

Theses of the University Doctoral (PhD) Dissertation

FINANCIAL PERFORMANCE ANALYSIS OF HUNGARIAN E-COMMERCE COMPANIES

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1. BACKGROUND, OBJECTIVES AND PRESENTATION OF THE RESEARCH HYPOTHESES

The importance of corporate performance measurement is emphasised in both international and domestic literature. One of the most dynamically developing areas of today's economy is electronic commerce, which—due to technological advancement, globalisation and changing consumer habits—has demonstrated significant growth in Hungary as well over the past two decades (Welsz, 2018; Zentai, 2018). Online sales not only opened new market opportunities but also fundamentally transformed the operation of businesses and their competitive environment. Entering the online space poses particular challenges for company leaders, as—unlike in traditional retail—new expectations, rapidly evolving market dynamics, and distinct consumer behaviours shape business success (Sadler-Smith et al., 2003).

The economic significance of e-commerce in Hungary is shown by the fact that the ten largest e-retailers achieved a combined turnover of 92 billion HUF in 2015, representing 34% of online retail sales, associated with more than 4.7 million purchases (GKI Digital, 2018). Growth in the market, however, is highly concentrated: major players expand more rapidly, while smaller enterprises may find specialisation a viable strategy. Consequently, the structure of the domestic e-commerce market is continuously transforming, which necessitates an in-depth analysis of financial performance and the development of appropriate measurement tools.

There are numerous methods for measuring corporate performance described in the literature, yet in Hungarian practice, accounting-, financial-, and cost-based indicators dominate (Musinszki, 2013; Neely et al., 1995). Traditional approaches to financial performance measurement primarily rely on accounting data and cost-based indicators. These include profitability ratios (e.g., ROA, ROE), liquidity ratios, indebtedness indicators, and efficiency metrics. These measures are easy to calculate and readily available from financial statements, which explains their widespread use in Hungary (Fenyves & Dajnoki, 2015; Musinszki, 2013). Liquidity, profitability, and efficiency ratios continue to play a central role in evaluating corporate performance; however, digitalization has highlighted new measurement perspectives as well.

A fundamental limitation of classical financial indicators is that they rely on past data, thus restricting opportunities for timely corrective action, as companies can react to unfavourable changes only with a delay. Another issue is their focus on short-term results; taxation strongly affects these indicators, which may distort outcomes (Csáki-D., 2017). Nevertheless, the use of financial indicators remains necessary.

Value-Based Management has become a significant contemporary approach. Investors expect a return at least equal to the cost of capital. The Capital Asset Pricing Model (CAPM) provides a basis for estimating the required business results relative to the capital invested in operations. This makes it possible to determine the cost of equity. The capital structure represents the combination of funds used to finance investments in real assets (Myers, 2001).

International literature increasingly emphasises that business performance is a multidimensional construct in which, in addition to financial indicators, non-financial factors—such as customer satisfaction,

innovation capacity and sustainability—play an essential role (Kaplan & Norton, 1992; Richard et al., 2009; Lebas, 1995). Performance management frameworks include traditional indicators, modern integrated systems (e.g., Balanced Scorecard, Performance Prism), and newly applied efficiency models such as Data Envelopment Analysis (DEA), all of which support comprehensive corporate evaluation (Eccles, 1991; Barney, 1991). Integrated indicator systems are gaining prominence, incorporating strategic and non-financial dimensions alongside financial factors. Concepts such as the Balanced Scorecard (Kaplan & Norton, 1992), the Performance Prism (Neely et al., 2004), and the Triple Bottom Line (Braun, 2013) highlight that sustainable competitive advantage is not based solely on financial results but also on consumer satisfaction, operational efficiency, and learning capability.

Measuring and evaluating financial performance is a fundamental determinant of corporate operations and competitiveness. Financial performance provides feedback on the effectiveness of past decisions and serves as a predictor for future operations (Wimmer, 2004). Performance measurement provides critical information for managerial decision-making, strengthening investor confidence, and ensuring long-term sustainability (Eccles, 1991).

International literature widely recognises that corporate performance is a multidimensional concept requiring integrated analysis of financial and non-financial factors (Kaplan & Norton, 1992; Richard et al., 2009). Nevertheless, financial performance indicators—such as revenue, profit, return ratios, and liquidity—remain central, as they underpin companies' short- and medium-term survival (Musinszki, 2013). Financial analysis helps assess corporate stability and profitability and provides reliable information for creditors and investors. Richard et al. (2009) view corporate performance as a multi-dimensional construct integrating financial, market, and operational outcomes.

The significance of financial performance measurement also lies in enabling comparisons across firms, sectors, regions and countries. Due to globalisation and digitalisation, competitive conditions are constantly evolving; financial indicators allow assessment of a firm's adaptability to market changes (Porter, 1985). Performance measurement must serve value creation, which has become a key element of modern management approaches (Csáki-D., 2019).

The resource-based view (Barney, 1991) also contributed to the reinterpretation of performance measurement: long-term success is determined by intangible resources that are difficult to imitate, such as knowledge, innovation capacity and brand value. Accordingly, modern performance indicators focus not only on short-term profitability but on the sustainability of long-term value creation.

The dynamic development of e-commerce presents fundamentally new challenges for financial performance measurement. Due to digital sales channels, online platform transactions and automated logistics, cost structures differ significantly from those of traditional commerce.

The key characteristics of e-commerce enterprises include:

- Lower fixed costs but high technological investments – the absence of physical stores reduces operating expenses, yet digital infrastructure, web development, cybersecurity and logistics require significant expenditures (Welsz, 2018).
- Liquidity challenges – rapidly growing online firms often face capital shortages due to a greater time gap between revenues and expenses compared with traditional commerce.
- Profitability and price competition – strong price competition in the online market often results in low margins, making profitability difficult to maintain (Zentai, 2018).
- Rapid response and flexibility – frequent and fast shifts in consumer demand and market trends require strong adaptability, which is reflected in financial indicators as well.
- Regional differences – significant performance gaps exist between e-commerce firms in Budapest and rural regions in Hungary, linked to economic development, infrastructure, and consumer habits (GKI Digital, 2018).

E-commerce simultaneously relies on lower fixed cost bases and significant technological investment, resulting in a financial structure distinct from that of traditional retail. The specific characteristics of the e-commerce sector justify the inclusion of digital performance indicators alongside classical financial measures. The Balanced Scorecard framework, for example, can be extended with online-specific metrics such as conversion rate, cart abandonment rate, and delivery time (Kaplan & Norton, 1996). The Balanced Scorecard model marked a milestone by demonstrating that, beyond financial indicators, strategic success requires considering non-financial factors such as customer satisfaction, operational processes and organisational learning.

The Triple Bottom Line model enables e-commerce enterprises to evaluate their activities not only economically but also socially and environmentally—for instance, through sustainable logistics, environmental impact of packaging, or job creation (Braun, 2013).

Efficiency models such as Data Envelopment Analysis (DEA) can also be applied to e-commerce firms, as they evaluate multiple inputs (costs, asset base) and outputs (revenue, profit, customer numbers) simultaneously (Eccles, 1991).

Reports of international organisations—including the OECD (2020), Eurostat (2021), and UNCTAD (2022)—highlight that e-commerce is a global engine of economic growth, making performance measurement essential for assessing competitiveness. Domestic studies (GKI Digital, 2018; Braun, 2013) show that while the Hungarian market is expanding dynamically, most enterprises are SMEs, where professional performance management tools are still underdeveloped.

Although international literature extensively discusses financial and non-financial performance indicators in e-commerce, in Hungary, relatively few comprehensive empirical studies have been conducted on the subject (Csáki-D., 2017). Statistical data are available, but complex performance measurement models (Balanced Scorecard, DEA, Triple Bottom Line) are not yet widely applied. Regional comparisons are also

lacking, which could reveal differences arising from economic development, consumer behaviour and logistics conditions.

This research fills an important gap by analysing the financial performance of Hungarian e-commerce enterprises using a multidimensional approach that integrates classical indicators with modern performance management tools. This is not only scientifically relevant but also practically beneficial, as it may support managerial decision-making and contribute to the sector's sustainable development.

To date, few comprehensive analyses have examined the financial performance of Hungarian e-commerce firms. While statistical data exist, applying less common measurement methods and exploring regional differences can yield valuable new insights. According to the Opten database, approximately 5,739 enterprises in Hungary engage in online retail as their main activity, including 121 in Hajdú-Bihar County. Regional-level analysis enables the identification of financial performance inequalities.

Main Objectives of the Research

- 1. Review of the Literature** – Exploring the theoretical frameworks of performance measurement and management, with special emphasis on the characteristics of e-commerce.
H1: It can be assumed that in the performance measurement practices of domestic e-commerce businesses, the emphasis is placed more on ex-post control than on decision support aimed at improving performance.
- 2. Mapping Performance Measurement Practices and Identifying Managerial Needs** – Identifying the financial and non-financial indicators actually used by domestic e-commerce companies through a questionnaire-based survey. Analysing decision-makers' expectations and information needs related to performance measurement.
H2a: It is assumed that e-commerce companies prefer financial and accounting indicators.
H2b: It is expected that non-financial indicators (customer satisfaction, logistics performance, innovation) receive less emphasis.
- 3. Examining Regional Differences** – Comparing financial performance indicators across regions and uncovering territorial heterogeneity.
H3: It can be assumed that the financial performance of e-commerce businesses differs significantly depending on the economic development of the region.
- 4. Analysis of Non-Financial Dimensions** – Examining the impact of customer satisfaction, digitalization, innovation, logistics performance and other factors on financial outcomes.
H4a: Quality is a key competitive factor for e-commerce businesses.
H4b: It is expected that time as a competitive factor is less consciously recognized by companies.
H5: It can be assumed that the factors determining the performance of online and traditional commerce are similar, but in the online environment the ability to react quickly is more emphasized.
H6a: It is assumed that there is a significant relationship between financial performance and non-

financial factors (e.g., innovation, logistics, human resources).

H6b: Customer satisfaction and loyalty are expected to have a positive, indirect effect on financial indicators.

H6c: It can be assumed that a higher level of digitalization and automation improves financial performance.

H7: It is expected that businesses with a specialized product range achieve more sustainable long-term financial performance than those offering a wide portfolio.

5. **Development of an Integrated Model** – Systematizing the examined indicators within the logic of the Balanced Scorecard, and proposing a complex performance measurement framework for businesses.

H8: It is expected that less widespread efficiency models (e.g., Balanced Scorecard) can be successfully applied in performance measurement for profit-oriented e-commerce enterprises.

6. **Analysis of the Impacts of COVID-19** – Examining the short- and long-term effects of the pandemic on the financial performance of businesses of different sizes.

H9a: It can be assumed that COVID-19 had a positive short-term impact on e-commerce turnover.

H9b: It is likely that in the long term the dominance of larger companies strengthened, while smaller businesses faced capital and competitiveness challenges.

Overall, the aim of my research is to examine the financial performance of domestic e-commerce enterprises both comprehensively and in regional comparison. The study seeks to uncover performance differences across regions, present the decision-support needs of company managers, and identify the factors—such as digitalization, specialization, or customer satisfaction—that may form the foundation of long-term sustainable and competitive operation in e-commerce.

2. DESCRIPTION OF THE DATABASE AND THE APPLIED RESEARCH METHODS 2.1

2.1. Basis of the Secondary and Primary Research

The starting point of my dissertation was an extensive secondary literature review, the aim of which was not only to gain a deeper understanding of the topic and identify research gaps, but also to create a theoretical framework on which the primary research could be built. During the literature review, I used relevant Hungarian and international scientific books and journal articles.

In line with the research objectives, I applied quantitative methods supported by secondary analyses based on the reviewed literature. To complement the quantitative data, I also conducted interviews with managers of e-commerce enterprises. The purpose of these interviews was to explore which indicators and methods are used in practice to measure performance, and how managers evaluate the role of financial and non-financial aspects in decision-making. Using the method of in-depth interviews, I aimed not only to understand the participants' opinions but also the underlying reasons behind them. The interview results contributed to interpreting the findings and refining the research hypotheses.

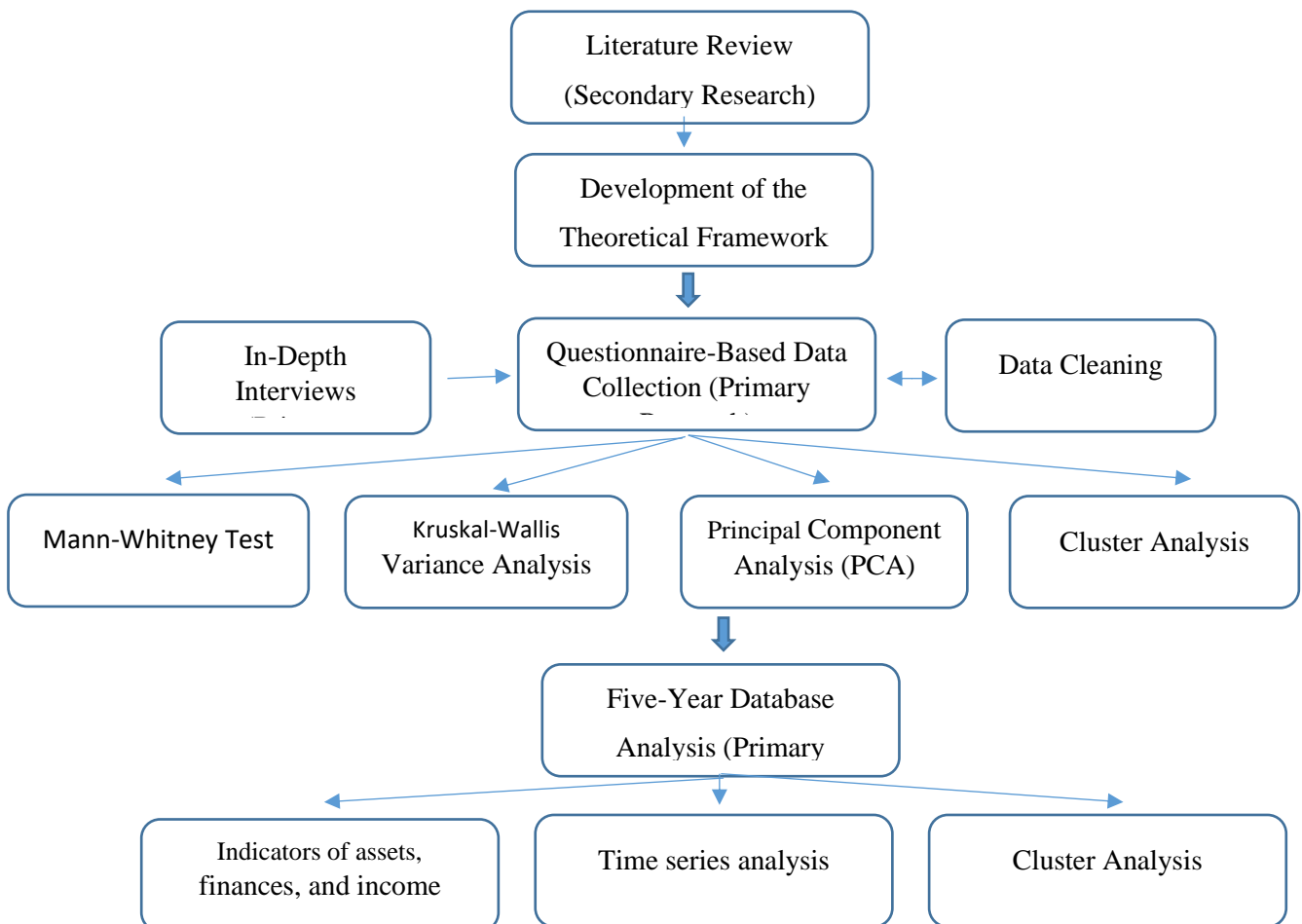


Figure 1: Research Methodology Flowchart

Source: Author's own compilation

2.2. Methodology of the Questionnaire Survey

The primary goal is not the measurement of performance itself, but its management and improvement. To enhance performance, it is essential to understand the causal relationships within business operations and the interactions among different performance elements. Uncovering and understanding these connections can support the development of performance measurement systems that aid operations and contribute to improving corporate performance. This was facilitated by the questionnaire survey conducted as part of the research.

Using a questionnaire survey, I assessed the performance measurement practices of e-commerce businesses. First, I defined the objective of my study with the help of an initial model, and then I designed the questionnaire. The survey consisted of 24 questions in two main sections. I divided the questions into nine groups, which comprised the following blocks:

- Basic information about the business: respondent's position, company size, ownership structure, location, product categories sold
- Questions related to performance objectives
- Restraining factors
- Risk factors
- Questions concerning the tools and methods of performance measurement
- Questions related to actual and expected performance: operational performance
- Questions related to actual and expected performance: financial performance
- Questions related to actual and expected performance: market-based performance
- Questions on the evaluation of measured performance

In the first part of the questionnaire, I collected basic data about the business, such as the respondent's position, company size, ownership structure, geographical location of the headquarters, the share of e-commerce revenue, and the range of products sold. These data support the grouping and comparison of the responses.

The second part of the survey included questions related to performance objectives, followed by restraining and risk factors. These were then followed by questions concerning performance measurement tools and methods, questions regarding the actual and expected performance, and questions addressing performance evaluation.

Likert scales are often used in quantitative research to measure attitudes related to a given concept or activity, for example in market research or personality tests (Mayer, 2018). In my questionnaire survey, I used this approach to define the concept of performance.

Most of the questions used a 5-point Likert scale (Horváth, 2004), which allows for quick data processing. Respondents express their opinion on various statements by placing themselves between two extreme endpoints (Zerényi, 2016). I applied the 5-point Likert scale, where 1 indicated "not important at all," and

5 represented the “most important.” Such scales reveal the internal structure of the measured phenomenon and indicate the presence or absence of certain evaluated attributes. Opposing characteristics—such as good–bad or satisfied–dissatisfied—are located at the ends of the scale. The Likert scale is thus an interval-like measurement scale used to assess attitudes.

The survey was conducted through a mailing system suitable for sending newsletters as well. During data collection, the questionnaire was sent multiple times to the same address database. Based on experience, in some cases telephone follow-ups were also necessary to increase the number of responses. The responses were aggregated in an Excel file, which enabled further data analysis. A total of 224 responses were received; to ensure representativeness, the responses were cleaned, and 200 valid questionnaires were analysed.

The questionnaire survey was predominantly completed by businesses whose average basket value was below HUF 30,000, accounting for 54% of all respondents. In terms of geographical distribution, respondents primarily represented the central region of the country, including Budapest and Pest County. According to 87.5% of respondents, more than half of their revenue originated from online commerce.

Subsequently, I analysed the collected data using statistical methods. The analysis included 10 question blocks with a total of 102 variables. In each block, I performed non-parametric tests on each variable separately, based on grouping criteria, and sought significant differences among the point averages of the groups. For the variable “type of company,” which consisted of two categories, I used the Mann–Whitney test (two independent samples). For the other two grouping variables, I applied the Kruskal–Wallis test (multiple independent samples, one factor), as in these cases I examined differences across more than two groups.

Using the non-parametric equivalent of one-way ANOVA—the Kruskal–Wallis analysis—I identified questions where differences occurred across the various criteria or question groups. The Kruskal–Wallis test (Kruskal & Wallis, 1952) can be applied when samples are independent and each sample contains at least five observations. Essentially, it is a hypothesis test based on multiple samples (Ostertagová et al., 2014). With this method, I examined the effect of a grouping variable on the quantitative behaviour of dependent variables (i.e., individual questions). The null hypothesis states that the averages are equal, meaning that the samples originate from populations with identical distributions. A significance value below 0.05 leads to the rejection of the null hypothesis, indicating a significant difference across groups. The Mann–Whitney–Wilcoxon test (also called the U test or rank-sum test) compares the median values of two independent samples and is the non-parametric equivalent of the two-sample t-test. The test can be applied to ordinal-level variables. All data are first ranked, and equal values receive the mean rank. If no difference exists between the medians, both groups will include low and high ranks, and average ranks will be similar. When this is not the case, one group will tend to have higher average ranks than the other. After ranking, rank sums are calculated for both groups. If $p > 0.1$, there is no difference; if $p < 0.1$, the difference is significant (Mann & Whitney, 1947).

During data analysis, I used Principal Component Analysis (PCA) to reduce the variable sets. I identified and grouped related variables into principal components based on their interrelationships. After defining the dependent variable, I used the Backward method to select those principal components with the strongest explanatory power.

The blocks included: Objectives, Obstacles, Risks, Performance Enhancers, Measurement Methods, Financial, Market, and Operational Performance. A key step in PCA is estimating component loadings based on observed variable values. Component loadings indicate how strongly each component influences each variable. I present the loadings in matrix format. Typically, variables with absolute loadings of ± 0.70 or higher are considered to belong to a component, while those with lower values are not (Szűcs, 2002). In justified cases, I also highlighted loadings above 0.40 when they provided relevant insights. The Kaiser–Meyer–Olkin (KMO) criterion was used to assess the suitability of the variables for factor analysis.

After selecting the dependent variable among the principal components, I performed multiple linear regression using the Backward variable-selection method in SPSS 25.0, treating all remaining components as independent variables. The Backward method first includes all variables in the model and then sequentially removes those with non-significant effects (Fliszár, Kovács, Szepesváry & Szüle, 2016).

Based on the Backward method, I selected the principal components that have the strongest explanatory power for the dependent variable. A major advantage of the principal components is that, beyond regression, they are also excellent for variance analysis, as they follow a normal distribution. Next, I selected four key criteria from the questionnaire (basket value, ratio of online revenue, type of business, and region), and performed one-way ANOVA on the principal component values. I analysed these results independently and formulated general conclusions. As the assumption of homogeneity of variances was not always met, I used the more robust Welch test to determine significance, applying a 10% significance level.

Using K-means clustering, I formed three clusters. The clustering was performed in R, and the optimal number of clusters was determined with the NbClust package. I selected the K-means method—specifically the Hartigan–Wong algorithm—because the cluster quality indices supported this method over other K-means algorithms and hierarchical clustering using the Ward method.

2.3. Analysis of the Database

I conducted the database analysis for a five-year period (2019–2023), based on data from OPTEN. For examining the financial statements, I used the data of 5,739 enterprises whose main activity was TEÁOR 4791 – internet mail-order retail. As a first step, I characterised the financial situation and performance of e-commerce companies using basic statistical indicators (mean, standard deviation, median, minimum, maximum).

I first carried out a descriptive statistical analysis. The purpose of descriptive statistics is to summarise and present the main characteristics of a dataset, providing a clear and comprehensible overview of the data's distribution, central tendency, and dispersion. This analytical step is the initial and fundamental phase of

any quantitative data processing, preceding more complex inferential statistical methods. Thus, descriptive analysis not only serves to summarise the data but also lays the groundwork for subsequent statistical procedures that draw conclusions about the entire dataset (Gravetter & Wallnau, 2016).

Asset, financial, and income indicators are central elements of economic analyses and social science research, particularly in the study of social and economic inequalities (Tóth, 2010). In my research, I applied classical indicators to analyse the financial performance of the enterprises.

The regional breakdown also made it possible to present territorial differences. To measure the economic performance of the companies, I calculated the most commonly used liquidity, profitability, indebtedness, and efficiency ratios in the academic literature. Among asset indicators, I calculated the ratio of fixed assets and current assets, the proportion of tangible assets and inventories, the free working capital indicator, the capital tension ratio, capital strength, the proportion of liabilities, net working capital, and the equity multiplier—averaged across the full dataset and presented by region. For examining financial stability, financial indicators (liquidity ratio, indebtedness ratio) can be used, showing where companies operate with more stable financial positions and in which regions the risks of insolvency or capital shortages are greater. Differences between regions may stem from varying financing opportunities, bank lending willingness, local market demand, or differing policy support measures. One of the cornerstones of a company's success is its profitability. Naturally, profitability depends on developments in asset and financial positions, so these indicators are not examined in isolation; instead, I analyse them jointly and seek correlations among them during the analysis. When calculating profitability, categories of income in the financial statements are compared to a reference value (a relevant value from the balance sheet or income statement).

Based on the results, I compared the performance of enterprises of different sizes and geographic locations. One of the objectives of the research was to identify regional differences. In this context, I compared companies in the Central Hungary region (the most developed area) with those in other counties, examining the extent to which the regional economic environment influences business performance.

Next, I created clusters using the K-means algorithm. Ninety-seven percent of the enterprises belong to the first two clusters. I examined the differences between the clusters and the characteristics of the clusters with the largest number of observations. I also investigated whether any changes could be observed between the years under study, as this period was influenced by a factor of major importance to economic activity: the COVID-19 pandemic and the related measures.

Using clustering, I formed groups and analysed the asset, financial, and income indicators of the resulting groups. The clustering was performed using the K-means algorithm, which is the most suitable method for handling large volumes of data. The procedure resulted in six clusters. Enterprises with zero or negative profit after tax were excluded from the clustering (5,014 balance sheet rows). Since the loss-making enterprises were excluded, the pattern in which all indicators (ROE, ROA, ROS) were negative did not

occur. The clustering was carried out exclusively using the three profitability indicators: ROE, ROA, and ROS.

Ninety-seven percent of the enterprises belong to the first two clusters. The proportion of firms with extremely high or low ROE values (+ and -) is relatively larger (1–2%), whereas extreme ROA and ROS values are very rare in the sample. In the first cluster, all three indicators take low, near-zero values; the second cluster comprises enterprises where all three indicators have positive values; and the remaining clusters contain enterprises with extreme positive or negative values of ROA, ROS, or ROE.

Several limitations had to be considered during the analysis:

- The OPTEN database contains only public financial data, meaning that non-financial factors (e.g., customer satisfaction, logistics performance) were not included.
- The number of interviews was limited, so they served more as qualitative additions than as statistically valid evidence.

The database and methodology used in the research allowed me to develop a comprehensive picture of the performance of Hungarian e-commerce enterprises. The OPTEN database provided an official and reliable foundation for the quantitative analysis. The regional comparison and the managerial interviews contributed to the complexity of the research and enabled the hypotheses to be examined from multiple perspectives.

3. MAIN FINDINGS OF THE DISSERTATION

The aim of the research was to conduct a complex analysis of the financial performance of Hungarian e-commerce enterprises, integrating accounting indicators, the results of the questionnaire survey, and regional comparative analyses. The empirical research produced several novel findings in the context of the Hungarian literature.

The first part of the dissertation addressed the theoretical frameworks of corporate performance measurement and performance management. The literature review highlighted that:

- Performance is a multidimensional concept, in which not only financial indicators but also non-financial factors (customer satisfaction, innovation, quality, sustainability) play an essential role.
- International performance assessment models (Balanced Scorecard, Performance Prism, EFQM) are suitable for comprehensive corporate evaluation in theory, yet are less widespread in Hungarian practice.
- In Hungary, performance measurement is predominantly accounting- and financially oriented, and its decision-supporting function is secondary.

These theoretical foundations supported the development of the research hypotheses, focusing on the performance measurement practices of domestic e-commerce enterprises and regional differences.

The comparison between online and traditional commerce showed that although they can be evaluated along similar factors, the ability to react quickly is far more critical in the online space. (Hypothesis H5 confirmed.)

The survey (with 200 evaluable responses) highlighted that Hungarian companies' performance measurement practices still rely predominantly on accounting and financial indicators. Managers primarily monitor revenue, profit, liquidity, and debt ratios, while non-financial indicators—such as customer satisfaction or logistics performance—receive less attention. This confirms the hypothesis that, in domestic practice, retrospective control dominates over a decision-support-oriented approach. At the same time, interviews indicated a growing demand from managers for integrated performance management tools (e.g., Balanced Scorecard).

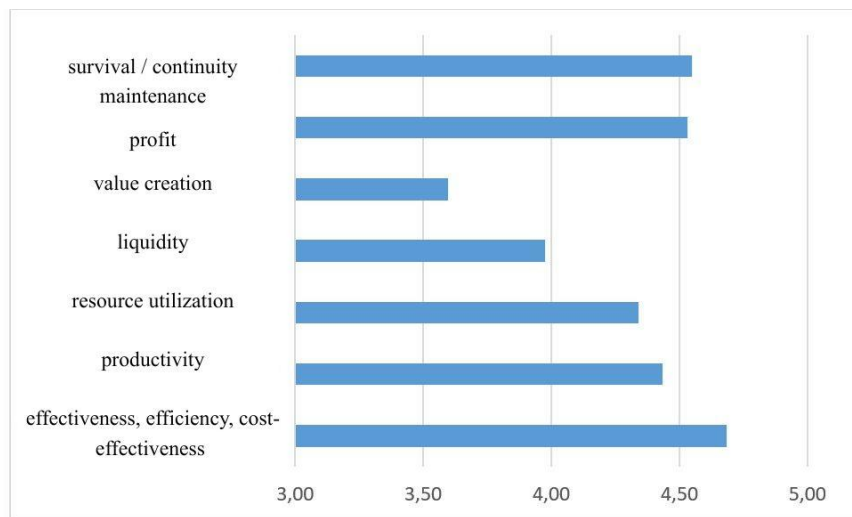


Figure 2: Interpretation of the Concept of Corporate Performance (Average Score)

Source: Author's own compilation

The figure above illustrates how respondents interpret the concept of corporate performance. Higher scores indicate that a particular concept is perceived as being closer to the idea of corporate performance. Based on the results, it can be stated that companies most commonly associate the concept of performance with effectiveness, efficiency, economy, as well as profit and maintaining levels, rather than with productivity, the quality of resource utilization, or liquidity. Value creation, on the other hand, is considered the least relevant in defining corporate performance. Accordingly, managers' understanding aligns most closely with Neely's definition, which describes performance measurement as the process of assessing the effectiveness and efficiency of an activity (Neely et al., 1995).

According to the **survey**, the most important quality objective for achieving corporate goals is maximizing customer satisfaction. The most significant obstacles are intense market competition and high development costs. Growing market competition and shrinking profit margins also emerge as prominent risk factors. Data from ekerstat show that, in response to increasing demand, the number of online stores doubled by 2021, and this growth continues, intensifying competition in the sector. Narrowing profit margins result from rising costs and high inflation rates, which cannot be fully offset by the sales prices of online products. Among the respondents, the most commonly used performance measurement systems are KPI indicators—using the SMART method, webshop and marketing channel metrics, and accounting-based indicators. These are perhaps the most readily available sources of information. Other systems are used relatively less frequently by companies or are not well known. An important task is the identification of key performance indicators (KPIs) as benchmarks of corporate success. KPIs are organized into groups according to specific objectives and correlations (Schnellbach and Reinhart, 2015) and structured in a logically hierarchical system (Ante et al., 2018). Proven methods for measuring performance include tracking website visitors, click-through rates (CTR), and revenue by source. This underscores the critical role of online marketing in the online marketplace. The three most important performance-enhancing tools are paid social media

advertising, SEO (search engine optimization), and content marketing combined with email newsletters. Less frequently applied efficiency models can also be useful in measuring the performance of e-commerce businesses (H8 confirmed).

The majority of managers primarily rely on financial indicators to evaluate performance (revenue, profit, liquidity). Non-financial factors (e.g., customer satisfaction, innovation) are less consciously considered. Performance measurement is more often used for retrospective control rather than strategic decision-making. Managers recognize the importance of quality, yet the time factor (rapid responsiveness) is less emphasized, even though it is crucial in e-commerce. Financial indicators dominate performance measurement practices in Hungarian companies (H1–H2 confirmed).

Based on the **Mann-Whitney test and the Kruskal-Wallis analysis**, I examined significant differences in mean scores between the various groups. Most differences were observed in measurement methods, applied performance systems, and objectives. Achieving high quality and introducing new products/services appeared relatively more important in the revenue category above 50%. A clear trend was observed in differences in the return on assets (ROA) indicator. In the category with a higher proportion of internet revenue, the ROA was more likely to exceed 30% in the recent period compared to lower categories. Regarding objectives, only the evaluation of meeting customer demands showed significant differences. Sharp differences were noted in the Mann-Whitney test according to company size. Except for unreliable supplier sources as a risk factor, small companies reported lower mean scores across all other factors compared to micro-enterprises. Maximizing customer satisfaction, low pricing, profit, and productivity were relatively more important for micro-enterprises. Liquidity problems and lack of skilled labor affected micro-enterprises more, whereas the risk of unreliable suppliers was significantly higher for small companies.

Based on **principal component analysis (PCA)**, it is possible to determine the extent to which individual weights influence the same variable. Generally, a variable with an absolute weight of ± 0.70 or higher is considered to belong to a given principal component, while variables with absolute weights below 0.70 are not associated with the examined principal component (Szűcs, 2002). PCA was performed with respect to the following aspects:

- The company's performance objectives
- Items obstructing the company's objectives
- Risks affecting expected performance
- Performance enhancers of the company
- The company's performance measurement methods
- Operational, financial, and market performance

Within these blocks, I identified which factors are most strongly correlated and influence the values. One principal component was selected as the dependent variable, and then a multivariate linear regression was

performed using the Backward variable selection method, with all other principal components as independent variables.

Table 1: Regression of Next Year's Performance

Principal Component	Standardized B Parameter	Significance
Social Media Advertising (Performance Booster, f12)	0.206	0.049
Return Rate (Measurement Method, f20)	0.192	0.014
New Product (Operational Performance, f26)	0.206	0.014
Minimal Risk (Goals, f3)	-0.144	0.007
Website (Operational Performance, f24)	0.159	0.030
New Customer (Operational Performance, f25)	0.098	0.009
Profit and Return Growth (Market Performance, f31)	0.115	0.001

$R^2 = 0.190$; Durbin-Watson statistic: 1.821; F statistic = 7.218; $p < 0.001$; maximum VIF = 1.058

Source: Author's own compilation

The next year's performance is most strongly influenced by the performance enhancer of social media advertising, followed by the measurement method of monitoring returns, and among operational performance indicators, by the increase in the number of new products. Among the soft objectives, minimizing risks is a particularly important goal, as high risks negatively impact the following year's performance. Within operational performance metrics, the increase in average time spent on the website and the acquisition of new customers are also especially important; all of these factors significantly affect next year's performance and showed growth compared to the previous year, contributing to the improved performance in the subsequent period. Among market performance indicators, profit and return growth also influence next year's performance. Quality is highlighted as a key competitive factor, while the time factor is less consciously considered (H4 partially confirmed).

Subsequently, three groups were formed using **K-means clustering**. The particularly important factors that differed most across the three clusters were identified.

Table 2: Evolution of Key Important Factors Across Clusters

Factor		Cluster		
		1.	2.	3.
Measurement Method	Purchase, Complaint	0.10	0.36	-1.04

Market Performance	Market Share	-0.44	0.48	-0.09
Performance Booster	Newsletter, Search Engine Optimization (SEO)	0.30	0.08	-0.86
Performance Booster	Product Catalog	-0.46	0.39	0.16
Financial Performance	Inventory Turnover	-0.38	0.08	0.66
Financial Performance	Result, Revenue, Purchase (Previous)	-0.33	0.41	-0.16
Goal	Long-term Growth	-0.11	0.34	-0.50
Measurement Method	Cart Value and Abandonment	0.37	-0.25	-0.28
Risk	Obsolete Technology	-0.34	0.17	0.38
Operational Performance	New Products_M	0.12	0.15	-0.61

Source: own compilation

Comparing the profiles of the three clusters, it is clear that Cluster 2 shows more positive values across almost all factors, while Cluster 3 exhibits strongly negative values in several key areas. Cluster 1 demonstrates mixed performance, with strengths mainly in measurement and marketing. Overall, Cluster 2 has a balanced profile, with no strong negative deviations. Companies in Cluster 2 have good market share, profit and return growth, improving financial performance, and increasing past and expected future results. Their strategic focus is on long-term growth. Increasing numbers of new products, higher website traffic, and longer time spent on the website, along with long-term growth objectives, are typical. Key performance-enhancing tools include product catalog and complaint monitoring, as well as tracking page visits and click counts, while high costs and potential data loss pose risks. They are characterized by a balanced product offering, strong financial and market performance, and customer-oriented measurement methods. Areas for improvement include monitoring abandoned shopping carts, and using newsletters and SEO as marketing tools. These companies exhibit the best performance and balanced development, with strong market positions and stable financial indicators, reflecting strategic thinking.

One of the most valuable aspects of this research is **the comprehensive examination of five years of data** from 5,739 e-commerce companies in the Opten database, covering the entire Hungarian e-commerce sector. The database allowed for detailed analysis of financial indicators (profitability, liquidity, indebtedness, efficiency), as well as temporal and regional comparisons.

Overall, Hungarian e-commerce companies showed dynamic growth between 2015 and 2020, although the sector is highly concentrated, with dominance by the largest companies. During the COVID period, e-

commerce companies experienced strong revenue growth due to implemented restrictions. A significant proportion of micro and small enterprises operate with low revenue and often capital shortages.

Based on the five-year database, I conducted a **regional comparative analysis** of the companies. Examining performance, the distribution of companies across the eight regions revealed three distinct patterns.

Table 3: Distribution of Companies Based on Performance

<i>Region</i>	2019	2020	2021	2022	2023
Budapest	22%	24%	21%	22%	24%
Southern Great Plain	18%	22%	22%	23%	24%
Southern Transdanubia	19%	28%	27%	23%	24%
Northern Great Plain	17%	17%	19%	20%	23%
Northern Hungary	17%	25%	25%	20%	28%
Central Transdanubia	23%	24%	27%	27%	25%
Western Transdanubia	25%	24%	19%	23%	21%
Pest	21%	26%	24%	23%	26%

Loss-making = all three indicators ROA, ROE, ROS are negative.

Source: own compilation

The proportion of loss-making companies increased in the Pest, Northern Great Plain, Northern Hungary, and Central Transdanubia regions. Stagnation or resistance was observed in the Southern Great Plain and Budapest regions, while the trend was reversed in Transdanubia, where the proportion of loss-making companies decreased. In Southern Transdanubia, the proportion surged during the COVID period but later declined, whereas in Western Transdanubia, the proportion of loss-making companies decreased to 23%.

Profitability indicators show strong variability, which depends on the market adaptability of the companies. Regional differences are significant: the performance of companies in Central Hungary is outstanding, while in Hajdú-Bihar County, the average performance of enterprises falls below the national average.

Since the examined companies primarily operate in online retail, an especially important factor to examine is inventory turnover, which measures how tied up a company's resources are in stock. Inventory turnover indicates how quickly inventory is sold and replaced during a sales cycle. The lower this value, the faster the stock is utilized, indicating more efficient inventory management.

Nowadays, inventory-free online stores are becoming increasingly common, which is also evident in the dataset, as in many cases the inventory value reported is 0 HUF. Inventory turnover (average daily inventory / net revenue) was exceptionally high in the Southern Great Plain region (3,824.2), while in other regions it ranged between 358.25 and 803.57.

Using the available five-year database, I examined the statistical characteristics of the data, including mean, minimum, maximum, standard deviation, relative standard deviation, and number of elements.

Table 4: Statistical Characteristics of Hungarian E-commerce Companies' Reported Data – Average Values for the 2019–2023 Period

Tangible Assets	Current Assets	Inventories	Total Assets	Equity	Liabilities	Net Sales Revenue	Material-type Expenses	Operating/Business Profit	Profit After Tax (Income Statement)	Tangible Assets
Average	7 608	35 581	13 025	47 878	18 657	28 046	108 193	96 930	3 422	2 627
Minimum	-535	-12 398	-339	-9 055	-4 739 000	-722	-339	-3 606	-9 373 832	-9 804 301
Maximum	1 868 260	30 150 522	12 325 431	49 073 057	9 628 734	39 518 913	2 125 021 301	96 489 840	1 772 578	1 593 691
Standard Deviation	49 240	344 738	136 752	515 733	153 246	390 525	1 124 920	1 181 227	103 612	106 272
Relative Standard Deviation (Coefficient of Variation)	6	10	10	11	8	14	10	12	30	40
Number of Elements (Sample Size)	19 636	19 638	19 638	19 638	19 638	19 622	19 639	19 600	19 638	19 639

Source: own compilation

The net sales revenue and material-type expenses are exceptionally high compared to the averages, which is typical for commercial activities. The total assets and current assets are also significant, whereas operating profit and net profit are substantially smaller in magnitude. The relative variation of profitability indicators (operating profit, net profit) is particularly high (30–40%), reflecting differing levels of profitability among companies.

Based on these indicators, it is evident that the database cannot be analyzed solely based on average values, as this could lead to misleading conclusions. Instead, key indicators need to be selected, and the population should be divided into homogeneous groups. This was accomplished using cluster analysis in SPSS.

Comparing regional financial, asset, and income indicators can reveal which areas host the most capital-intensive companies and where companies have lower capital availability. This can aid in planning regional development and investment policies. The ratio of fixed assets is highest in the Southern Great Plain (0.185) and Southern Transdanubia (0.167), indicating a greater role of long-term investments. In Budapest, it is lower (0.127), reflecting a more current-asset-intensive operation. The proportion of current assets is outstanding in Budapest (0.860), indicating a higher share of quickly circulating assets (e.g., inventories, receivables). Inventory ratios are higher in Northern Hungary (0.319), suggesting a more inventory-intensive operation. In Southern Transdanubia, the equity multiplier and capital intensity indicators are particularly high, indicating that companies in this region rely more on external financing, increasing business risk. The most favorable indicators were observed in the Northern Great Plain. The free current assets ratio ranges between 0.63–0.69 across regions, suggesting that domestic e-commerce companies can

generally cover short-term liabilities safely. Operating profit margin is highest in Budapest, reflecting higher profitability of companies in the capital. It is lower in Southern Transdanubia and Northern Hungary. Regarding return on assets (ROA), Budapest and Pest County lead, indicating more efficient asset utilization. Return on equity (ROE) is also highest in central regions, reflecting better capital efficiency.

Comparing regions, central regions (Budapest, Pest) are generally financially more stable and profitable but less capital-intensive. Among rural regions, the Southern Great Plain and Central Transdanubia show stronger asset positions (higher fixed asset ratios) but lag behind the capital in profitability. Northern Hungary and Southern Transdanubia are more inventory-intensive and have weaker profitability profiles. The thesis demonstrated that companies in Central Hungary have better financial indicators than other regions (H3 confirmed).

A comparative analysis was conducted using **clustering**, resulting in the identification of six clusters.

Table 5: Patterns of the Clusters

CLUSTER	ROE	ROA	ROS	
1	0,17	0,10	0,09	Low, around 0
2	0,72	0,45	0,25	All three positive
3	2,81	0,76	0,29	Outlier ROE (+)
4	-0,66	2,72	0,39	Outlier ROA (+)
5	0,36	0,32	2,85	Outlier ROS (+)
6	-0,86	0,35	0,18	Outlier ROE (-)
Full	0,30	0,20	0,13	

Source: own compilation

Clustering was performed solely using the three profitability indicators: ROE, ROA, and ROS. 97% of the companies belong to the first two clusters.

Table 6. Average Indicator Values of the Groups

Name		Inventory Ratio	Tangible Assets Ratio	Inventory Turnover	Current Ratio	Capital Strength	Liabilities Ratio
Cluster	1	0,30	0,13	533,41	24,62	0,54	0,45
	2	0,21	0,10	551,22	14,39	0,65	0,34
	3	0,22	0,11	296,93	4,80	0,28	0,70
	4	0,08	0,18	130,41	0,46	-12,81	13,74
	5	0,08	0,16	854,87	21,52	0,54	0,45
	6	0,31	0,11	663,13	3,30	-1,07	2,04

Source: own compilation

The majority of companies belong to the first two groups. Based on their average characteristics, it can be stated that their general liquidity is favorable (26.62 and 14.39). The capital strength of these groups is also

acceptable (0.54 and 0.65), meaning that 54–65% of their activities are financed through equity. It is generally accepted that a minimum of 25–30% equity is necessary to maintain a positive financial standing. Examining asset composition, the proportion of investments (fixed assets) is relatively low at 13%, while inventory accounts for 30%. This level of inventory is entirely reasonable for commercial enterprises. Cash assets also represent a significant portion of total assets, which is reflected in the liquidity values. Regarding the structure of financing sources, the proportion of liabilities is acceptable at 45%.

The highest debt and leverage are observed in Cluster 4. In this cluster, low liquidity ratios and low inventory turnover are also evident, since inventory must turn over quickly to finance the company’s operations. The most stable inventory ratio during the examined period is observed in Cluster 1, but high values are also seen in Cluster 6, whereas Clusters 4 and 5 show extremely low inventory ratios. Inventory turnover indicators remain relatively stable in Cluster 1, ranging between 372 and 773 days. The lowest values appear in Clusters 3 and 4, with an exceptional peak in Cluster 5 in 2019, indicating extremely rapid inventory turnover, which is typical for high-revenue companies operating with low inventory.

After examining the average values in the database, I investigated whether any changes or trends in profitability could be observed when taking the **COVID** period into account.

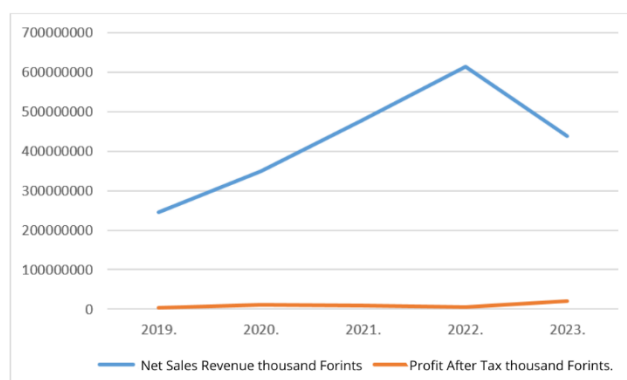


Figure 3: Net Sales Revenue Summarized by Year

Source: own compilation

The diagram above clearly shows the trend that the e-commerce sector experienced an overall increase in revenue during the COVID period, followed by a subsequent decline; however, the revenue remains higher than in the pre-COVID years. This is a typical COVID effect: an exceptional increase during the pandemic, followed by a partial correction after reopening.

In addition, net profit showed an exceptional value during the first COVID period (2020), then decreased, and after the pandemic, in 2022, reached an exceptionally high level, followed by a slight decline, but still remaining above previous periods. This indicates market concentration, with profits of large players increasing significantly, while several smaller companies downsized.

Table 7: Revenue and Net Profit by Year

Indicator	2019.	2020.	2021.	2022.	2023.
Net Sales Revenue (thousand HUF)	244 969 879	349 637 212	478 786 658	613 189 818	438 440 734
Profit After Tax (thousand HUF)	4 282 441	11 960 683	9 104 323	6 046 610	20 209 232
ROS %	1,75	3,42	1,9	0,99	4,61
Number of Companies	3 111	3 540	4 130	4 698	4 162
Net Sales Revenue per Company (thousand HUF)	78 743	98 768	115 928	130 521	105 344

Source: own compilation

The data from 2020–2021 indicate that the pandemic had a short-term positive effect on e-commerce revenue and sales volume. However, for smaller companies, capital shortages and logistical challenges intensified, leading to the closure of several businesses. In terms of profitability (ROS), a strong improvement was observed in the first year of COVID, followed by a decline and a low point in 2022, with another surge in 2023, which can be explained by high profits. Profitability is highly volatile, and the sector reacts sensitively to external influences.

The number of market participants decreased to 4,162 in 2023, reflecting the exit of smaller enterprises. During the pandemic, many new players entered the market, but market consolidation occurred rapidly. In contrast, larger players gained significant market share, further increasing market concentration in the long term. This differentiated effect confirmed the research finding that crisis situations tend to strengthen the dominance of large companies (H9 confirmed).

Table 8: Summary of Hypotheses, Applied Methodology, and Obtained Results

Hypothesis		Methodology	Result
H1	In the performance measurement practices of domestic companies, the emphasis is more on ex-post control than on decision support for performance improvement.	Literature review, questionnaire survey, interviews	Confirmed
H2a,b	In domestic corporate practice, accounting, financial, and cost-based indicators dominate.	Questionnaire	Confirmed

H3	The financial performance of e-commerce companies significantly differs depending on the economic development of the regions.	Regional comparison, variance analysis (ANOVA)	Confirmed
H4a	Quality is an important competitive factor.	Managerial interviews, questionnaire, PCA correlation	Confirmed
H4b	Time is less consciously considered; subjective opinions are less significant.	Questionnaire	Rejected
H5	The performance of online and traditional commerce is determined by similar factors, but rapid response is highlighted online.	Comparative analysis, in-depth interviews	Confirmed
H6a,b,c	Customer satisfaction, digitalization, and innovation indirectly but measurably influence financial indicators.	Questionnaire, PCA, correlation, Backward regression, K-means cluster analysis	Confirmed
H7	Companies choosing specialization achieve more sustainable financial performance than those offering a broad product portfolio.	Literature review, cluster analysis	Confirmed
H8	Efficiency models only rarely applied in business can also be successfully used to measure the performance of profit-oriented companies.	Theoretically possible, but not empirically validated.	Rejected
H9a	COVID increased turnover in the short term.	Time series analysis (2019–2023), cluster analysis	Confirmed
H9b	In the long term, the dominance of larger companies increased, and the competitiveness of smaller companies decreased.	Time series + grouping	Confirmed

Source: own compilation

4. NEW AND ORIGINAL CONTRIBUTIONS OF THE DISSERTATION

In the empirical part of the research, I conducted a multidimensional examination of the performance of Hungarian e-commerce enterprises. The analysis integrated the results of the questionnaire survey, principal component analysis, variance analysis, cluster analysis, and the processing of a five-year (2019–2023) financial statement database. The systematic integration of these methodological levels enabled the exploration of the sector's structural characteristics, regional heterogeneity, and performance differences embedded in corporate operations.

a. Identification of the Multidimensional Nature of Performance in Hungarian E-commerce

The analysis of international and domestic literature in the field of business performance measurement and performance management showed that corporate performance is a multidimensional concept, incorporating not only financial indicators but a wide range of non-financial dimensions such as customer satisfaction, innovation, sustainability, and quality. The empirical findings confirmed that performance measurement practices of Hungarian e-commerce enterprises are primarily retrospective, serving post-control rather than decision support. (H1 confirmed). Accounting-based and cost-based indicators dominate domestic practice, confirming the prevalence of traditional financial indicators.

This contrasts with international practice, where complex, integrated performance measurement models (Balanced Scorecard, Performance Prism, Triple Bottom Line) are more widely applied. These results highlight the developmental potential of Hungarian enterprises regarding performance measurement sophistication.

b. Mapping and Analysing the Performance Measurement Practices of Hungarian E-commerce Enterprises

Based on the questionnaire survey and interviews, it was confirmed that the primary purpose of performance measurement is retrospective control rather than decision support (H1 confirmed). The overwhelming majority of companies use financial and cost-based indicators (revenue, profit, liquidity), while the role of non-financial indicators is marginal (H2 confirmed). The survey revealed that quality is considered an important competitive factor, but the conscious management of time as a competitive factor is less evident (H4). Subjective factors (consumer and partner opinions) play only a minor role in performance measurement. The factors determining the performance of e-commerce and traditional retail companies are indeed similar; however, in the online sector, the ability to respond quickly is of critical importance (H5). Customer satisfaction and loyalty indirectly but measurably improve financial results (H6b), for example, through repeat purchases and increasing basket value. Overall, it can be stated that domestic e-commerce companies' performance measurement systems are less developed, with limited strategic-level application.

c. Mapping Financial Performance Differences Between Regions

Analysis of the Opten database shows significant regional differences. Financial indicators (profitability, revenue, liquidity) of companies in Central Hungary are significantly better than those in the eastern regions. E-commerce companies in the region including Hajdú-Bihar County perform below the national average. Based on reporting data, the research confirmed that significant differences exist between regional economic development and the financial performance of e-commerce companies (H3). Companies in the Central Hungary region dominate, while rural areas experience significant capital shortages. The level of regional development strongly determines the success of e-commerce companies. Principal component analysis and variance analysis results indicate that the proportion of online sales, economic differences between regions, and company size significantly influence performance levels. These factors result in different operational patterns, which were clearly revealed in the cluster analysis.

Cluster analysis based on the survey data distinguished companies with stable financial and liquidity indicators, rapidly growing but more vulnerable companies, and those operating with high indebtedness or low inventory turnover. Differences between clusters highlighted that performance disparities are not solely dependent on size or region but also reflect the quality of corporate governance practices and the performance measurement systems applied.

d. Understanding the Performance Measurement Needs of Managers and Decision-Makers

Interview results indicate that managers consider quality an important competitive factor; however, time-related aspects (e.g., delivery speed, responsiveness) are less consciously addressed. Subjective factors (opinions of customers and employees) play a minimal role in performance measurement. A change in entrepreneurial mindset is needed to give greater weight to consumer and time-related factors in performance measurement.

The analysis highlighted that fundamental factors (financial stability, profitability, liquidity) are decisive in both traditional and online retail. The research demonstrated that a higher level of digitalization and automation positively affects financial performance (H6c). Companies that opted for specialization achieved more sustainable long-term results compared to those offering a broad portfolio (H7). It is evident that financial and non-financial indicators (e.g., innovation capability, logistics efficiency) are closely linked (H6a), supporting the need for multidimensional performance measurement. In e-commerce, rapid response and immediate adaptation to market changes are critical, with flexibility and time factors providing a decisive competitive advantage.

Analysis of reporting data from 2019–2023 revealed macro-level sector performance changes. During the COVID-19 pandemic, online sales volume increased significantly, leading to temporary improvements in revenue and profitability. Post-pandemic, turnover declined, but sector performance remained more stable than pre-2019 levels. Companies' liquidity slightly deteriorated, while a decrease in indebtedness indicates a more cautious financing approach. Regional differences were moderate, although profitability remained persistently higher in economically more developed areas.

Cluster analysis based on reporting data identified six groups with different profitability profiles. Some clusters showed exceptional ROE, ROA, or ROS performance—typically linked to specialized business models or temporary market advantages—while other clusters displayed more moderate but stable indicators. Excluding loss-making companies created a more homogeneous, yet well-interpretable pattern in the sample.

Analysis of COVID-19 effects confirmed increasing sector concentration: smaller enterprises were largely forced out, while larger players continued to expand their market share. The crisis accelerated structural transformation and highlighted that the e-commerce sector is highly sensitive to external shocks, yet, with an appropriate business model and digital preparedness, it possesses significant growth potential.

The findings clearly support that the performance of domestic e-commerce companies is highly heterogeneous, influenced by digital maturity, management quality, regional economic development, and company size. The research emphasized that, alongside financial indicators, non-financial performance elements—particularly customer satisfaction, inventory management efficiency, innovation, and logistics performance—play a crucial role in establishing long-term competitiveness. The differing operational patterns observed across clusters illustrate that there is no single performance profile in e-commerce: company success is determined by a complex system integrating both financial and non-financial factors.

Comparing reporting data with survey results shows that sector development is closely linked to the level of digitalization and the ability to adapt to a changing market environment. Although COVID-19 caused significant short-term growth, achieving sustainable competitive advantage in the long term requires broader application of strategic performance management tools.

e. Description of the Current State of the E-commerce Sector, Supplemented with Own Research Findings.

The sector is growing dynamically but is highly concentrated: the largest 10 players account for one-third of the total turnover. For smaller enterprises, specialization is key to survival. Research has confirmed that while some Hungarian e-commerce companies operate efficiently, many firms show significant reserves in resource utilization. Integrated modern performance measurement models can serve as an effective tool for performance assessment, particularly in uncovering growth opportunities for smaller companies.

Evaluating e-commerce performance requires an integrated approach that builds on accounting indicators, the specificities of digital operations, and customer-oriented quality factors. This complex perspective can provide businesses with decision-support that is essential for long-term growth and stability in the rapidly changing online environment.

In summary, the objectives of the dissertation have been achieved, most hypotheses have been confirmed, and the research has contributed to establishing a performance measurement model that combines financial and non-financial indicators and also allows for mapping regional specificities.

Table 9: Proposed Indicator System for E-commerce Companies

Dimension	Indicator	Measurement Method	Data Source
Financial	Revenue growth rate (%)	$(\text{Current year revenue} - \text{previous year revenue}) / \text{previous year revenue} \times 100$	Annual report
	ROA (Return on Assets)	Net income / Total assets	Annual report
	ROE (Return on Equity)	Net income / Equity	Annual report
	ROI (Return on Investment)	Net income / Equity	Annual report
	Liquidity ratio	Current assets / Short-term liabilities	Annual report
Customer	Customer satisfaction	Average customer rating (1–5)	Webshop analytics
	Customer loyalty	Willingness to recommend (–100 – +100 scale)	Survey
	Repeat purchase rate (%)	Share of returning customers' orders relative to total orders	Webshop analytics
	Complaint rate (%)	Number of complaints / total orders $\times 100$	Internal records
Internal Processes	Delivery accuracy (%)	Orders delivered on time / total orders $\times 100$	Logistics system
	Cart abandonment rate (%)	Abandoned carts / initiated carts $\times 100$	Webshop analytics
	Marketing efficiency (conversion cost, click-through rate)	Cost / conversion (HUF / order)	Online marketing analytics
Learning & Growth	Employee turnover rate (%)	Departed employees / average headcount $\times 100$	HR records
	Training expenditure (skilled workforce)	Training hours per employee per year	HR records
	IT investment ratio (%)	IT investments / operating costs $\times 100$	Financial statements
	Ratio of automated processes (%)	Automated orders / total orders $\times 100$	Internal records
	Introduction of new products	Number of new products per year	Product records

Source: Own elaboration

The selection of key performance indicators listed in the table is based on the research findings: financial indicators are identified from the report analyses, while customer-related, digitalization, and other factors are derived from the questionnaire survey. The application of the integrated system can contribute to more transparent performance measurement and more conscious strategic decision-making for businesses.

5. PRACTICAL APPLICABILITY OF THE RESULTS

5.1. Entrepreneurial and Management-Level Utilization

Based on the research, the performance measurement practices of Hungarian e-commerce companies are largely limited to accounting and financial indicators. This implies that one of the most important practical messages for businesses is the need to implement comprehensive performance management. Adapting the Balanced Scorecard or similar integrated systems can help companies measure not only financial performance but also customer, operational, and innovation aspects. The DEA method is suitable for identifying efficiency reserves and can be particularly valuable for smaller companies competing in the market. Based on the interviews, a practical recommendation for managers is that performance measurement should not serve exclusively as retrospective control but should become an integral part of strategic decision support. These tools can contribute to consciously improving a company's profitability, liquidity, and efficiency.

5.2. Regional Economic Development Level

The research highlighted performance differences between regions, particularly between companies in Central Hungary and the Northern Great Plain region. The results support the need for targeted enterprise development programs in disadvantaged areas to improve the resource utilization efficiency of firms. Incubation and mentoring programs, as well as regional subsidies, can contribute to helping smaller companies catch up. The findings can assist in developing local economic development strategies in which e-commerce plays a key role.

5.3. Sectoral and Policy-Level Utilization

Over the past decade, e-commerce has become one of the fastest-growing sectors in the domestic economy, making its performance analysis useful for policymakers. The results can be applied in programs aimed at developing the digital economy, highlighting the sector's strengths (dynamic growth, flexibility) and weaknesses (capital shortage, regional disparities).

The analysis supports the need for developing digital competencies and investing in logistics and infrastructure, which enhance the competitiveness of smaller e-commerce firms. Implementing efficiency measurement models can also help shape regulatory frameworks and support systems to place market players on a more sustainable growth path.

5.4. Scientific and Educational Utilization

The theoretical and methodological findings of the research can also be applied in education and the academic community. The study contributes to teaching finance and management subjects by enriching case studies. The results from interviews and empirical investigations provide relevant examples for courses in entrepreneurship and business administration. The research can serve as a foundation for further studies,

such as a deeper analysis of non-financial indicators or examining the impact of digitalization on performance.

In summary, the practical applicability of the dissertation lies in offering concrete performance measurement tools that can also support strategic decision-making. By revealing regional differences, it contributes to the foundation of economic development programs. At the sectoral and policy level, it provides guidance on the need to support and develop the e-commerce sector. Academically, it contributes to methodological expansion in performance management and enriches domestic research in the field.

5.5. Crisis Management and Resilience Considerations

The impacts of the COVID–19 period highlighted that rapid digitalization and the ability to respond to crises provide a significant competitive advantage for e-commerce companies. The practical takeaway from the research is that businesses should incorporate resilience indicators (e.g., inventory turnover time, liquidity reserves, flexible scalability of delivery capacities) into their performance management systems. This helps management respond proactively to sudden changes in the market environment.

5.6. Promoting Innovation and Digitalization

The analyses showed that a higher level of digitalization (automated systems, big data-based customer and sales analysis, AI-based recommendation systems) is directly associated with better financial performance. From a practical standpoint, this means that companies investing in digital innovation enjoy more sustainable competitiveness. The results can be applied in programs supporting digital transformation, especially for small and medium-sized enterprises.

5.7. Utilization of Cluster Analysis Results

Based on the two entrepreneurial clusters identified in the research (well-capitalized vs. resource-constrained companies), financing and support policies can be tailored accordingly. In practice, this means that cluster analysis can provide banks and investors with a risk assessment framework, while economic development institutions can design targeted support programs to help resource-constrained companies catch up.

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7. PUBLICATIONS RELATED TO THE DISSERTATION TOPIC

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36. Csáki-D., R. (2017). Corporate performance measurement: An integrated approach. *Annals of University of Oradea – Economic Science*, 26(1), 87–94.

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37. Csáki-D., R. (2019). Opportunities for performance measurement in e-commerce. *LIMES: Scientific Yearbook of II. Rákóczi Ferenc Transcarpathian Hungarian College*, 6, 117–127.
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List of publications related to the dissertation

Articles, studies (6)

1. **Csáki-Darabos, R.:** A magyar e-kereskedelem üzleti teljesítménymérésének gyakorlati tapasztalatai = Practical experiences of business performance measurement in Hungarian e-commerce.
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5. **Csáki-Darabos, R.:** Corporate Performance Measurement: an Integrated Approach.
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The Candidate's publication data submitted to the Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

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