IMPROVING THE ASSESSMENT OF THE DIVERSIFICATION OF CONSTRUCTION COMPANIES

ROMUALDAS GINEVIČIUS

ABSTRACT
Various indicators are used to determine the level of company diversification. Their adequacy largely depends on the structure of the production programme. Its essential feature is the comparative weight of the main product in the total scope of the company’s work. In this situation, the intensity of the diversification process is reflected by the decrease in the volume of this product due to the inclusion of new products in the production programme. In this case, the adequacy of the diversification indicator can be reflected by comparing the scale of the main product with changes in the value of these indicators. The adequacy will be higher with more changes in the values of diversification indicators corresponding to changes in the volumes of the main product. Four indicators of corporate diversification are the most well-known and widely used: the Berry index, the entropy measure, Utton’s measure and the DG index. All of them have both strong and weak sides, so it is important to determine situations of the company’s production programme in which diversification indicators are appropriate to use, i.e., in which situations their adequacy is the greatest. The research has established that if the comparative weight of the main product of the production programme in the total scope of work is greater than 0.5, then the adequacy of the entropy measure and index DG is higher compared to the Berry index and Utton’s measure. If it is lower than 0.5, the other two diversification indicators should be used. The obtained results will help to more efficiently manage the process of diversification as a company’s development strategy.

KEY WORDS
strategic management, diversification indicators, their adequacy

INTRODUCTION
In the course of market globalisation, companies’ competitiveness becomes a condition for their successful commercial activity. In theory and practice, it is understood as the occupied part of both domestic and foreign markets. The company will be competitive if it is able to adapt to constantly changing external conditions. However, in this case, it will be able not only to maintain but also to improve its position. This can only be achieved by continuous development. The continuous development of the company is encouraged by the overall economic result and the

country’s position in international markets. As an economic entity of the country, this encourages the company to increase the scale of its activities; otherwise, it will lose its position and decay. Thus, the pursuit of an ever-increasing market share becomes the condition for the company’s competitiveness. They can increase this share and, at the same time, maintain and expand their positions only by maintaining development rates not lower than the overall growth of the market.

In this situation, companies apply various growth strategies, i.e., penetration, product improvement, market development and diversification (Ansoff, 1965; Ansoff, 1957). The simplest and least risky is the strategy of penetration or penetrating the market. In this case, the company only seeks to maintain its position in the markets where it has operated so far. To not lose customers, the quality of existing products is improved, better service is offered, the price is reduced etc. (Pierscionek, 1966).

Although involving more risk, better commercial performance results can be expected by applying a market development strategy. In this case, new products are offered to existing markets, or attempts are made to enter new markets with existing products. The greatest risk in this strategy comes from these market barriers, which protect markets from competitors (Sontheimer, 1989).

A product development strategy aims to increase sales volume by offering new products to existing markets. In this situation, the fundamental problem is the concept of a new product. This reflects the possible transformation of the product improvement strategy into other strategies presented in Table 1.

The most well-rounded is the company’s growth diversification strategy. It refers to the release and sale of new products in new markets that differ from those produced so far. It is characterised by high complexity, which is why it is risky. On the other hand, it acquires a special significance under economic recession conditions faced by countries today. It is risky because it requires fundamental changes in the company’s entire activity, i.e., technology, management etc. Technological changes are related to the adaptation of the production structure to the release of new products, and managerial changes are related to the reorganisation of the organisational management structure. In addition, implementing this strategy requires new knowledge and specialists who can work effectively with new technologies.

Quantitative assessment of its condition plays a special role in implementing diversification as a development strategy. In addition, effective management of this process is impossible. Several methods have been proposed for measuring unrelated diversification. All of them have strengths and weaknesses. Their scale largely depends on how the structure of the company’s production programme is evaluated. Today no answer to this question exists. Therefore, assessing the adequacy of diversification indicators has both scientific and practical significance. The solution to this problem is relevant for engineering technology management because diversification is a new organisational management structure of the company, new technologies etc.

The article aims to propose ways to assess the suitability of one or another diversification indicator depending on the structure of the construction company’s production programme.

1. Literature review

The diversification of companies, as one of their main growth strategies, is characterised by high complexity and is, therefore, quite controversial (Ansof, 1965; 1957). Attempts were often made to reduce or even deny this possibility of increasing production efficiency. It is based on the fact that a significant number of diversification projects have failed. The reason for this approach to this corporate growth strategy is insufficient knowledge of this phenomenon. It prevented a timely and sufficient assessment of the complex of conditions necessary for success. For example, existing organisational management structures that did not meet the operating conditions
of diversified companies were not changed and continued to rely on the existing qualifications of employees etc. The value of diversifying and the changed external situation, the business internationalisation has increased, economic crises have become more frequent etc. All this has made diversification one of the most important business management strategies. Today, it is applied by increasingly more international companies (Li, 2014).

The application of the diversification strategy in companies enables them to use capital flows more rationally to increase the efficiency and competitiveness of commercial and economic activities (Li, 2014; Atanasova & Li, 2019), which provides the opportunity to enter new markets, industry sectors or introduce new products to both existing and new markets (Errasti et al., 2014).

Many studies have focused on the impact of diversification and various aspects of corporate performance: reinvestment strategy (Mackey & Barney, 2013), capital costs and structure (Hann et al., 2013), corporate value (Kuppuswamy et al., 2014; Jara-Bertin et al., 2015; Nazarova, 2015; Hyland, 2003), profitability (Santarelli & Tran, 2016; Zahavi & Lavie, 2013; Becerra & Santaló, 2006; Dosi et al., 2020), production export (Gnangnon, 2021), land efficiency of business enterprises (Nurimbetov, 2017), corporate social responsibility (Patricia & Dastgir, 2017; Zandi et al., 2022) and dynamics of production sector diversification (Shikata et al., 2021).

Analyses have also been performed on the impact of banking diversification on the government securities market (Sawada, 2013) and the impact of technology on the diversification process (Wang et al., 2014; Li et al., 2014). Several studies have been devoted to examining the influence of the ownership form of business enterprises (Chung, 2013; Hernández-Trasobares & Galve-Górriz, 2016; Schmid et al., 2015; Sanchez-Bueno & Usero, 2014).

A separate line of research is geographical diversification (Qian et al., 2013; Yahaya et al., 2009; Chonghui et al., 2013; Thoumrungroje & Tansuhaj, 2005; Mauer et al., 2015; Gaur & Delios, 2015; Boehe & Jimenez, 2019).

An important research subject is the risk of diversification projects (Yücel & Önal, 2015; Busse et al., 2014; Jafarinejad et al., 2018). Diversification processes in corporate networks are also analysed (Chen & Jaw, 2014; Kim et al., 2014; Aivazian et al., 2019).

The literature analysis shows a lack of studies aimed at measuring the level of diversification of companies over several years.

Diversification measures of companies’ activities should follow from their nature and forms of manifestation. However, two essential ones are unrelated and related diversification. Assignment to one or another form is determined by the “core” of the company’s capabilities. It refers to the cumulative ability to accurately and efficiently combine the knowledge of markets with technology for the purpose of adapting to the external environment and, thus, making a profit (Wrigley, 1970). Related diversification reflects the qualitative side of this process and means the company’s expansion into the release of new products, the production and sale of which are located in the “core” area of its capabilities. Unrelated diversification reflects the quantitative side of this process and refers to the inclusion in the production programme of such products, the release of which requires capabilities located outside the mentioned zone. As the globalisation of markets grows and competition intensifies, companies aiming to increase profits and ensure long-term financial stability try to minimise the impact of fluctuations in the volumes of one developed business on others. This can be achieved by entering unrelated markets that are far apart. In connection with this, the evaluation of the

Tab. 2. Measures of corporate diversification

<table>
<thead>
<tr>
<th>THE NAME OF THE DIVERSIFICATION INDICATOR</th>
<th>SOURCE</th>
</tr>
</thead>
</table>
achieved level of diversification of an unrelated company becomes important since this process can be managed if there is an opportunity to measure it.

This literature analysis showed that the same measures of diversification had been used for many years (Table 2).

All reviewed and other literature sources refer to the indicators listed in Table 2. For example, when analysing the diversification of construction companies, the indicator of the number of activities is applied (Šaparauskas & Vilutienė, 2005) and for oil and gas diversification processes — the entropy measure (Kirichenko et al., 2020), for the impact of diversification as a company development strategy on the commercial activity results of manufacturing companies — entropy measure and Berry index (Wang et al., 2018), and for diversification of agricultural systems — Berry index and entropy measure (Phuge et al., 2020) etc.

Most of the diversification measures originate in the US because, at that time, Europe had not yet had research efforts on how to manage this process. All proposals for measuring diversification can be divided into two groups. The first group includes indicators based on the number of activity areas, which are determined by various types of classifications. The indicators of the second group are based on the number of activity areas and the variation of work volumes between them. The indicators of the first group have significant shortcomings. The main ones are:

- difficulty in unequivocally distinguishing one area of the company’s activity from another;
- the number of activities does not estimate their significance for production turnover and profit;
- the number of activities does not tell whether there is a relationship between the products produced by the firm (Wolf, 1995a; Wolf, 1995b).

The indicators of the second group are more accurate. The most famous and widely used Berry index (Berry, 1971):

\[ D_B = 1 - D_H = 1 - \sum_{i=1}^{n} P_i^2; \]  

(1)

here, \( D_B \) is the Berry diversification index; \( P_i \) — the relative volume of the \( i \)-th activity of the company; \( D_H \) — Herfindahl concentration index; \( n \) — number of activities (\( i = 1, n \)).

The Berry index was obtained by transforming Herfindahl’s concentration index (Herfindahl, 1950):

\[ D_H = \sum_{i=1}^{n} P_i P_i = \sum_{i=1}^{n} P_i^2. \]  

(2)

The Berry index is equal to 0 if the company is specialised, i.e., develops its activities in only one direction. The more diversified it is, the closer \( D_B \) gets to 1.0. When there is no variation between the volumes of work, the \( D_B \) index is equal to:

\[ D_B = 1 - \frac{1}{n}. \]  

(3)

Based on Berry’s index, an indicator was proposed, which is called the entropy measure of diversification (Jacquemin & Berry, 1979):

\[ E_D = \sum_{i=1}^{n} P_i \ln \frac{1}{P_i}, \]  

(4)

here, \( E_D \) is a measure of the entropy of diversification.

Berry’s diversification index has certain weaknesses. To avoid them, the proposed index \( D_G \) (Ginevičius, 2009)

\[ D_G = 1 - \frac{1}{1 + \sum_{i=1}^{n} 1 - P_{\text{max}}.} \]  

(5)

here, \( P_{\text{max}} \) is the volume of the company’s largest (main) activity.

In England, Utton’s measure is widespread (Utton, 1997):

\[ D_U = 2 \sum_{i=1}^{n} i P_i - 1. \]  

(6)

here, \( D_U \) is Utton’s measure of diversification.

From the fact that the diversification of the company’s activities is proposed to be measured in various ways, it can be concluded that none of them is perfect. To exploit their strengths, it is necessary to determine cases in which it is appropriate to apply one or another method. In other words, their adequacy should be determined according to the current situation.

### 2. Research Methodology

The possibilities and ways of assessing the adequacy of the company’s diversification indicators emerge from its definition (Arbeitskreis, 1973). So, it follows the essential feature of diversification, i.e., the ratio of existing products to new ones. The more distant the latter, the more diversified the company’s products. The extreme cases of a company’s production programme are a specialised one-product company and a company that keeps adding new, unrelated products to its production programme. In this situation, the intensity of the diversification...
process is reflected by the decrease in the relative weight of the main product due to the fragmentation of the production programme among a larger number of products. The legitimacy of such an approach is confirmed by indicators that were not so precise but reflected the essence of diversification (Kieser & Kubicek, 1992):

\[
D = 100 - D^{\text{max}}, \quad (7)
\]

\[
D = 100 - \sum_{i=1}^{n} \tilde{P}_i, \quad (8)
\]

here, \(D\) is the diversification rate; \(D^{\text{max}}\) — the volume of the largest production programme product, per cent; \(\tilde{P}\) — the volume of the \(i\)-th product (except for the largest product, %).

It follows from these formulas that the greater the comparative weight of the main product in the total volume of the company’s production programme, the lower the value of the diversification indicator will be, and vice versa, as the comparative volume of the largest product decreases, the value of the diversification indicator will increase. Therefore, the adequacy of diversification indicators can be reflected by comparing the extent of changes in the main product with changes in these indicators. The adequacy of one or another indicator will be reflected by the size that shows the extent changes in the volumes of the main product correspond to changes in the values of the relevant diversification indicator:

\[
K_{Dj} = 1 - \frac{\Delta P^\text{max}_k}{\Delta D_{kj}}, \quad (9)
\]

here, \(K_{Dj}\) is the adequacy indicator of the \(j\)-th diversification index; \(\Delta P^\text{max}_k\) — the ratio of the main product of the \(k\)-th production programme option to the volume of the main product of the next production programme option; \(D_{kj}\) — the same, for the \(j\)-th diversification indicator.

It follows from formula (9) that the closer in size the changes in the main product and the diversification indicator, the greater its adequacy. Ideally, when these changes coincide, \(K_{Dj} = 0\).

Size \(\Delta P_k\) is determined as follows:

\[
\Delta P_{kj} = \frac{p^\text{max}_k}{D_{kj}}, \quad (10)
\]

here, \(p^\text{max}_k\) is the comparative weight of the \(k\)-th main product of the \(j\)-th company in the general production programme of the \(j\)-th company.

Size \(\Delta D_{kj}\) is determined as follows:

\[
\Delta D_{kj} = \frac{D_{kj}}{D_{kj+1}}, \quad (11)
\]

here, \(D_{kj}\) is the value of the \(j\)-th diversification indicator of the \(k\)-th company.

Based on formula (9), it is possible to determine the case in which the indicator is appropriate to use when calculating the degree of diversification of the company’s production programme.

3. EMPIRICAL STUDY

To illustrate the application of the proposed methodology for determining the adequacy of diversification indicators, five construction companies with significantly different production programme structures were selected (Table 3).

Table 4 shows what products are offered by companies to the market.

To determine the adequacy of diversification indicators, it is first necessary to know their values. The results of the calculations are given in Table 5.

Table 5 was used to determine the relationships between the values of the main product volumes among the considered companies, i.e., size \(\Delta P^\text{max}_k\) (Table 6).

Table 6 and formula (11) were used to determine the ratio of values of diversification indicators among considered companies, i.e., size \(\Delta D_{kj}\) (Table 7).

Knowing this quantity, formula (9) was used to determine the adequacy indicator of the diversification indicator of the considered construction companies \(K_{Dj}\) (Table 8).

To obtain a generalised picture of the adequacy of diversification indicators, the results of Table 8 should be converted into ranks (Table 9).

Table 9 shows that the situation of the first, second, third and fourth construction companies is best reflected by indices \(D_u\) and \(E_u\) and fifth — indices \(D_u\) and \(U_{u'}\). Based on this, it is possible to present a generalised model of the adequacy of diversification indicators of the considered construction companies (Fig. 1).

Fig. 1 shows that when the size of the construction company's production programme compared to the rest of it is greater than 50 per cent, it is appropriate to use indicators \(D_u\) and \(E_u\) for diversification assessment; if less than 50 per cent — indicators \(D_u\) and \(U_{u'}\).
### Tab. 3. Structure of the production programme of the construction companies

<table>
<thead>
<tr>
<th>Construction Companies</th>
<th>Products</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>First (main)</td>
<td>Second</td>
<td>Third</td>
<td>Fourth</td>
<td>Fifth</td>
<td>Sixth</td>
<td>Seventh</td>
</tr>
<tr>
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<td>0.85</td>
<td>0.05</td>
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<td>0.04</td>
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<td>–</td>
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<tr>
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<td>0.71</td>
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<td>0.09</td>
<td>0.04</td>
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<td>–</td>
</tr>
<tr>
<td>Third</td>
<td>0.54</td>
<td>0.39</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
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<td>0.49</td>
<td>0.16</td>
<td>0.13</td>
<td>0.07</td>
<td>0.06</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Fifth</td>
<td>0.28</td>
<td>0.25</td>
<td>0.20</td>
<td>0.15</td>
<td>0.12</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* main product.

### Tab. 4. Content of the production programme of the construction companies

<table>
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<tr>
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<tbody>
<tr>
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<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
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<tr>
<td>Second</td>
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<td></td>
</tr>
<tr>
<td>Third</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
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<tr>
<td>Fourth</td>
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<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Fifth</td>
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<td>+</td>
<td>+</td>
<td>+</td>
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</table>

### Tab. 5. Meanings of the diversification indicators of the construction companies

<table>
<thead>
<tr>
<th>Construction Company</th>
<th>Berry index</th>
<th>D_{s} index</th>
<th>A Measure of Entropy</th>
<th>Utton’s Measure</th>
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<tr>
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</tr>
<tr>
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<tr>
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<td>0.501</td>
<td>0.684</td>
<td>0.965</td>
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<td>Fourth</td>
<td>0.679</td>
<td>0.717</td>
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<td>0.799</td>
<td>1.566</td>
<td>0.920</td>
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### Tab. 6. Ratios of main product volumes among the companies under consideration

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<th>third</th>
<th>fourth</th>
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<td>1.574</td>
<td>1.735</td>
<td>3.036</td>
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<tr>
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<td></td>
<td>1.315</td>
<td>1.449</td>
<td>2.536</td>
</tr>
<tr>
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<td>1.574</td>
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<td></td>
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<td>1.929</td>
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<tr>
<td>fourth</td>
<td>1.735</td>
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<td>1.102</td>
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<td>1.750</td>
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<td>fifth</td>
<td>3.036</td>
<td>2.536</td>
<td>1.929</td>
<td>1.750</td>
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</tbody>
</table>

### Tab. 7. Calculation results of the diversification indicator adequacy of considered construction companies

<table>
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<tr>
<th>Construction Company</th>
<th>D_{s}</th>
<th>E_{s}</th>
<th>D_{u}</th>
<th>E_{u}</th>
<th>D_{s}</th>
<th>E_{s}</th>
<th>D_{u}</th>
<th>E_{u}</th>
<th>D_{s}</th>
<th>E_{s}</th>
<th>D_{u}</th>
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<th>D_{s}</th>
<th>E_{s}</th>
<th>D_{u}</th>
<th>E_{u}</th>
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<td>0.143</td>
<td>0.301</td>
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<td>0.116</td>
<td>0.010</td>
<td>0.148</td>
<td>0.098</td>
<td>0.071</td>
<td>0.178</td>
<td>0.397</td>
<td>0.591</td>
<td>0.494</td>
<td>0.200</td>
<td>0.055</td>
<td>0.212</td>
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<tr>
<td>second</td>
<td>0.172</td>
<td>0.143</td>
<td>0.301</td>
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<td>0.010</td>
<td>0.148</td>
<td>0.098</td>
<td>0.071</td>
<td>0.178</td>
<td>0.397</td>
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<td>0.494</td>
<td>0.200</td>
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<td>0.212</td>
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<tr>
<td>third</td>
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<td>0.148</td>
<td>0.198</td>
<td>0.069</td>
<td>0.180</td>
<td>0.220</td>
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<td>0.008</td>
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<td>0.402</td>
<td>0.512</td>
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<td>0.402</td>
<td>0.512</td>
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<td>0.478</td>
<td>0.342</td>
<td>0.400</td>
<td>0.082</td>
<td>0.609</td>
<td>0.342</td>
<td>0.523</td>
<td>0.082</td>
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Tab. 8. Ratios of diversification indicator values among the examined companies

<table>
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<tr>
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<th>SECOND</th>
<th>THIRD</th>
<th>FOURTH</th>
<th>FIFTH</th>
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<tbody>
<tr>
<td></td>
<td>( D_0 )</td>
<td>( E_0 )</td>
<td>( D_e )</td>
<td>( E_e )</td>
<td>( D_u )</td>
</tr>
<tr>
<td>second</td>
<td>1.782</td>
<td>1.559</td>
<td>1.078</td>
<td>1.069</td>
<td>1.231</td>
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<td>fourth</td>
<td>2.032</td>
<td>2.530</td>
<td>2.879</td>
<td>1.394</td>
<td>1.403</td>
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</tbody>
</table>

Tab. 9. Ranks reflecting the adequacy of the diversification indicators of the considered construction companies

<table>
<thead>
<tr>
<th>FIRM</th>
<th>FIRST</th>
<th>SECOND</th>
<th>THIRD</th>
<th>FOURTH</th>
<th>FIFTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>first</td>
<td>3 2 4 1</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>4 2 1 3</td>
<td></td>
</tr>
<tr>
<td>second</td>
<td>2 1 3 4</td>
<td>1 2 4 3</td>
<td>1 3 4 2</td>
<td>4 2 3 1</td>
<td></td>
</tr>
<tr>
<td>third</td>
<td>1 2 3 4</td>
<td>3 2 1 4</td>
<td>1 3 4 2</td>
<td>4 2 3 1</td>
<td></td>
</tr>
<tr>
<td>fourth</td>
<td>2 4 1 3</td>
<td>2 3 4 1</td>
<td>4 2 3 1</td>
<td>1 2 4 4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8 10 11 12</td>
<td>9 9 13 9</td>
<td>8 8 13 11</td>
<td>6 10 12 12</td>
<td></td>
</tr>
<tr>
<td>Sum of ranks</td>
<td>8 21</td>
<td>18 22</td>
<td>16 24</td>
<td>15 26</td>
<td>22 8</td>
</tr>
</tbody>
</table>

**Fig. 1. Adequacy of diversification indicators depending on the structure of the construction company’s production programme**

**CONCLUSIONS**

With market globalisation and intensifying competition, the strategy of business diversification is becoming increasingly important for companies. It provides opportunities to adapt to constantly changing external conditions and, thus, maintain and improve the position. The success of a diversification strategy depends, to a large extent, on the ability to measure its achieved level at a desired point in time. Today, four indicators for measuring unrelated diversification are the most well-known and widely used: Berry index \( D_e \), the entropy measure \( E_v \), Utton measure \( D_u \) and the index \( D_{vu} \). On the other hand, the question remains which indicator to apply in a specific case and, at the same time, increase the adequacy of the assessment. The conducted research found that it largely depends on the structure of the company’s production programme, which is sufficiently accurately reflected by the comparative weight of the main product in the total volume of work. As the degree of diversification increases, this share decreases. In this case, the adequacy of the company’s activity diversification indicator can be reflected by changes in the scale of the main product compared to changes in the value of this indicator.

It has been established that if the relative size of the main product of the construction company’s production programme compared to the rest of its scope is greater than 50%, then it is appropriate to use the Berry index and the entropy measure to assess the
level of diversification if it is less than 50% — Utton measure and index $D_{Gr}$.

The limitations of the proposed methodology can be attributed to the fact that it is more suitable for the evaluation of the structure of the production programme of a construction company with a clear main product. The weakness of the methodology can be attributed to its remaining unclear sensitivity, i.e., to the extent changes in the main product correspond to changes in the adequacy of the considered diversification indicators; on the strong side, compared to the changes in the main product of the production programme, the adequacy indicator changes more.

**LITERATURE**


