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COPRAS BASED COMPARATIVE ANALYSIS OF THE EUROPEAN COUNTRY MANAGEMENT CAPABILITIES WITHIN THE CONSTRUCTION SECTOR IN THE TIME OF CRISIS

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Abstract. Construction industry and its impact on the national economy in different countries had been investigated. In general, it can be noted that development trends of the construction industry is almost the same as the development trends of the whole country economy itself.

Efficiency level of the construction and real estate industries depends on the specific quantities of the variables within micro, meso and macro context. Although factors of the macro level influence the efficiency level of the whole economy this investigation analyses its influence on the efficiency of the construction industry. Efficiency of the construction industry operation depends on the complex impact of the macro level variable factors such as economic, political and cultural level of development, construction industry are effected by the regulating documents, market, taxation system, drawing possibilities and conditions, inflation, local resources etc. (Kaklauskas *et al.* 2011). Construction industry development possibilities vary according to the effect of macro level factors.

Crisis, spin up in 2008–2009, had differently affected the construction industry markets of the European Union countries. The general part of countries had faced the decrease of outputs, real estate transactions, and predictable reduction in employment of population and quantity of construction companies. Adverse conditions and huge deviations that had arisen due to the crisis encourage analysing the situation of the construction sector not only in the particular country but in other ones, it happens because of possibility to analyse the international experience and get the broader view of the construction sector issues and solve them correctly.

Procedure, presented in the issue, provide the possibility to detect the one of 23 European countries which possesses the most effective construction sector market development according to the criteria set. Countries undergo the multi-criteria evaluation applying COPRAS methods (Zavadskas and Kaklauskas 1996), evaluation criteria relevance is determined via entropy method. The first time using the entropy concept (Shannon and Weaver 1947; Shannon 1948) for maximizing the quantity of information contained in the dataset. The entropy is described as the casual value of the uncertainty which makes it more valuable in comparison with other factors.

Thus, the main goal of the work is to group investigated European countries applying the COPRAS method and evaluating six criteria, describing the construction sector.

In order to implement this goal, economy of the European Union countries, construction sectors, statistical economic data, valuables set according to the entropy method and priority of the European country construction sectors set by COPRAS method will be evaluated.

Keywords: economic, construction sector, criteria, entropy weight, COPRAS method, Europe

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1. Introduction

Strategically important construction sector includes designing of buildings, formation of the infrastructure connecting the whole economic sectors. This sector is named as the most important employer, it makes the great contribution to the common capital of European countries. Construction is one of the biggest industries in Europe it takes 10 percents of GDP and requires 50.5 percents of the capital investment. The construction sector employes over 12 millions of European citizens and involves 26 millions to the particular sphere of the construction industry DKM Economic Consultants (2010).

In comparison with other economic sectors the construction importance depends on the different factors. According to Kaklauskas *et al.* (2011) construction efficiency at most depends on certain number of variables at macro level and micro level. The costs of the ground area, design process, construction process, business competition, efficiency level of enterprises etc. are possibly at micro level. At macro level economic, politic, legal, technological, cultural and natural environments have an impact on the construction. Thus, construction sector depends on the set global and local factors which cause certain swings in the economic activity both in construction and other industrial branches.

You can notice that the relationship between construction section and economy was studied by lots of scientists (Giang and Pheng 2010; Pellicer *et al.* 2009; Khan 2008; Wigrena and Wilhelmsson 2007; Chiang *et al*. 2006; You and Zi 2007). For example, Pellicer *et al.* (2009) analyzed the effect of decay on the construction sector in terms of macroeconomics. Authors used regression model for study and forecast of the situation in construction sector. Chiang *et al.* (2006) used the tables of the model "input-output (i-o)" for study of the construction sector in macroeconomics terms. This model is efficient instrument for determination of effect of macroeconomic factors on the construction and construction forecasting. Giang and Pheng (2010) carried out theoretical study of construction role on the economy in accordance with three scenario: (a) Infrastructure is adequate for economic growth when the infrastructure is built ahead, then the business activities of other goods and services that the infrastructure helps create come into place; (b) Infrastructure becomes excessive when the infrastructure is constructed ahead as planned, but then an unexpected economic downturn occurs; and (c) Infrastructure is inadequate to support economic growth when there is an unexpected economic upturn. Khan *et al.* (2008) analyzed the relation between construction sector and GDP (gross domestic product) in 1950–2005. In Pakistan Granger causality test is used (Granger and Newbold 1974). To calculate the reliability of relations and results the Unit Root tests based on time series and Co-integration test were applied. Economic time series – is sequential array of the values of economic variables. Weekly, monthly, annual indexes of productions, costs, income, population size, labour power, gross domestic product (GDP) are examples of economic time series. Obtained results of the investigations show that there is a strong causal relation between economy and construction sector. Two types of econometric models (cointegration and error correction) were applied by Wigren and Wilhelmsson for investigations of construction market in the Western Europe (2007). After analyzing criteria characterized the construction sector of fourteen countries of the Western Europe it was concluded that investments in residential and

non-residential building construction or in construction of other buildings have both direct and indirect impacts on economic growth. These investigations also detected that there is a strong relationship between infrastructure and economic productivity, particularly residential building construction has a long-term effect on the economic growth. You and Zi (2007) analyzed the construction industry development in Korea (in 1996–2000) for various periods of the crisis using the method of data environment analysis (DEA). By this method some important factors which delay efficiently of construction enterprises in crisis period were determined. The European construction sector at micro level was investigated by Proverbs and Holf (2000), Proverbs *et al.* (1999). Chateau (2007), Mymrin and Correa (2007), Knoepfel (1992) and other wrote about the market of construction products in Europe.

The European construction market is non-homogenous. The current situation of each member state and perspectives depend on state position taking into account needs, demographic trends, and main economic principles etc. Economic environment in the country affects directly on business. Economic environment is determined by the tax and financial resources policy, capital flow, investment environment, loaning and rate of interest implemented by state bodies. The situation depends also on when corrections of immovable property market were performed and economic openness of individual country for the impact of the financial and economic crisis. And finally it depends on what long-term measures of recovery will be selected and how successfully they will affect on the construction sector (Kaklauskas *et al.* 2010a). Certain industry branches are characterized by cyclical swing covered changes of production, work, and sales number. Among these branches there are such sectors as construction, steel industry, and aero industry. The ordinary swings of construction product values reach about 20 percent. It was noticed that cyclical swings in construction industry which appear as "booms" and recession are recurred (Kaklauskas *et al.* 2011).

Clear and reliable access to statistic data is very important while performing the monitoring of construction sector market. In this document collected data characterize the construction sector market of 23 European states in 2009. The data obtained from Eurostat (2010) and European Federation of Building and Woodworkers (2010) database demonstrate percent change of construction indexes in comparison with ones in 2008. The data describe six criteria affecting the market of the construction sector: GDP change, index of growth rate of buildings and all construction products, number of issued construction permits for new residential buildings, price index change for civil engineering products, price index change for new residential building construction, total employment in construction sector. 23 European countries, for which specific indexes were found, were selected for evaluation.

2. Determination of important entropy-based criteria

For achievement of the goal specified in this article, first of all the calculations were performed in order to determine criteria importance by entropy method. The initiator of the method (Shannon 1948) gave the following numerical expression of entropy method

(1) (quantity of information in dataset):

$$S = \frac{1}{N}\sum_{j} x_j \ln(x_j), \tag{1}$$

here S – entropy matrix, N – number of criteria, x_j – criteria value, j – criteria change limits ($j = 1...n$).

This method was applied for deciding construction issues (Zavadskas 1987) also in other fields (Liu and Zhang 2011; Mamtani *et al.* 2006; Li 2009; Ye 2010; Taheriyoun *et al.* 2010; Hsieh *et al.* 2010). The algorithm block diagram for entropy method is presented on Figure 1.

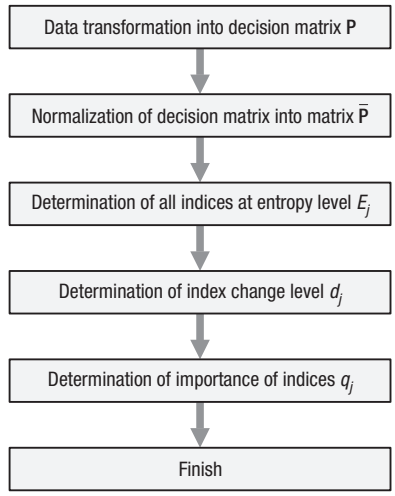

Fig. 1. The algorithm block diagram for the determination of important indices in accordance with entropy (Zavadskas and Kaklauskas 2007)

In this case the importance of indices is determined. Their importance demonstrantes what criteria are the most important in comprising with other criteria. For determining criteria importance, the indices are transformed in such a manner that maximum value of each criteria would be the best. While preparing initial data for multi-criteria evaluation by the alternative decision, first of all the list of criteria is made out. These criteria have an impact on the results of the most effective decision. Further in the article the following criteria will be analyzed:

- Growth rate of GDP volume
- Volume indices of production in all building and construction growth rates
- Index of building permits – number of dwellings, new residential buildings
- Index of production, civil engineering, growth rates
- Index of construction costs, new residential buildings
- Total Employment in construction sector

Initial criteria for evaluation of 23 European countries and data are presented in the Table 1.

Table 1. Criteria for evaluation of European states and statistic data

No.	Country	Growth rate of GDP volume – percentage change on previous year (%)	Volume indexes of production in all building and construction growth rates compared with previous period (%)	Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	Index of production, civil engineering, growth rates compared with previous period (%)	Index of construction costs, new residential buildings, gross, price changes (%)	Total Employment in construction sector, per cent variation on previous year (%)
		max	max	max	max	min	max
1	Austria	–3.9	–1.8	–9.3	–3.1	0.6	–1.1
2	Belgium	–2.8	–11	–13.2	–3.9	–1.1	–0.8
3	Bulgaria	–4.9	–70.3	–59.3	–2.3	10.9	–3.1
4	Cyprus	–1.7	–12.7	–17.1	9.0	0.8	–4.7
5	Czech Republic	–4.1	–0.5	–17.2	–2.9	–0.3	–7.6
6	Denmark	–5.2	–17.5	–51.7	–8.2	–0.4	–13.1
7	Estonia	–13.9	–35.6	–61.8	3.5	–8.5	–6.0
8	Finland	–8.2	–16.2	–1.5	–8.3	–1.1	–5.7
9	France	–2.6	–6.0	–18.5	–0.1	0.4	–2.0
10	Germany	–4.7	0.1	3.0	–3.3	0.1	0.3
11	Ireland	–7.6	–22.9	–40.1	–6.7	–9.9	–26.1
12	Lithuania	–14.7	–75.3	–52.6	–19.9	–14.5	–21.8
13	Netherlands	–3.9	–6.7	–16.7	0.4	0.3	–1.9
14	Portugal	–2.5	–5.9	–42.6	–5.0	–0.7	–8.8
15	Romania	–7.1	–30	–20.1	11.9	1.5	–9.0
16	Spain	–3.7	–9.2	–51.0	2.5	1.0	–24.9
17	Sweden	–5.3	–4.2	–11.1	–1.7	2.0	–4.2
18	Slovenia	–8.1	–33.1	–29.7	–5.9	–2.8	–2.3
19	United Kingdom	–4.9	–11.9	–24.0	13.6	–7.5	–12.2
20	Greece	–2.3	–16.1	–25.5	–12.7	–0.3	–2.6
21	Latvia	–18.0	–43.7	–40.2	–0.5	–6.2	–3.6
22	Hungary	–6.7	–3.5	–34.0	–6.0	3.0	–19.1
23	Poland	1.7	6.6	–23.6	–1.2	0.2	3.6

The values of analyzing criteria for each country are transformed by formula (2), thus the initial matrix without negative values are obtained:

$$x_{ij} = \frac{100 + x_{ij}^*}{100}, \quad (2)$$

here x_{ij}* – criteria values with negative values, x_{ij} – criteria values without negative values

Data obtained by formula (2) are given in the Table 2.

Table 2. The initial matrix without negative values **P**

No.	Country	Growth rate of GDP volume – percentage change on previous year	Volume indicies of production in all building and construction growth rates compared with previous period (%)	Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	Index of construction costs, new residential buildings, gross, price changes (%)	Total Employment in construction sector, per cent variation on previous year
		max	max	max	max	min	max
1	2	3	4	5	6	7	8
1	Austria	0.961	0.982	0.907	0.969	1.006	0.989
2	Belgium	0.972	0.89	0.868	0.961	0.989	0.992
3	Bulgaria	0.951	0.297	0.407	0.977	1.109	0.969
4	Cyprus	0.983	0.873	0.829	1.09	1.008	0.953
5	Czech Republic	0.959	0.995	0.828	0.971	0.997	0.924
6	Denmark	0.948	0.825	0.483	0.918	0.996	0.869
7	Estonia	0.861	0.644	0.382	1.035	0.915	0.94
8	Finland	0.918	0.838	0.985	0.917	0.989	0.943
9	France	0.974	0.94	0.815	0.999	1.004	0.98
10	Germany	0.953	1.001	1.03	0.967	1.001	1.003
11	Ireland	0.924	0.771	0.599	0.933	0.901	0.739
12	Lithuania	0.853	0.247	0.474	0.801	0.855	0.782
13	Netherlands	0.961	0.933	0.833	1.004	1.003	0.981
14	Portugal	0.975	0.941	0.574	0.95	0.993	0.912
15	Romania	0.929	0.7	0.799	1.119	1.015	0.91
16	Spain	0.963	0.908	0.49	1.025	1.01	0.751

End of Table 2

1	2	3	4	5	6	7	8
17	Sweden	0.947	0.958	0.889	0.983	1.02	0.959
18	Slovenia	0.919	0.669	0.703	0.941	0.972	0.977
19	United Kingdom	0.951	0.881	0.76	1.136	0.925	0.878
20	Greece	0.977	0.839	0.745	0.873	0.997	0.974
21	Latvia	0.82	0.563	0.598	0.995	0.938	0.964
22	Hungary	0.933	0.965	0.66	0.94	1.03	0.809
23	Poland	1.017	1.066	0.764	0.988	0.988	1.039

Further the normalization of the initial matrix (table 2) was performed applying formula (3) and (4):

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}}; \tag{3}$$

$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}}. \tag{4}$$

The every element of decision matrix is divisible by sum of components from the column where it is located. Thus obtained matrix $\mathbf{P_1}$.

Table 3. The initial matrix without negative values $\mathbf{P_1}$

No.	Country	Growth rate of GDP volume – percentage change on previous year	Volume indicies of production in all building and construction growth rates compared with previous period (%)	Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	Index of construction costs, new residential buildings, gross, price changes (%)	Total Employment in construction sector, per cent variation on previous year
		max	max	max	max	min	max
1	2	3	4	5	6	7	8
1	Austria	0.944	0.921	0.881	0.853	0.850	0.955
2	Belgium	0.956	0.835	0.843	0.846	0.865	0.958
3	Bulgaria	0.935	0.279	0.395	0.860	0.771	0.935
4	Cyprus	0.967	0.819	0.805	0.960	0.848	0.920

End of Table 3

1	2	3	4	5	6	7	8
5	Czech Republic	0.943	0.933	0.804	0.855	0.858	0.892
6	Denmark	0.932	0.774	0.469	0.808	0.858	0.839
7	Estonia	0.847	0.604	0.371	0.911	0.934	0.907
8	Finland	0.902	0.786	0.956	0.807	0.865	0.910
9	France	0.958	0.882	0.791	0.979	0.852	0.946
10	Germany	0.937	0.939	1.000	0.851	0.854	0.968
11	Ireland	0.909	0.723	0.582	0.821	0.949	0.713
12	Lithuania	0.839	0.232	0.46	0.715	1.000	0.755
13	Netherlands	0.945	0.875	0.809	0.884	0.852	0.947
14	Portugal	0.959	0.883	0.557	0.836	0.861	0.880
15	Romania	0.914	0.657	0.776	0.985	0.842	0.788
16	Spain	0.947	0.852	0.476	0.902	0.843	0.725
17	Sweden	0.931	0.899	0.806	0.865	0.838	0.923
18	Slovenia	0.904	0.628	0.683	0.828	0.880	0.931
19	United Kingdom	0.935	0.827	0.738	1.000	0.924	0.848
20	Greece	0.961	0.787	0.723	0.768	0.858	0.94
21	Latvia	0.806	0.528	0.581	0.876	0.912	0.931
22	Hungary	0.917	0.905	0.641	0.828	0.830	0.781
23	Poland	1.000	1.000	0.742	0.870	0.853	1.000

While transferring decision matrix the indices are determined by formula (5):

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, \quad (\forall ij, i = \overline{1,m};\ j = \overline{1,n}), \tag{5}$$

here p_{ij} – matrix indices, x_{ij} – criteria values.

Criteria obtained by formula (2) are divisible by criteria sum of each column and the final criteria matrix is obtained $\mathbf{P}$.

Table 4. Decision matrix $\overline{\mathbf{P}}$

No.	Country	Growth rate of GDP volume – percentage change on previous year	Volume indicies of production in all building and construction growth rates compared with previous period (%)	Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	Index of construction costs, new residential buildings, gross, price changes (%)	Total Employment in construction sector, per cent variation on previous year
		max	max	max	max	min	max
1	2	3	4	5	6	7	8
1	Austria	0.044	0.052	0.055	0.041	0.043	0.047
2	Belgium	0.049	0.048	0.053	0.046	0.043	0.047
3	Bulgaria	0.044	0.016	0.025	0.041	0.039	0.046
4	Cyprus	0.045	0.047	0.051	0.044	0.042	0.045
5	Czech Republic	0.044	0.053	0.05	0.043	0.043	0.044
6	Denmark	0.044	0.044	0.029	0.041	0.043	0.041
7	Estonia	0.040	0.034	0.023	0.046	0.047	0.044
8	Finland	0.042	0.045	0.06	0.041	0.043	0.044
9	France	0.045	0.05	0.05	0.044	0.043	0.046
10	Germany	0.044	0.054	0.063	0.043	0.043	0.047
11	Ireland	0.043	0.041	0.037	0.042	0.047	0.035
12	Lithuania	0.039	0.043	0.029	0.036	0.05	0.037
13	Netherlands	0.044	0.05	0.051	0.045	0.043	0.046
14	Portugal	0.045	0.05	0.035	0.042	0.043	0.043
15	Romania	0.043	0.037	0.049	0.05	0.042	0.043
16	Spain	0.045	0.049	0.03	0.046	0.042	0.035
17	Sweden	0.044	0.051	0.054	0.044	0.042	0.045
18	Slovenia	0.042	0.036	0.043	0.042	0.044	0.046
19	United Kingdom	0.044	0.047	0.046	0.051	0.046	0.041
20	Greece	0.045	0.045	0.045	0.039	0.043	0.046
21	Latvia	0.038	0.03	0.036	0.044	0.046	0.045
22	Hungary	0.043	0.052	0.042	0.042	0.042	0.038
23	Poland	0.047	0.057	0.044	0.044	0.043	0.048

The determination of entropy level for each criteria E_j:

$$Ej = -k\sum_{i=1}^{m} p_{ij} \ln p_{ij}, \quad (i = \overline{1,m};\ j = \overline{1,n}), \tag{6}$$

here $k = 1{:}\ln m$.

As is known, entropy index varies [1,0] by interval, so

$$0 \le E_j \le 1, \ (j = \overline{1,n}), \tag{7}$$

j – index change level in current tasks is determined:

$$d_j = 1 - E_j, \ (j = \overline{1,n}). \tag{8}$$

If all criteria are equally important i.e. there are no subjective or expert evaluations of their values, criteria importance is determined by formula:

$$q_{ij} = \frac{d_j}{\sum_{j=1}^{n} d_j}, \quad (j = \overline{1,n}). \tag{9}$$

Table 5. Entropy level, j index change level and criteria importance

Criteria	Growth rate of GDP volume – percentage change on previous year	Volume indicies of production in all building and construction growth rates compared with previous period (%)	Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	Index of construction costs, new residential buildings, gross, price changes (%)	Total Employment in construction sector, per cent variation on previous year
	max	max	max	max	min	max
E_j	0.99987	0.98774	0.98964	0.99935	0.99979	0.99897
d_j	0.00013	0.01226	0.01036	0.00065	0.00021	0.00103
q_i	0.0053	0.4975	0.4205	0.0264	0.0085	0.0418

After determination of criteria importance the priority order for considered criteria can be specified:

1. Volume indices of production in all building and construction growth rates.
2. Index of building permits – number of dwellings, new residential buildings..
3. Total Employment in construction sector.
4. Index of production, civil engineering.
5. Index of construction costs, new residential buildings.
6. Growth rate of GDP volume.

In order to evaluate the priority of each European country according to these criteria, COPRAS method is applied.

3. The determination of priority and importance of considered alternatives by COPRAS method

In 1996 COPRAS (Complex Proportional Assessment) method was created (Zavadskas and Kaklauskas 1996). In Lithuania this method is applied in construction, economy, immovable property and management. Zavadskas *et al*. (2010) evaluates the risks in construction projects in one of articles. The evaluation is based on different multipurpose evaluation methods. Risks evaluation indices are selected taking into account interests, purposes and factors of countries which affect on the construction process efficiency and immovable property price increase. For describing and considering task model, TOPSIS grey and COPRAS-G methods are applied. In another article, using COPRAS, Zavadskas *et al.* (2009a) carried out the comparative analysis of the fifteen housing enterprises according to 44 criteria taking into account needs of building owners. Kaklauskas *et al.* (2006) performed significant investigation for Vilnius Gediminas Technical University in order to find the best contractors for the window replacement in the central building. The contractors the best corresponding with the needs of the University were selected from many criteria (heat conductivity, light transmission, lifetime, sound conductivity etc.). Also Kaklauskas *et al*. (2010b) performed complex analysis of Intelligent Built Environment and evaluated more than 50 criteria of described alternatives for which analysis and reception of results was used COPRAS method. The significant investigations in immovable property were performed by Kanapeckienė *et al.* (2010), Šliogerienė *et al.* (2009), Tupėnaitė *et al.* (2010) using COPRAS method.

Chatterjee *et al.* (2011), Karbassi *et al*. (2008), Mazumdar *et al.* (2010), Hofer (2009) carried out interesting investigations and made conclusions applying COPRAS method. In the article applying multipurpose evaluation, Chatterjee *et al.* (2011) studied the efficiency of selection of production materials using three methods: COPRAS, multicriteria decision-making (MCDA) and evaluation of mixed data (EVAMIX) and made the conclusions that COPRAS method is the most efficient and precise. Karbassi *et al.* (2008) used COPRAS method for investigations of energy efficiency of the building and provision of energy efficiency.

Under varied economic conditions, continuously increasing uncertainties for variety and size, at existence of competitive interactions and risks, it is more difficult to make decisions among set of alternatives therefore these multipurpose evaluation methods are very important and significant under current conditions. According to Zavadskas *et al.* (2009b), the objective function is directly-proportional depends on indices characterized their alternative of values and weight of those indices. The multipurpose analysis is appropriate for decisions on economy, management, structural and other tasks. In COPRAS method the alternatives are described by values of discrete indices.

In the table 5 the calculation results obtained by COPRAS method are given. Applying COPRAS method, the priority and importance of considered alternatives are calculated at four stages:

1 stage. The normed matrix D is formed. The purpose of this stage is to obtain from comparable indices nondimensional (normalized) evaluation values. If nondimensional

evaluation values are known, it may compare the all indices of different units of measurement. This formula is applied:

$$d_{ij} = \frac{x_{ij} q_{ij}}{\sum_{j=1}^{n} x_{ij}}, \quad (i = \overline{1,m};\ j = \overline{1,n}), \tag{10}$$

here x_{ij} – i criteria value j decision variant, m – number of criteria, n – number of comparative variants, q_i – i criteria importance.

The sum of obtained nondimensional evaluation values d_{ij} for each criteria x_i is always equal to the importance of this criteria q_i:

$$q_i = \sum_{j=1}^{n} d_{ij}, \ (i = \overline{1,m};\ j = \overline{1,n}). \tag{11}$$

2 stage. The sum of evaluated normalized minimizing S_{-j} and maximizing S_{+j} values characterized variant j is calculated. The calculations are performed by formula:

$$S_{+j} = \sum_{j=1}^{m} d_{+ij};\ \ S_{-j} = \sum_{j=1}^{m} d_{-ij}, \ (i = \overline{1,m};\ j = \overline{1,n}). \tag{12}$$

3 stage. The relative importance of comparative variants is determined by their characterized positive S_{+j} and negative S_{-j} features. The relative importance of each project Q_j is determined using the formula:

$$Q_j = S_{+j} + \frac{S_{-\min} \sum_{j=1}^{n} S_{-j}}{S_{-j} \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}}, \quad (j = \overline{1,n}). \tag{13}$$

4 stage. The determination of the priority. The more Q_j, the more efficiency of the country in the construction sector.

On the basis of results obtained in the Table 5 it can conclude that according to selected criteria reflected the situation in construction sector in 2009 and their importance, most efficiently the construction sector market wilts in the countries which hold the first position according to the priority, i.e. in Germany, Austria, Czech Republic, Finland, France, Sweden and Poland. Meanwhile Netherlands, Bulgaria, Lithuania, Estonia, Latvia, Denmark and Slovenia remain short of their most of all.

The data given in the table of final results (5) shows that Lithuania holds position 21 and it is one of the countries which during the construction sector crisis experienced losses and difficulties. The construction activity weight in economic added value structure in 2009 reflects also this fact. The construction activity decreased in 2009 until the level in 2002 and reduced almost by 4 percent than in 2007–2009. Number of employees in construction sector in 2009 in comparison with 2008 reduced by 38 percent. The statistical indices of material investments also confirm the construction sector stagnation. In 2008–2009 investments in production means decreased by one fifth and in immovable property by 40 percent. The similar situation in construction market is in Latvia

Table 6. Quantitative information characterized construction sector of twenty European countries

Quantitative information characterized construction sector of twenty European countries

Considered criteria	*	**Significance**	**Measures**	Austria	Belgium	Bulgaria	Cyprus	Czech Republic	Denmark	Estonia	Finland
Growth rate of GDP volume – percentage change on previous year	+	0.0053	%	0.0009	0.0009	0.0011	0.0009	0.0009	0.001	0.001	0.0009
Volume indices of production in all building and construction growth rates compared with previous period (%)	+	0.4996	%	0.084	0.0781	0.0341	0.0757	0.0872	0.0815	0.0671	0.0746
Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	+	0.4188	%	0.0656	0.0644	0.0363	0.0608	0.0614	0.0403	0.0336	0.0741
Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	+	0.0263	%	0.0044	0.0045	0.0055	0.005	0.0045	0.0048	0.0057	0.0043
Index of construction costs, new residential buildings, gross, price changes (%)	–	0.0085	%	0.0015	0.0015	0.002	0.0015	0.0015	0.0017	0.0016	0.0015
Total Employment in construction sector, per cent variation on previous year	+	0.0416	%	0.0071	0.0073	0.0086	0.0069	0.0068	0.0072	0.0082	0.0071
Sum of evaluated normalized maximizing values				0.1620	0.1551	0.0829	0.1494	0.1608	0.1348	0.1156	0.1609
Sum of evaluated normalized minimizing values				0.0015	0.0015	0.002	0.0015	0.0015	0.0017	0.0016	0.0015
Importance of alternative				0.1633	0.1564	0.0838	0.1507	0.1627	0.1359	0.1168	0.1622
Priority of country				**2**	**8**	**22**	**11**	**3**	**18**	**20**	**4**

Considered criteria	France	Germany	Ireland	Lithuania	Netherlands	Portugal	Romania	Spain	Sweden	Slovenia
Growth rate of GDP volume – percentage change on previous year	0.0007	0.0008	0.001	0.0011	0.0001	0.001	0.0009	0.001	0.0009	0.0009
Volume indices of production in all building and construction growth rates compared with previous period (%)	0.0854	0.0836	0.0788	0.0306	0.0137	0.0876	0.0628	0.0878	0.0828	0.0642
Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	0.0626	0.0727	0.0518	0.0497	0.0106	0.0452	0.0606	0.04	0.0649	0.0571
Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	0.0048	0.0043	0.0051	0.0053	0.0008	0.0047	0.0057	0.0053	0.0045	0.0048
Index of construction costs, new residential buildings, gross, price changes (%)	0.0016	0.0014	0.0016	0.0018	0.0003	0.0016	0.0016	0.0017	0.0015	0.0016
Total Employment in construction sector, per cent variation on previous year	0.0075	0.007	0.0063	0.0081	0.0012	0.0071	0.0069	0.0061	0.007	0.0079
Sum of evaluated normalized maximizing values	0.1609	0.1685	0.1430	0.0949	0.0264	0.1455	0.1369	0.1401	0.1601	0.1349
Sum of evaluated normalized minimizing values	0.0016	0.0014	0.0016	0.0018	0.0003	0.0016	0.0016	0.0017	0.0015	0.0016
Importance of alternative	0.1622	0.1699	0.1442	0.0959	0.0341	0.1468	0.1381	0.1413	0.1614	0.1361
Priority of country	**5**	**1**	**14**	**21**	**23**	**13**	**16**	**15**	**6**	**17**

Considered criteria	United Kingdom	Greece	Latvia	Hungary	Poland
Growth rate of GDP volume – percentage change on previous year	0.0009	0.001	0.0009	0.0009	0.0009
Volume indices of production in all building and construction growth rates compared with previous period (%)	0.0792	0.0772	0.0574	0.09	0.0905
Index of building permits – number of dwellings, new residential buildings (excl. residencies for communities), growth rates (%)	0.0578	0.058	0.0515	0.052	0.0548
Index of production, civil engineering, seasonally adjusted, growth rates compared with previous period (%)	0.0054	0.0043	0.0054	0.0046	0.0045
Index of construction costs, new residential buildings, gross, price changes (%)	0.0014	0.0016	0.0016	0.0016	0.0014
Total Employment in construction sector, per cent variation on previous year	0.0066	0.0075	0.0083	0.0063	0.0074
Sum of evaluated normalized maximizing values	0.15	0.1479	0.1235	0.1539	0.1581
Sum of evaluated normalized minimizing values	0.0014	0.0016	0.0016	0.0016	0.0014
Importance of alternative	0.1514	0.1492	0.1247	0.1551	0.1595
Priority of country	**10**	**12**	**19**	**9**	**7**

and Estonia. The decrease of external demand has a high impact on construction sector of the Baltic States; particularly the internal demand wilted which aggravate changes, higher unemployment rate, salary cut and credit crisis (Ozols 2009).

In the international practice the different methods and models for analysis, forecasting, simulation and management of the crisis in construction and immovable property sectors are applied. In order to overcome the economic crisis, the governments of all member states take various measures, including the political, for stimulation the construction activity, particularly for increase of work programs by the state order and speedup of the implementation of planned investments. The heavy expenses for the infrastructure, for example, for roads and railways and nonresidential building construction, maintenance and repair. Some governments introduce tax concessions for demand in specific construction sector parts, particularly housing. Sometimes such measurements are supplemented by the subsidies for renovation and construction, including public building, road and bridge construction projects. Other countries, particularly in Southern Europe, for the purpose of increase of company liquidity partly changed the rules applied for works by the state order, reducing the time from submission of the accounts until their payment. For considering the cyclicality of construction sector and crisis management methods, this sector should be considered in all aspects taken in to account the impact of external and internal environment on it.

4. Conclusions

The progress of national economy and society is impossible without construction sector because construction products for various purposes is necessary for people life, work and satisfaction of social cultural and other requirements. Performed analysis of the literature confirms that there are two main opinions on levels of study of construction sector market: macro economic and micro economic. During the crisis the needs in study and investigations of construction and economic branches are particularly increased; lot of scientists use various methods for analysis, evaluation, forecasting.

In the article six criteria reflected construction sector and 23 European countries are selected according to available statistical data priority. The indices of 2009 reflected percent difference in comprising with 2008 were used for study. The period was selected nonrandom. In the article it was intended to present the countries which most harm due to crisis and countries which develop construction activity well.

Multipurpose evaluation method COPRAS allows sufficiently accurately performing math calculations and evaluate the priority of criteria. For provision data accuracy obtained by entropy method the criteria for weight are determined while evaluating values of minimizing and maximizing indices. After combining entropy and COPRAS methods as well as appropriately performing calculations, the useful information are obtained for further investigations and study.

Obtained results shows that following first five countries develop construction sector most efficiently: Germany, Austria, Czech Republic, Finland, France, and the worst countries: Netherlands, Bulgaria, Lithuania, Estonia, Latvia.

The investigations of European countries are important in the further for checking other periods and analyzing and comprising changes in specific countries as for achievement of efficient management of construction sector it is necessary to study experience of other countries and use practice of other countries.

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EUROPOS VALSTYBIŲ GEBĖJIMO VALDYTI STATYBOS SEKTORIŲ KRIZĖS LAIKOTARPIU PALYGINAMOJI ANALIZĖ TAIKANT COPRAS METODĄ

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Santrauka

Įvairiose šalyse buvo atlikti statybos šakos ir jos vaidmens nacionalinėje ekonomikoje tyrimai. Pažymėtina, kad dažniausiai konkrečios šalies statybos šaka vystosi pagal panašias tendencijas, kaip ir visa šalies ekonomika.

Statybos ir nekilnojamojo turto šakos efektyvumo lygis priklauso nuo tam tikro skaičiaus kintamųjų mikro-, mezo- ir makro- lygmenimis. Nors makrolygmens veiksniai veikia visos šalies pramonės efektyvumo lygį, šiame tyrime analizuojamas tik poveikis statybos šakos efektyvumui. Statybos šakos veiklos efektyvumas priklauso nuo ją kompleksiškai veikiančių makrolygmens kintamųjų veiksnių, tokių kaip šalies ekonominis, politinis ir kultūrinis išsivystymo lygis, statybos šakos veiklą reglamentuojantys dokumentai, rinka, mokesčių sistema, kreditų gavimo galimybės ir sąlygos, infliacija, vietiniai ištekliai ir t. t. (Kaklauskas *et al.* 2011). Priklausomai nuo šių makrolygmens veiksnių poveikio visumos kinta statybos šakos plėtros galimybės.

Įsisiūbavusi ekonominė krizė 2008–2009 m. skirtingai palietė Europos Sąjungos šalių statybos sektorių rinkas. Daugelyje valstybių sumažėjo gamybos apimtys, nekilnojamojo turto sandorių skaičius, pastebimai sumažėjo gyventojų užimtumas bei statybos įmonių skaičius. Nepalankios sąlygos krizės metu bei didelės permainos skatina analizuoti situaciją statybos sektoriuje ne tik savo šalyje, bet ir kitose, nes tarptautinio patyrimo analizė suteikia galimybę plačiau pažvelgti į statybos sektoriaus problemas bei rasti jų sprendimo būdus.

Straipsnyje pateikta metodika leidžia nustatyti efektyviausiai statybos sektoriaus rinką pagal parinktus kriterijus, vystančią šalį tarp 23 Europos valstybių. Šalys vertinamos daugiakriteriniu COPRAS metodu (Zavadskas, Kaklauskas 1996), o vertinimo kriterijų reikšmingumai nustatomi entropijos metodu. Entropijos sąvoka apibrėžiama kaip atsitiktinio dydžio neapibrėžtumo matas, suteikiantis jam svorio palyginti prieš kitus rodiklius.

Taigi pagrindinis darbo tikslas – COPRAS metodu sugrupuoti tiriamas Europos valstybes pagal prioritetiškumą, įvertinus šešis statybos sektorių apibūdinančius kriterijus.

Šiam tikslui įgyvendinti analizuojama šalių ekonomika ir statybos sektoriai, renkami Europos Sąjungos šalių statistiniai ekonominiai duomenys, nustatomi jų reikšmingumai, pritaikius entropijos metodą, bei Europos šalių statybos sektorių prioritetiškumas taikant COPRAS metodą.

Reikšminiai žodžiai: ekonomika, statybos sektorius, kriterijai, entropijos metodas, COPRAS metodas, Europa.

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