

The Evolution of Romanian Transportation Companies: Insights from Financial Data through a Machine Learning Approach

Gabriel DUMITRESCU

*Bucharest University of Economic Studies, Bucharest, Romania
dumitrescugabriel18@stud.ase.ro*

Adrian DOMENTEANU

*Bucharest University of Economic Studies, Bucharest, Romania
domenteanuadrian18@stud.ase.ro*

Elena Gabriela DOBRE

*Bucharest University of Economic Studies, Bucharest, Romania
dobregabriela10@stud.ase.ro*

Camelia DELCEA*

*Bucharest University of Economic Studies, Bucharest, Romania
Corresponding author, camelia.delcea@csie.ase.ro

Abstract. *The financial data of the companies reflects their performance, presenting the evolution and stability of the organization. Transportation area represents one of the most important sectors in the Romanian economy, thanks to the expansion of commercial international exchanges which is developing significantly in the recent years, thanks to the government investments in the highways and railways, that optimized the routes and minimized the costs. Multiple studies suggested that the transportation sector evolved in a significant manner in Romania, road transportation having numerous advantages compared with other types of transportation. The focus of the present research is on the transportation companies, which are characterized from the point of view of location, date of establishment, and county, together with the financial data such as Net Profit, Liabilities, Turnover, Fixed Assets, Current Assets, Shareholders Equity and Average number of Employees. Using Power BI and Jupyter Notebook, an overview on the data is performed with the purpose of identifying patterns among the companies based on the county, average number of employees or date of establishment. Using Python programming language, statistical information of the selected companies has been explored, as well as the clusters formed based on the considered features. The outcome of the research could be useful for researchers, aiming to contribute to the investigated area by highlighting the importance of the transportation sector in the Romanian economy.*

Keywords: Transportation; Romania; Machine Learning; Financial Data; Dashboard; Python

Introduction

The Romanian transportation sector growth significantly especially after the liberalization of the activities, apart from the railway area where the Government controls the freight company, representing a strategic interest. In the last decade of the 20th century, Romanian Government tried to save as much funds as possible, imposing limitations on fuel and transportation, resulting in a negative impact on the entire industry, leading in the end to a collapse of the domain, due to the lack of economic principles (Fistung et al., 2015).

Starting with 21st century, the Romanian government developed for the transportation domain numerous strategies, that improved the efficiency and security of people and cargo

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transports (Popescu & Fistung, 2015). Between 2002 and 2022, the country with highest increase of motorization rate among European Union Member States is Romania, having an annual growth average rate of 5.7%. Bucharest-Ilfov has the second highest number of motor coaches, buses and trolleybuses among the European Union, with a total of 4.8. On the same time, the North-East and Southern-Muntenia regions of Romania have one of the lowest motorization rate from EU, which points out the significant levels of investments of the Government in different regions of the country (Eurostat, 2024).

The road transportation is the most common mean of transportation used in practice, having multiple advantages, according to Isai and Radu (2013) such as the small amount of investments required, compared to naval or air transport, the monthly expenses (fuel, road taxes, divers facilities) represents a small percentage compared with the turnover. If something happens on the road and it's not possible to continue, it has the possibility to use rail or naval methods.

The contribution to the Gross Domestic Product (GDP) of the transportation industry increased from 4.9% in 1990 to 10.2% in 2005, while the value added taxes represented in 1990 5.4% while in 2005 represented 11.5%. The goods and passengers road transport had a positive trend, increasing by 10.55 times in 2011 compared to 1990 (Fistung et al., 2015). Florescu et al. (2018) presented the transport sector of Romania, which had approximately 7% share of GDP. Road transportation provided almost 78.5% of total freight transport and 70% of passenger transport. For Romania, there is a strong correlation between the development of transportation sector and the economic growth (Marin & Olaru, 2015).

Railway sector has a negative trend in Romania, not only on the passenger transport, but also on freight transport, as it was presented in the research of Raicu et al. (2022).

Taking into account the purpose of the analysis, which is to dive deep into the accounting information of transport companies from Romania, an exploratory investigation has been performed. In the section of methodology, the technologies and methods that have been applied will be presented, while in the results and conclusion sections detail the outcomes of the research.

Methodology

The data that was included in the analysis contains information about the most important 100 transport companies from Romania. The name of the company, date of establishment, city, address, county, turnover, net profit, liabilities, fixed assets, current assets, shareholders' equity, average number of employees and the investigated year has been extracted from the ListaFirme (2025) website.

In order to create the dashboard, Power BI has been used. It should be mentioned that Power BI is a software offered by Microsoft, representing a business intelligence and analytics platforms, providing the possibility to connect in cloud services multiple users and to create interactive graphs (Lachev & Price, 2018). Frayudha and Agung (2024) implemented in Power BI a dashboard which included the transportation data from Jakarta, Surabaya and Bandung, presenting also the employees metrics such as productivity. A comparison among multiple business intelligence tools, such as Power BI, Tableau, Qlik View, Micro Strategy and Pentaho has been performed from 3 different perspectives: marketing, financial and transportation services (Reddy et al., 2019). The outcome of the analysis was that Power BI is suitable for all three types of analysis. Using the Power BI application, an interactive dashboard for the transport companies has been created, defining a Romanian map where each company is located in a specific county, being much easier to observe the distribution of businesses.

Dashboards appear as a solution for the complex and various data that appeared in the last years, multiple factors lead to the existence of dashboards such as the lack of organization in the data, the differences between information processing and decision-making activities and the integration of an application in the cross-departmental processes. Using a dashboard, the information can be much easier monitored, planned, communicated and checked the consistency of the data (Pauwels et al., 2009).

Python is an object-oriented programming language that can be applied in a variety of areas, developed by Guido van Rossum, supporting numerous programming paradigms. The Python community, according to Srinath (2017) is the third biggest in the world. Python is the 4th most utilized programming language on GitHub platform and is the second most requested skill. On the same time, is the skill which offers the highest mean salary (Srinath, 2017). Hou and Ji (2024) analyzed the programming language performance on large language models and Python was the best algorithm. Python is also suitable for corporate financial problems, by using the data processing and analysis tools. Even if Python still have elements to improve in the financial area, it has the potential to become one of the greatest solutions (Xu, 2024).

Using Python programming language, an exploratory data analysis has been performed, extracting the main information on the financial data of the transportation companies. Furthermore, the dimensionality of the data has been reduced using Principal Component Analysis (PCA) algorithm, then the data was grouped using K-Means model. Multiple number of clusters has been tested, and using Silhouette Score, the optimum number has been extracted. In the end, interactive graphical representation of the clusters has been obtained on Power BI and Python. The process of clustering is conducted through an unsupervised Machine Learning (ML) algorithm, focusing on grouping multiple objects or attributes in multiple ways based on the similarities. There are numerous methods of clustering, based on partition, grid, density, hierarchy or model based (Saxena et al., 2017). ML is an artificial intelligence (AI) technology which is implemented in general to predict or automate tasks, encompassing a variety of models and algorithms which can be applied in numerous areas (Carleo et al., 2019; Jordan & Mitchell, 2015). The unsupervised learning method is also known as “learning without a teacher”, represents a ML algorithm which has the scope of grouping the variables based on probability density without interfering with a teacher or supervisor (Hastie et al., 2009).

Standard deviation is an important statistical metric that is used, together with the mean, to determine if a dataset is normally distributed or not. The division between mean square difference by number of elements – 1, resulting the data variance. The square root of data variance represents the standard deviation value (Livingston, 2004).

Silhouette score is a metric used in ML, used to measure the performance of the clustering, based on the data similarity of each cluster that is part of it and how different the clusters are. The metric is implemented especially when the K-Means algorithm is implemented, being one of the most known methods for grouping the data, by identifying the subgroups in order to be homogenous (Dabbura, 2022; Gültekin, 2023).

PCA Analysis serves as one of the main algorithms for dimensionality reduction, by combining features which explains the variance of the data, being easy to be implemented in Python or R programming languages (Greenacre et al., 2022).

Median represents a statistical indicator that measures the center of the values, representing an alternative for the mean (Bakker & Gravemeijer, 2006). The median value is the center number and it can be more relevant for a dataset, especially when there are outliers, which affects the mean (Ganti, 2024).

Accounting have evolved significantly in the last century, from a domain which recorded, summarized and classified the transactions and money, providing a financial direction of the results, according to the American Institute of Accountants (1953)., to a domain that measures the performance of the companies to a number of stakeholders of managers that are part of the organization, as Deegan (2019) explained in his paper.

Turnover, for the accounting companies represents a crucial metric, including collecting receivables, inventory that has been sold or the employees that has been replaced or the percentage of investment portfolio (Kenton, 2024).

Net Profit includes the total revenue that has been generated after business activity has been finalized. The profit obtained is also known as gross profit, is calculated as part of the costs of goods and services that has been sold from the revenue, representing an important metric for efficiency and competitiveness of the company on the market (Hayes, 2024a). The net profit is obtained based on the gross profit. Starting from gross profit, the total costs and expenses should be taken into account, together with the existing taxes on each market and country (Boyte-White, 2024).

Liability is a sum of money that the company owes to another company, which should be paid in a certain period of time, otherwise penalties could appear. The liabilities appear in the balance sheet, together with the bonds, mortgages or loans, and it represents for the firm a risk which should disappear as fast as possible. Liabilities could be recurring or non-recurring, in the short term or on long term (Hayes, 2024b).

Fixed Assets contain the long-term assets, such as equipment, buildings, and properties which have a life expectancy longer than one year. Current Assets include the short-term assets which are in general utilized in the same year, having a very high frequency of usage, in daily business activities. For businesses, it is crucial to distribute the capital in an optimal manner and to finance the investments correctly. For the transport companies, in general, the fixed assets are the vehicles, trailers and any other equipment that is used in daily activities, while the current assets include the cash, existing inventory, buildings or expenses (Nickolas, 2024a).

Shareholders' Equity is the net worth of the business or the amount of money that should be returned to the stakeholders if every single asset is sold and all debts are paid, representing an important metric for the financial situation, available on the balance sheet. The scope of the shareholders' equity is to quantify the fiscal health of the company. In order to calculate the shareholder's equity, a difference between total assets and total liabilities should be performed (Bloomenthal, 2024).

Average Number of Employees is a metric that was included in the analysis in order to measure the size and to quantify the dynamics among the companies.

Results

The data that has been collected from ListaFirme (2025) website was imported in Power BI as an Excel file and in Figure 1 is described the dashboard formed by eight figures. On the top left part of Figure 1 graph (A) is located, which contains the Romanian map with the companies, each one positioned geographically in the specific county. The size of the bubble reflects the number of employees, the higher it is, the bigger the number is. For instance, in Dolj county there are 425 employees on average, while in Iasi county, there are on average only 47 employees and in Timis there are 74 employees.

In graph (B), from Figure 1, is presented the Turnover of each county, and in this case, Sibiu county bubble is much higher compared with the previous figure, having an average turnover of 97.206.148 RON, in Harghita the turnover is 3.139.844 RON and in Dolj is 155.229.051 RON.

In third graph, (C), in Figure 1, is presented the standard deviation of shareholders' equity, having higher values in the south part of the Romanian and in the center of the country, pointing out the significant differences among companies. For instance, in Sibiu, which was one of the counties with the highest turnover, the standard deviation is 20.941.971 RON, compared to Teleorman where it is only 891.134 RON. A high value was found in Bucharest, with a total of 9.342.404 RON.

The last map, (D), in Figure 1, includes the median of shareholders equity for each county, in RON. The most significant county is Dolj (2.503.170 RON), together with Constanta (5.851.501 RON), Buzau (6.739.086 RON) and Brasov (5.191.172 RON). The smallest values were registered in Bistrita-Nasaud county (331.875 RON), Satu Mare (620.807 RON) and Suceava (165.436 RON).

Graph (E) in Figure 1 includes the mean liabilities and turnover per year for all companies. The trend for both of the metrics is positive, starting from 2005 with a small value and increasing year by year. The turnover had a faster growth, starting from a value of 5.141.189 RON in 2005, achieving in 2016 24.119.105 RON and the peak was registered in 2023, with a value of 40.210.873 RON on average. It is visible that the gap between liabilities and turnover increased year by year.

Graph (F) in Figure 1 explores the mean shareholders equity, fixed assets, current assets and net profit calculated as percentage of grand total yearly. At the beginning of the period, in 2005, all 4 metrics had positive values, shareholders' equity 23.67%, fixed assets 43.41%, current assets 21.13%, net profit 32.10%. Up to 2007, the trend was positive for all 4 metrics, but starting with 2008, when the financial crisis effects started to impact the companies. Due to the fact that the transport sector is strongly correlated with the globalization, during the financial crisis, the industry was heavily affected (Rothengatter, 2011). For instance, in 2007, the shareholders' equity was 45.66%, the fixed assets level was 76.30%, the current assets value is 36.52%, while the net profit is 46.89%. In 2008, the shareholders' equity decreased by 4%, to 41.04%, while the fixed assets increased to 80%. The current assets also increased by 4% to 40.82%, while the net profit registered a dramatic decrease, from 46.89% in 2007 to -1.0% in 2008, showing the impact of the financial crisis on the entire economy, not only in the transport sector. The trend was similar in 2009 and 2010, when the net profit was negative (-2.83% in 2009 and -2.15% in 2010), but starting with 2011, the trend changed the direction and started to increase significantly, having a shareholders' equity of 61.36%, 14% increase compared with 2010, fixed assets have a value of 93%, 11% increase compared with 2010, fixed assets have 48.52%, 2% increase compared with 2010, while the net profit increased from 2010 when the value was -2.15% to 76.78%. The peak was in 2023, when the net profit value was 221.05%, the shareholders' equity value was 194.14%, current assets value was 187.43%, while the fixed assets value was 165.32%.

Graph (G) in Figure 1 focuses on the maximum current assets for each county. The highest registered value was in Sibiu county, with a value of 1.333.243.660 RON (100% of Grand Total), followed by Cluj with 119.681.000 RON (89.82% of Grand Total), Arad with 101.564.965 RON (76.22% of Grand Total), Iasi with 67.426.464 RON (50.60% of Grand Total) and Dolj with 67.141.414 RON (50.39% of Grand Total). The smallest values were in Suceava with a value of 973.561 RON (0.73% of Grand Total), Hunedoara which have 1.290.746 RON (0.97% of Grand Total), Harghita with a value of 1.842.917 RON (1.38% of Grand Total), Mehedinti with a value

of 2.353.510 RON (1.77% of Grand Total) and Gorj which have a value of 2.423.354 RON (1.82% of Grand Total).

Graph (H) in Figure 1 presents the standard deviation for the mean number of employees per county. The highest volatility was registered in Sibiu county with a value of 283 employees, followed by Dolj with a value of 197 employees, Timis with 152 employees, Cluj with 114 employees and Arges with 113 employees. The counties with the smallest volatility are Hunedoara, with 3 employees, Vrancea with 3 employees, Suceava with 4 employees, Teleorman with 6 employees and Mehedinti with 6 employees.

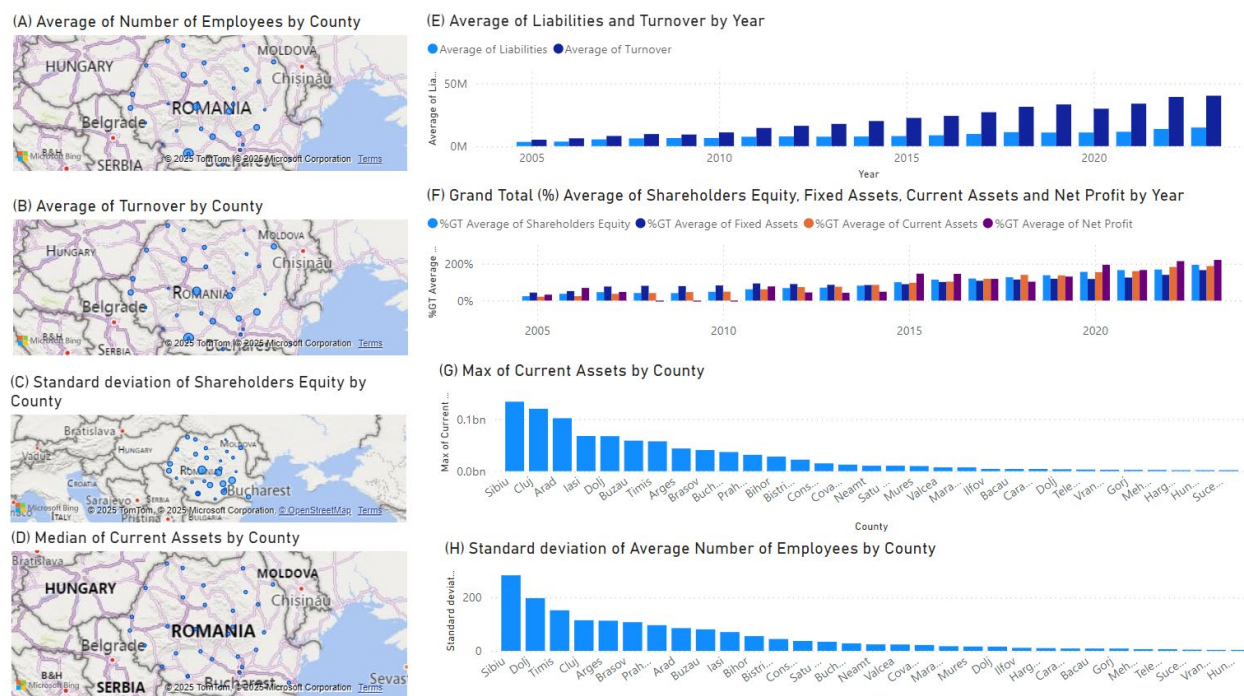


Figure 1. Dashboard in Power BI of 100 Transportation Companies: (A) Mean number of Employees per County, (B) Mean Turnover by County, (C) Standard Deviation of Shareholders' Equity per county, (D) Median Current Assets per County, (E) Average Liabilities and Turnover per year, (F) Grand Total (%) for average shareholders' equity, fixed assets, current assets and net profit per year, (G) Maximum of Current Assets per county, (H) Standard deviation of average number of employees per county

Source: Authors' own research.

The dataset that has been used in Power BI was imported in Python programming language, for a depth investigation among the financial data of the companies has been conducted, grouping also the companies based on similar information on clusters.

In order to perform the clustering, a transformation of the categorical data has been performed, in order to be taken into account. Using *LabelEncoder()* function, the county and City values were transformed into 0 and 1 values.

Figure 2 presents the dataset after using the *LabelEncoder()* function, but before the city and county columns to be dropped.

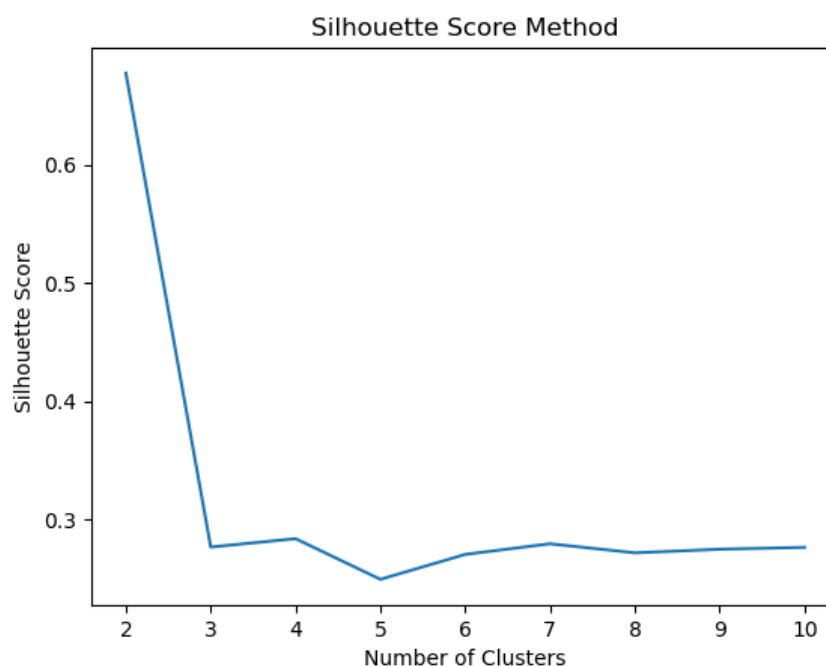
	Company Name	Date of Establishment	City	County	Year	Turnover	Net Profit	Liabilities	Fixed Assets	Current Assets	Shareholders Equity	Average Number of Employees	City_encoded	County_encoded
0	M.M.M. TRANS COMPANY SRL	2006-01-01	Loc. Arad	Arad	2023	19061054	1157367	9854763	4191706	6709142	1457438	62	0	1
1	M.M.M. TRANS COMPANY SRL	2006-01-01	Loc. Arad	Arad	2022	33986906	11503819	13613323	5205302	19574489	11733890	63	0	1
2	M.M.M. TRANS COMPANY SRL	2006-01-01	Loc. Arad	Arad	2021	26717357	7424288	10207039	8507544	8627287	7608159	66	0	1

Figure 2. Transformation of the data using LabelEncoder function

Source: Authors' own research.

The city and county categorical values have been dropped, and from the year was extracted from date of establishment. The columns that were kept into analysis for clustering are: City_encoded, County_encoded, Year, Turnover, Net Profit, Liabilities, Fixed Assets, Current Assets, Shareholders' Equity and Average Number of Employees. The dataset have been standardized in order to reduce the gap between the data, centered around mean, using *StandardScaler* function (Alam, 2024).

The silhouette model suggests the optimum number of clusters that should be taken into consideration while grouping the companies, as it is presented in Figure 3. In our case, the value of 2 represents the best scenario to group the transportation companies. After the clustering process, the investigation focused on extracting the main information from each group of companies.



Optimal number of clusters based on silhouette score: 2

Figure 3. Optimal number of clusters using Silhouette Score Method

Source: Authors' own research.

K-Means clustering method have been used to group the data, based on the number of clusters suggested by silhouette score method, resulting two groups, on colored in red, one colored in blue, according to Figure 4. The blue cluster is grouped in the left part of the plot, while the red cluster is distributed among the entire graph.

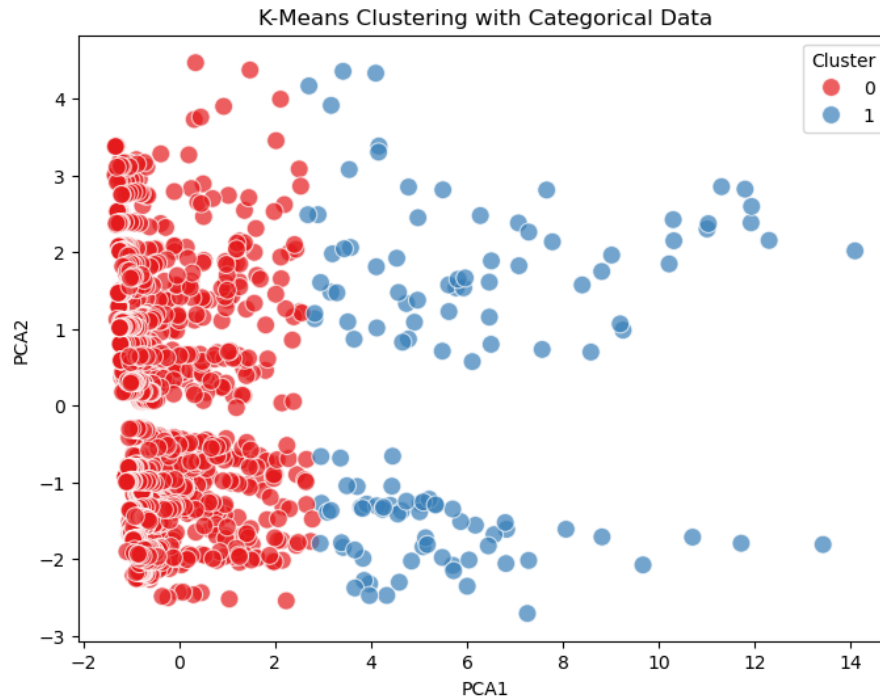


Figure 4. Clustering transportation data using K-Means

Source: Authors' own research.

Figure 5 explores the distribution of the 5 biggest companies in each cluster, based on the number of employees. Cluster 1 contains 64.4% of the biggest companies (4066 employees), while cluster 0 contains 35.6% of the largest companies (2243 employees).

Employee Distribution Among Top 5 Companies in Each Cluster



Figure 5. Distribution of top 5 biggest companies of employees on each cluster

Source: Authors' own research.

Figure 6 included the average profit per cluster. Cluster 1 contains the majority of the net profit, having a total of 3.198.924 RON (88.5%), while cluster 0 has only 414.214 RON (11.5%), showing the significant difference that is between the clusters.

Average Profit per Cluster



Figure 6. Mean profit per cluster

Source: Authors' own research.

Figure 7 presents the average liabilities per cluster. Cluster 1 is the most important, having an average liability of 56159949 RON (91.8%), while cluster 0 has an average liability of 5028142 RON (8.22%).

Average Liabilities per Cluster



Figure 7. Mean Liabilities per cluster

Source: Authors' own research.

Figure 8 includes the mean current assets for each cluster. The most representative cluster is 1, with a value of 38653496 RON, which represents 92.4% of total current assets, while cluster 0 has a value of 3174028 RON which represents 7.59% of total current assets.

Average Current Assets per Cluster



Figure 8. Mean Current Assets per cluster

Source: Authors' own research.

Figure 9 defines the standard deviation of fixed assets for each cluster. Similar with the previous graphs, cluster 1 is the most representative, having 81.2% of the pie chart (26.832.173 RON), while cluster 0 has only 18.8% (6.214.603 RON).

**Figure 9. Standard Deviation of Fixed Assets per Cluster**

Source: Authors' own research.

Figure 10 focuses on the standard deviation of shareholders' equity for each cluster. Cluster 1 has a much higher standard deviation, of 16.423.087 RON (81.7%), compared to cluster 0 which has only 3.686.529 RON (18.3%).

Standard Deviation of Shareholders Equity per Cluster

**Figure 10. Standard Deviation of Shareholders' Equity per Cluster**

Source: Authors' own research.

Figure 11 grouped the maximum number of employees of the biggest companies from each cluster. The cluster 1 is represented by *Duvenbeck Logistik SRL* company, which had a peak of 834 employees, which represents 58.2% compared to cluster 0 company, *Gartner Eurotrans Romania SRL*, which had 598 employees, which represents 41.8% of total employees.

Highest Number of Employees per Cluster (Top Companies)

**Figure 11. Number of Employee per Cluster for biggest companies**

Source: Authors' own research.

Figure 12 grouped the most common counties based on their frequency of appearance. The most important county based on the number of companies is Bucharest, with a value of 11 (28.2%),

followed by Arad with 9 companies (23.1%), Bihor with 7 companies (17.9%), Prahova with a total of 6 companies (15.4%) and Timis, having 6 companies (15.4%).

Top 5 Counties by Occurrence



Figure 12. Top 5 most frequent counties

Source: Authors' own research.

Conclusion

The transportation domain evolved in a significant manner in the last 20 years, thanks to the economical evolution of the domain, together with the investments that the government. All financial indicators experienced a positive trend during the timespan. A high shareholders' equity reflects that a significant number of assets are financed by the shareholders instead of acquiring it using borrowed cash (Corporate Finance Institute, 2025). If the fixed assets value is increased, it offers the possibility to the company to develop the production level and the investments and acquisition are more likely to generate profit (Fatima, 2024). The current assets value indicates the possibility of paying current expenses on short terms (Nickolas, 2024b). Net profit is one of the most important financial metrics that suggest the rewarding level of the company. The higher the net profit is, the better it is. Regarding the liabilities, it is the opposite to net profit, but it is also important to analyze the way that the money is spent.

In conclusion, the majority of the companies developed in all segments, which is visible in the financial indicators, even if during the financial crisis the profit decreased significantly and the liabilities growth, the firms managed the difficult situation, achieving high profits, especially in the last years.

The future research will focus on investigating in more details the transportation companies, by predicting the future values for the financial indicators, together with fiscal metrics, GDP per county, net salary per county, unemployment rate or inflation. Since the world is focusing more and more globaliation, the international transport for goods and people became crucial, not just for academical community which developed numerous methods and solutions to optimize the routes, in order to maximize the profits and minimize the time spent in traffic, but also for the governments and shareholders.

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