Clustering of Croatian Software Development Companies Based on Their Financial Indicators

Irena Konecki*, Dijana Oreški * and Nikola Kadoić*
* University of Zagreb, Faculty of Organization and Informatics, Pavlinska 2, Varaždin, Croatia
irena.konecki@foi.unizg.hr, dijana.oreski@foi.unizg.hr, nikola.kadoic@foi.unizg.hr

***Abstract* - The main objective of this study is to examine the financial performance of companies in the Croatian software development sector and identify which financial indicators could be predictive of future profitability. The research uses the Financial Agency (FINA) data focusing on pre and post-COVID-19. Cluster analysis of companies is performed based on their financial indicators. Four clusters of companies were identified. Findings indicate that there is no statistically significant difference between the clusters in the profitability growth rate after the COVID-19 crisis. However, the observed period might be too short to measure the long-term effects. The financial analysis of companies in the Croatian software development sector gives insight into how the sector operates and thus provides valuable information for policymakers who would like to support its growth and development.**

Keywords* - *financial indicators, software development sector, Croatia, cluster analysis, COVID-19 crisis

I. INTRODUCTION

Having a strong IT sector contributes to economic growth, employment and productivity. To create the support policies that would suit the software industry, it is necessary to know more about its heterogeneity and dynamic features during the expansion and during the economic crisis. In other words, it is beneficial to know whether there are different subsets of companies in the industry with similar goals, strategies, and financial characteristics. For example, it would be wrong to assume that all the companies in the sector would benefit from the loans aimed at growth since probably not all of them want to grow, and of those that do, maybe not all of them have the financial structure that would benefit from the loan. Thus, financial data can be used to identify clusters of companies with similar financial backgrounds to tailor public policies to their specific needs.

In this paper, the Croatian software development sector is in focus. Section 2 overviews the Croatian software development sector and the belonging financial data. Section 3 defines financial indicators and describes their usage. In Section 4, the methodology used is presented. Section 5 contains the main findings of the clustering procedure, while Section 6 concludes the paper.

This paper has been prepared in the scope of the project SIMON: Intelligent system for automatic selection of machine learning algorithms in social sciences. The main goal of the project SIMON is to develop an intelligent system for the automatic selection of machine learning algorithms in the social sciences that perform better on a given data set, taking into account the specific characteristics of the data. In this paper, we focus on the analysis of business data.

II. CROATIAN SOFTWARE DEVELOPMENT SECTOR

Based on criteria of export orientation, employment capacity and earnings before taxes, interest and amortization, the activity of computer programming, consultancy and related activities (J62.0, NKD 2007) may be considered as the driving force of Croatian industry [1]. It is one of the rare sectors in Croatia that has had growth of gross added value and employment in the period of the highest economic recession [2]. Its profitability measured by gross profit margin indicates convergence to the European Union average [1, 3].

One-third of the revenues of Croatian software companies come from two leading software markets (Northern America and Europe), which allows a better inflow of international capital in situations when domestic capital is scarce [15]. Unlike large companies in the sector, small and medium-sized companies have adopted an agile approach to software development as their main competitive advantage in the industry, characterized by fast development and quick-win strategies in discovering and targeting new markets [4].

The sector predominantly consists of micro-enterprises. In 2012 only the companies that were 16 years old or older had, on average, ten employees [5]. The software industry and data processing activity have the smallest minimum efficient size among ICT services [6], which generally increases the survival chances of enterprises in a particular industry [5]. They also have low entry barriers, capital intensity coefficient [6], and industry concentration levels [7].

Previous research confirmed Gibrat's law in the Croatian software supply and consultancy industry, meaning that the growth of companies in this sector does not depend on their size at the start of observation [8]. That indicates there is no tendency for smaller companies to grow faster in this sector compared to larger companies. This is in accordance with the fact that in the sector, besides the companies that cannot achieve growth due to their internal weaknesses (survivalists) or due to strong competition (low-growth companies), there are a lot of lifestyle entrepreneurs who favor those strategies that do not strive for growth [9]. In the Croatian software

development sector, the relationship between net working capital and profitability is concave quadratic, suggesting an optimal level of net working capital concerning the company's total revenue [10], which the management should strive for.

Research shows that entrepreneurs in this sector do not perceive Croatian institutions as supporting their activities, but on the contrary, they emphasize their repressive function executed through penalty instrumentary [2]. Non-flexibility, slackness, passiveness, standardization, and lack of understanding of the entrepreneurial field are the most common features attached to institutions and their employees. At the same time, the political system is seen as full of illegal favoritism [2]. Inconsistent legislation, high tax burden, and cumbersome and inefficient public administration are reasons why Croatia has not positioned itself as a desirable high-tech investment destination [11].

ICT industries are human capital intensive [12], which is reflected in average salary as a proxy for human capital. Because of this, software companies should pay attention to knowledge management. Research shows that there is a positive attitude towards knowledge sharing in Croatian IT companies [13].

The software industry is a part of the high-tech industry in which noticeable improvements can be made even without substantial financial resources. However, the lack of developers and other IT professionals is impeding more remarkable progress, especially since, after Croatian accession to the European Union, a number of Croatian high-tech professionals have decided to leave the country [11]. One of the possible solutions is engaging more women to pursue ICT professions. The popularization of informatics among women within the educational system should potentially increase their self-efficacy in this area and consequently make ICT occupations more attractive to women [14].

In figures 1-5, we present the sector of Croatian companies classified into area J, class 62.01 Computer Programming (2007 National Classification of Activities) through (the data collected from the Info.biz platform [15]):

- the number of entrepreneurs in the sector in the last five years (Figure 1.),
- the number of employees in the sector in the previous five years (Figure 2.),
- the number of entrepreneurs with profit/loss in the sector in the last five years (Figure 3.),
- total income and expenses in the sector in the previous five years (Figure 4.)
- the trade balance in the sector in the last five years (Figure 5.),

The number of entrepreneurs in the sector grows steadily in the observed period. With the growing number of companies, employees increased by approximately 50%.

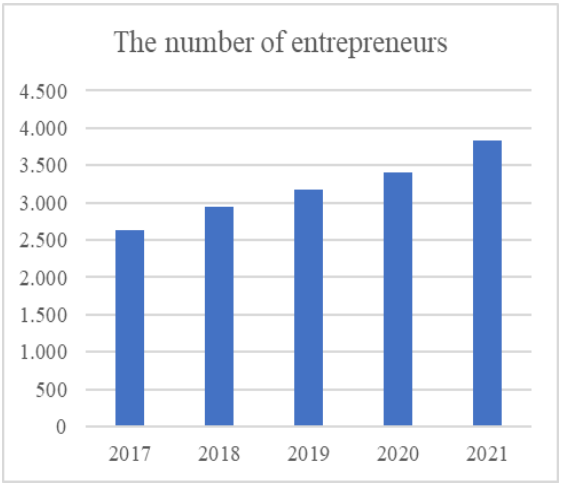

Figure 1. The number of entrepreneurs in the class of Computer Programming in the last five years (authors' work based on [15])

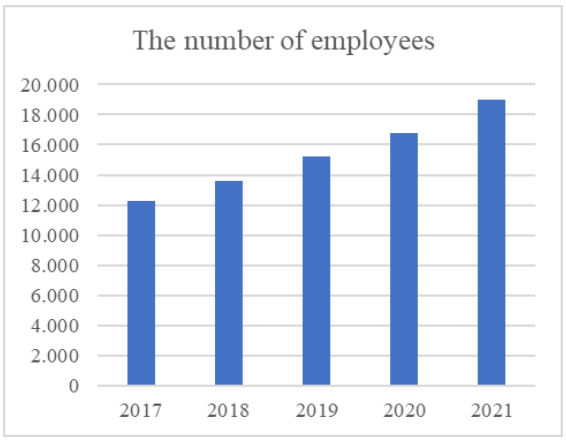

Figure 2. The number of employees in the class of Computer Programming in the last five years (authors' work based on [15])

Most of the companies in the sector make a profit. The difference between total income and expenses increases throughout the observed years, confirming the IT sector's growing profitability and attractiveness.

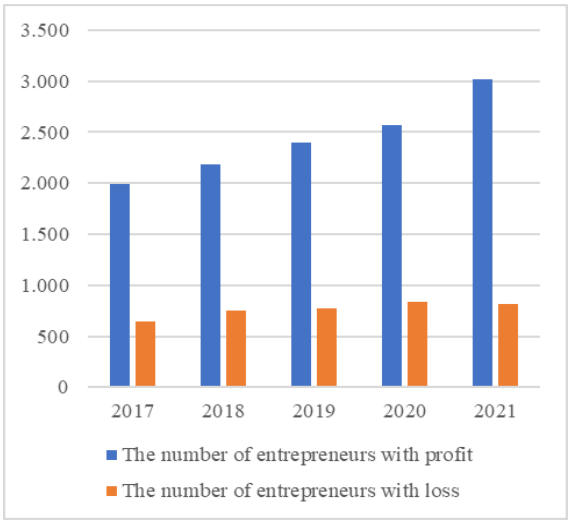

Figure 3. The number of entrepreneurs with profit/loss in the class of Computer Programming in the last five years (authors' work based on [15])

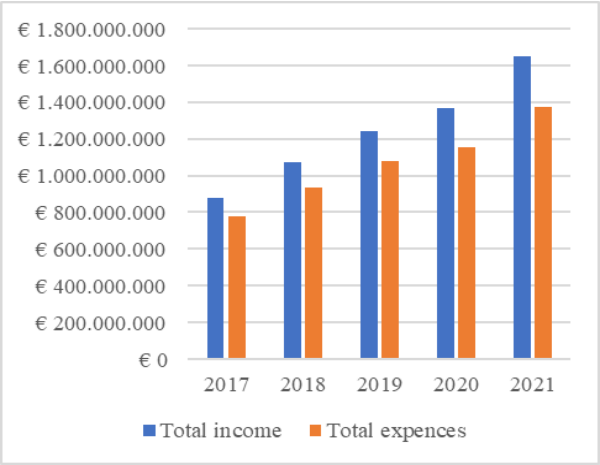

Figure 4. Total income and expenses in the last five years in the sector (authors' work based on [15])

The sector is strongly export-oriented. The trade balance has almost tripled in the observed period.

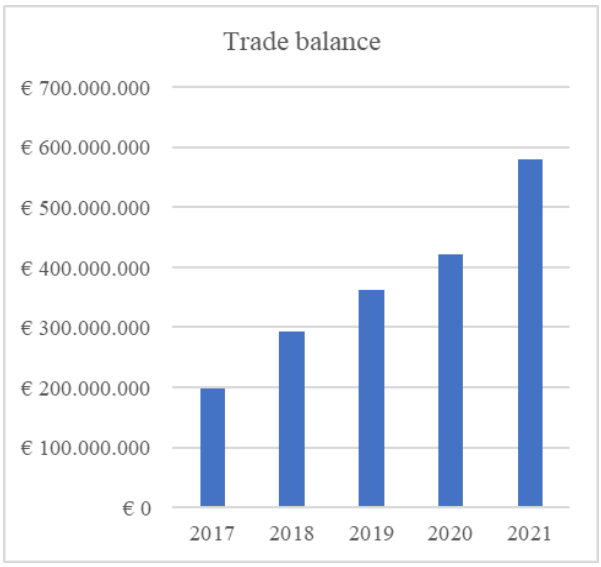

Figure 5. The trade balance in the class of Computer Programming in the last five years (authors' work based on [15])

III. FINANCIAL INDICATORS

Financial statements, mainly balance sheets and profit and loss accounts, are the main source of information when evaluating a company's business activities. Financial statements analysis includes calculating various financial indicators covering several areas of business performance. Such evaluation of business performance is one of the pillars of managerial decision-making. A glance at the financial indicators enables risk assessment and gives information on business security and success. Financial indicators are thus interesting for various stakeholders, internal (owners, managers, employees) and external (partners, creditors, media, etc.).

Financial performance measures are often used because they provide an aggregate view of an organization's performance resulting from its strategic, operating, and tactical management [16]. In that way, financial indicators are "lagging" because they result from former actions [17]. Their objectivity is dependent on the quality of prepared financial statements [18].

Financial indicators are organized into six groups: liquidity indicators, indebtedness indicators, activity indicators, efficiency indicators, profitability indicators, and investment indicators [12].

Business management is assessed based on the security criterion reflected in the liquidity and indebtedness indicators and on the performance criterion for which one looks at efficiency, profitability, and investment indicators. Activity indicators are both security indicators and performance indicators.

Liquidity indicators measure the company's ability to meet its due short-term obligations. They are calculated based on data from the balance sheet. Liquidity indicators include cash ratio, quick ratio, current ratio, and coefficient of financial stability [12].

Indebtedness indicators reflect the structure of liabilities. They show the percentage of assets financed from own capital (principal) and the percentage of the assets funded from external sources (liabilities). Indebtedness indicators are debt-to-assets ratio, equity-to-assets ratio, debt-to-equity ratio, indebtedness factor, level of coverage 1, and level of coverage 2 [19].

Activity ratios measure how efficiently a company performs day-to-day tasks such as collecting receivables and managing inventory [20] and are calculated based on data from the balance sheet and profit and loss account. They include total assets turnover, working capital turnover, receivables turnover, and days of sales outstanding [19].

Efficiency indicators measure the ratio of revenues and expenditures, i.e., they show how much income is generated per unit of expenditure and are calculated based on data from the profit and loss account. They include the efficiency of the overall business, the efficiency of sales, the efficiency of financing, and the efficiency of extraordinary activities [19].

Profitability ratios measure the company's ability to generate profitable sales from its assets [20]. Profitability indicators are net profit margin, gross profit margin, net return on assets (ROA), gross return on assets, and return on equity (ROE) [19]. Investment indicators measure the success of investments in ordinary shares (for joint-stock companies) [19].

Financial indicators have the potential to predict the future financial success of companies. A company's financial success is usually reflected in earnings growth rate before interest, tax, and depreciation (EBITDA). The goal of this paper is to use the cluster analysis based on the financial indicators and to test the following hypothesis:

> *H1: Based on the financial indicators, there is a statistically significant difference in the EBITDA growth rate between the clusters identified.*

IV. METHODOLOGY

The research sample consists of Croatian companies classified into area J, class 62.01 Computer Programming (2007 National Classification of Activities) that existed both in the pre-pandemic year 2019 and 2021. Financial Agency (FINA) database was used for this research [15]. Croatian enterprises have to submit regular financial reports to Financial Agency each year. The companies that disappeared from or entered the market during the observation period were excluded from the initial sample of 4355 companies. The final data set consists of 2069 companies. According to Financial Agency's data, there were three medium companies, 218 small companies, and 1848 micro companies in the sample.

Companies' data included in this research are basic information about companies and quantitative (financial and non-financial) variables, including the percentage of domestic capital, current ratio, debt-to-assets ratio, days of sales outstanding, the efficiency of the overall business, return on assets (ROA), return on equity (ROE), average monthly gross 2 salaries per employee.

The current ratio is calculated as the ratio of short-term assets to short-term liabilities. For the company to be liquid, it should be greater than 2. Debt-to-assets ratio is a percentage of a company's assets financed from external sources. Days of sales outstanding is the average number of days a company takes to receive payment for a sale. The efficiency of the overall business is calculated as the ratio of total income to total expenditure. ROA is the ratio of profit to total assets. ROE is the profit-to-equity ratio [19]. EBITDA growth rate was calculated as a growth rate of earnings before interest, tax, and depreciation from the year 2019 to the year 2021.

The clustering algorithm is applied to group companies. Financial indicators are numerical variables, so a k-means clustering algorithm is applied. The k-means algorithm divides the companies into a certain number of clusters using an iterative algorithm. The k-means algorithm divides data into clusters in order to reduce the distances between cluster centroids. The number of clusters, *k*, must be determined. The outcomes of various *k* values are compared to identify the best number of clusters. The cubic Cluster Criterion (CCC) is applied as a criterion for cluster evaluation. CCC estimates the number of clusters using Ward's minimum variance method, based on minimizing the within-cluster sum of squares. The sum of squared residuals in each clustering approach selects the number of clusters. The clustering model is interpreted by considering mean cluster values for each variable (as algorithms names suggest).

The Levene test and the Welch test were used to determine whether the EBITDA growth rate is statistically significantly different among the companies in different clusters and, consequently, to test the hypothesis.

V. RESEARCH RESULTS

Table I shows the movements of the variables used in the research for the last five available years. The average current ratio of the companies in the sector is above 2 in all observed years, indicating high liquidity. Moreover, liquidity of the sector slightly grows in the observed period. On average, 40% of the assets are financed by debt. Indebtedness has decreased in the last five years. Both average ROA and average ROE are growing from year to year, confirming the sector's attractiveness. What is more, the average EBITDA margin shows the growing efficiency of the sector, while in absolute terms, the total EBITDA of the sector has more than doubled in the last five years. The average monthly gross 2 salary per employee is also growing, but more slowly than profits. It has grown by 25.85% in the last five years. Days of sales outstanding are decreasing in the observed period indicating better business activity.

The k-means algorithm enables clustering by using continuous numerical variables. Five cluster analyses were run separately, specifying two, three, four, five, and six-cluster solutions. The Cubic Cluster Criterion (CCC) was used to determine the optimal number of clusters. When comparing the CCC values for two models, the model with the higher CCC is considered better.

TABLE II CLUSTERS EVALUATION (AUTHORS' WORK)

Number of clusters	CCC	Best
2	-4.62081	
3	-10.837	
4	3.034135	Optimal CCC
5	-9.36535	
6	-0.66089	

The results presented in Table II lead to the selection of four clusters solution. Considering sample sizes in each cluster (table III) and interpretability, the four-cluster solution proved to be the best.

TABLE III CLUSTERS EVALUATION (AUTHORS' WORK)

Cluster	Number of companies
Cluster 1	635
Cluster 2	126
Cluster 3	577
Cluster 4	731

TABLE I THE MOVEMENTS OF THE VARIABLES USED IN THE RESEARCH FOR THE FIVE LAST AVAILABLE YEARS (AUTHORS' WORK)

	2017	**2018**	**2019**	**2020**	**2021**
Current ratio	2,09	2,29	2,21	2,36	2,55
Debt-to-assets ratio	0,43	0,39	0,4	0,38	0,35
ROA	13,30%	15,02%	15,80%	17,64%	19,73%
ROE	25,29%	27,35%	29,40%	31,13%	32,94%
EBITDA margin	16,01	15,83	16,58	18,81	19,90
EBITDA	€ 139.255.585	€ 167.618.066	€ 203.810.154	€ 252.405.263	€ 323.860.871
Average monthly gross 2 salary per employee	€ 1.698	€ 1.858	€ 1.935	€ 2.011	€ 2.137
Days of sales outstanding	64,21	59,71	55,69	55,65	47,74

TABLE IV CLUSTERS` CHARACTERISTICS (AUTHORS' WORK)

Cluster	% of domestic capital	Current ratio	Debt-to-assets ratio	Efficiency of the overall business	ROA	ROE	Average monthly gross 2 salary per employee	Days of sales outstanding
1	99.8837	4.3234	0.4583	114.8768	0.1183	0.2227	935.47	72.3891
2	3.440945	4.3559	0.5148	116.9631	0.2058	0.4509	1996.47	43.4001
3	98.55187	18.342	0.1178	328.7169	0.5741	0.6603	648.24	50.2990
4	99.68144	4.9496	0.2943	155.7054	0.5543	0.8100	1053.44	43.1428

Cluster 4 is the largest cluster comprising most companies, followed by Cluster 1. Cluster 2 is the smallest. Table IV reports on the profiles of the four identified clusters.

Cluster 1 can be characterized as companies of Croatian ownership with the lowest current ratio and the longest days of sales outstanding. This is the cluster with the lowest profitability reflected both in ROA and ROE, with a monthly gross 2 salary per employee at the average level for the sector. Cluster 2 consists of foreign-owned companies with a low current ratio, medium debt-to-asset ratio, and medium profitability. This cluster has the highest average monthly gross 2 salary per employee.

Cluster 3 comprises companies characterized by the highest liquidity and the lowest indebtedness. The efficiency of the overall business is the highest in this cluster. However, this is not reflected in the monthly gross 2 salaries that are below average for the sector. On the other side, ROA and ROE are high. Cluster 4 consists of companies of average liquidity and low indebtedness. This is the cluster with the highest average ROE.

The Levene test results (p=0.000) showed the appropriateness of using the Welch test to test the difference in EBITDA growth rate between the four clusters. The Welch test showed that there is no statistically significant difference in the EBITDA growth rate between the four clusters (p=0.102), rejecting hypothesis H1.

VI. CONCLUSION

Products and services provided by software development companies are important to overall economic growth and development since the software industry has a high level of innovation that spills over to other industries and to research. Strengthening the software industry through institutional support can aid the overall economy since all industries rely on ICT to a greater or lesser degree [4]. It is important to understand the different characteristics of the companies in the sector to create entrepreneurship incentive policies and employment and self-employment policies.

The paper proved that cluster analysis based on financial data is successful in identifying four clusters in the sector of computer programming. This indicates potentially different needs of the companies belonging to different clusters in terms of incentive policies. Future research should complement financial indicators with other quantitative and qualitative variables. It would be interesting to see if the level of internationalization, the level of innovation, and the type of management strategy would improve the clustering model. Also, the more extended observation period of the EBITDA growth rate might yield a different result and should be used in future research.

ACKNOWLEDGMENT

This work has been fully supported by Croatian Science Foundation under the project UIP-2020-02-6312.

REFERENCES

[1] Republika Hrvatska Industrijska strategija Republike Hrvatske 2014. – 2020., Zagreb. Retrieved from http://www.mingo.hr/userdocsimages/industrija/Industrijska_strategija.docx. 2014

[2] T. Šmaguc and K. Vuković. "Institutional field in the Republic of Croatia: Perspective of entrepreneurs pertaining to computer programming activities," In Central European Conference on Information and Intelligent Systems (pp. 145-151). Faculty of Organization and Informatics Varazdin. 2017

[3] Republika Hrvatska. Ekonomska analiza sektora profesionalnih i poslovnih usluga, Zagreb. Retrieved from http://www.cut.hr/resources/publikacije/9/Ekonomska%20analiza%20sektora%20profesionalnih%20i%20poslovnih%20usluga.pdf 2014

[4] N. Vlahović, Lj. Milanović Glavan and A. Franković. "Comparative advantages of software industry in developing countries: Study of structure, market strategies and software development approaches in Croatian software companies," Recent Advances in Computer Science / Xiaodong Zhuang - Zakynthos Island, Greece: CSCC, 2015, 227-233, 19th International Conference on Computers (part of CSCC'15) Zakintos, Grčka, 16.07.2015. - 20.07.2015. 2015

[5] K. Vuković. "Enterprise size distribution in the Croatian software industry," Journal of International Scientific Publications: Economy and Business, 6. 2012

[6] Z. Kovačević and K. Vuković. "Performanse poduzeća u hrvatskom sektoru informacijskokomunikacijske tehnologije (ICT)," Ekonomska misao i praksa, 15(2):217-240, 2006

[7] Ministry of Economy. Industrial Strategy 2014 - 2020, http://www.mingo.hr/default.aspx?id=4980,April 12th 2014

[8] K. Vuković, D. Korent and I. Kedmenec. "Testing Gibrat's Law on software companies in Croatia," In Central European Conference on Information and Intelligent Systems (p. 86). Faculty of Organization and Informatics Varazdin. 2014

[9] Ecorys. FWC Sector competitiveness studies - competitiveness of the EU SMEs in the ICT services industry, http://ec.europa.eu/enterprise/sectors/ict/files/study_report_ict_services_en.pdf, downloaded: March 10th 2014.

[10] D. Korent and S. Orsag. "The impact of working capital management on profitability of Croatian software companies, "Zagreb International Review of Economics & Business, 21(1), 47-65. 2018

[11] G. Dukić, G. Kozina, and D. Dukić. "Croatian high-tech industry: Current state and prospects," Tehnički vjesnik, 26(2), 545-551. 2019

[12] K. Vuković and Z. Kovačević. "Economic impact of information and communications technology - Identifying its restraints and exploring its potential," In M. J. Er (ed.), New Trends in Technologies: Devices, Computer, Communication and Industrial Systems, Sciyo, Rijeka, pp. 119-134, 2010

[13] M. Klačmer Čalopa, J. Horvat and L. Kuzminski. "The role of human resource management practice mediated by knowledge management (Study on companies from ICT sector, Croatia)," TEM Journal, 4 2; 178-186, 2015

[14] T. Šmaguc. "Gender stereotypes in entrepreneurship process: evidence from the Croatian ICT industry," Economic and Social Development: Book of Proceedings, 52-60. 2020

[15] FINA (Financial Agency). "Infobiz platform," https://infobiz.fina.hr/, 2023

[16] R .S. Kaplan and A. A. Atkinson. "Advanced management accounting," (third ed.), 3 Prentice-Hall, USA. 1998

[17] S. Cohen, D. Thiraios and M. Kandilorou. "Performance parameters interrelations from a balanced scorecard perspective: An analysis of Greek companies," Managerial Auditing Journal, Vol. 23 Iss: 5, http://dx.doi.org/10.1108/02686900810875307, 2008.

[18] I. Kotane and I. Kuzmina-Merlino. "Assessment of financial indicators for evaluation of business performance," European integration studies, (6). 2012

[19] K. Žager and L. Žager, L. "Analiza financijskih izvještaja," second edition. MASMEDIA: Zagreb, 2008

[20] T. R. Robinson. "International financial statement analysis," John Wiley & Sons Inc., Hoboken, New Jersey. 2009