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Forecasting the demand for blue-collar workers in the construction sector in 2020: the case of Lithuania

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After 2020 all new buildings must be energy efficient, which means that the construction industry workforce must be prepared and up-skilled. Formal and informal continuing education must respond to these changes, which means the curriculum needs to be updated and supplemented with the necessary knowledge and skills. This article provides the forecasts for blue-collar worker demand by 2020 in the construction industry and the number of construction workers who should be up-skilled or have extra training to be able to build energy efficient buildings and to install the renewable energy systems. The need for blue-collar workers in the construction sector up to the year 2020 was estimated by the use of mathematical models and expert evaluation, as well as taking into account the Lithuanian economic growth forecasts for the year 2020, trends of employment changes in the construction sector, the impact of EU support to the national economy and other factors having significant impact on employment in the construction sector.

Keywords: nearly zero-energy buildings; forecasting; blue-collar workers; case study

JEL classification: C4, C53, E17, E27, J23, L74

Introduction

The construction sector is one of the most important sectors in the European Union. It creates about 10% of the GDP and positively affects the growth of employment in other related economic areas. The sector features a specific cyclical nature of work, relatively low productivity and a dominant number of small companies compared to other industries.

The Lithuanian construction sector contains about 5000 companies, of which 39% specialise in the construction of buildings and parts thereof. The sector is dominated by small companies (with less than 49 employees). The construction sector employs approximately 107,000 employees, of which a majority work in the subsector of building and their parts (about 68% of the construction industry are blue-collar workforce).

Now the construction industry in Lithuania is faced with a variety of structural problems: many companies lack a skilled workforce, young people are not particularly attracted to the working conditions in this sector as it offers poor opportunities for innovation and is infested with extensive undeclared work. The built environment sector which grew at a staggering rate before the economic crisis, after the collapse of the real

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estate bubble in Lithuania and the shrinkage of the investment, experienced, in two years, the largest downfall among all sectors of the economy in 2009. The number of unemployed in the sector has increased, labour rates and earnings shrunk significantly, and investment rates fell. The results of Ginevičius and Podviezko's (2013) study revealed the instability of the Lithuanian commercial bank market in the 2007–2009 period. Similar situations in banking sectors also occurred in other European countries (Jurčević & Mihelja Žaja, 2013). The crisis distorts the statistics and in the absence of reliable data it is difficult to assess the financial state of construction enterprises, sectors or regions, therefore new techniques have to be applied (Ginevičius & Podvezko, 2008; Brauers, Ginevičius, & Podvezko, 2010). The crisis has had a dramatic impact on economies and labour markets worldwide. Despite indications that the world's economy is now emerging from recession, it is likely that employment growth in Europe will only gradually recover over the next decade. Recent studies prove that shocks affecting industry output have long lasting and even increasing effects over time (Škare & Stjepanović, 2013). It is difficult to plan, formulate strategies and make decisions in a complex world characterised by limited predictability and high levels of uncertainty. Practically all economic and business decisions forecasts are crucial, however there are many studies (e.g. Makridakis, Hogarth, & Gaba, 2009; Danese & Kalchschmidt, 2011; Davydenko & Fildes, 2013) proving that accurate forecasting in the economic and business world is usually not possible. Even statistical models and human judgment have been unable to capture the full extent of future uncertainty. Analysts say that in the near future, in the most optimistic case, low growth can be expected – the prevailing uncertainty about the European debt crisis discourages enterprises from investing, and public sector contracts are scarce. The crisis in the Lithuanian built environment sector forced market participants to re-orient, giving more focus on the modernisation of buildings, construction of non-residential and engineering, utility buildings and EU-funded projects.

Due to the variety of the construction sector activities, the sociological and economic, organisational, cultural and technological challenges are addressed differently, there is different adaptation to the new rules and in taking advantage of the market opportunities. The targets of the Energy Performance of Buildings Directive[1] indicate that the construction sector will face some of the biggest challenges – to start the construction of nearly zero-energy buildings.[2] Jakovac (2013) study revealed that energy conservation policies together with the establishment of a competitive energy market may be feasible with little or no detrimental side effects to economic growth and employment. The market still has several years to prepare. The construction sector will have to adapt to these changes and provide personnel with the required skills and abilities. This is especially important in the training of employees for the construction of nearly zero-energy buildings, regardless of whether the work will be related to new or renovated buildings. In order to implement new technologies and organise the work flexibly, the blue-collar workforce in construction will need new skills and qualifications. Many studies (Gudienė, Banaitis, Podvezko, & Banaitienė, 2014; Zavadskas, Vilutienė, Turskis, & Šaparauskas, 2014; Hwang & Ng, 2013; Ibrahim, Costello, & Wilkinson, 2013 and other) reveal that a qualified workforce within the project team is one of the main success factors for construction enterprise.

This article presents the results of research performed in project BUILD UP Skills LT funded by strategic initiative BUILD UP Skills – EU under the Intelligent Energy Europe (IEE) programme to improve the qualification and skills of Europe's building workers, which are essential to build, equip and renovate buildings of high energy performance. The Initiative focuses on continuing education of craftsmen and other on-site construction workers and systems installers in the construction sector. While the European Commission recognises the strategic importance of other professions, such as energy experts and consultants, architects and engineers, these professions were not included in the scope of this research, as it was considered that there is a greater demand for skilled workers who must have skills related to the concept of energy efficient buildings and installation and maintenance of renewable energy systems. The final aim is to increase the number of qualified workers across Europe to deliver renovations of high energy performance as well as new, nearly zero-energy buildings. The initiative addresses skills in relation to energy efficiency and renewables in all types of buildings.

The project was initiated taking into account the declared 2020 targets of European Union member states and focuses on the continuing education and training required for the construction of energy efficient buildings and the efficient use of technologies of renewable energy sources. After 2020 all new buildings must be energy efficient, which means that the entire construction industry workforce must be prepared and up-skilled. Formal and informal continuing education must respond to these changes, which means the curriculum needs to be updated and supplemented with the necessary knowledge and skills. One of the objectives of the project is to provide the forecasts for blue-collar worker demand by 2020 in the construction industry and the number of construction workers who should be up-skilled or have extra training to be able to build energy efficient buildings and to install the renewable energy systems. This article presents the result of the implementation of this objective.

Forecasts for the demand for blue-collar workers in construction was made in two steps and cover both qualitative and quantitative approaches:

(1) The first step covers the analysis of available initial data, assumptions, expert assessment of separate indicators as well as expert assessment of demand for blue-collar workers using three different scenarios.
(2) The next step shows the demand for workers employed in the construction sector was forecasted using the experts' assessment of priority occupations in construction and the selected mathematical model.

The results of the forecast present the distribution of necessary occupations in construction until 2020 according to pessimistic, optimistic and most likely scenarios. We do not state that we are providing precise and accurate forecasts, however this study can add value in planning the training of professions with strategic importance.

Mathematical model to forecast the demand of employed in the construction sector

While forecasts cannot predict the future precisely and in great detail, they can signal trends and complement other labour market information. Their forward-looking dimension is key to inform institutions which devise long-term and proactive strategies (Skills Supply, 2010). Forecast results also can have an early warning function as they draw an attention to problematic areas and highlight areas where we need to know more. Forecast results do benefit education and training providers, guidance and placement services and enterprises. The better they are informed, the more effective their decisions on skills investment will be.

Ross, Dalton, and Sertyesilisik (2013), Chen, Chen, and Wei (2011), Gupta, Ye, and Saco (2013), Nazarko and Kononiuk (2013), Yazdani-Chamzini, Yakhchali, Volungevičienė, and Zavadskas (2012), Catik and Karacuka (2012), Mahmud and Mirza (2011) among other authors recently applied different mathematical models for forecasting of dynamics of the various phenomena.

The majority of the mathematical models (assisting in forecasting the values of the dynamic processes) are based on n year observation results (t_i, y_i) – statistical data or expert assessments, t_i is a observation period, y_i – the Y values of the relevant year T in observation period; i = 1,2, ..., n.

The prediction model is based on n year observation results – statistical data or expert assessments (t_i, y_i) – the Y values of the relevant year T (Table 1); i = 1,2, …, n.

Few mathematical models can be suggested for a specific period, sufficiently adequately describing a specific period – an observed segment of time. Though, the forecasted values, counting in accordance with the different models, can differ among themselves and these differences can be considerable.

The forecasting models must correspond to these requirements:

(1) Models must be sufficiently simple so they could be easily put into practise and the obtained results could be easily perceived and considered.
(2) In the future, the tendencies towards the development of the examined phenomenon must remain the same as they were in the period of observation.
(3) The possibility to regulate the mathematical models when additional information about the development of the process and new statistic data is received should be foreseen.
(4) The final model must be multivariate; individual models are able only to accidentally reflect the possible development of the process.
(5) The models must evaluate the stochastic nature of initial information.
(6) When trying to use the professional experience and intuition of the specialists, it is significant to evaluate the estimations and opinions of the qualified experts.

It is obligatory to evaluate the value of Y throughout the year t_i, when t_i = T+1, T+2, …, T+L, where L is a forecasted period.

The aim of forecasting is to determine the Y values $y_i = Y(t_i)$ during the observation period n, i.e. when $i > n$.

In most cases linear time trend, multiple regression model, auto-regression and models of moving average and other expert-based evaluation models are used to create a forecast.

Table 1. Employment trends by sector, Lithuania.

	Levels (000s)			Change (%)	
	2000	2010	2020	2000–2010	2010–2020
Primary sector & utilities	304	151	127	−50.3%	−15.9%
Manufacturing	244	210	210	−13.9%	0.0%
Construction	84	93	105	10.7%	12.9%
Distribution & transport	316	373	405	18.0%	8.6%
Business & other services	111	190	227	71.2%	19.5%
Non-marketed services	336	322	359	−4.2%	11.5%
All industries	1 394	1 339	1 432	−3.9%	6.9%

Source: Cedefop, Skills Forecasts, Data published in 2013, http://www.cedefop.europa.eu/.

Table 2. Employed persons by occupational group in construction sector (in thousands) (2000–2006).

	2000	2001	2002	2003	2004	2005	2006
Total	83,7	84,8	93,2	107,1	116,2	132,5	148,7
Skilled workers and craftsmen	48,2	50,2	53,3	61,1	69,6	75,7	85,5
Unskilled workers	8,8	8,7	10,6	15,8	17,6	19,3	23,1

Source: Statistics Lithuania, Database of Indicators.

In the models of trend, an influence of a time factor t upon the forecasted characteristics is being singled out: $y = Y(t)$.

At the beginning the curve – the mathematical relationship (equation) $y = Y(t)$ is determining. The defined mathematical relationship (equation) should give the best (most accurate) description of dependency in observed period from t_1 till t_n.

This task can be solved using the method of least squares, with the condition that the equations are linear in the respect of unknown coefficients a_0, a_1, …. The method of least squares is a standard approach to the approximate solution of overdetermined systems, i.e. sets of equations in which there are more equations than unknowns. 'Least squares' means that the overall solution minimises the sum of the squares of the errors made in the results of every single equation.

Mostly, the models of trend are being linear in respect of the unknown coefficients or are transformed into being linear in respect of the unknown coefficients. The examples would be: linear regression $y = a_0 + a_1 t$, logarithmic curve $y = a_0 + a_1 \cdot \ln t$, hyperbolic curve $y = a_0 + \frac{a_1}{t}$, exponential curve $y = a_0 + a_1 \cdot e^t$, parabola curve $y = a_0 + a_1 x + a_2 x^2$ and other analogous curves.

For every (1) – (5) curve mean square error is calculating:

$$S_y = \sqrt{\frac{\sum_{i=1}^{n} \left(y_i^{teor} - y_i\right)^2}{n - k}} \tag{1}$$

here k – the number of unknown coefficients of the curve equation, i.e. $k = 3$ in case of parabola, $k = 2$ in other cases; y_i^{teor} value calculated from the corresponding function (1) – (5).

The best suitable, i.e. closest to points (t_i, y_i), curve among selected is the one, that has the smallest value of the mean square error.

Multifactorial models of regression, studying the Y dependence upon the independent factors X_1,X_2,...,X_n, could be presented in this way:

$$Y = b_0 + b_1 f_1(X_1, X_2, \ldots, X_n) + b_2 f_2(X_1, X_2, \ldots, X_n) + \ldots + b_m f_m(X_1, X_2, \ldots, X_n) \tag{2}$$

Multifunctional models (as well as trend models) are usually linear in respect of the unknown coefficients or are transformed into being linear in respect of the unknown coefficients:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_m X_n \tag{3}$$

or are converted into the second degree polynomials:

$$Y = b_0 + \sum_{j=1}^{n} b_j X_j + \sum_{j=1}^{n} \sum_{l=1}^{n} b_{jl} X_j X_l, \tag{4}$$

Where the factors of X_j models can be transformed into functions e^{X_j}, $\ln X_j, \frac{1}{X_j}$, $\sqrt{X_j}$ and others.

In the models of autoregression, the values of the processes of a AP(p) p line are presented as being a linear combination of the values of a variable p in the previous year:

$$Y_t = b_0 + b_1 X_{t-1} + b_2 X_{t-2} + \ldots + b_p X_{t-p} \quad (5)$$

In the case of a process Y_t being unstable, the models of an autoregression for some different Y_t.

Autoregressions of a moving average CC(q) q line and compound APCC(p,q) p line and models of a moving average of q line are also used to create a forecast.

In this case, retrospective data collected between 1990 and 2010 was poorly suitable when forming the mathematical methods, adequately describing the data of an examined period by forecasting the need of the professional workers from the construction sector till the year 2020. During the period of transition to market economy, few recessions, the birth of the new and the death of the old professions, only the qualified experts could have forecasted an upcoming need for labourers. They were asked to indicate the most probable meanings for the planned period of five years. They had to offer pessimistic, optimistic and the most likely to be realistic forecasts. From the various possible mathematical curves, a parabola $y = a_0 + a_1 x + a_2 x^2$ described the estimations of experts most adequately.

Prediction of annual number of blue-collar workers by expert assessment

The historical data for 1990–2010 was not suitable in our case for the prediction of the demand for construction workers until 2020 and for the construction of mathematical models that adequately describe the data for the observed period. The application of mathematical forecasting models alone is possible only if stable reliable historical statistical data that give clear trend is available. In our case these conditions are not met. During the mentioned period the regulatory mechanisms of market changed fundamentally. In early the nineties the country faced the transition to market economy, since then several recurrent crises have shaken the economy, the accession to the EU has influenced the monetary politics and changed regulatory systems of economy sectors. Undoubtedly these changes had an impact on the construction sector and lead to a distortion of the indicators. Crises distorted the demand indicators of occupations in construction. During this period new professions appeared, some existing professions were in less demand. In the period of transition to a market economy, facing a crisis of the economy, the emergence of new professions and the disappearance of previous professions, the prediction of the demand for workers must be performed by qualified experts. Experts representing the construction industry were asked to specify what they think was the highest expected value for the five year planning period. They were also asked to specify the 'pessimistic', the 'most realistic' and 'optimistic' forecasts. The annual demand for the blue-collar workforce in construction was determined according to three scenarios, i.e. the pessimistic, the most likely and the optimistic. These three forecasting scenarios were decided according to the estimated construction growth up to the year 2020 that was estimated according to the official Lithuanian economic growth forecasts for the year 2020, trends of employment changes in the construction sector, the impact of EU support to the national economy and other factors having significant impact on employment in the construction sector. For instance, demand for the profession could be substantially influenced by the building projects' characteristics for each building's purpose, therefore this factor was analysed by using Lithuanian normative standards. According to the cost ratios of work materials and machinery work, man hours were calculated and the annual demand for the blue-collar workers of main professions was estimated.

In addition, in the formation of the Forecast, possible changes in the structure of buildings were assessed by experts. Starting with 2015, there should be a rise in the relative weight of residential buildings in the total scope of the work. Also, taking into account the development of new technologies and renewable energy sources, as well as building energy efficiency requirements, the partial change in the blue-collar professions is forecasted by extending the requirements for basic qualifications. It should be noted that predictions can not be based on the number of buildings to be modernised, since most of them are privately owned (individual owners of separates flats in one building) and therefore due to little support it is hard to predict the future of the modernisation process.

According to the data from the European Centre for the Development of Vocational Training (CEDEFOP[3]), employment in the construction sector will increase by 12.9% in 2020 compared with 2010. Compared with the last decade's changes, this forecasted rate is somewhat optimistic. During the period 2000–2010 the change in number of persons employed in the construction sector accounted for 10.7%. (Table 1).

For the estimates of the demand of the profession, the annual domestic construction volume in million litas excluding VAT, including new construction, reconstruction, repair and other works, also the construction work carried out outside the country on own facilities, was assumed.

The target groups of the case study are skilled workers and craftsmen and unskilled workers. In the second quarter of 2013 this group accounted for 57,800 workers (Tables 2–3).

The Lithuanian economy and labour market in comparison with other EU economies are relatively young, having been rebuilt over the past two decades. The results of the case study presented in the research paper *Skills Supply and Demand in Europe 2012* (CEDEFOP) revealed that Lithuania is structurally different because of supply and demand ratios of different qualifications. In Lithuania there are more severe shortages of workers with low- and medium-level qualifications than in the EU-28 average.

The prediction of demand for blue-collar workforce in the construction sector (hereinafter referred to as the Forecast), as mentioned previously, was conducted by

Table 3. Employed persons by occupational group in construction sector (in thousands) (2007–2013 IIQ).

	2007	2008	2009	2010	2011	2012	2013 IIQ*
Total	170,9	166,5	122,6	93,3	93,7	89,5	97,2
Skilled workers and craftsmen	98,8	95,7	68,9	46,4	49,2	47	49,8
Unskilled workers	22,8	15,6	12,4	7,9	7,0	7,4	8

Source: Statistics Lithuania, Database of Indicators.
*Labour Market Yearbook, 2012.

Table 4. Projections of Lithuanian economic indicators.

	Projection 2013 September				
Macroeconomic indicators	2012	2013	2014	2015	2016
Gross domestic product at current prices	113471.5	119302.7	126036.5	134825.1	144168.5
Nominal growth – %	6.7	5.1	5.6	7.0	6.9
Gross domestic product, chain-linked volume	83735.3	86822.9	89781.9	93645.1	97389.6
Chain-linked volume growth, percentage	3.7	3.7	3.4	4.3	4.0
Average annual number of employed, according to labour force survey (in thousands)	1278.5	1289.6	1297.3	1304.7	1309.0
Average annual unemployment rate, according to labour force surveys – %	13.2	11.5	10.5	9.8	9.1

Source: The Ministry of Finance of the Republic of Lithuania. Projections of Lithuanian Economic Indicators (10 September, 2013).

expert assessment in accordance with the Lithuanian economic growth forecasts for the year 2020,[4] and the forecasts of main economic indicators of the Ministry of Finance of the Republic (Table 4), as well as in the light of the main economic indicators of construction sector (Tables 5 and 6). In the projections of Lithuanian economic indicators made by the Ministry of Finance of the Republic of Lithuania the forecast of the Lithuanian economic growth in 2020 was made on the assumption that the scope of EU financial support for Lithuania during the new financial period of 2014–2020 will decrease by 14%, while the structure of support will remain the same as in the current period. The forecast included the evaluation of three economic growth scenarios, differing by exogenous indicator assumptions. The first pessimistic scenario was based on the assumption that Lithuania's main trading partners (Russia, Germany and Poland) will not develop, and the outside world's economic dynamics were ignored. Under these assumptions, the average annual real GDP growth is dependent on Lithuania's internal developments, and will reach 2.5%. In the second scenario the assumptions on the growth of Lithuania's major trading partners, global growth forecasts over the medium term were applied, based on the data from experts and international institutions. In this, the most likely scenario, the average GDP growth rate in Lithuania in 2012–2020 might be 3%, and up to half of this increase would be due to the EU's financial support. In the third scenario, with optimistic assumptions (low Lithuanian export price increases and inflation rates and more rapid development projections of partners), i.e. disregarding the problems causing doubts for experts in the world, our country's economic growth could reach an average of 4% per year.

Table 5. Gross value added of construction in gross domestic product (2001–2006).

Indicators	2001	2002	2003	2004	2005	2006
GDP* – LTL billion	48879.5	52351.05	57232.43	62997.37	72401.94	83227.15
Construction – LTL billion	2582.81	2938.83	3565.35	4110.36	5085.66	7053.60
Part in GDP – %	5.3	5.6	6.2	6.5	7.0	8.5

Note: *gross domestic product by production approach, current prices.
Source: Statistics Lithuania, 2012. Gross value added and GDP by production approach by statistical indicators, economic activity (NACE 2).

Table 6. Gross value added of construction in GDP (2007–2012).

Indicators	2007	2008	2009	2010	2011	2012
GDP* – LTL billion	99229.29	111920.1	92032.4	95675.98	106893.4	113471.5
Construction – LTL billion	10001.45	11261.31	5486.79	5047.02	6244.32	6131.44
Part in GDP – %	10.1	10.1	6.0	5.3	5.8	5.4

Note: *gross domestic product by production approach, current prices.
Source: Statistics Lithuania, 2012. Gross value added and gross domestic product by production approach by statistical indicators, economic activity (NACE 2).

In order to determine the extent to which construction companies are already prepared for the year 2020, employers were asked the following questions in the survey:

- How do you assess the preparedness of the company's blue-collar workers for the construction of energy efficient buildings?
- How do you assess the preparedness of the company's blue-collar workers for the use of renewable energy source technologies?

The survey results revealed that only about 40% of the company's blue-collar workers are prepared for the construction of energy efficient buildings (Figure 1). It means that additional learning is required for about 60% of the construction company workers, related to the construction of buildings, in the target group.

The number of those well prepared for the use of renewable energy source technologies is about 30% (Figure 2). It means that additional learning is required for about 70% of the construction company blue-collar workforce, related to the use of renewable energy technologies, in the target group.

The prediction of need for workers in the construction sector up to the year 2020 has been made by expert assessment of work extents and labour costs demand

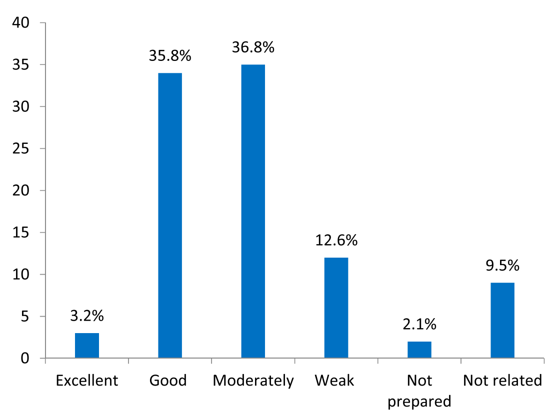


Figure 1. The readiness of company blue-collar workers for the construction of energy efficient buildings.
Source: Created by the authors.

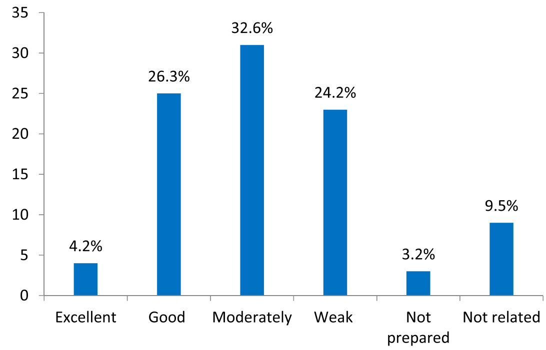


Figure 2. The readiness of company blue-collar workers for the use of renewable energy technologies.
Source: Created by the authors.

(Vaitkevičius, 2012). In carrying out the Forecasting estimates the building project's characteristic for each building's purpose were analysed. For the work planned in main projects, in the normative way (according to the cost ratios of work materials and machinery) the demand of labour costs was calculated in man hours and the annual demand for the blue-collar workforce of main professions was estimated. Estimates of work extents and labour cost demands are carried out with the assumption that the country's construction sector is dominated by the buildings according to the building purpose indicated in Table 7.

After assessing the results of employers and educational institutions survey, as well as the structure of buildings under construction, the following priority occupations in the construction sector were determined:

- Installers of prefabricated structures (Occ1)
- Joiners, carpenters (Occ2)
- Roofers (Occ3)
- Plumbers (Occ4)
- Welders (Occ5)
- Electricians (Occ6)
- Painters (Occ7)
- Plasterers (Occ8)

Table 7. Buildings' weighting by the purpose of building (per cent).

	Residential buildings	Office buildings	Industrial buildings	Commercial buildings	Engineering utility networks	Sewage disposal networks	Roads and streets	All structures
2012 – 2014 *	9.7	10.9	15.6	6.9	29.1	9.9	17.9	100
2015 – 2020 **	10.6	10.2	15.8	6.7	29.5	10.0	17.2	100

Notes: *Statistics of 2012 – 2014 from Official Statistics Portal, Statistics Lithuania
**Figures according to expert forecasts.
Source: Vaitkevičius (2012).

Table 8. The prediction of annual scope of construction work according to the projections of Lithuanian Economic Indicators (LTL million).

	Pessimistic scenario with annual growth 2,5%*	Most likely scenario with annual growth 3,0%*	Optimistic scenario with annual growth 4,0%*
2015	7628.0	7740.0	7968.0
2018	8215.0	8457.0	8963.0
2020	8630.0	8973.0	9694.0

Note: *The annual growth scenarious of Lithuanian Economic Indicators were taken from the Evaluation of the impact of the EU structural funds on the economy, economic growth forecasts till the year 2020, see: www.esparama.lt/
Source: Authors‘ calculations.

- Tilers (Occ9)
- Facade installers, thermal insulation installers (Occ10)
- Bricklayers (Occ11)
- Locksmiths (Occ12)
- Concrete workers (Occ13)
- Heating system installers (Occ14)
- Engineering equipment installer (Occ15)
- Finishers (Occ16)
- Roadwork workers (Occ17)
- Auxiliary workers (Occ18)

The annual demand for the blue-collar workforce in construction was calculated according to three scenarios, i.e. the pessimistic, the most likely and the optimistic. It was assumed that in the pessimistic scenario, the scope of work will grow by 2.5% every year, in the most likely scenario, 3% and in case of optimistic assumptions, 4% every year. These three forecasting scenarios were distinguished according to the estimated construction volume growth. The expert assessment until 2020 of the quantitative growth of the basic professions of blue-collar workforce and structural changes in occupations was prepared after considering the construction development trends, the forecasted scope of work, as well as the changes in the ongoing structure of work directly related to the implementation of innovative solutions and advanced methods in construction.

For the estimates of demand for workers, the annual domestic construction volume in million litas excluding VAT, including new construction, reconstruction, repair and other works, also the construction work carried out outside the country on own facilities, was assumed (Table 8).

The annual predicted demand for the blue-collar workforce in construction calculated according to three scenarios, i.e. the pessimistic, the most likely and the optimistic,

Table 9. The annual predicted demand for blue collar workers in construction.

	Optimistic scenario	Most likely scenario	Pessimistic scenario
2015	62,256	63,170	65,031
2018	67,047	69,030	73,152
2020	70,434	73,233	79,118

Source: Authors‘ calculations.

Table 10. The predicted demand for blue collar workers for all scenarios made by expert assessment (PS – pessimistic scenario; LS – most likely scenario; OS – optimistic scenario).

	Year														
	2012			2013			2015			2018			2020		
Occupations	PS	LS	OS	PS	LS	OS	PS	LS	OS	PS	LS	OS	PS	LS	OS
Occ1	6,004	6,004	6,004	6,154	6,184	6,245	6,489	6,584	6,778	6,988	7,195	7,624	7,341	7,633	8,246
Occ2	3,184	3,184	3,184	3,263	3,279	3,311	3,502	3,554	3,658	3,772	3,883	4,115	3,962	4,120	4,451
Occ3	1,278	1,278	1,278	1,310	1,317	1,330	1,441	1,463	1,506	1,552	1,598	1,694	1,631	1,696	1,832
Occ4	7,884	7,884	7,884	8,081	8,120	8,200	8,598	8,725	8,982	9,260	9,534	10,103	9,728	10,114	10,927
Occ5	1,460	1,460	1,460	1,496	1,504	1,518	1,585	1,608	1,656	1,707	1,757	1,862	1,793	1,864	2,014
Occ6	6,362	6,362	6,362	6,521	6,553	6,617	6,914	7,016	7,222	7,446	7,666	8,124	7,822	8,133	8,787
Occ7	2,060	2,060	2,060	2,111	2,121	2,142	2,227	2,260	2,326	2,398	2,469	2,617	2,520	2,620	2,830
Occ8	1,492	1,492	1,492	1,529	1,536	1,551	1,628	1,652	1,701	1,753	1,805	1,913	1,842	1,915	2,069
Occ9	1,444	1,444	1,444	1,480	1,487	1,502	1,574	1,597	1,644	1,695	1,745	1,849	1,780	1,851	2,000
Occ10	3,196	3,196	3,196	3,276	3,292	3,324	3,461	3,512	3,615	3,727	3,838	4,067	3,916	4,071	4,398
Occ11	2,058	2,058	2,058	2,109	2,120	2,141	2,295	2,329	2,398	2,472	2,545	2,697	2,597	2,700	2,917
Occ12	638	638	638	653	657	663	682	692	712	734	756	801	771	802	866
Occ13	5,039	5,039	5,039	5,165	5,190	5,241	5,451	5,531	5,694	5,871	6,044	6,405	6,167	6,412	6,928
Occ14	1,199	1,199	1,199	1,229	1,235	1,247	1,309	1,328	1,368	1,410	1,452	1,538	1,481	1,540	1,664
Occ15	6,042	6,042	6,042	6,193	6,223	6,284	6,566	6,662	6,858	7,071	7,280	7,715	7,428	7,723	8,344
Occ16	608	608	608	623	626	632	648	657	676	697	718	761	733	762	823
Occ17	2,986	2,986	2,986	3,061	3,076	3,106	3,090	3,136	3,228	3,328	3,427	3,631	3,496	3,635	3,927
Occ18	4,443	4,443	4,443	4,554	4,577	4,621	4,795	4,866	5,009	5,164	5,317	5,634	5,425	5,641	6,094
TOTAL	57,375	57,375	57,375	58,809	59,097	59,676	62,256	63,170	65,031	67,047	69,030	73,152	70,434	73,233	79,118

Source: Authors‘ calculations.

Table 11. Expert assessment of annual demand for workers in construction (all occupations).

	Pessimistic scenario	Most likely scenario	Optimistic scenario
2012	57,375	57,375	57,375
2013	58,809	59,097	59,676
2014	60,541	61,131	63,323
2015	62,256	63,170	65,031
2016	63,799	65,051	67,618
2017	65,441	67,052	70,377
2018	67,047	69,030	73,152
2019	68,751	71,134	76,116
2020	70,434	73,233	79,118

Source: Authors' calculations.

Table 12. Expert assessment of annual increase in demand for workers up to 2020.

	Pessimistic scenario	Most likely scenario	Optimistic scenario
2013	1,434	1,722	2,301
2014	1,732	2,034	3,647
2015	1,715	2,039	1,708
2016	1,543	1,881	2,587
2017	1,642	2,001	2,759
2018	1,606	1,978	2,775
2019	1,704	2,104	2,964
2020	1,683	2,099	3,002
Total	13,059	15,858	21,743

Source: Authors' calculations.

provided by experts presented in Table 9. Table 10 provides the annual predicted demand for the blue-collar workforce in construction by occupation.

Expert evaluation results (see Tables 11–13) show that by the year 2020 according to the optimistic scenario 39,613 workers will need additional training, according to the most likely scenario, 36,676 workers, and in the pessimistic scenario 35,277 workers will need additional training.

The prediction of annual numbers of blue-collar workers in the construction sector using the mathematical forecasting model

In our case, for the prediction of the demand for construction workers until 2020, the historical data for the period 1990–2010 was not suitable for the construction of mathematical models that adequately describe the data for the observed period. In the period of transition to a market economy, facing a crisis in the economy, the emergence of new professions and the disappearance of previous professions, the prediction of the demand for workers could only be performed by qualified experts. They were asked to specify what they think the expected value for the five year planning period would be. It was necessary to specify the 'pessimistic', the 'most realistic' and 'optimistic' forecasts. One of the various possible mathematical relationships more adequately describing the assessment of experts is the parabola $y = a_0 + a_1x + a_2x^2$. The application of parabolic model resulted less mean square error (S_y) (see formula (1)) than other applied

Table 13. Expert assessment of annual number of workers to be trained.

	Pessimistic scenario	Most likely scenario	Optimistic scenario
2013	7,366	7,402	7,473
2014	9,098	9,436	11,120
2015	9,081	9,441	9,181
2016	8,909	9,283	10,060
2017	9,008	9,403	10,232
2018	8,972	9,380	10,248
2019	9,070	9,506	10,437
2020	9,049	9,501	10,475
2012 – 2020	70,553	73,352	79,226
50% of predicted number to be trained*	35,277	36,676	39,613

*assumption made based on survey results.
Source: Authors' calculations.

Table 14. Mathematical forecast of blue collar workers demand in construction sector (2012 base year).

Occupations		Year							
		2012	…	2015	2016	2017	2018	2019	2020
Joiners, carpenters (Occ2)	PS	3,184	…	3,488	3,587	3,684	3,779	3,871	3,960
	LS	3,184	…	3,539	3,658	3,775	3,891	4,005	4,118
	OS	3,184	…	3,643	3,802	3,962	4,123	4,285	4,449
Roofers (Occ3)	PS	1,278	…	1,428	1,475	1,518	1,558	1,595	1,629
	LS	1,278	…	1,450	1,504	1,556	1,605	1,651	1,694
	OS	1,278	…	1,493	1,564	1,633	1,700	1,766	1,830
Plumbers (Occ4)	PS	7,884	…	8,577	8,810	9,041	9,270	9,498	9,725
	LS	7,884	…	8,704	8,983	9,263	9,545	9,827	10,110
	OS	7,884	…	8,960	9,337	9,723	10,115	10,515	10,923
Welders (Occ5)	PS	1,460	…	1,582	1,624	1,666	1,708	1,750	1,793
	LS	1,460	…	1,606	1,656	1,707	1,758	1,811	1,864
	OS	1,460	…	1,653	1,721	1,792	1,864	1,938	2,013
Electricians (Occ6)	PS	6,362	…	6,902	7,085	7,268	7,452	7,636	7,820
	LS	6,362	…	7,003	7,224	7,447	7,673	7,901	8,131
	OS	6,362	…	7,209	7,509	7,816	8,131	8,454	8,784
Facade installers, thermal insulators (Occ10)	PS	3,196	…	3,457	3,547	3,637	3,729	3,822	3,915
	LS	3,196	…	3,508	3,617	3,727	3,840	3,954	4,070
	OS	3,196	…	3,611	3,759	3,912	4,069	4,231	4,397
Engineering equipment installer (Occ15)	PS	6,042	…	6,555	6,728	6,902	7,077	7,251	7,426
	LS	6,042	…	6,650	6,860	7,072	7,286	7,502	7,721
	OS	6,042	…	6,846	7,131	7,423	7,722	8,028	8,342
…	…	…	…	…	…	…	…	…	…
Total	PS	57,372	…	62,164	63,698	65,438	67,090	68,749	70,419
	LS	57,372	…	63,078	65,042	67,051	69,080	70,835	73,216
	OS	57,372	…	64,930	67,616	70,176	73,206	76,115	79,096

Source: Authors‘ calculations.

Table 15. Increase in annual demand for workers (2013-2020).

	Pessimistic scenario	Most likely scenario	Optimistic scenario
2013	1,547	1,867	2,415
2014	1,622	1,894	2,539
2015	1,623	1,945	2,604
2016	1,534	1,964	2,686
2017	1,740	2,009	2,560
2018	1,652	2,029	3,030
2019	1,659	1,755	2,909
2020	1,670	2,381	2,981
Total	13,047	15,844	21,724

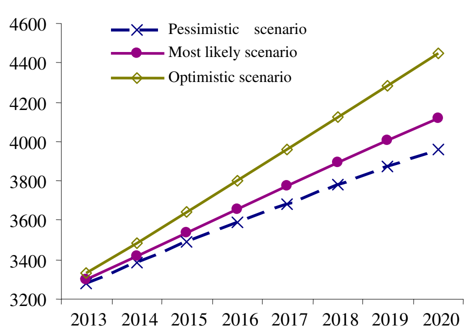
Source: Authors‘ calculations.

mathematical models (linear regression, logarithmic, hyperbolic, and exponential models). Further calculations show that the results of the applied parabolic model (Table 14) are more consistent and coincide with the experts' assessments (Table 10). Therefore we only use the results of the parabolic model for the illustration of forecasting results of the annual number of blue-collar workers in the construction sector (Tables 14–16). Tables 14–16 present the forecasts of demand for only most demanded occupations in construction.

The example diagram functions of the mathematical models used to forecast the demand of workers employed in the construction sector are presented in Figures 3 and 4. Similarly, the predictive functions were calculated for all other occupations from target group. Figures 3 and 4 present the prognostic features for the roofers and joiners/carpenters occupational group.

Forecasted annual demand for blue-collar workers until 2020 by occupation are presented in Table 14 and illustrated in Figure 5.

The results of the revised forecast by a mathematical model shows that by the year 2020, according to the pessimistic scenario 35,210 workers will need additional training, according to most likely scenario, 36,608 workers, and in to the optimistic scenario,



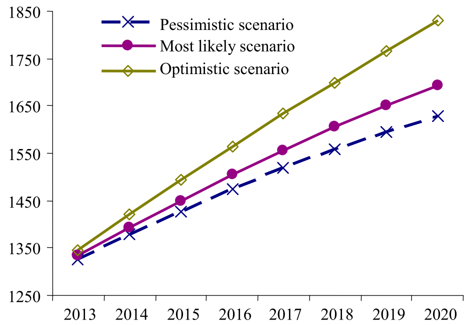
$$Y_{PS}=3065.37 + 110.65\,t-1.25\,t^2$$
$$Y_{LS}=3050.61 +125.03\,t-0.72\,t^2$$
$$Y_{OS}=3021.39+152.94\,t + 0.63\,t^2$$

Figure 3. Diagrams and functions of prognostic features for joiners/carpenters.
Source: Created by the authors.

Table 16. Forecasted annual number of blue collar workers to be trained (results of mathematical forecast).

	Pessimistic scenario	Most likely scenario	Optimistic scenario
2013	7,365	7,405	7,473
2014	8,987	9,299	10,012
2015	8,988	9,350	10,077
2016	8,899	9,369	10,159
2017	9,105	9,414	10,033
2018	9,017	9,434	10,503
2019	9,024	9,160	10,382
2020	9,035	9,786	10,454
Total 2013–2020	70,419	73,216	79,096
50% of predicted number to be trained*	35,210	36,608	39,548

*assumption made based on survey results.
Source: Authors‘ calculations.



$$Y_{PS}=1211.08 + 60.68\,t - 1.58\,t^2$$
$$Y_{LS}=1204.77 + 66.94\,t - 1.40\,t^2$$
$$Y_{OS}=1192.27 + 78.75\,t - 0.88\,t^2$$

Figure 4. Diagrams and functions of prognostic features for roofers.
Source: Created by the authors.

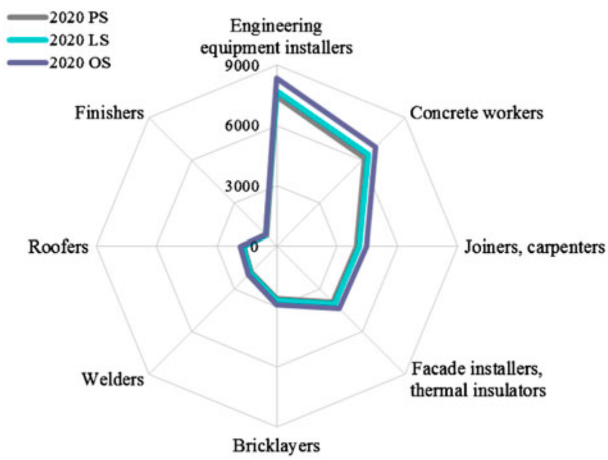


Figure 5. Distrubution of demanded occupations in the construction sector (2020).
Source: Created by the authors.

39,548 workers will need additional training. How many workers will be trained each year will depend on many unpredictable factors and may not correspond to the forecasted numbers.

Conclusion

(1) The targets of the Energy Performance of Buildings Directive indicate that the construction sector will face some of the biggest challenges – to start the construction of nearly zero-energy buildings. In order to implement new technologies and organise the work flexibly, the blue-collar workforce in the construction sector will need new skills and knowledge. This is especially

important in the training of employees for the construction of nearly zero-energy buildings, regardless of whether the work will be related to new or renovated buildings.

(2) The forecasts provided in this article for blue-collar worker demand by 2020 in the construction industry and the number of construction workers who should be up-skilled or have extra training to be able to build energy efficient buildings and to install the renewable energy systems were based on expert assessment and mathematical model.

(3) The forecasting process was complicated due to the lack of proper historical data suitable for the construction of mathematical models. The historical data needed for forecasting covered the period of transition to a market economy (1990–2010), facing a crisis in the economy, the emergence of new professions and the disappearance of the previous professions, therefore the decision was made to involve qualified experts for the primary prediction of the demand for workers. The results have shown the significant coincidence between both the expert assessment and the figures of the applied mathematical model.

(4) The annual demand for the blue-collar workforce in construction was determined according to three scenarios: the pessimistic, the most likely and the optimistic. These three forecasting scenarios were decided according different factors having significant impact on employment in the construction sector.

(5) The extent to which construction companies are already prepared for the year 2020 was also determined by questioning the employers in the survey. These figures were used in prediction of the number of construction workers who should be up-skilled or have extra training. Expert evaluation and results mathematical model indicated that by the year 2020 up to 39,000 workers can be trained.

(6) An assessment presented on paper could serve as a guideline for the planning of worker trainings and other related initiatives in the construction sector by 2020.

(7) Since most of the construction workers must pass extra training, formal and non-formal continuing education need to respond to the potential increase in demand for training and should be prepared. This means training programmes need to be updated, supplemented by appropriate topics covering necessary knowledge and skills, training facilities upgraded, teachers to be prepared (if necessary, trained additionally). Only then can the retraining of workers be started.

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Notes

1. The Directive 2010/31/EC of the European Parliament and of the Council of 19 May 2010 on the energy efficiency of buildings.
2. More information on the relevant provisions can be found In paragraph 2 of article 2 and in article 9 of the Directive 2010/31/EC.
3. CEDEFOP – European Centre for the Development of Vocational Training, http://www.cedefop.europa.eu/.
4. Evaluation of the impact of the EU structural funds on the economy, economic growth forecasts till the year 2020, www.esparama.lt/.

References

Brauers, W. K. M., Ginevičius, R., & Podvezko, V. (2010). Regional development in Lithuania considering multiple objectives by the MOORA method. *Technological and Economic Development of Economy*, *16*, 613–640. http://dx.doi.org/10.3846/tede.2010.38

Catik, F. N., & Karacuka, M. (2012). A comparative analysis of alternative univariate time series models in forecasting Turkish inflation. *Journal of Business Economics and Management, 13*, 275–293.

Chen, H. L., Chen, W. T., & Wei, N.-C. (2011). Development a cost-payment coordination model for project cost flow forecasting. *Journal of Civil Engineering and Management, 17*, 494–509.

Danese, P., & Kalchschmidt, M. (2011). The role of the forecasting process in improving forecast accuracy and operational performance. *International Journal of Production Economics, 131*, 204–214.

Davydenko, A., & Fildes, R. (2013). Measuring forecasting accuracy: The case of judgmental adjustments to SKU-level demand forecasts. *International Journal of Forecasting, 29*, 510–522.

The Directive 2010/31/EC of the European Parliament and of the Council of 19 May 2010 on the energy efficiency of buildings.

Evaluation of the impact of the EU structural funds on the economy, economic growth forecasts till the year 2020. Retrieved December 12, 2012, from www.esparama.lt/

European Centre for the Development of Vocational Training (CEDEFOP) (2012). Future skills supply and demand in Europe. Forecast 2012. Research paper No 26. Luxembourg: Publications Office of the European Union, [online], [cited 17 September 2013]. Retrieved from http://www.cedefop.europa.eu/doi:10.2801/93487

Ginevičius, R., & Podvezko, V. (2008). Multicriteria graphical-analytical evaluation of the financial state of construction enterprises. *Technological and Economic Development of Economy, 14*, 452–461.

Ginevičius, R., & Podviezko, A. (2013). The evaluation of financial stability and soundness of Lithuanian banks. *Economic Research-Ekonomska Istraživanja, 26*, 515–535.

Gudienė, N., Banaitis, A., Podvezko, V., & Banaitienė, N. (2014). Identification and evaluation of the critical success factors for construction projects in Lithuania: AHP approach. *Journal of Civil Engineering and Management, 20*, 350–359. Retrieved from http://dx.doi.org/10.3846/13923730.2014.914082

Gupta, R., Ye, Y., & Saco, C. M. (2013). Financial variables and the out-of-sample forecastability of the growth rate of Indian industrial production. *Technological and Economic Development of Economy, 19*(Suppl. 1), 583–599.

Hwang, B.-G., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management, 31*, 272–284.

Ibrahim, K. I., Costello, S. B., & Wilkinson, S. (2013). Key practice indicators of team integration in construction projects: A review. *Team Performance Management: An International Journal, 19*, 132–152. Retrieved from http://dx.doi.org/10.1108/TPM-10-2012-0033

Jakovac, P. (2013). Empirical analysis on economic growth and energy consumption relationship in Croatia. *Economic Research-Ekonomska Istraživanja, 26*, 21–42.

Jurčević, B., & Mihelja Žaja, M. (2013). Banks and insurance companies' efficiency indicators in the period of financial crisis: The case of the Republic of Croatia. *Economic Research-Ekonomska Istraživanja, 26*, 203–224.

Mahmud, M., & Mirza, N. (2011). Volatility dynamics in an emerging economy: Case of Karachi stock exchange. *Economic Research-Ekonomska Istraživanja, 24*, 51–64.

Makridakis, S., Hogarth, R. M., & Gaba, A. (2009). Forecasting and uncertainty in the economic and business world. *International Journal of Forecasting, 25*, 794–812.
Nazarko, J., & Kononiuk, A. (2013). The critical analysis of scenario construction in the Polish foresight initiatives. *Technological and Economic Development of Economy, 19*, 510–532.
Projections of Lithuanian Economic Indicators. (2013, September 10). The Ministry of Finance of the Republic of Lithuania. 2013. Retrieved October 10, 2013, from http://www.finmin.lt/
Ross, A., Dalton, K., & Sertyesilisik, B. (2013). An investigation on the improvement of construction expenditure forecasting. *Journal of Civil Engineering and Management, 19*, 759–771.
Škare, M., & Stjepanović, S. (2013). A fractionally integrated model for the Croatian aggregate output (GDP) series. *Economic Research-Ekonomska Istraživanja, 26*, 289–330.
Vaitkevičius, A. (2012). *Forecasts of the demand of workers professions in the construction sector for 2020*. Vilnius: Sistela.
Yazdani-Chamzini, A., Yakhchali, S. H., Volungevičienė, D., & Zavadskas, E. K. (2012). Forecasting gold price changes by using adaptive network fuzzy inference system. *Journal of Business Economics and Management, 13*, 994–1010.
Zavadskas, E. K., Vilutienė, T., Turskis, Z., & Šaparauskas, J. (2014). Multi-criteria analysis of projects' performance in construction. *Archives of Civil and Mechanical Engineering, 14*, 114–121.