volume of production is significantly higher (8 percentage points) than in the construction of buildings.

In the sub-sector of construction of urban management infrastructure, the increase in costs was higher than the increase in production volume from the end of 2015 to the beginning of 2017 (see fig. 38). Later in the period from 2017 to mid-2021, the situation was generally very low with a very low risk of overheating, as construction output in most periods was significantly higher than cost changes, and only in a few quarters lower. Starting from the 3rd quarter of 2021, trends indicate an increase in costs in the construction of urban infrastructure facilities faster than the volume of production, a lower increase in costs is observed than in the construction of buildings, however, a much larger difference from the volume of production.

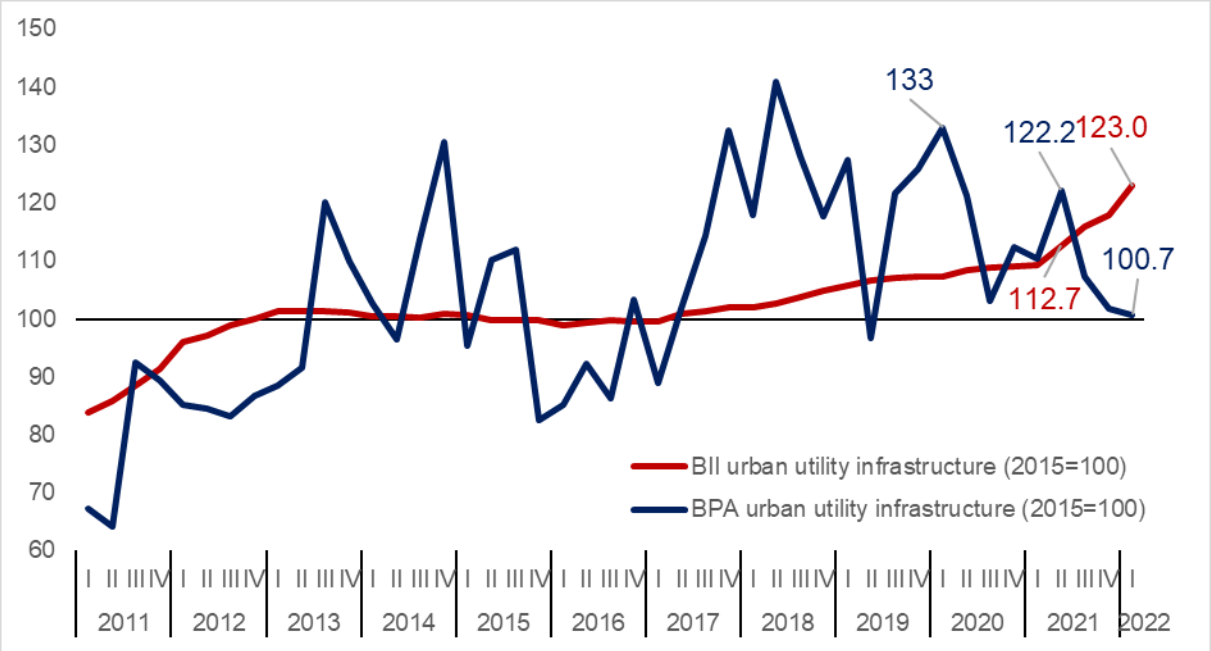


Fig. 38. Development dynamics of urban utility infrastructure construction cost index (BII) and construction output of buildings (BPA) in 2011-2022 by quarter, index compared to 2015. Source: CSB

In the infrastructure sub-sector of urban agriculture, the ratio between the construction cost index and the construction production volume index in the 3rd quarter of 2021 was 115.9 to 107.4 or 1.08 ratio, but already in the 1st quarter of 2022 it reached a ratio of 123 to 100.7 or 1.22. In the 1st quarter of absolute units of measurement, the cost index exceeds the production index by 22 percentage points. This is the largest difference in both relative and absolute construction costs and output volumes between the considered subsectors.

To sum up, the researchers conclude that in 2022, both residential and non-residential buildings, roads and railroads and urban infrastructure construction sub-sectors show an increasing degree of risk of classical overheating, as costs are rising faster than output. The highest risk is in the sub-sector of urban infrastructure construction. Although this subsector does not have the largest cost increase, it had the lowest construction activity at the end of 2021 and the beginning of 2022, which results in a high ratio. In the construction of residential and non-residential buildings there is the highest increase in costs, but this is compensated by high activity in the construction of buildings.

Conclusions and recommendations

Based on the results of the conducted Research and the interpretation of the authors, **conclusions** are put forward, which are divided according to the area to which they relate.

Research methodology

1. Expanding the methodology by including the overheating risks of the construction industry in 2022, the methodology made it possible to more widely cover various potential indicators that can indicate overheating risks. It needs to be further developed by identifying new indicators and clarifying the existing ones using in-depth interviews of macroeconomic experts.
2. The transition of determining development trends to ARIMA models provided opportunities for wider use of open source solutions and making calculations more unified, which would allow more automation of them.
3. The number of experts who do not complete or do not completely complete research surveys due to their volume and complexity is increasing.

Factors affecting changes in construction costs

4. Labor costs are mainly influenced by the volume of construction in Latvia, the level of wages in construction in other EU countries and the demand for labor in the construction industry of other EU countries. Current events and projects on a national scale (the COVID-19 pandemic, the Rail Baltica project, digitization, etc.) have a moderate impact on labor costs.
5. The cost of building materials is most affected by the price dynamics of metal, timber and energy resources in Latvia. The Russo-Ukrainian war is one of the main causes that indirectly affects the increase in the cost of construction materials. Global logistics disruptions caused by the COVID-19 pandemic are also having a major impact.
6. The maintenance and operation costs of machines and mechanisms have been significantly affected by the prices of fuel and energy resources, as well as the low level of competition in the market of machines and mechanisms in Latvia. An actual problem that affects the maintenance and operation costs of machines and mechanisms are problems with the availability of spare parts, the supply of certain brands of machines and the degree of wear and tear.

Forecasts of the costs of the most important building materials

7. For basic construction materials, a significant increase in costs is expected in all positions, which is estimated in 2022 in the range of 12.8% to 32.5%, depending on the type of materials.
8. The most significant increase in the cost of basic construction materials in 2022 is predicted for timber (32.5%), bituminous products (31.3%) and metal products (28.8%).
9. For finishing materials in 2022, an increase in costs is predicted in the range of approximately 15-30%, with the largest increase for exterior finishing materials (29.3%).
10. For the equipment of the main systems, the largest cost increase in 2022 is predicted for plumbing systems in the amount of 35%, as well as for heating and cooling systems in the amount of 33.3%.
11. For all categories of building materials, experts predict the end of the jump in costs in 2023.

Forecasts of changes in the volume and costs of construction production

12. The forecast for construction output in 2022 is 1.1% growth according to the combined forecast and 0.9% according to the experts' forecast, while in 2023 a decline of 0.2% to 1.4% is predicted. In the time period from 2024 to 2026, an increase in the volume of construction output is predicted on average by 1.6% to 2.3% per year.
13. Construction costs in 2022 are predicted to increase by 14.9% according to the combined forecast and 20.5% according to the experts' forecast with greater reliability of the experts' forecast, while in 2023 the increase in costs is predicted in the range of 5.9-9.4% . In the period from 2024 to 2026, it is estimated that costs could increase by an average of 3.2-4.5% per year.
14. Taking into account the negative impact of the consequences of the Russian-Ukrainian war on the regional building materials market, the forecasts obtained in 2022 have a lower level of reliability than the forecasts developed in previous years, due to the greater uncertainty of the industry.

Forecasts of changes in construction production and costs in construction sub-sectors and by types of resources

15. In the construction of residential buildings in 2022 and the following years, the most significant increase in the volume of production of all sub-sectors is predicted, 8.2% in volume in 2022 and 3.8% in volume in 2023. The increase in costs is also predicted to be significant - in 2022 in the amount of 25.1%.
16. For the construction of non-residential buildings in 2022, a 5.6% increase in the volume of construction is predicted, which could decrease to a 1.4% increase in volume per year in 2023. The cost increase in 2022 is predicted to be 26.6%.
17. In the sub-sector of road and railway construction, in the construction of roads, highways, bridges and tunnels, according to experts' assessment, a decrease of around 3% in the volume of construction is predicted, while in the construction of railways a 1.5% increase. A faster growth is predicted in the construction of all roads and railways in 2025-2026. year. The increase of costs in the construction of roads and railways is mostly predicted in the range of 23-25% in 2022 and 10-13% in the range of 2023.
18. In the construction of municipal facilities in 2022, a small decrease in production volume by 0.8% is predicted according to experts' assessment, but an increase in costs is predicted in the amount of 21% in 2022 and in the amount of 19% in 2023.
19. In the sub-sector of specialized construction works, volume changes in 2022 are predicted with an insignificant increase, but in 2023-2026. could grow by 5-8% per year. Costs in the subsector could increase by 18% in 2022.
20. In the field of architecture and engineering services, technical inspection and analysis, a rapid increase in volume is predicted in 2022 in the amount of 10%, which could decrease to 2.4% growth in 2023. In this sub-sector, an increase in costs is predicted in 2022 in the range of 8.3% to 14% compared to the previous year, where from the perspective of experts in architecture and engineering services, technical inspection and analysis, the upper limit is more reliable, from the perspective of general experts - the lower. It could grow more in building construction (13.2%), but less in urban infrastructure construction (below 3%) and road and railway construction (5.0%).
21. Costs in the construction sector will increase the most for building materials, which are predicted to increase by 21% in 2022 according to expert assessments. They will grow faster in

building construction, where a 28-30% increase is predicted in 2022, and in road and railway construction 32% in volume.

22. The second significant increase in resource costs is expected for the maintenance and operation of machines and mechanisms in the amount of 14.5% in 2022. A larger increase in costs is predicted in the construction of buildings, roads and railways and urban economy infrastructure by around 20%, but lower in the field of specialized construction works.
23. The increase in wages in the construction industry is predicted to be 7.8% in 2022. No significant differences were observed by subsectors.

Assessment of the impact of the fight against the shadow economy, COVID-19 and the Russia-Ukraine war and the impact of the volume of production on the profit margin

24. In general, the estimated acceptable profit margin in the construction industry under various scenarios has increased. In the case of an increase in construction volumes, the acceptable construction profit margin in the industry would be within 8-12%, while in the case of negative growth within 6-7%.
25. Shadow economy measures do not significantly affect construction costs. The impact on construction material costs is negligible and on labor costs is medium. Labor costs have been most affected by the construction industry's general agreement on the minimum wage in the industry.
26. The impact of the COVID-19 pandemic on the industry still remains, mainly affecting the cost of construction materials. It is significantly felt in the urban economy and specialized construction sub-sectors.
27. The Russia-Ukraine war has had a very significant impact on the costs of construction materials in all sub-sectors, but its significant impact on labor costs has been observed only in the sub-sector of road and railway construction.

Risks and possible causes of overheating in the construction industry

28. As the most important indicators, which could conceptually serve as indicators of possible risks of overheating, the ratio of construction costs and volumes, the amount of housing loans and the budget institutions' planned capital investments in construction were determined.
29. The volume of housing loans and the volume of capital investments of budgetary institutions are very close to the limit of medium overheating risk and may reach it in 2022-2023.
30. None of the considered indicators is close to the high risk limit and would not reach it until 2024 even if the current trend continues.
31. The weighted average level of the construction overheating risk index of seven indicators is 66% in volume from the average risk limit and 45% in volume from the high risk limit, which indicates a moderate level of overheating risk.
32. In the short term, in 2022, based on the 1.cet. according to the data, a relatively higher risk of overheating can be observed in the construction of urban infrastructure, but it is not considered dangerous.

Based on the results of the study, expert opinions, dynamics of the development of the industry and the assessment of researchers, **recommendations** for state institutions are put forward.

1. Competition monitoring institutions to analyze market concentration indicators in the machinery and machinery trade sector and develop measures to promote competition (e.g. prevention of price collusion, price control of dominant companies, etc.) in order to reduce the costs of machinery and machinery.
2. Taking into account that the Research found that a significant factor affecting labor costs is labor demand in other EU countries, to compensate for this by promoting the influx of labor supply from third countries (e.g. by simplifying procedures, reducing barriers, etc.), thus reducing the increase in labor costs.
3. To provide support to companies for attracting new supply partners for raw materials, building materials and mechanisms to countries outside the countries involved in the Russia-Ukraine war, because the increase in the cost of building materials has been affected by the loss of existing supply channels and the need to look for new supply routes.
4. Based on the evaluations of research experts during the development stage of the construction overheating risk index, it is recommended to develop a measure to slow down housing lending, if their volume reaches 200-250 million. EUR per quarter, while at the same time promoting the transfer of loans to housing outside Riga and Pieriga.
5. Continue the initiated measures to combat the shadow economy and develop new ones, taking into account the short-term tendency for the share of the shadow economy to increase in the construction sector.
6. Develop the research methodology by reducing the number of questions in expert surveys, conducting a more extensive analysis of overheating indicators and creating online tools for monitoring indicators that characterize the construction industry.

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Annex 1 – Experts involved in the research

Organization	**Name, surname**	**Title**
General experts		
Bank of Latvia	Agnese Rutkovska	Chief Economist
State Environmental Service	Elita Baklāne-Ansberga	Director-General
Rezekne municipality	Inga Aleksandroviča	Head of the Construction Board
Partnership of Latvian Construction Contractors	Gints Miķelsons	Manager
JSC "Swedbank"	Aleksandrs Bērziņš	Corporate Client Relations Manager
Bank of Latvia	Daina Pelēce	Senior Economist
Latvian Union of Civil Engineers	Raimonds Eizenšmits	Chairman
Independent analyst	Jānis Platais	Economist
Latvian Chamber of Commerce and Industry	Krišs Zvirbulis	Policy department expert
LLC "Ober Haus Real Estate Latvia"	Diāna Frīdenberga	Chairwoman of the Board
Ministry of Finance	Inta Vasaraudze	Director of the Economic Analysis Department
Ministry of Finance	Māris Katkovskis	Senior Expert
Financial and Capital Market Commission (FKTK)	Ģirts Rūda	Member of the Board
Latvian Chamber of Commerce and Industry	Krišs Zvirbulis	Policy department expert
Daugavpils City Municipality City Planning and Construction Department Construction Board	Nadežda Giptere	Head of the Construction Board
Ministry of Environmental Protection and Regional Development	Māris Klismets	Department Director
Latvian Builders' Association	Normunds Grinbergs	Chairman
Competition Council	Rūta Šutko	Director of the Analytical Department
Ministry of Finance	Dainis Stikuts	Dep. of Macroeconomic Analysis. Deputy
Organization	**Name, surname**	**Title**
Experts of the sub-sector of building construction		
LLC "RIGENSI"	Andris Mačs	Member of the Board
LLC "Skonto Būve"	Juris Pētersons	Member of the Board
LLC "UPB"	Uģis Grīnbergs	Member of the Board

LLC "UPTK"	Juris Gulbis	Commercial Director
LLC "CEL"	Kaspars Štokmanis	Construction Consultant
LLC "CEL"	Māra Vītiņa	Member of the Board
Latvian Construction Industry Trade Union	Mārtiņš Dunskis	Vice-President
LLC "CEL"	Raimonds Vītiņš	Project Manager
Organization	**Name, surname**	**Title**
Experts of the sub-sector of construction of roads and railroads		
Latvian Association of Electrical Engineers and Energy Builders	Gunārs Valdmanis	Executive director
LLC "Saldus ceļinieks"	Gints Karols	Chairman
LLC "LLKU Viadukts"	Jurijs Haritonovs	Member of the Board
JSC "Ceļu projekts"	Mārtiņš Liepiņš	Chairman
LLC "Baltijas Būve"	Roberts Kuiva	Member of the Board
IC "Gamma"	Juris Karss	Civil Engineer
Organization	**Name, surname**	**Title**
Experts of the sub-sector of urban infrastructure construction		
LLC "Moduls Engineering"	Kristaps Grīniņš	Member of the Board
LLC "Lika"	Gunārs Valinks	Founder
LLC "Ditra Networks"	Jānis Mednis	Director
LLC "RUBATE"	Andis Augulis	Member of the Board
Latvian Association of Engineering Consultants	Jānis Uzulēns	Member of the Board
Latvian Association of Building Structure Designers (LBPA)	Normunds Tirāns	Member of the Board
LLC "Citrus Solutions"	Raimonds Gerbis	Director of the building engineering systems construction service, member of the board
Organization	**Name, surname**	**Title**
Experts of the special construction sub-sector		
LLC "KULK"	Janis Melbardis	Member of the Board
LLC "Caverion Latvija"	Aleksandrs Petruss	Head of the company
LLC "Newcom Construction"	Jānis Čodars	Member of the Board
LLC "Pro Dev"	Māris Stakens	Member of the Board
LLC "Belam-Rīga"	Marks Kacs	Chairman

Latvian wood construction cluster	Kristaps Ceplis	Acting Executive Director
Latvian Union of Geotechnicians	Kaspars Bondars	Member of the Board
Latvian Union of Civil Engineers	Ilmārs Leikums	Executive director
LLC “Primekss”	Janis Oslejs	CEO
Organization	**Name, surname**	**Title**
Experts in the field of architectural and engineering services, technical inspection and analysis		
LLC “ar.4”	Andris Vītols	Chairman
Kuldīga Municipality	Elīna Zīle	Senior Project Manager
Latvian Architects' Union	Elīna Rožulapa	Head of certification centre
Ventspils State City Local Government Institution 'Ventspils City Council Administration'; Latvian Association of Landscape Architects (LAAA)	Lilita Sproģe	Architect; LAAA Board Member
LLC "ARKA"	Uldis Ekšteins	Architect, member of the board
Valmiera Municipality Construction Board	Rasma Liepiņa	Deputy Head of the Construction Board, Building Inspector
LLC “Virtu”	Anda Kursisa	Chairwoman of the Board
Organization	**Name, surname**	**Title**
Building materials trade experts		
LLC “Windows Factory”	Zemgus Liepa	Member of the Board
LLC “TN Kurši”	Agnis Bērziņš	Chairman
SJC “SAKRET Holdings”	Juris Grīnvalds	Commercial Director
LLC “Bauroc”	Māris Cimmermanis	Chairman
LLC “Consolis Latvija”	Mārtiņš Bariss	Factory manager
LLC “Schwenk Latvija”	Jānis Zāle	Head of Material Quality and Product Technology
LLC “Knauf”	Juris Tensbergs	Sales Manager in Latvia
LLC “Knauf”	Dzintars Šulcs	Sales Representative
Latvian Traders Association	Henriks Danusevics	President
Latvian Association of Window and Door Manufacturers (LLDRA)	Roberts Viļumsons	Expert in the assembly of glazed structures
Organization	**Name, surname**	**Title**

Macroeconomic experts, group 1		
Bank of Latvia	Edvards Kušners	Head of Sustainability
University of Latvia	Ģirts Brasliņš	Doctor of Economic Sciences, Member of the Master's Degree Examination Committee of the Finance Programme
Bank of Latvia	Santa Bērziņa	Head of the Macroeconomic Analysis Division
Competition Council	Rūta Šutko	Director of the Analytical Department
Ministry of Finance	Dainis Stikuts	Deputy Director of the Economic Analysis Department
Organization	**Name, surname**	**Title**
Macroeconomic experts, group 2		
Ventspils State City Council	Austris Galindoms	Head of Economics and Procurement
Association of Economists	Edmunds Krastiņš	Member of the Board
RISEBA	Andrejs Limanskis	Docent
Ventspils University of Applied Sciences	Sergejs Hiļķevičs	Professor
Liepaja City Municipality Administration	Inga Leimane	Development Department Economist
University of Latvia	Oļegs Krasnopjorovs	Deputy Director of the Scientific Institute of Productivity 'LV PEAK'
Kuldīga Municipality Construction Board	Jana Jākosone	Head of the Construction Board
University of Latvia	Kārlis Purmalis	Assoc. Professor
University of Latvia	Anda Batraga	Professor

Annex 2 – Object groups and resource types

Groups of objects considered in the study

1. Construction of buildings:
   1.1. construction of residential buildings;
   1.2. construction of non-residential buildings.
2. Civil engineering:
   2.1. construction of roads and railways;
      2.1.1.construction of roads and highways;
      2.1.2.construction of railways and metro;
      2.1.3.construction of bridges and tunnels;
   2.2. urban agriculture construction of infrastructure facilities;
   2.3. other civil engineering.
3. Specialized construction work:
4. professional, scientific and technical services;
   4.1. architectural and engineering services.

Types of resources to be considered in the study:

1) building materials;
2) labour remuneration of workers;
3) maintenance and operation of machinery and equipment.