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Special issue in memoriam of our Editor-in-Chief, Prof. Dr. Mária Illés (1947-2023).

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Tax Compliance Costs for SMEs: A Survey of Tax Professionals in Ghana on External Cost of Compliance

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SUMMARY

This study seeks to ascertain the magnitude of the external tax compliance costs incurred by SMEs in Ghana from the perspective of the tax professionals who provide the service. A survey was conducted with tax professional firms selected from the Institute of Chartered Accountants and the Chartered Institute of Taxation. The study distinguishes between the average annual costs for small, medium-sized and larger firms to compute and file returns, deal with tax authorities, implement changes in tax laws, and maintain records for tax purposes on behalf of their clients. SMEs were found to incur an annual average cost of USD 239. The external cost of compliance was found to be regressive in nature, indicating that the burden was relatively higher for small businesses. Furthermore, the costs incurred by SMEs were mainly due to tax computations as opposed to tax planning.

Keywords: Small and Medium-sized Enterprises, Tax compliance costs, External tax compliance costs, Tax professionals, Ghana
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INTRODUCTION

Small and medium-sized enterprises (SMEs) are globally recognised as engines of economic development and growth (Domingo, 2017). In emerging economies, SMEs are perceived to be the transformers and developers of communities (Dlamini & Schutte, 2021). Ghana is not an exception to the contribution brought by the sector to the economy (OECD, 2019). These small enterprises are considered to be a key contributor to the production landscape in Ghana, as the sector represents a large portion of businesses and provides approximately 85% of manufacturing employment (Aryeetey, 2001). This paper uses the definition of the Ghana Statistical Service's Integrated Business Establishment Survey (IBES) report (2016), which defines small firms as those with less than 30 employees, while medium-sized firms have 30 to 100 employees and large enterprises have above 100 employees. SMEs contribute about 70% of the country's GDP and account for about 99.6% of businesses (IBES report 2016). However, the Association of Ghana Industries (AGI) business barometer indicated that exchange rate volatility, the cost of credit, and a multiplicity of taxes were the main factors affecting enterprises in Ghana (ITC, 2016). Taxes could become a burden to businesses, especially SMEs, if the costs of complying with these taxes are too high (Bruce-Twum & Schutte, 2021). The high costs that SMEs incur could also be a result of the complexity of the tax system, and complexity is clearly a major determinant of the compliance burden (Evans, 2008).

High tax compliance costs (TCC) diminish the profitability of small firms and consequently slow down economic growth (Schoojans et al., 2011). Therefore, in a drive to promote SME growth and development by reducing compliance costs and administrative complexity, the government of Ghana introduced the Self-Assessment Tax System (SAS) in 2015. In the SAS, the taxpayer assesses himself and is mandated to pay taxes based on the estimated income. It is the responsibility of the taxpayer to ensure compliance by understanding tax laws and regulations (Okello,2014), maintaining proper record-keeping, engaging external tax professionals (Kasipillai & Hanefah, 2000; Okello, 2014; Smulders, 2013), and conducting tax audits and investigations (Marshall et al., 1997; Okello, 2014). Sapiei (2012) stated that SMEs also incur psychological costs as they deal with the negative experiences of taxpayers when obeying tax laws. Due to the activities associated with tax compliance and penalties for tax non-compliance, SMEs engage the services of agents for their tax affairs (McKerchar et al., 2009).

This research is motivated by the paltry research-based evidence about the magnitude of resources SMEs in Ghana devote to complying with tax, especially how much they incur on external compliance costs (fees). This study seeks to reduce the research-based knowledge gap on the magnitude of the external tax compliance costs incurred by SMEs in Ghana. Therefore, the objective of this study was to ascertain the external costs incurred by SMEs from the perspective of the tax professionals that provided these services. The study further investigated the components of fees charged for the different services performed by these professionals for SMEs. Additionally, the study sought to ascertain the views of the tax professionals on the difficulties faced by their clients on tax issues as well as provide recommendations for the reduction of TCC in Ghana. This paper is structured as follows: the next section provides a review of literature related to TCC. The paper further presents the methodology of the study. It then discusses the results of the study and culminates by presenting the conclusion and recommendations of the study.

LITERATURE REVIEW

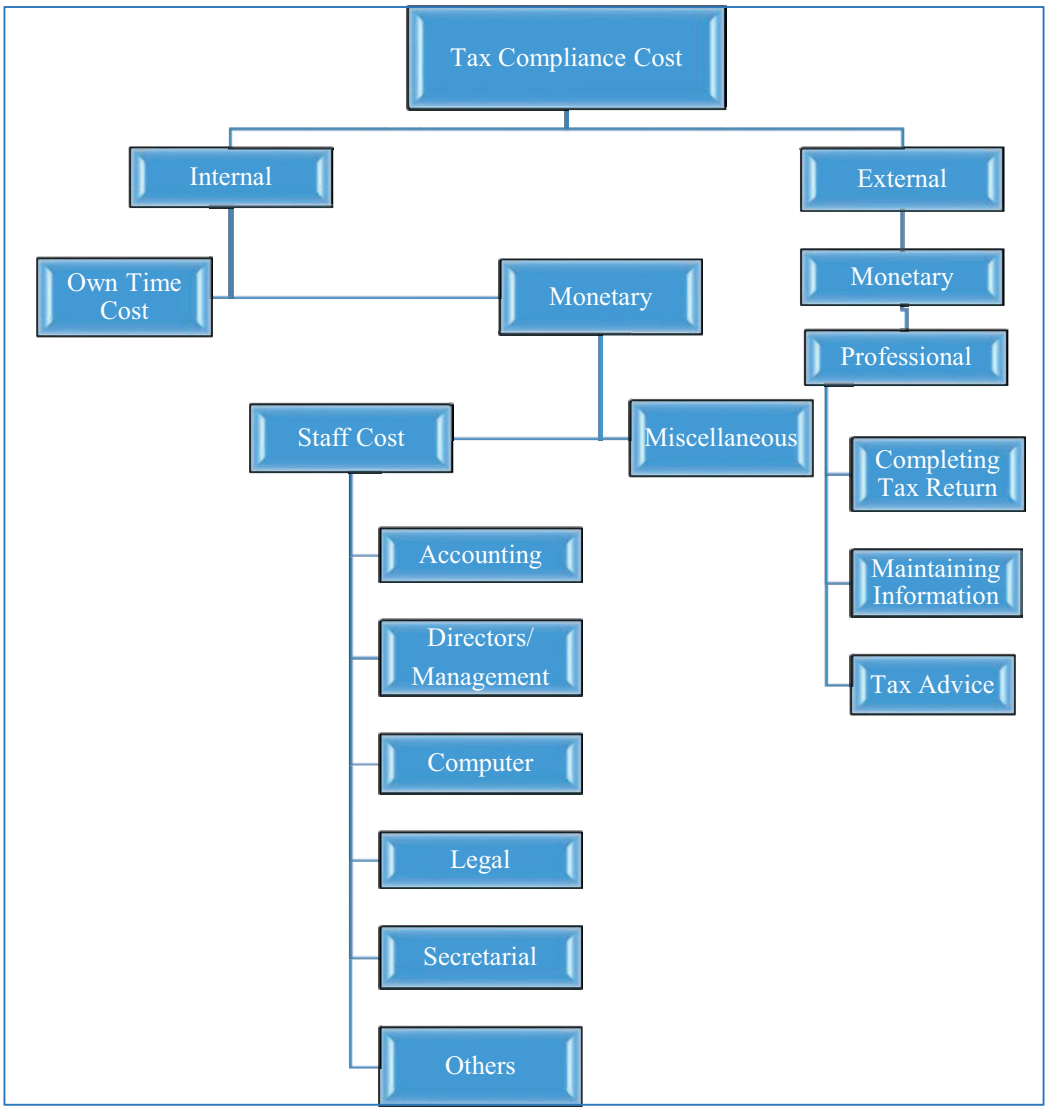
There have been various discussions as to what constitutes compliance cost (Ariff & Pope, 2002; Blaufus & Hoffmann, 2020; Blaufus et al., 2019; Eichfelder & Hechtner, 2018; Eichfelder & Vaillancourt, 2014; Lignier & Evans, 2012; Sapiei, 2012; Schutte & Van der Zwan, 2019), the measurement of these costs (Shaw et al., 2008), and conceptual issues (Tran-Nam et al., 2000). The challenges facing TCC research have to do with how TCC should be defined and how to measure it (Sapiei, 2012).

There are three main components of TCC, which are viewed as opportunity costs that are linked to tax compliance activities (Evans et al., 2014). According to Tran-Nam et al. (2000:236), the first is the time taxpayers spend on assistants and internal personnel; the second and third components comprise of external paid tax advisers and non-labour expenses. These costs are tax-related individual incidental costs or firm overhead costs, including stationery, electricity, computers, photocopies, postage, telephone and transport costs. Tran-Nam et al. (2000) postulate that some of these expenses are clear and easily identifiable and involve direct payments, while others are indirect, for example, the time spent by taxpayers and their unpaid assistants.

The non-labour cost of business is more difficult to estimate and is often ignored in tax compliance cost research. Differences exist among scholars as to the impact it will have on the measurement of the cost, as it is dependent on the level of business analysis (Evans et al., 2014; Sapiei, 2012). Klofsten et al (2021) contends that these expenses could be virtually overlooked in studies that only focus on small firms and microenterprises. Tran-Nam et al. (2000), on the other hand, claim that the omission of non-labour costs would cause a miscalculation of the compliance costs of large business taxpayers.

Furthermore, Evans et al. (2014) and Sapiei (2012) summarised the components of TCC into four types: internal costs, external costs, psychological costs, and incidental costs. Internal costs include how much the time a firm's employees spend on tax matters is worth; external tax costs refer to the payments made to external tax experts (fees for their professional services); incidental costs are other miscellaneous tax costs that might consist of transport, stationery, computers, telephone, and court proceedings costs; and psychic costs, which, according to Sapiei (2012), are the negative experiences of taxpayers in obeying tax laws.

Ariff and Pope (2022) classified TCC into economic and non-economic costs. According to the researchers, economic costs could be divided into monetary and time costs, which can be quantified. In contrast, the expenses of stress and worry (psychological costs) experienced due to tax compliance are known as non-economic costs and are more difficult to calculate. Their classification of the compliance cost is depicted in Figure 1 below.



Source: own editing

Figure 1: Compliance costs of business taxation (Ariff & Pope, 2002)

Ariff and Pope (2002) classified miscellaneous costs under internal economic costs, which are extra expenses incurred in obeying tax laws (incidental costs). In addition to providing the various components of TCC, Figure 1 further indicates that the tax compliance burden's appraisal involves identifying and evaluating the internal and external costs incurred. The external costs could be fees paid to the professional for computing and filing tax returns on behalf of the SMEs, providing for tax advisory (planning) service, or maintaining information (records) for the SME. Studies conducted in both developed and developing countries have shown that external costs incurred by SMEs represent a high proportion of their cost of complying with income tax legislation (Hansford & Hasseldine, 2012; Schoonjans et al., 2011; World Bank, 2020). Smulders et al. (2012) found that in South Africa, external costs represent 40% of the TCC incurred by SMEs. In Ethiopia, the World Bank (2020) also found the external cost to be 37% of the TCC. Abdul-Jabbar and Pope (2008) estimated the external cost at 41% in Malaysia. While the external cost was found to be very high (69%) in Australia (Lignier & Evans, 2012), it represents about 27% in the United Kingdom (Hansford & Hasseldine, 2012), and Schoonjans et al. (2011) estimated it to be quite low (18%) in Belgium.

METHODOLOGY

A positivist approach was adopted due to the quantitative nature of this study. This decision was informed by the dominance of the positivist paradigm in TCC research and the ability to produce statistically

rigorous and focused results (Evans, 2003). The targeted population of this study was tax professionals, mainly because practitioners provide a valuable information source to estimate the TCC for small businesses (Smulders & Stiglingh, 2008). The tax professionals selected for this study were practising chartered accountants who are also members of the Chartered Institute of Taxation (Ghana). A total of 50 (out of a population of 398) external tax professional firms were purposively selected from lists obtained from the Institute of Chartered Accountants and responses were obtained from 33 participants, representing a response rate of 66%. Yehuda and Holtom's (2008) analysis of research that acquired data from businesses found that the average response rate was 35.7%; as a result, the overall response rate for this study is within acceptable bounds.

A pilot study was also performed involving 10 tax professionals to ensure the validity of the research instrument and enhance its reliability. The final questionnaires were sent out from December 16 to April 17, 2020. The research collected data for the 2018 year of assessment, as returns for the 2019 year of assessment were not ready during the period of the data collection. A self-administered questionnaire was adopted based on previous research conducted by Saipei (2012), Abdul-Jabbar (2009) and Loo (2006). The questionnaire comprises four parts. The first part requested general information about the tax professionals. The second part focused on the activities and professional fees to assist SMEs in complying with income tax. The perceptions and opinions of the professionals on various tax compliance issues constituted the third part. The final part focused on general and overall issues of the tax compliance burden faced by SMEs. The data was analysed using SPSS and comprised of descriptive statistics for the profiling of the respondents.

RESULTS AND DISCUSSION

The background information of the tax professionals surveyed is presented in Table 1. The information solicited from them includes their place of work, current position, membership in professional bodies, and years of experience in tax-related work.

Table 1

Background information on tax professional

Variable	Frequency	Per cent
Place of work		
Big-four accounting firm	1	3.0
Non-big-four firm	30	90.9
Tax firm/tax agent	2	6.1
Current position in the firm		
Partner	23	69.6
Senior/Junior	5	15.2
Manager	5	15.2
Membership of a professional body		
ICAG	29	87.9
CITG	3	9.1
Other	1	3.0
Years of experience in tax		
Less than 10 years	9	27.3
10 to 20 years	8	24.2
More than 20 years	16	48.5
Total	**33**	**100.0**

Source: Own formulation

As can be seen in Table 1, only one respondent was a member of a Big Four accounting firm. The majority (90.9%) of respondents were part of non-big four firms, whereas the rest (6.1%) were tax agents. The majority (69.6%) were partners at firms, with about 15.2% of them being managers, whereas the remaining respondents were senior staff (15.2%). Most (87.9%) of them were members of the Institute of Chartered Accountants, Ghana (ICAG); about 9.1% of them were members of the Chartered Institute of Taxation, Ghana

(CITG), whereas one respondent had other qualifications. This appears to be the membership pattern of the accounting professional bodies in Ghana. Almost half (48.5%) had more than 20 years of tax practice experience. About 24.2% of them had between 10 and 20 years of experience, whereas the rest (27.3%) had less than 10 years of tax experience. The respondents thus appear to be experienced, and their responses thus add value and creditability to the results obtained in this study.

Description of external tax professionals' clients

External tax professionals provided information on the size of their clients' businesses, as shown in Table 2.

Table 2

Client distribution

Types of companies	N	Min (%)	Max (%)	Mean (%)	SD
SME (%)	27	5	100	58	30
Large companies (%)	26	1	100	28	24

Source: Own formulation

Of the 33 respondents, 27 provided information on SMEs. The approximate percentage of SMEs engaging the services of the respondents ranged from 5% to 100%, with an average of 58% over the past three years. The approximate percentage of large companies served by responding tax professionals ranged from 1% to 100% of their clientele, with an average of 28% within the past three years. Table 2 further indicates that SMEs were the main client base of the respondents. The study further sought the breakdown of the client base in terms of sales turnover. The results are presented in Table 3.

Table 3

Client sales turnover

Sales Turnover	N	Min (%)	Max (%)	Mean (%)	SD
Less than GHC 50,000	5	8	85	27	33
GHC 50,000 – GHC 100,000	17	2	50	20	17
GHC 100,001 – GHC 200,000	19	3	49	14	12
GHC 200,001 – GHC 500,000	19	1	75	24	20
GHC 500,001 – GHC 1,000,000	21	2	100	52	33

Source: Own formulation

As shown in Table 3, five professionals indicated that an average of 27% of their clients have a turnover of less than GHC 50.000. Seventeen professionals reported that an average of 20% of their clients have a turnover between GHC 50,000 and GHC 100,000. Nineteen professionals indicated that an average of 14% of their clients have a turnover between GHC 100,000 and GHC 200,000. Nineteen (19) professionals suggested that an average of 24% of their clients have a turnover between GHC 200,000 and GHC 500,000. Twenty-one (21) professionals indicated that an average of 52% of their clients have a turnover between GHC 500.,000 and GHC 1.000.000. The sectors in which the clients operated their businesses were also solicited from the respondents. The percentage of client distribution per business sector is presented in Table 4.

Table 4

Percentage of tax clients' business sector

Business Sector	**N**	**Min(%)**	**Max (%)**	**Mean (%)**	**SD**
Manufacturing	24	1	70	16	17
Service	28	1	90	38	26
Property and construction	17	1	25	9	6
Finance and banking	16	1	52	16	18
Trading	26	1	80	30	24
Other sectors	8	2	100	24	32

Source: Own formulation

Table 4 shows that 24 professionals indicated that an average of 16% of their clients are from the manufacturing sector. Twenty-eight 28) professionals indicated that an average of 38% of their clients are from the service sector, whereas 17 of them showed that an average of 9% of their clients are from the property and construction sectors. Sixteen 16 professionals indicated that an average of 16% of their clients are from the finance and banking sectors. At the same time, 26 of them noted that an average of 30% of their clients are from the retail (trading) sector. Lastly, 8 of them have an average of 24% of their clients from other sectors.

External tax fees

In order to obtain the external tax costs incurred by SMEs, the practitioners were required to indicate the average tax fees charged by the professionals. The tax fees charged to clients, as indicated by the tax professionals, are presented in Table 5.

Table 5

Clients' external tax fees

Tax Fees (GHC)	**N**	**Min**	**Max**	**Mean**	**SD**
Lowest range	30	1 000	30 000	6 150	6.767
Highest range	30	1 800	200 000	25 670	36.003
Overall	**30**	**1 400**	**115 000**	**15 910**	**21.385**

Source: Own formulation

From Table 5, the minimum tax fees charged range from GHC 1,000 (USD 204) to GHC 30,000 (USD 6,122), with an average of GHC 6 150 (USD 1,255). Also, the maximum tax fees charged range from GHC 1,800 (USD 367 to GHC 200,000 (USD 40,815), with an average of GHC 25,670 (USD 5,239). An overall average tax fee of GHC 15,910(USD 3,247) was charged. To further enhance the interpretation of the compliance cost (external fees), the fee charged was expressed by sales turnover category of SME clients. The results are presented in Table 6.

Table 6

External tax fees by sales turnover

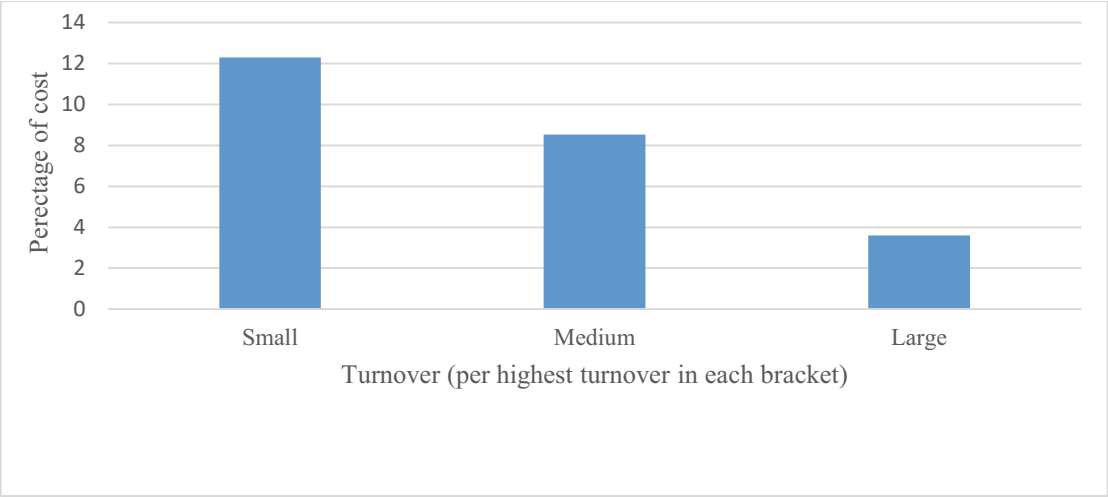
Turnover	N	Mean GHC
Small (<GHC 50 000)	30	1,398
Medium (GHC 50 000-GHC 100 000)	30	4,756
Large (>GHC 101 000)	30	25,670
Overall	**30**	**6,150**

Source: Own formulation

Table 6 indicates that external tax fees increase with increased firm size and turnover. In other words, the results appear to show that the size of a business (as measured by turnover) is a major determinant of the fees charged for tax services in Ghana. To ensure a meaningful comparison with other studies, the researcher found it appropriate to consider studies in Africa first and thereafter compare them with other international studies. The interpretation of these comparative results should, however, be made with caution as a result of three main factors. Firstly, there are differences in the methodologies for the computation of compliance costs (Chattopadhyay & Das-Gupta, 2002; Tran-Nam et al., 2000). Secondly, there are differences in the systems of taxation as well as the culture of tax payments between countries (Sapiei, 2012). Thirdly, there are variations in the time when the studies were conducted. However, it is suggested that tax systems in African countries and the culture of tax payments could be largely similar. As a result of this view, the author deems it appropriate to compare the current study with similar studies conducted in Africa.

There is a lack of literature on compliance costs in African studies. However, two studies were found (Smulders et al., 2012; World Bank, 2016) related to SMEs and were used for comparative purposes. All currencies were converted into US dollars for ease of comparison. The South African Rand was converted using 1 USD = ZAR 8.6527 (rate as of 12 December 2012), and the Ghana Cedi was converted using 1 USD = GHC4.9002 (rate as of 31 December2018). The World Bank study in Ethiopia was already stated in US dollars. However, the interpretation of the absolute amounts is limited by factors such as inflation and the time value of money.

The external cost in Ethiopia was USD 120.90, and in South Africa, it was estimated to be USD 3,693.18, while the cost in Ghana was USD 234. The results indicate a higher external compliance cost in South Africa compared to the other two countries. The external costs in Ghana and Ethiopia represent 88% and 3.3%, respectively, of the cost incurred in South Africa. A better comparison of the external tax costs incurred by SMEs would be to express the cost as a percentage of turnover. The external fee cost per percentage of turnover in Ghana is shown in Figure 2.



Source: Own formulation

Figure 2. External fee cost by percentage of turnover for Ghana

It appears that the smaller the firm, the greater the impact of the external fees. The burden of external tax costs appears to be heavy on the smaller businesses in Ghana. These findings suggest the regressive nature of taxes in Ghana. The result of this study is consistent with findings in the World Bank (2016), Smulders et al. (2012) in Africa, and other international compliance cost studies like Abdul-Jabbar and Pope (2008) conducted in Malaysia, Lignier and Evans (2012) conducted in Australia, the Belgium study by Schoonjans et al. (2011), the United Kingdom study by Hansford and Hasseldine (2012), as well as the Chattopadhyay and Das-Gupta (2002) study conducted in India.

Analysis by firm characteristics

This section provides a cross-tabulation analysis of the external tax costs incurred by SMES by their characteristics. The results are shown in Table 7.

According to Table 7, approximately half of the TCC for SMEs in the manufacturing and service industries was spent on external compliance costs. However, the retail (trade) sector experienced much higher external tax costs (61%). These findings imply that trading firms paid more in external professional fees than their counterparts in the manufacturing and service industries. On the other hand, SMEs in other industries (such as plantations, agriculture, banking, and finance) had external tax costs that were much lower (43%) than those in all other industries. This suggests that businesses in other industries typically conduct their own tax-related activities, resulting in lower payments to tax experts to act on their behalf.

A split of TCC according to the ownership structure of SMEs is also shown in Table 7. The findings show that partnerships and sole proprietorships were substantially more likely to devote a larger portion of their compliance expenditures to paying external tax fees. Private limited liability corporations, on the other hand, spend a sizable portion of their compliance expenditures internally. As a result, partnerships and sole proprietorships hire external tax professionals for the majority of their tax compliance tasks. Private limited liability firms, on the other hand, typically handle their own tax compliance needs. As a result, the limited liability firms pay less for tax professionals.

When data are analysed according to how long businesses have been in operation, it becomes clear that businesses with an operational history of 20 years or less are more likely to spend a larger portion of their compliance costs on external tax fees. On the other hand, businesses that have been operating for more than 20 years are more likely to incur lower costs for tax professionals.

Table 7

External compliance cost ratios by firm characteristics

Variable	External
Firm Sector	
Manufacturing	50
Service	52
Trading (Retail)	61
Other	43
Ownership structure	
Sole proprietorship	54
Partnership	57
Private limited by liability company	45
Firm size/turnover	
Small (<GHS50 000)	55
Medium (GHS50 000-GHS100 000)	52
Large (>GHS100 000)	50
Firm age	
Less than 10 years	54
10-20 years	53
More than 20 years	48

Source: own editing

Analysis by computational-planning cost ratios

The fees charged by professionals were further analysed to ascertain the various components in terms of charges resulting from tax computations and tax planning activities. External tax professionals were requested to state the estimated percentage of their fee for tax computational work, as well as their fee for tax planning and other types of work. The results are presented in Table 8.

Table 8

Tax fees: computational-planning cost ratio

Cost nature	N	Min %	Max %	Mean %	SD
Computational	28	3	100	66	29
Planning	23	1	80	21	20
Other	8	5	69	27	27

Source: Own formulation

From Table 8, the average percentages of the computational, planning and other costs were 66%, 21% and 27%, respectively. Therefore, the computational and planning cost ratio is 66:21, or 3:1. Hence, the feedback suggests that most of the fees charged were for tax compliance activities of SMEs, such as tax computation for inclusion in annual financial statements, self-assessment estimation at the beginning of the year, and responding to tax demands by the revenue authority.

Reasons for engaging external tax clients

The researchers further sought from the tax professionals' reasons why SMEs engage their services. The main reasons they provided are listed in Table 9.

Table 9

Reasons for hiring external tax professionals

Reasons	Frequency	Per cent	Per cent of Cases
Estimating income tax payable	27	21.8	81.8
Understanding income tax legislation	24	19.4	72.7
Implementing income tax changes	25	20.2	75.8
Maintaining records for income tax purposes	20	16.1	60.6
Dealing with tax authorities	26	21.0	78.8
Other	2	1.6	6.1
Total	**124**	**100.0**	

Source: Own formulation

From Table 9, the majority (81.8%) of external tax professionals claimed their services were mainly engaged for calculating the income tax payable. Other significant reasons include dealing with tax authorities (78.8%), implementing income tax changes (75.8%), understanding income tax legislation (72.7%), and maintaining records for income tax purposes (60.6%), in descending order of importance.

Tax difficulties faced by SMEs

After ascertaining the reasons for engaging the tax practitioners for their services, the respondents were asked to provide information on some of the difficulties faced by their SME clients. The main difficulties faced by their SME clients are listed in Table 10.

Table 10

Tax difficulties faced by SMEs

Difficulties	Frequency	Per cent	Per cent of Cases
Difficulties in understanding income tax changes	26	26.5	86.6
Maintaining records for income tax purposes	24	24.6	80.0
Implementing income tax changes	14	14.3	46.6
Dealing with tax authorities	16	16.3	53.3
The short period to lodge tax returns	16	16.3	53.3
Other	2	2.0	6.1
Total	**98**	**100.0**	

Source: Own formulation

From Table 10, the majority (86.6%) of external tax professionals claimed that the major difficulty faced by SMEs is understanding the income tax laws whenever amendments are made. Also, 80% of the external tax professionals indicated that maintaining adequate records for income tax purposes was a major challenge for SMEs. Other difficulties identified included dealing with tax authorities (16.3%), the short period to lodge tax returns (16.3%), and the difficulty in implementing tax changes. The professionals' views on tax difficulties faced by their clients provide further information to cross-check the validity of the reasons provided for the engagement of the professionals. The results confirm that the three top difficulties faced by SMEs were the main reasons for engaging the tax professionals.

Suggestions to reduce tax compliance costs and improve the tax system

Finally, the tax professionals were asked to provide suggestions about reducing tax compliance costs. The recommendations provided by the tax professionals are presented in Table 11.

Table 11

Suggestions to reduce tax compliance cost

Suggestions	Frequency	Per cent
Computerisation/digitisation of the tax system makes filing online possible	7	38.9
There should be more education on the company and individual income tax systems	3	16.7
Good record keeping	4	22.2
The Ghana revenue authority should maintain data for each taxpayer indicating deduction from source	1	5.6
The law must be simplified	3	16.7
Total	**18**	**100.0**

Source: Own formulation

From Table 11, digitisation to make online filing of returns possible (38.9%) was suggested by the majority of tax professionals. Other vital suggestions for the reduction of compliance costs include good record-keeping (22.2%), the need for more education on the tax system in Ghana (16.7%) and simplifying the tax law (16.7%). One professional suggested that the GRA should maintain data for each taxpayer on the deduction of taxes from the source.

CONCLUSION

The study sought to ascertain the magnitude of the external tax compliance costs incurred by SMEs in Ghana from the perspective of the tax professionals who provide the service. The study found that on average, tax practitioners charged SMEs GHC 6,150 (USD 1,255) which also showed that small firms incurred an estimated annual cost of GHC 1,398 (USD 285), and medium firms GHC 4,752 (USD 970), to compute and file returns, deal with tax authorities, implement changes in tax laws, and maintain records for tax purposes on behalf of their clients. Furthermore, the cost incurred by SMEs was mainly for tax computations as opposed to tax planning. The external tax fees charged thus increase the cost of tax compliance for SMEs in Ghana. The cost was found to be regressive in nature, indicating that the burden was heavy mainly on small businesses. This study also found evidence to support McKerchar et al.'s (2009) theory that firms engaged the services of external tax professionals on tax issues, and the external tax fees were found to increase with firm size. One of the key reasons for the use of tax professionals by SMEs is the difficulty of understanding tax legislation. As such, it is recommended that constant training be provided to SMEs to enhance their understanding of tax laws and facilitate compliance with them. The training should also take into consideration other tax problems faced by SMEs. To this end, the problems identified by this study will further assist the Ghana Revenue Authority (GRA). This study should be seen as a baseline study that needs frequent updates to ascertain whether the cost of compliance has been reduced.

Author's contribution

Conceived and designed the study: Ernest Bruce-Twum 60%, Daniel P. Schutte 40%; collected the data: Ernest Bruce-Twum 100%, performed the analysis: Ernest Bruce-Twum 60%, Daniel P. Schutte 30%, Banele Diamini 10%; wrote the paper: Ernest Bruce-Twum 60%, Daniel P. Schutte 30%, Banele Diamini 10%

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Smart Cities and Sustainability in Central-Eastern Europe

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SUMMARY

Accelerating globalisation is setting economies serious challenges. Rapidly changing conditions (globalisation, industry 4.0, sustainability or pandemics) demand innovative solutions from regions. The way in which regions with different levels of development respond to external shocks can have a major impact on (and increase) existing socio-economic disparities between regions worldwide. Central and Eastern Europe is particularly vulnerable in this respect, as a peripheral region, where the impact of various crises is greater due to less diversified economies and lower income levels. The aim of this study is to examine the territorial differences in Central-Eastern Europe and to analyse the situation of smart cities as a potential alternative in the region. The results show that the region's capitals are in the second half of the European ranking in terms of both smart cities and sustainable development, forming a broadly defined Polish-Czech-Slovak and Hungarian-Romanian-Bulgarian capital cluster. The comparison of the components of the sustainability index revealed that cities in the CEEC region are in a less favourable position in the dimensions measuring mostly "hard" indicators (innovation, industry, infrastructure) than in the components measuring more "soft" elements, and the opinion of the inhabitants is diverse about the cities' sustainable performance.

Keywords: smart cities; sustainability; Central-Eastern Europe.
Journal of Economic Literature (JEL) codes R11, R12
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INTRODUCTION

Spatial social and economic inequality is a fundamental feature of spatial economics (Nemes Nagy, 1990). No two points in space have identical characteristics because their initial conditions (economic, social, and cultural factors) are different (Benedek & Kurkó, 2011). The degree of difference varies in space and time. In the European Union, the issue of spatial disparities is of particular interest, as economic and social inequalities are a major problem in Europe today (Widuto, 2019). With the enlargements of the EU, disparities between countries and their regions have increased steadily, and since the mid-1980s (with the enlargement of the EU to the South and then to the East), to a significant extent. By the late 2000s, income distribution in Europe was much more unequal than the OECD average (Sánchez Carrera et al., 2021).

The European Commission report, while showing convergence between the different parts of Europe since 2000 due to high levels of regional support, also pointed out that these are growing internal disparities at the level of regions (European Commission, 2022). In 2021, the highest GDP per capita among EU Member States was in Wolfsburg (GER) at NUTS3 level with €172,100, while the lowest was in Silistra (BG) with €4,200, a 40-fold difference (Eurostat, 2023). The development of economies (countries/regions) is affected by shocks that are fundamentally reshaping their development paths. Some of these are in the form of crises (economic, financial, health, natural, etc.), others are leading to major transformations such as industrial revolutions (e.g., Industry 4.0, robotics, automation), which are the result of the emergence of key innovations and which are bringing about significant changes at national and regional level. In today's Europe, the main concern, in addition to widespread regional disparities, is the increasing inflationary pressures, which are particularly

affecting peripheral countries in Central and Eastern Europe (Baba et al., 2023). At the same time, in all areas, the idea of sustainability is becoming increasingly important in the face of growing problems, putting new pressures on regions from an economic, social and environmental point of view.

The aim of the study is to examine the territorial differences and current challenges in Central-Eastern Europe (a peripheral region) and to analyse the situation of smart cities as a potential alternative in the region, focusing on the capital cities (Prague, Bratislava, Warsaw, Bucharest, Sofia). Central and Eastern Europe (CEE) was called for several years as the post-Soviet bloc (Nepala, 2018), although there are many different approaches of the geographical limitations of the region. There is an agreement that the EU member states of the CEE region are the Baltic states (Estonia, Latvia, and Lithuania), the four Visegrad countries (Czech Republic, Slovakia, Hungary, and Poland), Romania, Bulgaria and Slovenia (e.g., Istenic et al., 2014; Gajewska, 2021). Also, we can talk about Central, Eastern and Southeastern Europe, which contains from the EU member states Croatia as well as the above-mentioned ones. Besides them the states of the Western Balkan (Albania, Bosnia & Herzegovina, Kosovo, FYR Macedonia, Montenegro, and Serbia), and some countries of the CIS (Commonwealth of Independent States) countries (Belarus, Moldova, Russian Federation and Ukraine), so a much broader area (IMF, 2016). From these countries, the recent analysis is focusing on six countries from the narrower CEE area and dealing with the capitals of the V4 countries extended with Romania and Bulgaria based on their similar development path and common economic history. So later, the recent study's CEE is covering that six territories.

The main research question of the study was to analyse the theoretical and empirical gap between smart city and sustainable city concept. As among the EU member states, different solutions have emerged in the specific geographical areas, and capital cities are at different levels of development in terms of both smart city strategies and sustainability considerations. Both Northern-Southern and Western-Eastern differences can be identified. In CEE, 4 out of 11 cities do not have a complex smart city strategy and only 3 cities have a sustainability focus (Szendi, 2023). The hypothesis is, that among the capitals of the CEE region's member states, different approaches can be found on the application and use of smart and sustainable city strategies, which are stronger in the V4 area, and relatively weaker by Romania and Bulgaria. However, there is not a significant difference in the application of given SDGs.

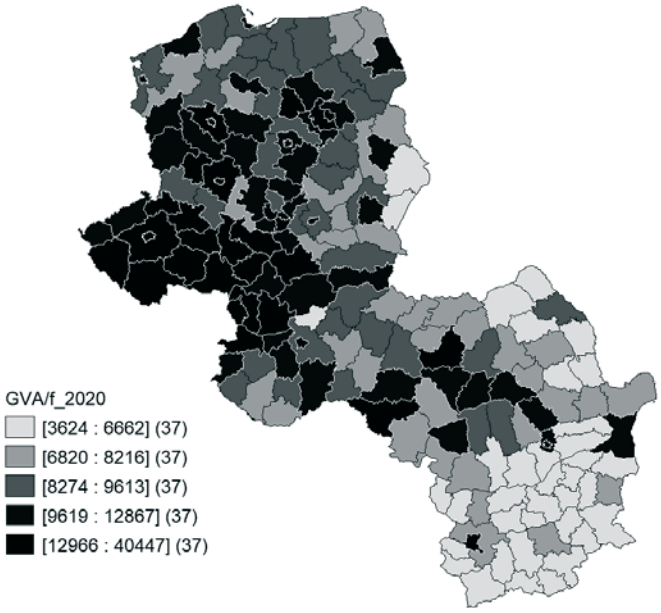
THEORETICAL BACKGROUND

The study of territorial disparities and catching up is not new. Nowadays, several researchers have analysed the convergence processes of the European regions (Goecke & Hüther, 2016). The question has been whether less favoured/developed regions can grow faster than richer ones and thus catch up. Economic convergence refers to the process whereby relatively poorer countries (or regions) grow faster than relatively richer ones, allowing the former to catch up with the latter (Alcidi et al., 2018). A European Commission study from 2009 looked at the main processes of interregional convergence in the EU. The study found that the process of beta-convergence between EU regions has been achieved in both the EU-15 and EU-27, but that the speed of convergence has not been constant over time. In addition, convergence within some groups of regions was sometimes stronger than in other groups (e.g., centres and peripheries). Sigma convergence suggests a reduction in inequalities between regions over time (Barro & Sala-I-Martin, 1992). The coefficient of variation (CV indicator) of GDP per capita is a widely used measure of sigma convergence. Over the period 1995 to 2019, the value of CV has been roughly halved in both the euro area and the EU27, but the global financial crisis has slowed the rate of convergence significantly in both cases. In contrast, the COVID-19 crisis led to an increase in the indicator in the EU (Licchetta & Mattozzi, 2023), further widening the gap. The authors therefore argue that it is worth looking at changes across several indicators (Widuto, 2019). However, different crises can affect convergence processes to different degrees and in different directions.

According to some researchers, although peripheral regions and countries in the EU tend to grow faster than richer ones, there is more divergence between areas in the long run (Alcidi et al., 2018), and convergence is only meaningful within certain clusters/clubs.

Following the Commission report described above, the European Investment Bank has also examined the impact of the 2008-09 economic and financial crisis on territorial processes. Their analysis shows that regional economic convergence slowed down significantly in 2008-09, after nearly a decade of rapid convergence (European Investment Bank, 2012).

The impact of the COVID-19 pandemics on regional disparities has been analysed by several organisations and researchers. According to the OECD (2020), the COVID-19 crisis has highlighted the widening of regional disparities in economic growth in Europe. Palomino et al. (2020) measured the impact of policies emphasising social distance on poverty and wage inequality in Europe and found that poverty increased, and wage losses occurred during the pandemic.



Source: own calculation and editing based on Eurostat data

Figure 1: Regional disparities of the GDP per capita in the CEE countries, 2020

The above Figure 1 shows the disparities of the regional GDP per capita in the Central and Eastern European region for the period 2020. Regional differences within the region are significant and the differences in growth rates suggest that disparities may have widened over the last 15 years. This is supported by the fact that, for example, Hungarian counties had on average lower growth rates than, for example, Slovak or Polish regions. In addition to the existing West-East disparities, the data also show a North-South slope in the country group. Besides some industrial areas, and new areas of excellence (with intensive R&D capacity), the capital cities are the CEEC region's hot spot areas, where the GDP is clustering.

The widening regional disparities and the problems arising from external shocks point out the need for resilience[i]. Resilience is also important for the catching-up of peripheral regions, where the negative impact of various crises can be greater due to a less diversified economy and lower income levels (Sondermann, 2016). So even similar economic shocks can have very different impacts on the performance/competitiveness of more developed and less developed areas (Pénzes et al., 2014). This is why I chose to analyse the processes in the Central and Eastern European region and to explore possible alternatives.

Today, cities are the most important centres of economic activity worldwide (concentration of population, businesses, trade, stock markets). The challenges of the external environment demand new and innovative solutions. At the same time, the sustainable development of cities is emerging as a key policy, which is also challenging them. Smart cities can be the winners in this process, as the smart solutions they deploy can make a major contribution to their resilience and competitiveness. This is why the choice was made to analyse the capital cities of the CEEC region in terms of their smart city performance and sustainability objectives.

The concept of smart cities emerged in the literature in the 1980s and 1990s, primarily as a way of integrating the use of ICT into the everyday functioning of cities. In this period, it was mostly the use of ICT that made cities smart. For example, Hall (2000, p. 1) in his definition stresses the importance of monitoring processes, as a smart city is a "city that can monitor and integrate the status of all its critical infrastructure, better optimise its resources and monitor safety aspects while maximising the services provided to its citizens". Subsequently, soft elements (knowledge, innovation) have been increasingly included in the definitions, but there is still no common conceptual definition. Kourtit and Nijkamp (2012, p. 93), for example, define knowledge and innovation as key elements of smart cities, where "smart cities are the result of knowledge-intensive and creative strategies". In my analysis, I draw on the following definition based on previous analyses.

Smart cities are defined as areas that apply innovative strategies and solutions to improve the quality of life of their inhabitants, while making effective use of their creativity and knowledge base (Szendi, 2019).

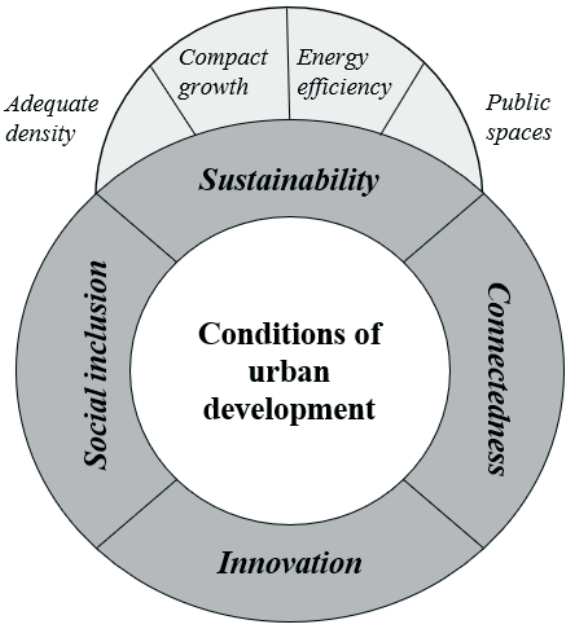
There is no agreed concept in the literature for measuring the performance of smart cities and different ideas have been put forward for the calculation of the component values and the content of the complex index (Nagy et al., 2018). The common feature of these concepts is that they aim to define smart city

performance based on several components and a number of indicators and rely on data from both qualitative and quantitative scales (Szendi et al., 2020).

One of the most used models is the six-component model (economy, people, governance, mobility, environment and living conditions) developed by Giffinger et al. (2007), which measures the performance of cities using 82 indicators of these six dimensions. In Fernandez-Anez et al.'s (2018) smart city model, to adapt to rapidly changing circumstances (resilience), the dimensions are complemented by global trends affecting cities. The main trends affecting cities are interpreted as: climate change, social polarisation, the need for new governance models, global urbanisation, economic instability, and the growing importance of new technologies.

At the same time, the speed and form of responses to changing global trends and shocks may also differ, due to the different governance models of cities. The application of a top-down urban governance model and a bottom-up approach to shocks may not be equally successful, as demonstrated by the response to the impact of the Covid19 epidemic especially in terms of their short- and long-term measurable effectiveness (Szendi & Sárosi-Blága, 2022). In the first period of the pandemics, some cities could improve their position with a bottom-up and co-creation approach, while in the second year of the pandemics, cities that had worked well in the short term with bottom-up management (Amsterdam, Helsinki) has lost ground, while top-down strategies were a more effective way of dealing with the crisis in the longer term (Szendi & Sárosi-Blága, 2022). Duggal (2020) argues that top-down planning should be combined with multi-level, integrated urban governance to respond effectively and flexibly to urban shocks (e.g., pandemics) and to ensure long-term sustainability. A sustainable smart city is therefore a city that, with the support of ICT, meets the needs of its current inhabitants without compromising the ability of other people or future generations to meet their needs, and thus does not exceed environmental limits (Höjer & Wangel, 2014).

According to Barrionuevo et al. (2012), a smart and sustainable city means using all available technologies and resources in a smart and coordinated way to create urban centres that are integrated, liveable and sustainable. Their model can be summarised in the figure below, which in its present form represents a simplification along the sustainability dimension



Source: Barrionuevo et al. 2012, own edition

Figure 2: Conditions for urban development in terms of sustainability

Based on this, for the sustainability pillar, it is important to maintain an appropriate population density in cities, i.e., it draws attention to the problems of overpopulation and economies of scale. Compact growth is understood as the integrated treatment of all elements and services, creating synergies and balanced growth. The model also includes the classic energy efficiency dimension, reinforcing the role of renewable energy sources. While in community spaces, the idea of social sustainability and inclusion is mainly present (Barrionuevo et al., 2012).

The concept of economic sustainability is mainly characterised by solutions related to smart economy and smart governance, while socially sustainable solutions are more in the people and living conditions components. Classical environmental sustainability can be found in the environment and mobility pillars.

METHODOLOGY AND RESULTS

Building on the above, the following section examines the capital cities of the Central and Eastern European region from the perspective of smart and sustainable cities. The analysis will focus about the broader CEEC capitals (Prague, Bratislava, Warsaw, Bucharest, Sofia), which are based on similar starting conditions, historical characteristics, strategic cooperation, and socio-economic characteristics.

In the first step of the study, there was a comparison made for the cities' performance in the smart city rankings and their position among sustainable cities. To analyse the smart city rankings, first the IMD Smart City Index was checked, which was developed in 2017 by two institutions, IMD and the Singapore University of Technology and Design (SUTD). The index focuses on the "human dimensions" (quality of life, environment, inclusion) of smart cities, in addition to their economic and technological aspects. In its definition, a "smart city" is an urban environment that uses technology to enhance the benefits and reduce the drawbacks of urbanisation. The index takes a holistic approach, aiming to explore the different urban dimensions in terms of smart applications (IMD, 2019). The methodology relies primarily on the perceptions of those living and working in the cities under study, while recognising that not all cities start from the same level of development or have the same assets and benefits. The first version was published in 2019, creating the Global Smart Cities Ranking, which has been updated annually since then. Cities are ranked and positioned in clusters (A-D) based on their national HDI value, with an increase in the number of letters (e.g., AAA) indicating a more prominent position within the cluster.

As in previous years, Singapore tops the list for 2021 (Table 1), followed this year by Zurich and Oslo. In Europe as a whole, the Nordic capitals are the best performers, but there are also shifts in their ranking. The capitals of the Central and Eastern European region are mostly in the bottom third of the 118 cities surveyed, as members of cluster C (with a national HDI level around the average). In terms of ranking, the Polish capital is the smartest, followed by Prague only slightly behind. The Slovakian and Hungarian capitals, Bucharest and Sofia form a cluster thanks to their similar positions, lagging the two leading cities in the region by a larger margin (20 and 30 positions for the two groups respectively). Analysing the trends, Budapest has dropped one position in the ranking after 2020, but this is only a change of position, as its results in each year move in line with the corresponding indicator for Bratislava. Another shift in the region is the displacement of Warsaw and Prague, with Warsaw becoming the best CEEC capital by 2021.

Table 1

Ranking of smart and sustainable cities, with a special focus on CEEC capitals

	Ranked by SDG aggregate score (2019)	SDG value		IMD Smart City Ranking (2021)	Smart city classification
1	Oslo	74,8	1	Singapore	AAA
2	Stockholm	74,2	2	Zurich	AA
3	Helsinki	71,3	3	Oslo	AA
	...	...		...	
26	Bratislava	60,2	75	Warsaw	CCC
27	Prague	60,1	78	Prague	CCC
31	Warsaw	57,8	96	Bratislava	CC
37	Budapest	55,4	97	Budapest	CC
38	Sofia	55,2	106	Bucharest	C
41	Bucharest	54,4	107	Sofia	C

Source: own editing

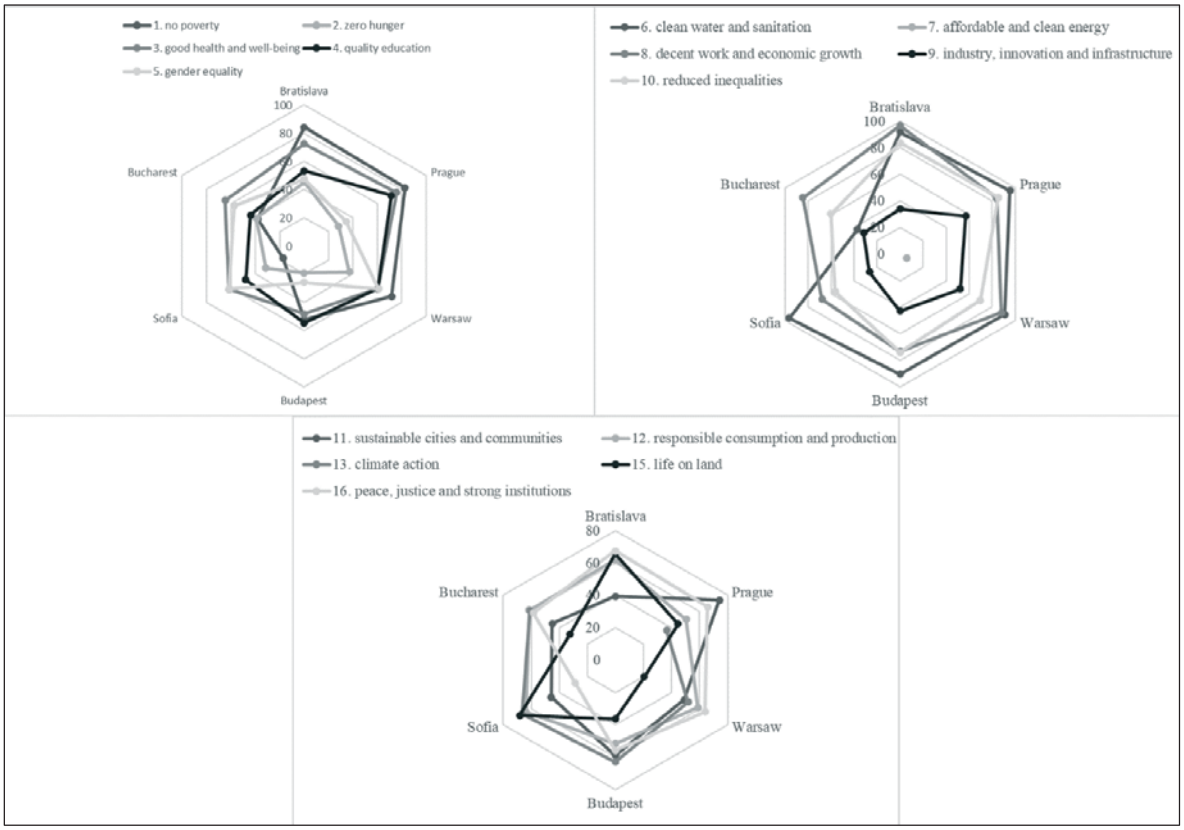
As a continuation of the Millennium Development Goals, the UN adopted the Sustainable Development Goals (SDGs) in 2015, which aim to achieve sustainability by 2030 with a total of 17 targets. The Goals have been adopted by national governments in a global partnership, in line with the UN principles (Lafortune et al., 2019).

The Sustainable Development Solutions Network (SDSN) and the Brabant Center for Sustainable Development (Telos) have produced an SDG index-based benchmarking of European cities, without the less meaningful and data-poor SDG 14 (underwater habitat) and SDG 17 (partnership) targets at the city level, so a total of 15 variables were assessed. The aim of the study was to show that, although national governments have adopted the SDG targets, it is also clear that regions and cities play a crucial role in achieving them (Lafortune et al., 2019). For each target, the level of achievement in the city was assessed and categorised as follows: SDG target achieved (100%); challenges remaining (66-99%); significant challenges remaining (33-65%); significant challenges remaining (0-32%); missing data.

The main finding of the SDG analysis of the European cities is that of the 45 European cities surveyed, three Northern European cities ranked first in the index: Oslo, Stockholm, and Helsinki (Table 1). However, even for these best performing cities, significant challenges remain in achieving the SDGs. The CEEC capitals are in the second half of the 45 cities surveyed, and in this case, they fall into two clusters with similar characteristics. Bratislava, Prague, and Warsaw have similar overall rankings, while Budapest is like the Bulgarian and Romanian capitals. Thus, it can be said that the position of the cities differs slightly from the smart city ranking, although a Polish-Czech-Slovak and a Hungarian-Romanian-Bulgarian cluster can be formed in both cases.

Given the diversity of the SDGs, it is also worth looking at the position of the CEEC capitals at the level of each objective to see which factors are driving the clustering. Due to the number of targets, the position of cities had been checked in three clusters, reviewing 5 to 5 targets in each case.

Looking at the first five targets, Bratislava, and Prague score above average on three and Warsaw on four, with Bratislava scoring particularly high on the poverty (SDG1) and well-being (SDG3) targets. In particular, the Romanian and Bulgarian capitals perform poorly on SDGs 1 and 2 on poverty and hunger, while for Budapest, the gender issue emerges as a problematic component alongside hunger (Figure 3).



Source: based on https://euro-cities.sdgindex.org/#/ own editing

Figure 3: Position of CEEC capitals along each SDG (2019)

The second set of targets (SDG6 - SDG10) shows a more balanced picture than before, except for the clean energy component (target 7, data-poor in the region), with larger differences being identified only in the Romanian and Bulgarian cases. The clearly weakest component in the region in this comparison is the industry, innovation, and infrastructure component (SDG9), where only Prague is close to the European average. Bratislava and Prague are also the most prominent in the ranking along three dimensions.

In the last group (SDG11 - SDG13, SDG15 - SDG16), Prague, Warsaw and Budapest have the most balanced performance, with above average scores along all dimensions except for the life on land (SDG15) factor. Responsible Consumption (SDG12) scores very well in almost all regions, while the highest score for SDG11 on Sustainable Cities is in Prague, but the Hungarian capital also scores well.

The analysis of the targets therefore clearly shows that there are significant differences among the CEEC capital cities and that the value/distribution of some dimensions has a significant impact on the overall performance of the cities.

Regarding the positions of the CEEC capitals, it is worth to check whether there is a complex smart or sustainability strategy in the capitals (Table 2).

Table 2

Existence of a complex smart city strategy in the CEEC capitals

Country	Capital	Existence of a smart city strategy	Role of sustainability in the strategy	Sustainability is a main objective?
Bulgaria	Sofia	no	Smarter-Together project: 2012-2020. There is a Sustainable Energy Action Plan.	no
Czech Republic	Prague	yes (2017-2030)	principle of resilience and environmental awareness, but not as exclusive or primary	no
Hungary	Budapest	yes	a three-pillar sustainability strategy, integrated into the vision 6 smart components	yes
Poland	Warsaw	no	Giffinger et al. (2007) 6 components, not a priority dimension of sustainability	no
Romania	Bucharest	no	an evolving strategy, sustainability is not a priority	no
Slovakia	Bratislava	no	there is only a climate change adaptation strategy	no

Source: own edition

Most of the capital cities surveyed do not have a comprehensive smart city strategy, nor is the sustainability dimension a priority. Therefore, also the sustainability aspects from the citizens' perspective was reviewed, starting from the premise that most of the sustainability assessments presented earlier were based on statistical indicators, pollution data, energy consumption and similar data, but that the public's opinion on the improvements achieved and the 'green' status of cities was mostly marginalised. The aim was also to show trends over time, so I checked the status of the data for several years (2012, 2015, 2019).

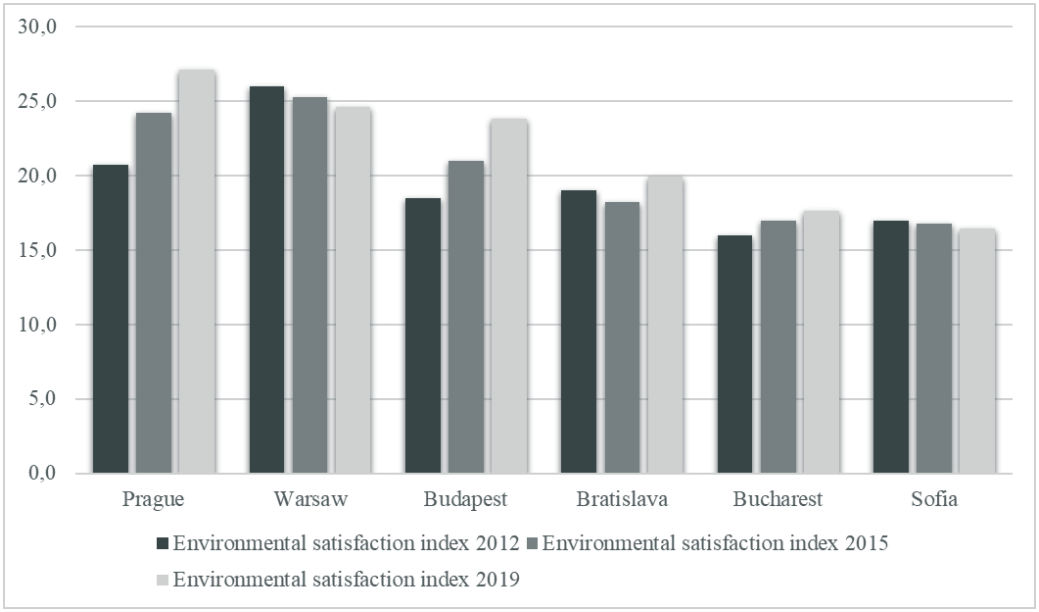
The Eurostat Urban Audit Perception Survey helped me in my analysis. The Urban Audit Perception Survey, which contains a total of 278 indicators measured on a qualitative scale, is a tool for qualitative studies. The survey uses a five-point Likert scale for the indicators, in which respondents can be grouped (1 - very satisfied, 2 - rather satisfied, 3 - rather dissatisfied, 4 - not satisfied, 5 - don't know/no answer). I have reviewed the following indicators:

- satisfaction with urban green spaces (more than 80% of the population very satisfied),

- satisfaction with air quality in the city (more than 80% of the population very satisfied),
- satisfaction with living in the city (more than 80% of the population strongly agree),
- satisfaction with the noise level in the city (more than 80% of the population very satisfied).

Since the scaling and the unit of measurement of the indicators were the same, no further transformation was needed in the calculations. Thus, the complex environmental satisfaction index can be calculated by aggregating and averaging the indicators.

The results of the index in 2019 for capital cities reflect the results seen previously, with capitals in the North and cities with relatively smaller populations performing well, while global cities with large populations, cities in the South and Central and Eastern Europe also top the satisfaction rankings. The Figure 4. below shows cities in the CEEC region.



Source: own editing

Figure 4. CEEC region capitals based on the Complex Environmental Satisfaction Index (2012, 2015, 2019)

An overview of the rankings shows that Prague was the leader in 2019, which position was new for the city, as in 2012 and 2015 Warsaw had a clear advantage among the capitals of CEEC, but after that a rapid increase happened in the Czech capital, presumably as an effect of developments, and now both in GDP and environmental term, the Czech capital is the best of the broader region. Almost all the capitals have improved their position from 2012 (except for Sofia, and Warsaw), but its extent was different. The biggest improvements happened in Budapest and Prague, the two cities with complex smart city strategy

SUMMARY

Accelerating globalisation and the growing importance of socio-economic shocks pose significant challenges for individual economies. Given their socio-economic parameters, the resilience and adaptability of each region will vary. Some regions are better able to cope with these processes, others less so. The study had sought to answer the question of the challenges that the various shocks pose to the Central and Eastern European region and the possible solutions.

The results show that the capitals of the region are in the second half of the European list in terms of smart city ranking and in terms of meeting sustainability targets, and the position of the capitals differs slightly on the two dimensions, but a Polish-Czech-Slovak and a Hungarian-Romanian-Bulgarian cluster can be formed in both cases. The comparison of the sustainability index components revealed that cities in the CEEC region are in a less favourable position in the dimensions measuring mostly hard indicators (innovation, industry, infrastructure) than in the components measuring more soft elements. Most of the capital cities of the area do not have a comprehensive smart city strategy, nor is the sustainability dimension a priority. Based on the opinion of the inhabitants, the Czech capital is the best performer followed by Warsaw and Budapest in 2019, however it is also clear that the biggest improvements in environmental satisfaction happened in Budapest and Prague, the two cities with complex smart city strategy. So, turning back to the initial hypothesis, the difference in the application of smart and sustainable city strategies

is not as clear as indicated, rather only the Czech Republic and Hungary has clear approaches. The second part of the hypothesis suppose that there is not a significant difference in the application of given SDGs, it is true. Only some of them shows great diversity. However, it is worth to mention, that in the future also the other geographical areas should be checked based on these components to see the European disparities better both in smart city strategies and the priority of sustainability. The conclusions can further highlight the success factors of some cities.

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[i] "resilience is the ability of systems, entities, communities or individuals to adapt successfully to changing external conditions and to withstand shocks from outside while maintaining the functionality of subsystems" (Santos & Leitmann, 2016, p. 12).

Questions for the Audit of Green Financial Statements

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SUMMARY

Nowadays, it is also an extremely important issue for businesses to examine and understand the environmental and social effects on the community, since sustainable and competitive operation is becoming a key element. Sustainable development means that we do not fully exploit the resources of any area during development and development for the sake of future generations. This point of view is integrated into politics, the economy, and people's everyday lives. In the case of companies, environmental awareness must not only take effect in production, manufacturing, and final products, but must also be integrated into company systems - including the accounting system - in order to be able to meet the changed expectations. In our study, we examine what processes are currently taking place in the field of environmental awareness, sustainability, and social responsibility, how these elements are integrated into the everyday life of companies, and how information about the interactions between the company and the environment appears in the information published by the companies. Therefore, we review the appearance of environmental accounting issues in the financial reports prepared on the basis of the Accounting Act in Hungary (Act C. of 2000 on Accounting).

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Journal of Economic Literature (JEL) codes: M41, M42
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INTRODUCTION, RESEARCH QUESTION

Protection of the environment became an important part of everyday life today (Buallay et al., 2023), reasoned by the increasing emission of waste polluting the environment on the one hand, and the over the long run unsustainable use of natural resources on the other hand. The most important aspect of treating environmental problems is prevention, as a consequence of which the next step of accountancy-evolution took place, mentioned in the technical literature as green (or eco) accountancy (Becsei et al., 2021; Bor & Pál, 2019).

Environmental protection is often associated only with the incurred costs and expenses, they forget about income, profit, and savings, despite the fact that several researches prove that there is a positive relationship between environmental protection and corporate competitiveness, the company's value (Süveges et al., 2022; Selmeczi-Kovács et al., 2020). The result can be positively influenced by the environmental protection subsidies and the improvement of the efficiency of the company's activity, more precisely the reduction of costs (EPA, 2000; Murányi & Borbás, 2016).

Based on the accounting law, the principle of going concern is as follows „Drawing up the financial report and the accounting records shall be based on the

assumption of the economic entity's capacity to sustain operations in the foreseeable future and on its ability to continue its activity, and the termination of or a considerable reduction, for any reason, in the operation is not expected". If we interpret this basic principle broadly, we reach the "peak" of green accounting, sustainability accounting, which, using the formulation of Burritt and Schaltegger (2010):

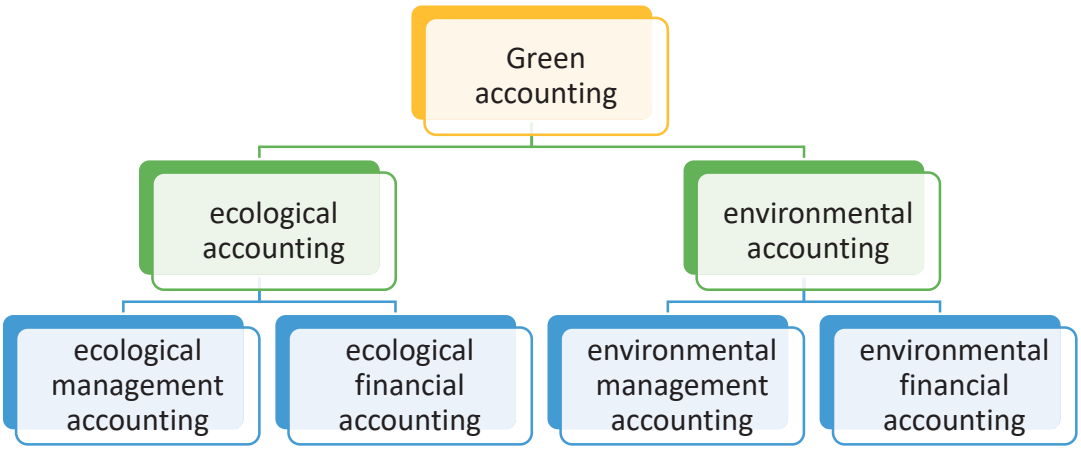
„Sustainability accounting describes a subset of accounting that deals with activities, methods and systems to record, analyse and report:

- First, environmentally and socially induced financial impacts,
- Second, ecological and social impacts of a defined economic system (e.g., the company, production site, nation, etc.), and
- Third, and perhaps most important, the interactions and linkages between social, environmental and economic issues constituting the three dimensions of sustainability." (Burritt & Schaltegger, 2010).

LITERATURE REVIEW

Concepts related to green accounting

Two subsystems of green accounting can be distinguished: on the one hand, ecological accounting that shows the environmental effects of corporate operations, and on the other hand, environmental accounting that reveals their financial consequences. Both subsystems can be divided into two parts: management accounting and financial accounting.



Source: authors' work

Figure 1. Parts of green accounting

Environmental management accounting is a data collection, systematization and analysis activity on environmental emissions and related environmental costs, therefore the information produced can primarily support management in rational decision-making. In contrast, environmental financial accounting presents the company's environmental obligations and costs to stakeholders through financial reports (Henderson, 2023), which influence (can influence) the company's financial situation. Ecological accounting deals with changes in the natural physical environment.

The appearance of green accounting can include:

- Ecological bookkeeping, which is the regular accounting that continuously records the impact of the organization's activities on the environment. Environmental events - which is a concept similar to economic events and includes events that have an impact on the natural environment of the enterprise - are not recorded in money, but in natural units of measurement. (Ecological accounting can be used primarily for analysis, decision-making and control purposes, but the methodology for determining the ecological factors is not yet fully developed and contains many subjective elements.) (Winter, 1997, 35-37).
- Eco-balance, which, by applying systemic thinking, examines the organization's impact on the environment with specific tools. The ecological balance not only takes into account the effects caused in the narrow sense of the factory area, but also the further fate of the manufactured products, i.e. further transport to

other producers, and the amount of environmental damage caused by consumption in households. With its help, it is also possible to manage, control and optimize the environmental effects, however, there is a lack of general and objective evaluation methods, there is a significant range of non-quantifiable environmental effects, the environmental impact of individual materials and procedures is not fully known, and when preparing the balance sheet, it is difficult to demarcate the boundaries of the investigation in space and time (Kerekes & Kindler, 1997, 16-23). Ecological scales are not even scales in the original sense of the word, because they are not bilateral comparisons. It would be more correct to call these analyzes environmental reports, but the jargon has already accepted the use of the term balance sheet (Pál et al., 2003, 213).

- Life cycle analysis, which is actually nothing more than product-level eco-balance. It helps to recognize the actual environmental impacts of a product, but it is a difficulty that the life cycle of any product is connected to the life cycles of countless other products, and where to draw the boundary of the "system" is somewhat arbitrary (Kerekes & Kindler, 1997, 16-23).
- Environmental capital in the balance sheet, which shows the contribution of resources provided by the environment. The value of environmental capital is equal to the external costs caused by the company. The theory is based on the assumption of a hidden social contract, that is, that the environment is also present among the owners of the company. It becomes visible how much of the limited natural resources the company has used. The greater the value of the environmental capital, the further the company moved behind in terms of profitability (Magness, 1997, 15-18).
- Environmental reports, which usually represent environmental goals, policies, and specific problems made public within the framework of annual reports (Kerekes & Kindler, 1997, 42-49). This category also includes the ESG reports explained later.

Appearance of environmental accounting in the report compiled on the basis of the Accounting Act in Hungary (Act C. of 2000 on Accounting).

Among the provisions of the Hungarian accounting act regarding the balance sheet, we can only find a clear provision regarding environmental protection in the sources and provisions. Thus, a provision must be made against the pre-tax profit - to the extent necessary - for those payment environmental protection obligations to third parties arising from past or ongoing transactions and contracts, which are probable or certain to exist on the balance sheet date, but whose amount or due date is still unknown uncertain, and the contractor did not provide the necessary coverage for them in any other way. In addition, a provision can be made for expected costs for such expected, significant and periodically recurring future costs (especially costs related to environmental protection) which on the balance sheet date can be assumed or certain to arise in the future, but their amount or the date of their occurrence is still uncertain and cannot be classified as deferred income.

Despite the fact that it is not named in the law, the following environmental protection-related assets may appear among the assets in the balance sheet:

- the „Capitalized value of research and development", followed by the capitalized value of environmental improvements,
- in the line of „Concessions, licenses and similar rights", the right to rent or use environmental protection equipment,
- „Intellectual property products" include environmental protection inventions, patents, technology,
- „Goodwill" can be the value of the acquired company's green image,
- property, equipment, machinery, investments for the purpose of environmental protection in the „Tangible assets" balance sheet group,
- „Stocks" in the balance sheet group are environmentally friendly stocks and waste.

In addition to the nominal provision, the source side of the balance sheet may show:

- „Tied-up reserve", if the capitalized value of research and development is shown in line with the „Capitalized value of environmental improvements"
- „Liabilities" include environmental protection compensation obligations, loans taken out for environmental protection purposes, and advances received from customers for environmentally friendly products.

In the profit and loss statement, grants awarded for environmental protection purposes may be included as income among other income.
Environmental costs can be:

- cost savings demonstrable in the „Raw materials and consumables", basic and auxiliary materials not used for production,
- the cost of waste removal, treatment cost, maintenance of environmental protection equipment, cost of education, or licensing fees appearing in the „Value of services consumed",
- insurance fees related to environmental protection appearing among the „Costs of other services",
- wages and contributions of those involved in environmental protection appearing among „Staff costs",

- the depreciation of environmental protection equipment appearing on the „Depreciation" line.

In addition to the balance sheet and profit and loss statement, a number of information related to the environment (protection) must be published in the notes, thus:

- The notes on the accounts shall contain the opening gross value of tangible assets serving environmental protection purposes directly, any increase or decrease therein, any re-classification, the closing gross value, as well as the opening value of accrued depreciation, any increase or decrease therein in the current year, any re-classification, the closing gross value, showing the amount of depreciation in the current year broken down by balance sheet item.
- In the notes on the accounts the quantity and value figures of the opening and closing inventories of any hazardous waste and pollutants, and any increase and decrease in the quantity and value of hazardous waste and pollutants in the current year shall be described by the hazard classifications defined in accordance with the relevant legislation.
- The amount of provisions formed in the current year and in the previous financial year for the purpose of covering environmental protection obligations and future expenses related to environmental commitments, separated by title, the amounts claimed in the current year and in the previous financial year as environmental protection costs, as well as the expected amount of environmental damages and liabilities not included in the balance sheet shall be described in the notes on the accounts (Kántor, 2016).

The business report to be prepared together with the annual report must also cover a number of topics based on the provisions of the Accounting Act, and must be shown in the following way:

- expected development (in line with the development of the business environment, known or anticipated, and with the proposed impact of internal policies);
- any effect of environmental considerations on the company's financial standing, and the company's environment-related commitments and responsibilities;
- environmental protection related projects, completed and anticipated, and any aid in connection therewith;
- the company's policy in terms of the means of environmental protection;
- measures taken for the protection of the environment and their implementation.

The above elements should be supplemented - the 2014/95/EU directive (NFRD, Non-Financial Reporting Directive) and the Accounting Act III. Chapter, 95/C. § - in Hungary, from 2018, certain organizations must also report non-financial data in their business reports.

Large companies which are public-interest entities where:

a) on the balance sheet date in the previous two consecutive financial years either two of the following three indices exceed the limit indicated below:
- the balance sheet total exceeds 6,000 million forints,
- the annual net turnover exceeds 12,000 million forints,
- the average number of employees in the financial year exceeds 250 persons; and

b) the average number of employees in the given financial year exceeds 500 persons;

shall publish a non-financial statement containing information to the extent necessary for an understanding of the company's development, performance, position and impact of its activity, relating to, as a minimum, environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters.

The non-financial statement shall at least contain:

- a brief description of the company's business model;
- a description of the policies pursued by the company in relation to environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters, including due diligence processes implemented;
- the outcome of these policies;
- a description of the principal risks related to those matters linked to the company's operations including, in particular, its business relationships, products or services in relation to environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters, which are likely to cause adverse impacts in those areas, and a description as to how the company manages those risks;
- non-financial key performance indicators relevant to the particular business.

However, the law does not specify special sanctions for failure to publish non-financial information, it only mentions the rules of responsibility for violating the accounting rules prescribed by law under the title of legal consequence (Füredi-Fülöp & Várkonyiné, 2022).

DISCUSSION OF MAIN FINDINGS

Trends in non-financial reporting

Nowadays, the idea of sustainability has become an integral part of business life, as responsible investors are no longer only interested in information regarding the assets and liabilities, financial position and profits and losses of businesses, but also on their non-financial characteristics, so in addition to past performance and financial risks, value creation and long-term performance of companies are emphasized.

The sustainability assessment of companies is usually based on three criteria, which are typically referred to by the abbreviation ESG. ESG is the abbreviation of the words Environmental, Social and Governance, which are the pillars of the ESG framework, so these are the three subject areas in which companies are expected to report. The purpose of ESG is to monitor the non-financial risks and opportunities inherent in the everyday activities of companies (Wei et al., 2023).

In September 2015, the 193 member states of the UN committed themselves to balanced social development, sustainable economic growth and environmental protection. The new global development program was unanimously adopted at the summit. The newly adopted program aims to eradicate poverty and build a sustainable future by 2030. The unanimously adopted seventeen Sustainable Development Goals (SDGs) set a new universal standard for development. The objectives and indicators behind the individual development goals are a suitable benchmark for measuring the success of progress (Alapvető Jogok Biztosának Hivatala, 2019).

Source: United Nations. Transforming Our World, 2015.

Figure 2. The UN Sustainable Development Goals

Those financial professionals who follow the ESG strategy already rank companies based on sustainability aspects during their investment decisions. So this is not just a temporary trend, but an attitude increasingly demanded by both financiers and regulators.

Several elements are linked to each ESG pillar, but of course not all of them are equally relevant for different companies. The differences in involvement between individual sectors are called materiality. The factors that can affect the company's financial performance are fundamentally important. The so-called interpretation of the principle of double materiality. This means that not only the factors deemed to be financially relevant must be taken into account during reporting, but also social aspects (Deloitte, 2021).

Companies decide what and how to report based on sustainability reporting standards. Reporting usually takes place along one or more reporting frameworks, which regulate the type and form of disclosures. In line with the needs of investors and other key stakeholders, they demand greater certainty about the authenticity of published data.

Previous standards issued in relation to non-financial reporting: (Lippai-Makra et al., 2019)

- GRI (Global Reporting Initiative) – which was developed in such a way as to take into account the information needs of all interested groups

and to make their contribution to sustainable development visible in addition to the economic, social and environmental effects of the organization.

- SASB (Sustainability Accounting Standard Board), which is the most widely used industry-specific disclosure standards in the USA.
- IIRC (International Integrated Reporting Council) which aims to create integrated reporting and thinking.
- CDP (Carbon Disclosure Project) which is the world's largest and most comprehensive database on the environmental impacts of businesses and cities.
- TCFD (Task Force on Climate-related Financial Disclosures), or the financial approach to climate risks, which was created in 2015. A voluntary reporting system that aims to inform investors, creditors and insurance companies about their climate-related financial risk in a uniform way.
- CDSB (Climate Disclosure Standards Board) which raises natural capital to the level of importance of financial capital, and created a sustainability reporting framework.

The two most commonly used reporting frameworks are the Global Reporting Initiative (GRI) and the Sustainable Accounting Standards Board (SASB).

Based on the 2023 IFAC, AICPA & CIMA collectively work, it can be seen that the reporting is still not uniform, among the above standards, the number of reports based on the GRI stands out between 2019 and 2021. The distribution ratios shown in Figure 3 show the number of times an ESG framework/standard was referenced in non-financial reports.

Source: IFAC: The State of Play in Sustainability Assurance, 2023

Figure 3. The proportion of references to certain ESG frameworks/standards in non-financial reports

The demand and importance of non-financial reports is increasing nowadays (Mock et al., 2013). Continued regulatory tightening, increasing interest from investors and society present new disclosure challenges to companies. In addition to published sustainability reports, an increasingly common solution is to publish the company's ESG performance on websites instead of or together with the report.

The formal appearance of non-financial reports is regulated by the European Union's efforts, so we can count on significant harmonization regarding the form and content of the previously voluntarily published reports.

A significant step in this is the Non-Financial Reporting Directive (NFRD), which defines general rules for listed companies, banks and insurance companies (Green Finance, 2021). Pursuant to the directive, companies - including banks - had to publish information on environmental, social and employment issues, respect for human rights, bribery and corruption issues to the extent necessary to understand the development, performance, situation and impact of the company's activities.

It is also a significant step that the European Commission published its action plan entitled "Financing sustainable growth" in the spring of 2018, in which three main goals - the redirection of capital flows towards sustainable investments in order to achieve sustainable and inclusive growth; managing financial risks from climate change, resource depletion, environmental degradation and social problems; and the promotion of transparency and a long-term approach in financial and economic activity - the Commission designated ten intervention points.

In November 2019, an EU regulation on sustainability-related disclosures was also published for

the financial services industry (2019/2088 EU Regulation - Sustainable Finance Disclosure Regulation, SFDR).

The latest element of the process is the "Corporate Sustainability Reporting Directive" (hereinafter: CSRD) adopted by the Commission on April 21, 2021, which amends the previous reporting requirements of the NFRD (Boros et al., 2022).

The proposal reformed and expanded the range of disclosure obligations, so that from 2023, more than 50,000 European companies will be required to publish a standardized report on compliance with environmental (E), social (S) and governance (G) criteria, which are expected to meet the goals of sustainable development helps to achieve (Hegedűs, 2022).

The purpose of CSRD is to ensure that, despite the fact that some of the ESG indicators cannot be directly measured numerically, companies disclose adequate information about the sustainability risks and opportunities they face, as well as their impact on people and the environment (principle of double materiality).

The regulation is applied in three stages:

- On January 1, 2024, for companies already covered by the Non-Financial Disclosure Directive (NFRD), it means large companies listed on EU regulated markets and employing more than 500 employees,
- On January 1, 2025, for large companies that are currently outside the scope of the directive on the publication of non-financial information,
- On January 1, 2026, for listed SMEs and other businesses.

In addition to large companies and companies listed on EU regulated markets, non-EU companies with significant activities in the EU must apply the CSRD regulations from January 1, 2028.

The CSRD therefore introduces a more detailed reporting obligation according to the mandatory EU sustainability reporting standards. In addition, it requires companies to digitally label the reported information so that it is included in the single European access point provided for in the Capital Markets Union Action Plan. However, the CSRD is a directive, so the effectiveness of its implementation will largely depend on its implementation in the Member States. It can be concluded that, as a result of the above processes, we can expect significant changes and definitely progress in terms of the quality, usability and comparability of the information presented (Madarasiné & Győri, 2023).

Source: IFAC: The State of Play in Sustainability Assurance, 2023

Figure 4. Changing global reporting practices in 2021

The demand for the reliability of ESG disclosures is increasing, which means that as the willingness to prepare reports increases, certification also becomes more and more important. This is confirmed by the map in the collectively work of IFAC, AICPA & CIMA, on which we can see the data for the year 2021. The percentage values show the following:

1. what percentage of large companies prepare some kind of report,
2. the proportion of verified ESG reports,

3. in what proportion companies entrusted auditors with the verification of ESG reports and the performance of assurance services, since the external certification can also be performed by an independent consultant or an organization with environmental protection expertise.

The study also examined how, globally The International Auditing and Assurance Standards Board's (IAASB) International Standard on Assurance Engagements (ISAE) 3000 (Revised) remained the most widely used standard for ESG.

Assurance reports also play an important role in building trust in the reliability of non-financial information. In order to ensure the quality and reliability of the reporting, information related to the sustainability of the company must be provided at a certain level, but it can also be required later to obtain sufficient certainty. In 2023, the IAASB brought forward the public consultation on the new International Standard on Sustainability Assurance (ISSA) Topic 5000, Requirements for Engagements of Sustainability Assurance Services, to August 2-December 1 for agreement, allowing for broad comprehensive agreement and early information acquisition for further development, as well as facilitate the finalization of the standard in 2024.

ISSA 5000 will be a comprehensive standard suitable for both limited and due assurance engagements on sustainability information reported on sustainability topics. The standard will be applicable to sustainability information engagements based on multiple frameworks and will be industry independent, supporting both auditors and assurance providers in the performance of sustainability information assurance engagements.

CONCLUSION

Nowadays, non-financial reports, the publication of ESG information and their applicability in the capital market are highly emphasized areas both in international literature and in corporate practice. Green accounting - as a significant branch of accounting - has long been an integral part of literature studies, however, in the reports published by companies, data on past performance and financial risks are much more prominent than information on environmental impacts.

Today, the idea of sustainability has become an integral part of business life. The so-called responsible investors are no longer only interested in the property, financial and income situation of companies, but also in their non-financial characteristics, so future challenges, value creation and long-term performance of companies become emphasized.

The legal requirements must therefore also be adapted to the needs arising from practical life. Accordingly, the formal appearance of non-financial reports is also regulated by European Union efforts. The latest element of the process is the "Corporate Sustainability Reporting Directive" (hereinafter: CSRD), adopted by the Commission on April 21, 2021, which reformed and expanded the scope of disclosure obligations, so that from 2023, more than 50,000 European the company will be required to publish a standardized report on compliance with environmental (E), social (S) and government (G) criteria, which is expected to help achieve the goals of sustainable development. It can be concluded that, as a result of the above processes, we can expect significant changes and definitely progress in terms of the quality, usability and comparability of the information presented.

The demand for the reliability of ESG disclosures is therefore constantly increasing, as a result of which certification is also becoming increasingly important. Auditors can promote transparent disclosure, thereby contributing to the long-term, sustainable operation of companies.

This growing worldwide demand for clear and transparent disclosure of the long-term ESG obligations of companies and institutions can of course also be felt in Hungary. Domestic investors, suppliers, customers and employees alike want to know and understand the goals and values of the companies they work with. Due to this trend, reporting on non-financial indicators is developing rapidly.

Author's contribution

Judit Füredi-Fülöp's contribution to the study is 33%, Gábor Süveges's contribution to the study is 33%. and Mária Várkonyi Juhász's contribution to the study is 33%.

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A Behavioural Approach to Strategic Management

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SUMMARY

The concepts, methods and practices of strategic management have evolved significantly since the beginning of the 20th century. In the 1950s and 60s the use of long-term planning was characteristic. Until the end of the 1980s strategy was perceived as a response to environmental changes. During the 1990s strategy formulation was perceived as a process based on internal resources and capabilities of firms. This radical change with the previously applied concepts was influenced by the accelerated rate of environmental changes. Companies – especially large firms – were unable to change their strategies parallel with changes in their environment. They needed a more stable starting point for developing their strategies. Strategic decision makers intended to make optimal strategic decisions until the end of the 70s. Due to the newly emerged theory of limited rationality it has become accepted as a strong influencing factor of strategic decision-making. Parallel with the above mentioned changes the role of managerial behavioural characteristic had emerged as a more broadly accepted factor in strategic decision-making. In the present paper our intention is to present this development process.

In preparing the paper the author has relied on his previous publications in the field.

Keywords: strategic management, behavioural theory, decision-making, limited rationality, meaning
Journal of Economic Literature (JEL) codes: L1, M12
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INTRODUCTION

The history of using strategy in management of organisations – especially in business firms – goes back to the beginning of the 20th century. The first strategies were born in large enterprises during the 1st world war. Alfred Chandler wrote about it in his seminal book Strategy and Structure (Chandler, 1962). Strategy emerged as a response to environmental changes, and resulted in the development of new products and entering into new markets.

The next phase of development emerged after the 2nd world war, specifically during the 1950s and 60s in the US and West European companies. Strategies emerged during the 1950s and 1960s in the form of long range planning. Environments of firms in this period were relatively fast growth and it was possible to use longer term forecasting. The new strategies aimed at increasing production and sales based on diversification of markets and responding to increasing demand of both corporate and individual customers.

From the beginning of the 70s – as a consequence of economic crises – the timeframe of forecasting the future decreased to 3 to 5 years. Strategies in this period concentrated on giving answers to the new environmental conditions. Instead of growth new strategies aimed at adaptation to new market demands. Sales income of most companies decreased compared to the level realized during the 50s and 60s. Competition became stronger as existing companies had to share limited sales possibilities and many companies collapsed.

In this period companies introduced formalized strategic planning and developed their strategies in details. Strategic decisions aimed at making optimal decisions based on rational decision-making processes. Managers of firms intended to solve the problems which emerged as a consequence of disadvantageous environmental changes by optimising their decisions.

The limits of rational strategic decision-making were not recognised in this period.

A concept of strategic management emerged at the beginning of the 1980s. In the new approach emphasis were not only on strategic planning, but implementation of strategies as well. The later was seen as equally important as strategy development. Another characteristic of strategic management was that strategies concentrated on rapid answers to accelerated environmental changes. Detailed strategic plans – sometimes as long as many hundreds of pages – became not capable of supporting strategic decision-making of top managers. Using strategic concept became the newly emerging practice of strategy development. Parallel with it large departments of strategic analysis and development of alternatives became reduced in number of personnel, and their work started to be moderately formalised. This new approach to strategy development concentrated of shorter strategic concepts which could be updated within short period of time. Strategies helped strategic decision-makers to react newly emerged environmental conditions. Adaptation became the new focus of strategies instead of growth which characterized the strategies of the 50s and 60s.

The above summarized characteristics were described in details in the landmarking books of Michael Porter. His two publications: Competitive Strategy (1980) and Competitive Advantage (1985) described the theoretical foundations and methodology of developing successful strategies. The basic concept of Porter is that strategy formulation starts with analysis of environment, then developing business strategies, and after it designing the organisation which leads to lasting competitive advantage (Porter, 1980). The „structure conduct performance" logic was the bible of strategic planning until the end of the 1980s.

At the beginning of the 1990s radical change started to emerge in the theory and practice of strategy formulation. While during the previous period – between the early 50s and the end of the 80s – the basic idea of strategy formulation was: how firms can adapt to environmental conditions and its changes, the new thinking about strategy emphasised the importance of resources and capabilities in strategy development (Prahalad & Hamel, 1990; Teece, Pisano, & Shuen, 1997). The above characterised change was partially due to increased difficulty to follow the more and more accelerated environmental changes. There was a need for stable influencing factors, that are characteristics of the organisation dealing with developing its strategy.

As a response to the changes in environments and also within the organisations, a dynamic approach was necessary in the research and capability based approach as well. This resulted in the concept of dynamic capabilities and the incorporation of knowledge into the framework of strategy formulation (Grant, 1996).

The changes in concepts of strategies resulted in modifications of content and process of strategic decisions. In the present paper the central issue is the analysis of factors that led to incorporation of behaviour oriented characteristics into strategic decision-making processes of organisations.

CHARACTERISTICS OF STRATEGIC DECISION PROCESSES

The perceptions and analysis of corporate decision-making was strongly influenced by the development and application of the results of operation research. Operations research had its heyday during the 1960s. Proponents of the field intended to develop methods for managers which help them to deal with large volume of information and use them in arriving at decisions. This process was supported by the beginning application of computers in business life providing previously unimaginable capabilities for data processing. Management Information Systems (MIS) were developed, which made it possible to compare alternatives of strategic decisions, and selection of optimal strategies. It seemed to be possible to solve the largest barrier of optimal decisions, that is shortage of information.

Analysis of possibilities for optimal strategic decision-making lasted for limited time horizon. During the mid-seventies papers were published in international literature on limits of operations research. It was a revealing example that Russel Ackoff, one of the fathers of operations research published a paper in 1974 with the title: Management Misinformation Systems (Ackoff, 1974).

Nobel Prize winner Herbert Simon emphasized that studying strategic decision processes it is necessary to make distinction between so called programmed and non-programmed decisions (Simon, 1982, 48). The new rarely reoccurring decisions with important consequences belong to the category of non-programmed decisions, and strategic decisions typically bare these characteristics. Among managers programmed decisions mainly occur at lower levels in the hierarchy, where complexity is lower than in higher level decision-making. While optimal, routine type decisions may be possible at lower level, at higher level the non-programmed decisions are mainly characteristic for strategic decision-making, where intuition and innovative solutions have an important role.

EMERGENCE OF BEHAVIOURAL CHARACTERISTICS IN STRATEGIC DECISION-MAKING

Approaches based on behavioural theory emerged as a critic of rationality in strategic decision-making. Rational approach to decisions deals with optimal

decisions. This approach is based on neoclassical economics. The assumption supposes that values are clearly defined, goals and all information is available, all possible alternative are known and they can be ordered, and the best option to realize the goal can be selected (Bromiley, 2005, 41-42).

Among the first scholars following the behavioural approach – among others – were Herbert Simon, James March and Chester Barnard had outstanding role. Barnard's theory of contribution and reward regarded it a precondition of long term successful functioning that members of organizations perceived recognition of their efforts by managers, and in return adequate rewards were provided for them concerning e.g. level of wages, working conditions, promotion into higher positons in the organization (Barnard, 1938). As realizing long term survival and success are basic criteria of strategic management, Barnard's concept may be understood that behaviour of members of organizations are the key factor to realize it.

Cyert and March argued that the first decision in connection with functioning of an organization is were made by an individual person when decided to become a member of the organisation. This state will be staying until the employee has the opinion that being a member of the present organization is not worse for himself/herself than leaving the organization and enter as employee into another firm (Cyert & March, 1963).

Based on his research Simon arrived to the conclusion that in case of complex, hardly understandable and important situations decision-makers' intention was not to make optimal, - as it is impossible - but satisfying decisions (Simon, 1982). Limited rationality does not mean that decision-makers do not intend to arrive at optimal decisions. Intended rationality may be observed in case ill-structured problems as well. The problem is that in case of complex problems (and strategic decisions typically belong into this category) cannot be realised due to lack of information, limits of information processing, the ambiguity of preferences and limited time available for making decisions.

Understanding the strategic decision-making process is regarded to be a crucial question in behaviour-oriented decision theory. In his book titled „A Primer on Decision Making" (March, 1994), the author gave the subtitle „How Decisions Happen? The book discusses many issues which are absolutely necessary to understand the decisions of managers. Such issues are identity, power, ambiguity, meaning, loosely coupled connections between elements of organizations.

In theories of limited rationality attention is regarded to be one of the lack of resources. This problem is discussed in nearly each field of social and behavioural sciences, such as psychology, sociology, political science. Limited attention is related to complexity of decisions. When making strategic decisions many factors have (or should) to be taken into consideration, e.g. what is the consequence of decisions for stake-holders, what is the influence on short long run. To take into consideration all influencing factors is impossible due to limited information available, the barriers of individual information processing, and lack of enough professional knowledge. Due to the above mentioned characteristics the success of decision-making processes depends on rationalisation of attention (March, 1994, 23-28).

Strategic management integrated many approaches into the field of studies, which resulted in broad variety of strategic analysis. Mintzberg and his co-authors distinguished ten different schools of strategy, each of them describing one variation observable in practice (Mintzberg et al., 1998). From among the strategic schools the cognitive, the learning, and the cultural schools are close to the field of the present paper.

The cognitive school perceives strategy formulation and a process of thinking. This approach emphasizes that decision-makers formulate their viewpoint based on processing information on the world surrounding them. It means that decision makers construct their reality which is the basis of their decisions (Mintzberg et al., 1998). This social constructivist theory does not perceive the category of optimal decision. The reality is not objective and independent from the decision-maker, as reality constructed by him/her, that is how they see the world surrounding them. Disposition, experience, information processing activity of decision-makers are those factors, which are decisive influencing factors of decisions. It provides explanation why decisions show a lot of differences even in case of the same environmental conditions. Leavitt named managers following unique, innovative approaches in their decision-making „path-finders" of the organisation (Leavitt, 1986).

The learning school distinguishes intended and emerging strategies. Intended strategy concentrates on control and want to be sure the intentions of managers will be realized in practice. Emerging strategies are the results of organizational learning processes (Mintzberg et al., 1998, 206-207). Understanding strategic decision-making behaviour may be supported by relying on the typology of March (1991) which distinguishes learning by exploration and learning by exploitation. Learning from past experiences provides capability for arriving at more effective solutions used by organizations. This learning process leads to rationalization, refining solutions, reduce costs or to improving quality. These changes may be useful in case of stable business environments, when there is moderate need to use new approaches. It may be dangerous however and may result in limited capability for survival in periods of radical changes in markets, technologies, economic and social conditions. Small improvements – incremental changes – leave the organization on the past development pathway.

In case of learning by experimentation organizations rely on new initiatives, which may be in technology,

market or other areas (March, 1991). Let us take the example of introducing new product or service. The company sells them on market. In the next period it monitors the reception of customers and market information connected to it. The firm analyses market success of the new product/service. If the reception of market shows that buyers are not satisfied with certain characteristics of the product, it is developed further to achieve satisfaction of buyers. Learning contributes to development of future oriented activities to assure longer term success on market.

March emphasized that a balance was necessary between the two types of learning (March, 1991). Learning by exploitation may be useful in improving short term efficiency, but may be disadvantageous for longer term prosperity. Learning by exploration in itself may be risky because possible success involves risk which may result in lower level efficiency of the organization. Development and innovation result in increased level of costs on the short run, but return on longer term is unsure. That is the often observable case that managers with short term orientation disfavour radical changes. Studies in the US have revealed that shareholder companies have shorter strategic time horizon – especially when small investors have majority ownership – than firms with concentrated ownership structure (Hayes & Abernathy, 1980).

The basic concept of the cultural school is that strategy formulation is a process of social interaction, which is based on mutually admitted and followed interpretations by organizational members. These characteristics are formulated during socialization, when new members after entering the company learn and internalize the values followed by the organization. These values formulate behaviour of decision-makers during the strategy development processes (Mintzberg et al., 1998, 267-268).

Another important role of culture is that it has an influence on limiting strategic changes. Commitment toward values of the company leads to consistent organizational behaviour and disprefer strategic changes. Before strategic learning could take place, unlearning of old values connected to the previous dominant logic of the firm is necessary to realise (Mintzberg et al., 2005).

WHOSE STRATEGY IS ORGANIZATIONAL STRATEGY?

In market economies today it is a generally accepted view that without strategy it is impossible to realise successful company activities. Practice tells us that decisions on organizational strategy are made by top managers. In large organisation however many employees of organisation participate at the decision processes and individuals and organisational units and have different roles. In such situation the question arises: who and to what extent can influence the strategy development process. Formal approach suggests that those members have possibility to influence strategic decisions who are in direct connection with persons or bodies who make final decisions. From this point of view, we have to make distinction between individual and council decisions. In business firms, according to their organisational regulations, shareholder companies' board of directors are authorised to make strategic decisions. Professional knowledge, business experience, values and interests reveal themselves during decision-making processes. At first sight we may give the answer to the above raised question that those individuals and/or boards are the owners of strategies who make the final strategic decisions. Taking into consideration the above mentioned opinion of Barnard and March, it is reasonable to question that members of organizations accept the decisions of top managers? Legally the answer is yes, but we have to take into consideration that formal rules and regulations do not follow the emerging realities of organisational and social relationships. Such examples may be observed in tense conflict situations. In organisations built on participation and empowerment it is a reasonable question that what type of strategic decisions are acceptable for employees at bottom level?

Following the above way of thinking we may argue that management style applied in an organisation has strong influence on whose strategy is the strategy of an organisation. In case of participative management style employees may take part in strategic decisions, e.g. by suggesting alternatives, commenting them, or by using group decisions. Today many companies use brain storming, or Nominal Group Method, which are based the capabilities of organisational members to utilise their knowledge, business experiences, and their interest in evaluating and formulating possible alternatives. Empirical studies of strategy formulation have shown that innovative ideas often emerge at lower level of the organisation. Initiative for strategic renewal may originate from those organisational members who were not participants of development of the previous strategy of the firm (Burgelman, 1991).

Members of organisations regularly have examples showing that strategy formulation processes are not only determined by formal rules of strategy formulation, but the participating persons' interests and their values have relevant influence in the process. When studying strategy formulation in organisations it is reasonable to take into account the interests of formal and informal groups, coalitions. According to the opinion of the well-known English professor John Child, strategic decisions are made by the dominant coalition. Members of a dominant coalition are those persons who – based on their formal or informal positions – have possibility to influence strategic decision-making processes. Strategic choices of dominant coalitions are made by taking into consideration the environmental conditions and the internal characteristics of firms.

DECISION ON STRATEGIC DIRECTION OF THE ORGANISATION

Harold Leawitt, a professor of organisational behaviour at Sanford University published an influential book with the title Corporate Pathfinders (Leawitt, 1986). The author identified three phases of leadership process: pathfinding, problem-solving and implementation. Pathfinding means setting the longer term future direction of the organization. Problem-solving deals with collecting and analysing data, and formulating alternatives for decisions based on the available information. Implementation in concentrating on perceiving and motivating people to accept and implement the decisions of top managers.

The three phases of leadership are connected to three type of managers, so pathfinders, problem solvers and implementers can be identified in organisations (Leawitt, 1986).

Pathfinder managers hardly deal with short term, operative problems of the organization. They leave such tasks for lower level people. They analyse future possibilities, and search for longer term perspectives. They are the intuitive and innovative persons, who bring new way of thinking into the organization. Creativity, innovation, and entrepreneurship are characteristic for their personality and behaviour. They are often described as entrepreneurial managers. Pathfinders are especially necessary in top management of firms. In periods a rapid environmental changes they are those who can introduce novel attitude and help proactive adaptation to new conditions.

Problem solver managers work with large amount of data, and try to find solutions in decision situations. Structuration, relying on detailed rules and procedures are characteristic for their daily managerial work. Their behaviour concentrates mainly on short term problems, search for optimal decisions, which is described as procedural rationality in literature.

Implementer type managers have outstanding capabilities for convincing and motivating their subordinates. They are capable to get their initiatives accepted. They provide support for their manager and influence others to do so as well. They do not have capabilities for novel strategic initiatives. They are rather useful members of organizations as their activity is necessary to implement strategies of firms.

In market economies there is need for internally driven managers who perceive they role as being those who push the organization ahead. Pathfinder managers may fulfil such roles. Practice however shoes that they are often missing in managerial roles. Among the reasons behind it management education, especially the teaching of business schools has to be mentioned. All over the world courses of business schools concentrate on teaching analysis, methods and techniques. Market analysis, financial analysis, cost analysis, return on investment analysis, inventory analysis – all these topics are present in curriculums of business schools. So graduates know how to analyse the business but have limited capabilities to create new business opportunities and formulate innovative strategies.

THE ROLE OF SENSEMAKING IN STRATEGIC DECISIONS

During the last 20 years sensemaking has got increased attention in organization studies. Sensemaking includes those processes in which members of firms intend to clarify ambiguous, chaotic and ill-structured situations and actions (Brown et al., 2015). Sensemaking means not only passive internalisation, but active behaviour in a given situation as well, in order to be capable of providing adequate reactions to newly emerged problems or possibilities. In this process perception, overview and action are all present. Sensemaking has a central role in theory development and in formulation of concepts and solutions (Weick et al., 2005). It incorporates evaluation of past events and future oriented, strategy formulating activities as well (Corley & Gioia, 2011). Sensemaking intends to understand the followings (Weick, 1995):

- How do organizations adapt to changing environmental conditions, and how do they contribute to transforming it;
- What type of organisational structures and mechanisms help or hinder this adaptation;
- How do these structures and processes make it possible for organisations to rich a level of operating certainty when they are faced with ambiguous situations.

These sensemaking processes formulate the knowledge of organisations, which builds of past experiences (Carvalho, 2021).

The above interpretation of decision situations explains learning by exploitation (March, 1991). In this learning process organizations rely on past information as well, when they develop future initiatives, evaluate their reception and evaluation, and improve their decisions. Sensemaking process connects learning processes by exploitation and exploration.

Due to its nature sensemaking contains not only objective elements, but its decisive characteristic is subjective sensing and evaluation. Sensemaking in this way is connected to interpretative and social constructivist organizational researches (Brown et al., 2015). Knowledge emerging in this way provides basis for strategic decisions, which are value- and interest-dependent. Strategic decisions are formulated jointly by participation of individuals and organisations.

CLOSING REMARKS

In this short paper it was not my intention to discuss in details the behaviour-oriented approach to strategic management. The aim was to raise and characterise in short those approaches to strategy formulation which have emerged during the last decades and which may contribute to a deeper understanding of strategy formulation. We may see that development of strategic thinking and practice emphasises the values, interests and power positions of decision-makers contrary to previous focus on optimal strategic decision-making.

In the next phase of studying strategic behaviour my intention is to conduct empirical research by involving PhD students.

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Leverage Effect between ROA and ROE During the Covid-Crisis Based on a Hungarian Company Database

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SUMMARY

This paper is devoted to examining two extremely popular financing principles in the practice of Hungarian companies during the Covid-crisis. The leverage effect explains how the Return on Equity can be improved compared to the Return on Assets, the risk matching principle states that the risky assets should be financed mostly from equity and the secure assets should be financed mostly from debt. The Covid-crisis is an excellent opportunity to study the relevance of these principles. The validity of these principles is examined in a sample containing about 30.000 company financial reports. The most important findings are the following: The profitability does not determine the leverage, but the high leverage determines the low profitability. The profitability is the consequence of former decisions about the debt-equity relationship, the debt/equity ratio would be the consequence of the profitability. The risk matching principles cannot be justified by the used sample.

Keywords: leverage effect, risk matching principle, ROA, ROE
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INTRODUCTION, RESEARCH QUESTION

This paper is devoted to examining two immensely popular financing principles in the practice of Hungarian companies during the Covid-crisis. The leverage effect explains how the Return on Equity can be improved compared to the Return on Assets (Brealey & Myers, 2013), the risk matching principle (Coleman, 2011) states that the risky assets should be financed mostly from equity and the secure assets should be financed mostly from debt. The Covid-crisis is an excellent opportunity to study the relevance of leverage effect, since the Hungarian economy faced strong recession in 2020 which was followed by a quick recovery in 2021.

The research question of this study, if the companies of different sectors follow the leverage effect rule or not. By that rule, the companies with higher ROA than cost of finance will increase their leverage, and the opposite companies will reduce their leverage.

At first the concept of ROA and ROE is determined among the various ROI indicators, since they are important in point of both testing principle (Engler, 1987). Then the methodology and the introduction of the sample is demonstrated. The analysis of the data can be found in the analysis and result chapter. The paper ends with the conclusions.

LITERATURE OVERVIEW

The ROA and the ROE are accounting indicators derived from the general concept of ROI (Chen & Mansa, 2007). The ROI has countless versions known both in the theoretical literature and in practice. (Lipták et al., 2022) This is because the indicator has several uses. It is used to measure the profitability of individual investments, specific processes (e.g., research, market acquisition, learning). (Phillips & Phillips, 2005)

ROI is an efficiency indicator that compares the net income of a program with its net cost. (Duermyer, 2020)

$$ROI = \frac{Net\ income\ (Benefits - Costs)}{Costs}$$

In the literature we have found three interpretations of financial ROI.

In our interpretation, ROI can be considered as return on assets. This indicator can be used to evaluate the company's profitability as a whole or to appraise a project/investment.

$$ROI = \frac{Profit\ of\ investment}{Invested\ amount}$$

The profit of an investment usually means the operating profit produced by the investment. In this case, the ROI can be directly compared to the cost of financing (loan interest rate, expected return on equity, or a combination of these).

At the company level, profit can be the contribution, the operating profit, or the net income. The denominator can be the average of non-current assets, or net assets (non-current assets + net working capital).

There are several other names and calculations of profitability on assets. Several specialist literatures also refer to the following ratios as ROI.

ROA - Return on Assets - Typically the ratio between operating profit and total assets, but some author considers the profit as profit after tax.

RONA - Return on Net Assets - The ratio of profit to net assets. Net assets are the difference between total assets and current liabilities.

ROCE - Return on Capital Employed - The ratio of profit to capital employed. Capital Employed is the same as net assets but is calculated from the liability and equity side. Capital Employed is the sum of equity and long-term liabilities. The long-term liabilities can be considered of IFRs, where accruals and provisions do not form a separate main balance sheet group, but part of liabilities.

ROE - Return on Equity – Profit of the owners. Here, the nominator shows the net income. (Jewell & Mankin, 2011)

From the above-mentioned ROI terms, we focus the difference between ROA and ROE. The ROA measures the profitability of the core operation regardless the source of finance, and can be defined in the following way:

$$ROA = \frac{Operating\ profit}{Total\ Assets}$$

The ROE is the annual profit earned by the owners of the company from the annual operation of the company. Its formula is the following:

$$ROE = \frac{Net\ income}{Total\ Equity}$$

The relationship between ROA and ROE is called leverage effect, which is described with the following equation:

$$ROE = ROA + (ROA - R_d) \times \frac{D}{E}$$

where ROE – Return on Equity,
ROA – Return on Assets,
R_d – average interest rate of borrowings,
D – book value of debt,
E – book value of equity.

This is called leverage effect. The D/E ratio is called leverage. The reason of this equation is demonstrated by a brief example.

Let us compare the income statements of two companies! The asset structure of the two companies should be completely identical. The only difference should be in the leverage (Debt to Equity ratio). The first company is fully financed by equity of one hundred currency unit, while the second company should have 50 unit of equity and 50 million of loan at a 10% interest rate. Both companies achieve an operating profit of twenty million in a good year, 10 million in an average year, and HUF 5 million in a bad year. Let us ignore the taxes! What will be the capital gains of the two companies in each year?

Table 1 shows the result.

Table 1

The ROE of a levered and an unlevered company

Unlevered company (Equity of 100 million)			
Term	***Good***	***Average***	***Bad***
Operating profit	20	10	5
Interest expense	-	-	-
Net income	20	10	5
ROE	20%	10%	5%
Levered company (Loan of 50 million, Equity of 50 million)			
Operating profit	20	10	5
Interest expense	5	5	5
Net income	15	5	0
ROE	30%	10%	0%

Source: own calculations

The Return on Assets of the two companies is the same because both companies have the same operating profit and total assets in each year (which is equal to total resources). This value is 20% in the first year, 10% in the second, and 5% in the third.

However, their ROE is significantly different, since the second company faces a fixed interest expense of 5 million. (This is 10% of the 50 million loan). Its Debt-to-Equity ratio is 1, since 50/50 = 1. While the ROE indicators of the first company are the same as the ROA indicator values, the ROE indicators of the second company can be obtained using the formula above.

$$ROE_{good} = 20\% + (20\% - 5\%) \times \frac{50}{50} = 30\%$$
$$ROE_{average} = 10\% + (10\% - 5\%) \times \frac{50}{50} = 10\%$$
$$ROE_{bad} = 5\% + (5\% - 5\%) \times \frac{50}{50} = 0\%$$

The example above shows that the wealth of the owners increases if the loan interest rate lower than the return on assets (ROA). In this case, the ROE is higher than the ROA. However, if the ROA falls below the interest rate on loans, the ROE is lower than the ROA.

This relationship works only ex-post. The ROA can only be planned, while the loan interest rate is fixed in the contract. The higher is a company's leverage (D/E), the more volatile its ROE. A company with a higher leverage can get a loan at a higher interest rate. (Süveges, 2021)

If we study the above relationship, the following conclusion can be drawn: If the company's ROA is volatile, then the company Debt to Equity should be low, consequently the risky assets should be finance from secure sources – mean equity. If the assets are secure, then the companies use more debt. (Ross et al., 2022)

The risk of the company's assets depends not only on the management decision but also on the nature of business sector. Assets are considered risky in capital intensive sectors like heavy chemicals, metallurgy, and agriculture. Classically low-risk industries are supermarket chains, the production of pleasure goods, and the food industry.

MATERIALS AND METHODS

The aim of this research is to evaluate the validity of leverage effect and risk matching principle during the two years of Covid-crisis of the Hungarian economy.

The following research questions were raised:

- Is it true, if the companies with higher ROA than rate of lending uses more debt than companies with lower ROA than lending rate?

- Is it true if the higher ROA volatility leads lower leverage?

To answer the first question, two groups were created by each sector. The first one behaves by the rule, the second behave against the rule. The examination is made in 2020 and in 2021.

To answer the second question, the difference between the 2021 ROA and 2020 ROA was calculated, similarly the difference between the 2021 leverage and the 2020 leverage. The data are grouped by main NACE (comes from the French 'Nomenclature statistique des Activites economiques dans la Communaute Europeenne'-Statistical classification of economic activities in the European Community) sectors. (Eurostat, 2008)

The sectorial distribution is calculated to detect which were the highly levered sectors and which were the lower ones.

To evaluate the leverage effect, the assumptions behind the concept should be considered and the used ratios should be cleared from the hidden assumptions.

The assumptions behind the model are the followings:

1. There is no (corporate) tax. To ignore the effect of taxation, the pre-tax profit is used in the nominator of ROE, rather than the net income. (Füredi & Várkonyiné, 2023)
2. The liabilities consist only of borrowings. The borrowings are used as a proxy of debt like loans, issued securities (bond, bill of exchange) and credits. The non-borrowings are ignored like provisions, account receivables, passive accruals. To balance the asset side, not the total assets but the total assets – non-borrowings is used by calculating the ROA. (Ramsay, 2005)
3. The company has not got financial incomes, the whole profit come from the core operation. To manage this assumption, the financial revenues are added to the operating profit, and the total financial expenses are used as a proxy to the cost of borrowings. (Kántor, 2021)

Finally, the following testable indicators are used in the examinations:

$$MROA = \frac{Operating\ profit + Financial\ revenues}{Total\ Assets - Non - borrowings}$$

$$MROE = \frac{Net\ income + Tax\ paid}{Total\ Equity}$$

$$ML = \frac{Borrowings}{Total\ Equity}$$

$$Return = \frac{Financial\ expenses}{Borrowings}$$

The findings of this article are based on the database provided by Crefo. The company database was purchased from the CrefoPort company (CrefoPort, 2022) by the Faculty of Economics of the University of Miskolc. This database contains the financial reports of Hungarian enterprises from 2004 to 2021 in text files, from which the data was uploaded to an MSSQL database. In addition to balance sheet and income statement data, the database contains information on the name and address of the enterprises, the number of employees, the core activity sector, the territorial location of the enterprises and their legal status (operating or liquidated).

Originally the database contains 245 579 data, but the database was queried to those companies, whose sales are larger than HUF 100 million and total assets are larger than HUF 100 million. The examined population was reduced to 30 443 enterprises.

The examinations were made by SPSS 25.0.

DISCUSSION OF MAIN FINDINGS AND THEIR RELATION TO THE REVIEWED LITERATURE

At first, we have tested, if our modified indicators are good proxy for the leveraged effect, namely it is true, that.

$$MROE = MROA + (MROA - \text{Return}) \times \text{ML}$$

The Pearson correlation between the MROE and the right side of the equation was calculated for 2020 and 2021. The result was the following:

Table 2

Pearson correlation between the raw ROE and the calculated ROE

Year 2020		Right side of equation
MROE20	Pearson Correlation	1,000**
	Sig. (2-tailed)	
	N	30443

**. Correlation is significant at the 0.01 level (2-tailed).

Year 2021		Right side of equation
MROE21	Pearson Correlation	1,000**
	Sig. (2-tailed)	,000
	N	30443

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Own calculations on Crefo database

In next step, the number of companies were calculated by each NACE main sectors, if their ROE is lower or higher than ROA. If ROE is higher, it means that they were able to increase the owners return by using debt, however if the ROE is lower than ROA, they decrease the owners return by using debt. Table 3 shows the distribution of these two groups in 2020.

In the table below, you can see the number of companies where the ROE was higher than ROA (good practice) and the number of companies where ROE was lower than ROA (bad practice) and the average leverage of both groups.

Table 3

Number of companies following good or bad practice with leverage in 2020

2020	NACE sectors	Good practice		Bad practice		Total
		Count	Leverage	Count	Leverage	
A	Agriculture, forestry, and fishing	1617	1.3	373	14,8	1990
B	Mining and quarrying	67	0.8	12	0,6	79
C	Manufacturing	3645	1.8	1285	3,3	4930
D	Electricity, gas, steam, and air conditioning	139	10.5	57	11,6	196
E	Water supply, sewerage, waste management	259	2.5	58	3,2	317
F	Construction	3651	2.2	365	11,7	4016
G	Wholesale and retail trade	7325	2.7	1338	4,0	8663
H	Transporting and storage	1310	2.3	382	32,1	1692
I	Accommodation and food service	481	2.2	201	6,6	682
J	Information and communication	1128	5.5	162	8,7	1290
K	Financial and insurance activities	205	3.0	53	23,0	258
L	Real estate activities	1513	5.9	424	10,6	1937
M	Professional, scientific, and technical activities	2102	6.0	276	19,3	2378
N	Administrative and support service	997	4.0	179	10,2	1176
O	Public administration and defence	13	1.3	3	4,6	16
P	Education	102	1.0	13	1,6	115
Q	Human health and social work	344	1.6	68	31,1	412
R	Arts, entertainment, and recreation	110	4.7	41	8,1	151
S	Other services	114	1.2	31	2,5	145
Total		25122	3,0	5321	7.6	30443

Source: own calculation based on Crefo database

Even in the bad 2020 year, about three quarter of the companies earned higher ROE than ROA. The share of companies following good practice is higher than the average in the construction industry, the information and communication sector, professional, scientific, and technical activities, education and human health and social work. These are the sectors which were unharmed by the consequences of the Covid-crisis. The share of companies following bad practice is higher than the average in manufacturing, transporting and storage, accommodation, and food service.

Comparing the average leverage of the companies with good and bad practice we can detect that the companies following bad practice have got significantly higher leverage (higher debt to equity), than the opposite group. This indicates that those companies' ROE is lower than ROA, who were over-indebted. The difference in leverage between good and bad companies are extremely high in agriculture, construction, financial and insurance activities (they are not banks but financial enterprises). This indicates that the companies did not follow this bad practice voluntarily, but this was the consequence of their former decision to raise debt. Naturally during a crisis period, they paid the price for it.

Table 4

Number of companies following good or bad practice with leverage in 2021

2021	NACE sectors	Good practice		Bad practice		Total
		Count	Leve-rage	Count	Leve-rage	
A	Agriculture, forestry, and fishing	1608	0.9	382	1.8	1990
B	Mining and quarrying	63	0.6	16	0.4	79
C	Manufacturing	3747	1.4	1183	5.6	4930
D	Electricity, gas, steam, and air conditioning	139	7.7	57	20.8	196
E	Water supply, sewerage, waste management	266	1.9	51	9.0	317
F	Construction	3582	1.6	434	17.1	4016
G	Wholesale and retail trade	7504	2.4	1159	3.5	8663
H	Transporting and storage	1320	2.1	372	3.1	1692
I	Accommodation and food service	578	1.8	104	2.9	682
J	Information and communication	1098	3.8	192	14.4	1290
K	Financial and insurance activities	203	3.7	55	5.2	258
L	Real estate activities	1499	2.6	438	7.4	1937
M	Professional, scientific, and technical activities	2033	2.3	345	47.4	2378
N	Administrative and support service	1002	3.9	174	5.1	1176
O	Public administration and defence	13	2.0	3	0.2	16
P	Education	91	0.7	24	1.1	115
Q	Human health and social work	345	1.5	67	3.9	412
R	Arts, entertainment, and recreation	115	3.9	36	10.9	151
S	Other services	124	1.3	21	10.0	145
Total		25330	2.1	5113	5.6	30443

Source: own calculation based on Crefo database

2021 was an extremely good year for the Hungarian economy, since the economic growth was the highest in the XXI. century. Surprisingly, this economic boom did not reflect in the profitability of the analysed companies. The number of companies following good practice increased slightly, but not dramatically.

However, the gap between the leverage of the two groups narrowed significantly. Both company group can drastically build down their indebtedness thanks to the government programs launched during the Covid-crisis. Two populous sector is exception, the manufacturing and construction industry, their leverage increased from 2020 both in the good practice and bad practice group due to the targeted loan facilities for these sectors.

Let us answer the first question, namely „Is it true, if the companies with higher ROA than rate of lending uses more debt than companies with lower ROA than lending rate?"

Based on these data, the answer is No. The debt financing depends not on profitability issues, but on other influencing factors like the sectorial characteristics and the financing needs of companies. The leverage is higher in those companies where the core profitability of the company is lower than the average lending rate. It means that the casualty is totally the opposite. Not the profitability determines the leverage but the (high) leverage determines the (low profitability). The profitability is the consequence of former decisions about the debt-equity relationship, the debt/equity ratio would be the consequence of the profitability.

Let us look the relationship between the volatility of ROA and the leverage! By the theory, if the volatility of ROA is high, thus the assets are risky, then you should finance your company from equity. If the volatility of ROA is low, thus the assets are secure, you should use more debt.

To measure the volatility of ROA between 2020 and 2021, the 2020 figure was deducted from the 2021 figure. Similarly, the difference between the 2021 and 2020 leverage was calculated.

$$Difference\ in\ ROA = ROA_{2021} - ROA_{2020}$$
$$Difference\ in\ leverage = Leverage_{2021} - Leverage_{2020}$$

To get rid from the outliers, the analysis tool of Descriptive Statistics/Explore in SPSS 25.0 was used. The following values remain in the analysis.

leverage20>=0 and leverage21>=0 and lendingrate20>=0 and lendingrate21>=0 and leverage20<3.72 and leverage21<3.47 and lendingrate20<0.119 and lendingrate21<0.108

Table 5

Cases used in the analysis

Name of variable	Description	Minimum value	Maximum value
leverage20	Leverage in 2020	0	3.72
leverage21	Leverage in 2021	0	3.47
lendingrate20	Lending rate in 2020	0	11.9%
lendingrate21	Lending rate in 2021	0	10.8%

Source: own calculations on Crefo database

The result of the examination is shown by table 6.

Table 6

Sectors which followed the rules and sectors which did not follow the rule

Nace name	DROA	leve-rage20	Number of cases	Risky	Indebt-edness	Rule
Accommodation and food service	0.06	0.82	599	Risky	Risky	No
Administrative and support service	-0.08	0.85	851	Risky	Risky	No
Agriculture, forestry, and fishing	0.01	0.58	1757	Secure	Secure	No
Arts, entertainment, and recreation	-0.02	0.62	123	Secure	Secure	No
Construction	-0.04	0.74	3273	Secure	Secure	No
Education	-0.10	0.44	100	Risky	Secure	Yes
Electricity, gas, steam, and air conditioning	0.01	0.79	125	Secure	Risky	Yes
Financial and insurance activities	-0.17	0.59	171	Risky	Secure	Yes
Human health and social work	-0.05	0.62	353	Risky	Secure	Yes
Information and communication	-0.10	0.72	915	Risky	Secure	Yes
Manufacturing	0.00	0.78	3400	Secure	Secure	No
Mining and quarrying	-0.01	0.55	65	Secure	Secure	No
Other services	0.01	0.76	125	Secure	Secure	No
Professional, scientific, and technical activities	-0.35	0.74	1703	Risky	Secure	Yes
Public administration and defence	-0.08	0.69	12	Risky	Secure	Yes
Real estate activities	-0.08	0.82	1399	Risky	Risky	No
Transporting and storage	-0.02	0.89	1125	Secure	Risky	Yes
Water supply, sewerage, waste management	0.03	0.72	246	Secure	Secure	No
Wholesale and retail trade	-0.01	0.88	6147	Secure	Risky	Yes
Total	-0.05	0.79	22489			

Source: own calculation based on Crefo database

Column DROA contains the difference in ROA, leverage20 is the borrowing/equity ratio in 2020, number of cases is the number of companies in the sector.

The average DROA in 2020 in the examined population was -0.05, which means that the ROA decreased from 2020 to 2021. The sector was considered risky, if the absolute value of DROA is higher, than the absolute value of -0,05. The sector was secure if the average is lower. The same method was used in case of leverage. The financing of the sector was considered risky, if the borrowings to equity ratio is higher than 0.79, which was the average indebtedness. The financing was considered secure if the average was lower than 0.79.

The result is mixed. Some sectors followed the rules, mostly the sectors of the service providers. But the agriculture, mining, manufacturing construction did not follow this rule.

Empirically the risk matching principle cannot be justified by the examination.

The empirical literature is also mixed. Chen and his coauthors (2021) examined this relationship with multivariate regression and found weak correlation between profitability and leverage. Christensen (Christensen, 2015) found, that the risk-return relationship is important only during crisis, otherwise insignificant. Artikis (2011) detected even negative relationship between leverage and profitability.

CONCLUSIONS

This examination has some limitations.

1. The examined period was very brief, but the dedicated theories suppose long-term relationships.
2. The original theory regards the long-term financing, but this study uses the long and short-term borrowing as a proxy. The reason is, that the annual repayment of long-term debt is among the short-term liabilities, and the financial expenses are not separated by interest payment of long- and short-term loans, thus only the overall indebtedness can be examined.
3. The financial expenses contain not only the interest expenses, but exchange losses, financial fees, which artificially increases the cost of lending, and the exchange losses have not got direct relationship with the cost of finance.
4. The nominal main sector of the company may not reflect to its real activity and the main NACE sectors cover vastly different subsectors in nature. The use of average hides these differences.

Based on the data of analysis, we draw the following conclusions.

1. It is not true that the companies with higher ROA than rate of lending uses more debt than companies with lower ROA than lending rate, totally the opposite is true. The leverage is higher in those companies where the core profitability of the company is lower than the average lending rate.
2. The debt financing depends not on profitability issues, but on other influencing factors like the sectorial characteristics and the financing needs of companies.
3. The profitability does not determine the leverage, but the high leverage determines the low profitability. The profitability is the consequence of former decisions about the debt-equity relationship, the debt/equity ratio would be the consequence of the profitability.
4. The risk matching principle, which means that the risky assets should be financed from equity and the secure assets should be financed from debt, cannot be justified due to the above-mentioned limitation of the study.

Based on these results, one suggestion should be made for the companies. Never exceeds the perceived risk limit of their borrowings. If the lender began to worry about the riskiness of their outstanding, they will increase the interest rate of loans further deteriorating the profitability of the company.

Author's contribution

Sándor Bozsik was responsible for 50% of the overall work. His tasks included data collection, analysis, and crafting the discussion and conclusion sections. Judit Szemán contributed 50% to the study. She conceived and designed the study, penned the introduction and the literature review, and also provided supervision throughout the study.

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Territorial Differences in Hungary's Residential Property Market

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SUMMARY

Investigations related to residential real estate can still be considered topical issues today. During our research, on the one hand, we drew conclusions based on long-term data series, and on the other hand, with the help of horizontal, territorial investigations, we revealed spatial correlations regarding the events of the past decade. In our article, firstly we reviewed some concepts related to real estate, with special attention to the domestic literature. With the help of long time series data, we examined the relationship between the change in the residential population and the stock of residential real estate. We have revealed connections, or we specified the number of built residential properties and the real income per capita, as well as examined the distribution of apartments according to comfort in the regions of our country.

The aim of our research was to find out and, based on the results obtained, to visualize how the concentration of housing transactions between private individuals has changed in relation to the Central Hungarian region and the countryside. We compared the data of 2010, which was still characterized by the crisis in our country, and 2020, which can still be considered a favourable period for housing construction, but which was already affected by the Covid epidemic. With the help of the Moran I index and the territorial autocorrelation, we clarified our correlations regarding the number of built apartments and found that the territorial autocorrelation was noticeably stronger thanks to the housing policy of the period.

Keywords: residential real estate; built residential properties; regional differences; Moran I index; real estate market
Journal of Economic Literature (JEL) codes: R20, R21, R23, R30
DOI: https://doi.org/10.18096/TMP.2023.02.06

INTRODUCTION, RESEARCH QUESTION

Residential real estate is the most important asset of most Hungarian households, and buying or selling a home is one of the most important financial decisions made in our lifetime. This decision can be influenced by several relatively well-measured factors, for example the wealth accumulated by previous generations, the past, current and expected income, the location, size, condition of the property, or such little measurable factors as e.g., the subjective sense of security, the assessment of the settlement, its perceived vision of the future. The basic purpose of our studies is to summarize the most important trends of the residential real estate market in Hungary in recent decades, with regard to regional differences. In the first part of our study, we reviewed the relevant domestic and foreign literature, then in the methodological part, we explained the characteristics of regional autocorrelation and the Local-Moran's I. During the analyses, we first revealed correlations using time series data, which we supplemented with correlations based on frequency distributions based on the years 2013 and 2020 and territorial autocorrelation.

LITERATURE REVIEW

We often come across the term real estate in our everyday lives, the concept can appear, among other things, in our conversations, in scientific or less well-founded presentations, in written form in newspaper ads or online advertisements, in documents of institutions, companies dealing with real estate, in sales contracts, in connection with legacies or gifts. However, in addition to the term real estate used in public speech, legislation and the actors of scientific life define its characteristics more precisely. The law on Real Estate Registration (Act CXLI of 1997) considers real estate as the subject of real estate registration. Its basic unit is the independent property. It can be considered independent, which can be owned, sold, gifted, etc. independently of the other properties.

253/1997. (XII. 20.) Government decree on the national settlement planning and construction requirements defines the apartment (residential property in our interpretation) as follows: An apartment is a self-contained accommodation unit intended for long-term residence, the living and other rooms of which must be designed in such a way that they together enable rest and the continuation of activities at home, as well as the storage of materials and objects necessary for living. The apartment must be able to be heated, and ventilation and natural lighting must be ensured in every room.

In the English literature, real estate can be the land, or fixed, immovable, or permanently connected accessories on it, such as: buildings, fences, roads, flora, canals, utility networks and walls. Property rights in some countries include air rights, mineral rights, and surface rights. (http://www.businessdictionary.com/).

Dwelling house/residential estate means an apartment, house or other structure in which people live (http://definitions.uslegal.com).

The literature related to the Hungarian residential real estate market has many research due to the importance of the topic. We would like to emphasize the work „Ingatlangazdaságtan", which discusses the situation of our country's real estate market in the period after the regime change, including the most important property valuation methods, the practice of real estate development, marketing, financing, and housing policy (Soós et al., 2005).

Studies examining state housing policy and housing support systems can serve as an addition to the understanding of the most important national and regional processes (Mádi, 2008; Hegedűs 2006).

In the domestic literature, a prominent topic is the investigation of prices and the evaluation of real estate. Based on the calculations using different methods - based on multiple sales, hedonic and hybrid (mixed) evaluation methods - it can be said that the rise in housing prices in Hungary was significant and further increases can be expected in the near future (Horváth, 2008). Other research draws attention to the decreasing demand due to the expected unfavourable demographic processes and the resulting effects (Farkas, 2011).

With the calculations of Horváth and Székely using different hedonic methods, they came to the conclusion that the Hungarian housing market can be characterized by fairly stable relationships (Horváth & Székely, 2009).

Békés and his co-authors used a hedonic and empirical method. Their results indicate that the characteristics of settlements strongly influence the price of residential real estate, the most important of these factors being the population of the settlements and the average income, as well as the importance of such geographical characteristics as e.g., proximity to water (Békés et al., 2016).

The very first housing price index in Hungary was the "Takarék Housing Index", the source of which was its own data collected by "Takarék Jelzálogbank Nyrt.", as well as the transaction database of real estate purchased from the National Tax and Customs Office (takarekindex.hu).

Every year, OTP prepares a "Land and Real Estate Value Map" based on the database of the National Tax and Customs Office for residential and holiday real estate, car storage, agricultural land, and industrial real estate. Their latest study draws attention to the significant increase in the prices of properties in residential complexes and other condominiums (+21, +23%).

Other significant players in real estate sales, e.g., Duna House also prepares real estate market analyses/estimates, their "hedonic method" considers the property's structure, condition, size, year of construction, and several location parameters.

During the review of the foreign literature, we concluded that regional autocorrelation studies are mostly conducted in relation to the prices of residential real estate. Zhang L. and co-authors presented an empirical study on the spatial spillover effect of house prices in 25 cities of the Yangtze Delta in China based on annual panel data for the period 2000-2013. The Moran's I and LISA tests were used to investigate whether the spatial correlation of housing prices existed in the examined period, especially after 2005. They concluded that, in terms of spatial correlation, the income variable does not show an obvious effect on house prices; instead, the spatial lag of house prices plays a dominant role, and the Yangtze Delta has a significant spillover effect on house prices. Cities with a close economic connection to the city center, a high level of urbanization, optimized industrial structures and strong innovation capabilities showed a large spatial spillover effect (Zhang et al., 2019).

Wang W.-C. and co-authors (2019) in their article explored the factors affecting housing prices using regression models and used spatial autocorrelation to explore price changes in urban areas in the city of Taitung. Spatial autocorrelation analysis showed that the

selected variable contained significant spatial dependence. The results were analysed based on the spatial change of real estate prices, spatial clustering, and model analysis. The results highlighted that the locations and attributes of historical real estate transactions varied. In 2017, property prices were more concentrated than in previous years (Wang et al., 2019).

Another study used spatial autocorrelation and spatial Markov to study 353 used houses in Hefei. The results show that in the city of Hefei, high housing prices are concentrated in the south and southwest of the city, while the price level gradually weakens from the south moving northward, and housing development shows a north-south differentiation. A significant spatial autocorrelation was shown between the prices of second-hand apartments in Hefe. The "high-high" residential price clusters are mainly distributed in Shushan District and Binhu New Area, while the "low-low" residential price clusters are mostly located in Yaohai District and its surrounding areas. The number of "low-high" agglomeration and "high-low" agglomeration is small, and the degree of change is not large either (Yin et al., 2022).

MATERIALS AND/OR METHODS

During our research, we set out to explore the regional differences in residential real estate in Hungary. During the analyses, we used the CSO and TEIR databases, which contain data on 3,154 settlements in 2013 and 3,155 in 2019 and 2020 and 175 districts.

The location of the territorial units and their relationship to each other significantly influences the distribution of the indicators, so that the degree of influence can be determined, it is requiring the use of spatial econometric methods (Szendi, 2016).

Spatial econometrics examines spatial aspects (autocorrelation, spatial structures) in regression models based on cross-sectional, time-series and panel data. Spatial effects arise when the spatial location of the observation units affects the interactions between the units. The formation of territorial effects is characteristic to the greatest degree in neighbouring territorial units (Gerkman, 2010).

In the case of spatial autocorrelation, we can talk about positive spatial autocorrelation, which can be inferred from the very similar spatial grouping, and we can talk about negative spatial autocorrelation, which is characterized by a significant difference between neighbouring observation units (Varga, 2002). It follows from this that autocorrelation means the influence of neighbouring areas on each other and the mutual influence of their values. Spatial lag is suggestive of a possible diffusion process – events in one place predict an increased likelihood of similar events in neighbouring places.

Moran's I index is used to measure these spatial effects:

$$\boldsymbol{I = \left(\frac{N}{\sum D_{ij}}\right) * \frac{\sum\sum (x_i - x) * (x_j - x) * D_{ij}}{\sum (x_i - x)^2}}$$

where:
$(x_i-x) *(x_j-x)$: the product of the difference between the values and averages belonging to the territorial units.
D_{ij}: the matrix describing the neighbourhood relations.
N: number of territorial units.

If I>-1/N-1 then there is a positive autocorrelation relationship, if I<-1/N-1 then there is a negative autocorrelation relationship between the individual territorial units. However, if I=-1/N-1, there is no autocorrelation relationship. An exact value cannot be determined, as this value depends on the neighbourhood matrix and the number of territorial units, so its maximum is close to 1, while its minimum is close to -1 (Dusek, 2004).

The test requires the determination of the appropriate weight matrix in advance. This matrix describes the spatial structure of the variables, the neighbourhood relationship (Gerkman & Ahlgren, 2011).

General form of weight matrix:

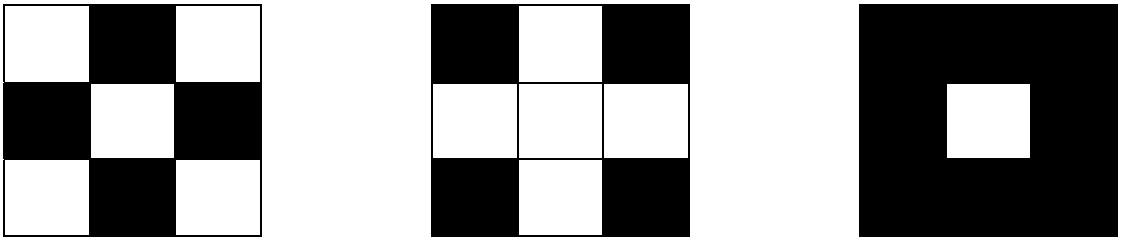
$$W = \begin{pmatrix} w_{11} & \cdots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{n1} & \cdots & w_{nn} \end{pmatrix}$$

where: n is the number of observations.

The simplest form of defining the neighbourhood matrix and the neighbourhood weights is to mark adjacent areas with 1 and non-adjacent areas with 0. So that the analysis does not show a distorted picture, we must introduce a standardized matrix, where the sum of the values of each row is equal to 1. Depending on which areas are considered bordering, we are talking about bastion, king, or queen neighbourhood (in the case of square grids) (Figure 1).

- Bastion neighbourhood: wij=1, if i has a common boundary with j, the boundary is to the right, left, up and down,

- Leader neighbourhood: wij=1 if i has a vertex in common with j, in the northeast, southeast, southwest, or northwest direction,
- Queen neighbourhood: wij=1 if i has a common boundary or vertex with j (Gerkman, 2010.).



Bastion Leader Queen

Source: Bálint (2010)

Figure 1. Square grid-based neighbourhood approaches

Neighbourhood weight can also be determined based on a threshold distance, or using the nearest method, or perhaps taking the Euclidean distance into account.

Table 1

Meaning of Local Moran's I clusters

Cluster name	Meaning	Spatial structure type
High-High	both the given NUTS 3 area unit and its neighbours have significantly above-average values	Divided spatial structure, center area
High-Low	the given NUTS 3 territorial unit significantly above average, while its neighbours have values significantly below average	Polarized spatial structure, one dominant regional center
Low-High	the given NUTS 3 territorial unit significantly below average, while its neighbours have significantly above-average values	Mosaic-like spatial structure, center-periphery areas
Low-Low	both the given NUTS 3 area unit and its neighbours have significantly below average values	Segmented spatial structure, peripheral area

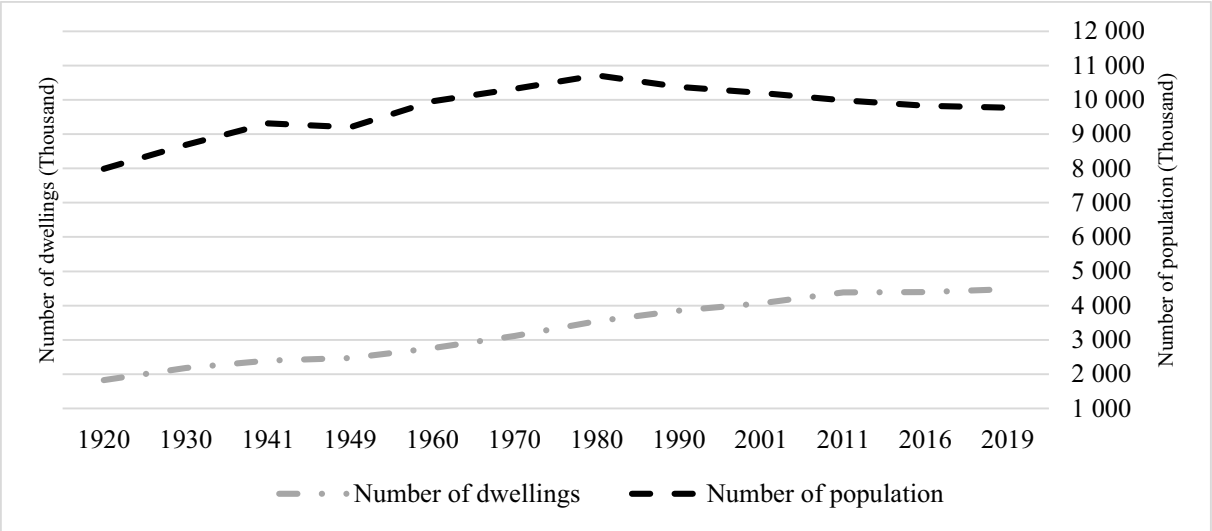
Source: Benedek and Kocziszky (2015)

The Local Moran I indicator is a local version of Moran's I characterization for the entire spatial system, which assigns a specific numerical value to each area unit. Negative values mean negative, and positive values mean positive spatial autocorrelation. The indicator also shows where these high or low values are clustered in space (HH-LL), as well as where the territorial units that differ greatly from their neighbours (HL-LH) are located, thus forming clusters (Tóth & Nagy, 2013, p. 605.). (Table 1)

DISCUSSION OF MAIN FINDINGS AND THEIR RELATION TO THE REVIEWED LITERATURE

The residential real estate stock of our country is basically determined by the processes of urbanization, since more than 70% of Hungary's population lives in cities. As a result of urbanization, as the population increases, the density of housing increases, and multi-level housing becomes common in residential areas. Health, entertainment, culture, and vacation services are

more easily available for the population and those arriving here, with a higher quality and variety.



Source: own editing based on CSO and TEIR data

Figure 2. Development of dwelling stock and population from 1920 to 2019 in Hungary

We collected data on the housing stock, which we also examined depending on changes in the resident population. The population of the current territory of our country (apart from the adverse effects of World War II) tended to increase until the beginning of the 1980s, after which a clear population decrease occurred, which continues to this day. While in the 1920s more than five people lived in a residential property on average, this value decreased to around 3 by the 1980s. In 2023, CSO registered 4,586,878 residential real estates, while there were only 209 residents per 100 residential properties.

In our country, a large number of residential real estate investments are linked to housing estates. Housing estates can be found in most countries of the world, their role in the housing stock varies by continent and country, they are typically found in Europe and now more and more in Asia. Hungary is one of those countries where a significant part of the housing stock is concentrated in housing estates (Egedy, 2005).

In the domestic and international literature, in the case of housing estates, we can come across the concepts of housing estate, residential park, residential garden. In A. Ferkai's interpretation, a residential complex is a complex of buildings that is created in a relatively short time during a single construction operation, usually for a specific social class and separates from the usual image of the settlement (Ferkai, 2005).

According to Imre Perényi, a housing estate is a form of housing construction based on a unified plan, organized in an organized manner, using standard designs for multi-story residential buildings. Its components include the roads, parking lots, garages, basements, and public utilities necessary to serve the residential buildings, as well as green areas and other public spaces for the residents (Perényi, 1987).

According to the approach of the Central Statistical Office, a housing estate is primarily a combination of medium-rise and high-rise residential buildings, as well as rows of houses, mostly constructed in recent decades using factory-built technology (CSO, 1996). After World War I, in the 1920s, barracks settlements were built to improve the housing situation, which mostly consisted of one-room apartments without comfort. Despite the temporary nature of these settlements, in several cases, their demolition only took place after World War II (Gyáni,1992).

Due to the destruction of World War II and a significant decline until the 1950s, there was a severe housing shortage. This situation was further exacerbated by the modernization of agriculture, leading to people moving from villages to cities and the needs of political refugees. Industrialization led to the creation of new urban areas and sometimes entirely new cities. In Eastern and Central European countries, housing estate construction became predominant after World War II.

Table 2

Inhabited residential properties, by year of construction

Year of construction	Total (pcs)	Total (%)	In a housing estate (pcs)	In a housing estate (%)
-1945	1072728	28	12156	2
1945-1959	450204	12	27111	4
1960-1969	579570	15	109555	15
1970-1979	828900	22	335800	45
1980-1989	683506	18	255454	34
1990-1996	152199	4	11064	1
Total	**3767107**	**100**	**751140**	**100**

Source: CSO – Microcensus (1996)

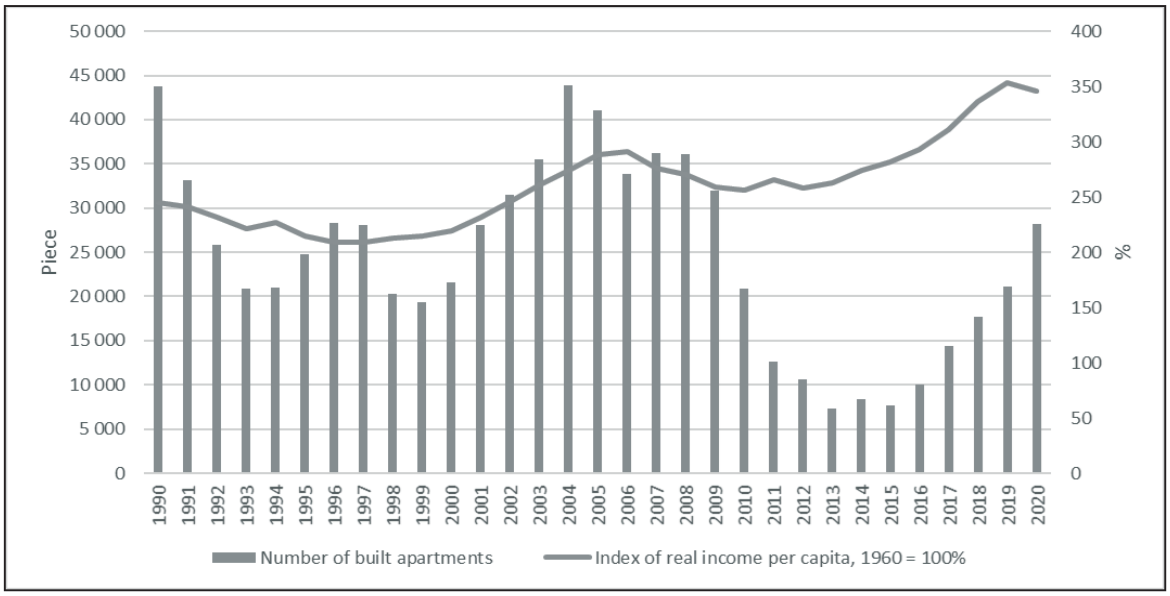
In Hungary, the housing estates of the 1950s were smaller, with 300-800 residential properties, typically consisting of 3-4 level buildings surrounding courtyards and squares. However, due to the high proportion of one-room apartments (52%), there was no substantial improvement in residential real estate size.

However, the level of comfort of the residential real estates improved, as the majority of the residential properties had a bathroom (Egedy, 2000). In the decade of the 1960s, the "15-year housing development program" was launched, which envisaged the construction of one million residential properties, of which 250,000 in Budapest. After the second half of the decade, panel technology became the determining and general. The decade of the 1970s was the most successful period in the history of housing estates in terms of housing construction: 45% of new residential properties were built in housing estates during the decade (Table 2).

From the end of the 1970s, the average size of residential properties increased significantly, thanks to the increasing proportion of two- and three-room apartments, while the number of one-room apartments decreased drastically. (Farkas, 1993).

By the end of the 1980s, housing estate construction was practically completed in Hungary, with the exception of some smaller-scale investments, the completion of which was delayed until the beginning of the 1990s (Egedy, 2000).

In this part of our study, we would like to give a brief overview of housing construction and housing stock over the past decades. In the year of the regime change, nearly 44,000 (43 771) residential properties were built. As a result of the significant economic and related real income decline of the 90s, the number of built residential properties halved within a few years, reaching the 1990 level only in 2004. The Hungarian economy has been struggling with problems from a macroeconomic point of view since 2006, which manifested itself in the decrease of real incomes by 2007, and then by 2013 the number of built residential properties dropped drastically to 7,600.



Source: Own calculation based on CSO data

Figure 3. The number of built residential properties and the development of real income per capita (1990-2020)

Our investigations included examining the correlations between the number of built residential properties and the development of real income per capita. Based on the visual analysis of Figure 3, we formulated our hypothesis that there is a probable relationship between incomes and the number of built residential properties known from the literature, the question is rather how much time has passed and to what extent changes will occur depending on the real income.

Table 3

Correlation between income and number of built residential properties (t_0=1990)

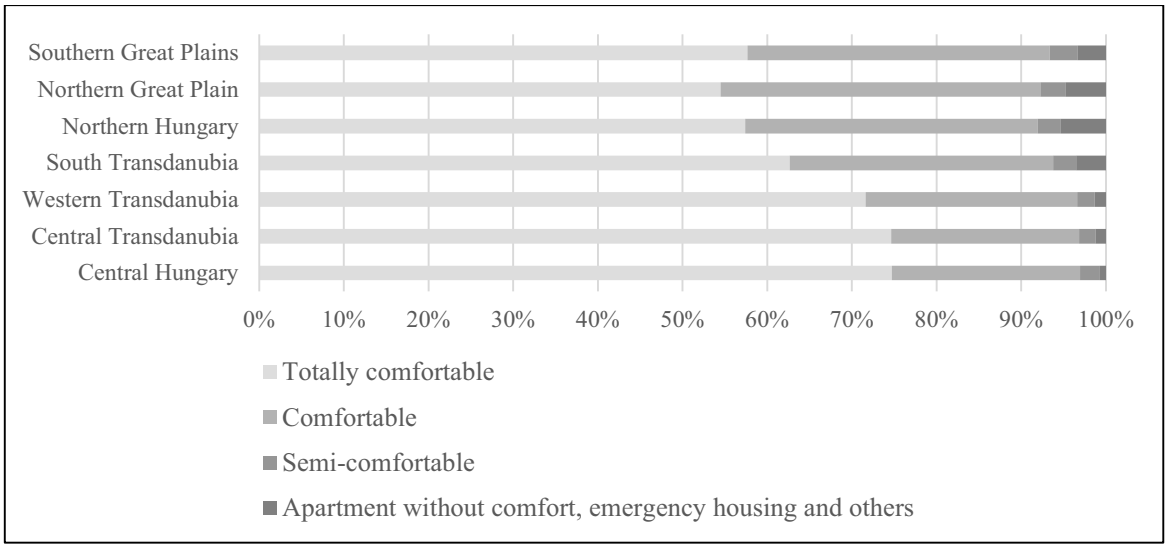
	Real income index/Number of residential properties							
Amount of delay	0 year	1 year	2 years	**3 years**	4 years	5 years	6 years	7 years
Correlation coefficient	-0,089	-0,026	-0,040	**0,417**	0,231	0,055	-0,147	-0,359
Significance level	0,632	0,893	0,839	**0,027**	0,246	0,791	0,483	0,085

Source: Own editing based on TEIR data

We performed a correlation calculation in such a way that the correlation coefficient was calculated by the real income, or we calculated the values of the built residential properties at time t0,1,2,3...n. Based on the data in Table 3, the number of residential properties built in the 3rd year fluctuates to the greatest extent, like changes in real incomes.

In parallel with the construction of a relatively small number of newly built residential properties in comparison to the existing housing stock, "the quality of the housing stock has improved, and the proportion of non-acceptable quality (substandard) housing is decreasing. By 2015, only 8.2% of the housing stock belonged here. There are still connected settlements in the country where the quality of the residential real estates is permanently poor and there is no significant new housing construction (CSO, 2016).

Figure 4 characterizes the regions of our country according to the comfort of residential properties (NUTS 2 regions before January 1, 2018). The proportion of fully equipped residential properties in the Central Hungarian and Transdanubian regions is outstanding, at nearly 75%. The largest proportion of non-comfortable, emergency- and other residential properties are found in the regions of Northern Hungary and the Northern Great Plain.



Source: own editing based on CSO data

Figure 4. Distribution of inhabited residential real estates according to comfort in the regions of our country (2016)

At the national level, in 1990, the proportion of fully equipped residential real estates did not even reach 40%, but by 2016, 95% of the residential properties belonged to the fully equipped or comfortable category (Mikrocenzus, 2016). Based on the above, it is probable that a significant part of the investments in residential real estate in the decades following the system change were related to the development and modernization of the existing real estate stock. While at the county level, 80% of the residential properties in the counties of Győr-Moson-Sopron and Komárom-Esztergom were fully comfortable, but in the counties of Pest, Fejér, Veszprém and Baranya we can talk about values over 70%, while in the counties of Nógrád and Szabolcs-Szatmár-Bereg only exceeded, in the county of Jász-Nagykun-Szolnok it did not even reach 50% (Mikrocenzus, 2016).

Our research goal was, among other things, to examine whether, if yes, what direction and extent of changes have been experienced in the past decade due to a different housing and support policy compared to the previous ones. We considered the fact that in 2010, 29.5% of the population lived in Central Hungary (in addition to a decreasing national population), and in 2020 it will already be 31.2%. In the case of used residential properties, the data in Table 4 show a tendentious decrease especially after 2014, which by the end of the period is even lower than the proportion of the population. Based on the above, it can be concluded that the relative positions of the rural areas have improved compared to the Central Hungarian Region.

Table 4

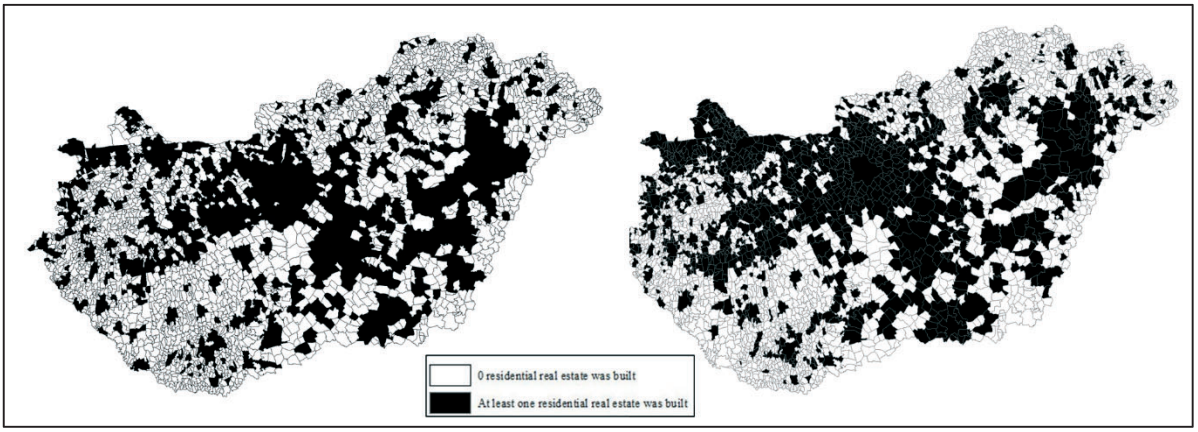
The proportion of housing transactions between private individuals in Central Hungary compared to the national value for used and new residential real estates.

Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
used residential real estates Central Hungary	37,7%	35,3%	36,9%	37,4%	39,7%	39,6%	36,0%	33,7%	31,6%	29,4%	26,8%
new residential real estates Central Hungary	66,4%	64,3%	65,9%	66,4%	62,0%	60,2%	49,7%	42,1%	48,4%	49,2%	54,4%

Source: own editing based on CSO data

In the 2010-2020 period, Central Hungary's share of transactions involving new residential real estate far exceeded its population ratio. Except for 2011, this high share decreased significantly (from 66.4% to 42.1%) in 2017 and started to increase again in the following years. Comparing the values with our figure for the number of newly built residential properties, it can be concluded that rural areas were more "put into position" by the period of recession than by truly favourable trends.

In addition to the examination of higher-level territorial units, we also strive to make the trends of recent years visible at the settlement and district level. In the case of the series of settlements, we examined 3,155 settlements in the database of TEIR, while in the case of districts, the number of analysis units was 175. Figure 5 illustrates how in 2013 and 2020 in which settlements at least one residential property was built (excluding resorts). In 2013, there were 783 and in 2020 there were 1,117 settlements in Hungary where at least one residential real estate was built, which is a significant increase of more than 42%.



Source: own editing based on CSO data

Figure 5. Settlements not affected by residential real estate construction in 2013 (left) and 2020 (right)

When exploring the differences in housing construction, a methodological problem is caused by the change in the number of settlements. The distribution of built residential real estates was illustrated on a logarithmic scale, as Budapest is an outlier, and the low values of smaller settlements greatly distort the evaluation of settlement series data. Figure 5 illustrates how the distribution of built residential real estates (excluding resorts) by settlement developed in 2013 and 2020. When examining the distributions, we considered only those settlements (783 in 2013, 1117 in 2020) where at least one residential real estate was built. However, it should be noted that the increase only appears significant against an extremely low base. However, thanks to the large number of analysis units (investigated settlements), the map display clearly shows which settlements and which parts of the country are affected by the economic period. It can be observed that new housing developments mostly appeared in the neighbourhood of settlements, where they had already existed before. This raises the need to analyse neighbourhood relations later. In the least developed regions of the country, there is essentially no meaningful positive movement (e.g., Northern Hungary, settlements close to the eastern borders, Southwestern Hungary), while the settlements surrounding the capital, in the north-west, and somewhat around Lake Balaton, appear in much greater numbers. Housing construction typically continues to lag in areas less favourable for investment. Despite the reduction of the VAT on newly built residential real estates and the introduction of home building subsidies initiated by the government, their impact was not significantly felt in the least developed settlements. With these incentive systems, they achieved that developers build new residential real estates only in those settlements where they can enforce high prices. Overall, thanks to the government measures, new residential properties were not built where they could not have been built without these subsidies, but where they would have been built anyway in a few years. Thanks to these processes, territorial differences have intensified in the residential real estate market (Varga, 2022).

In 2013, there were only ten settlements where a hundred or more apartments were built. The magnitude of the concentration is shown by the fact that in 2013, these ten settlements accounted for approx. 50% of the residential properties built. However, by 2020, we can already speak of 39 such settlements, which can be said to be a significant increase.

To illustrate the settlement dynamics of housing construction, the settlements have been classified into categories (Table 5).

Table 5

Our country's settlements by built residential properties (2013, 2020)

	2013				2020			
Number of built residential properties (pcs)	Number of settlements (pcs)	Distribution of settlements (%)	Number of residential properties built in each category (pcs)	Distribution residential properties (%)	Number of settlements (pcs)	Distribution of settlements (%)	Number of residential properties built in each category (pcs)	Distribution of built residential properties (%)
0	2371	75,17	0	0	2038	64,60	0	0
1	375	11,89	375	5,14	351	11,13	351	1,24
2-9	317	10,05	1112	15,25	487	15,44	1847	6,55
10-49	72	2,28	1518	20,81	191	6,05	4438	15,73
50-99	9	0,29	625	8,57	49	1,55	3538	12,54
100-999	9	0,29	1893	25,96	35	1,11	7901	28,01
1000-	1	0,03	1770	24,27	4	0,13	10133	35,92
Total	3154	100	7293	100	3155	100	28208	100

Source: Based on TEIR data, own calculation

While in 2013 no new residential property was built in 2,371 settlements (75.17%), by 2020 there will only be 2,038 such settlements (64.6%). The proportion of settlements where only one residential real estate was built also decreased. The number of settlements where more than a thousand residential properties were built practically quadrupled, and the number of settlements with 100-999 built residential real estates also expanded to a similar extent.

Table 6

Districts of our country according to built residential properties (2013, 2020)

	2013				2020			
Number of built residential properties (pcs)	Number of settlements (pcs)	Distribution of settlements (%)	Number of residential properties built in each category (pcs)	Distribution residential properties (%)	Number of settlements (pcs)	Distribution of settlements (%)	Number of residential properties built in each category (pcs)	Distribution of built residential properties (%)
0	13	7,43	0	0	11	6,29	0	0
1	15	8,57	15	0,21	6	3,43	6	0,02
2-9	62	35,43	303	4,16	53	30,29	285	1,01
10-49	58	33,14	1257	17,26	35	20,00	938	3,33
50-99	12	6,86	897	12,32	28	16,00	1957	6,94
100-999	14	8,00	3041	41,75	35	20,00	10707	37,96
1000-	1	0,57	1770	24,30	7	4,00	14315	50,75
Total	175	100,00	7283	100,00	175	100,00	28208	100,00

Source: Based on TEIR data, own calculation

Examination of the district data shades the settlement-by-settlement results. In 2013, not a single residential property was built in 13 districts (7.43%). By 2020 (even though the national value had almost quadrupled), there were still 11 districts where no newly built residential property was registered in a single settlement. The above confirms the connection, only guessed based on the settlement series data, according to

which the country has regions with typically peripheral locations, where housing policy instruments and subsidies were ineffective or marginally effective, since the number of districts belonging to categories 0.1, 2-9 did not change drastically. A significant increase was observed in the number of districts where fifty or more residential properties were built. In the category from 50 to 99, it more than doubled, in the category from 100 to 999, and in terms of residential property constructions with a few over 1,000, this number increased from one district to seven.

During our investigations, we concluded that the spatial relationships can be further clarified through the analysis of neighbourhood relations. We calculated the Local Moran index of territorial autocorrelation for the districts of Hungary. Local Moran I calculations were made using GeoDa software. Due to the peculiarity of the method, the interpretation of the results obtained during the examination can be significantly influenced by the choice of the neighbourhood matrix, therefore I also used three different neighbourhood matrices. In this way, we can get an idea of the influencing effects they cause by comparing the calculations with the neighbourhood matrices (Table 7). It can be concluded that the values calculated with the different neighbourhood matrices for the number of newly built apartments differ less from each other.

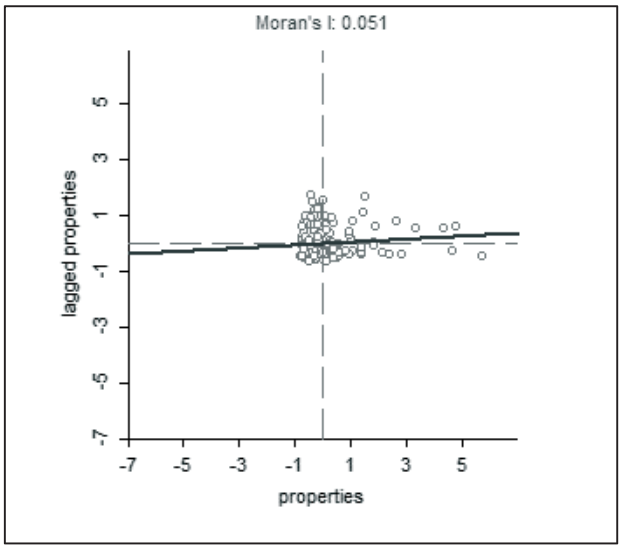
Table 7

Local Moran's investigation of the districts of Hungary in 2010

	Leader neighbourhood	**Nearest neighbourhood method**	**Threshold distance method**
Moran I	0,064	0,051	0,078
number of permutations	999	999	999
pseudo-p value	0,065	0,097	0,06
z score	1,6221	1,392	1,764
Local Moran clusters are created	high-high: 4 low-low: 10 low-high: 11 high-low: 5	high-high: 5 low-low: 9 low-high: 11 high-low: 2	high-high: 19 low-low: 6 low-high: 22 high-low: 4
significance level	95-99,9%	95-99,9%	95-99,9%

Source: own editing based on CSO data

Figure 6 shows the values of the Moran I index in the districts of Hungary in 2010 for the residential real estates built per ten thousand people. The value of its index is 0.051, which means a weak positive autocorrelation. In other words, in the case of built residential real estates, neighbouring areas only have a small effect on each other. We used the nearest neighbour method during further investigations. The autocorrelation of the areas is weak, as the number of built residential properties per ten thousand people in each area is not strongly related to each other.

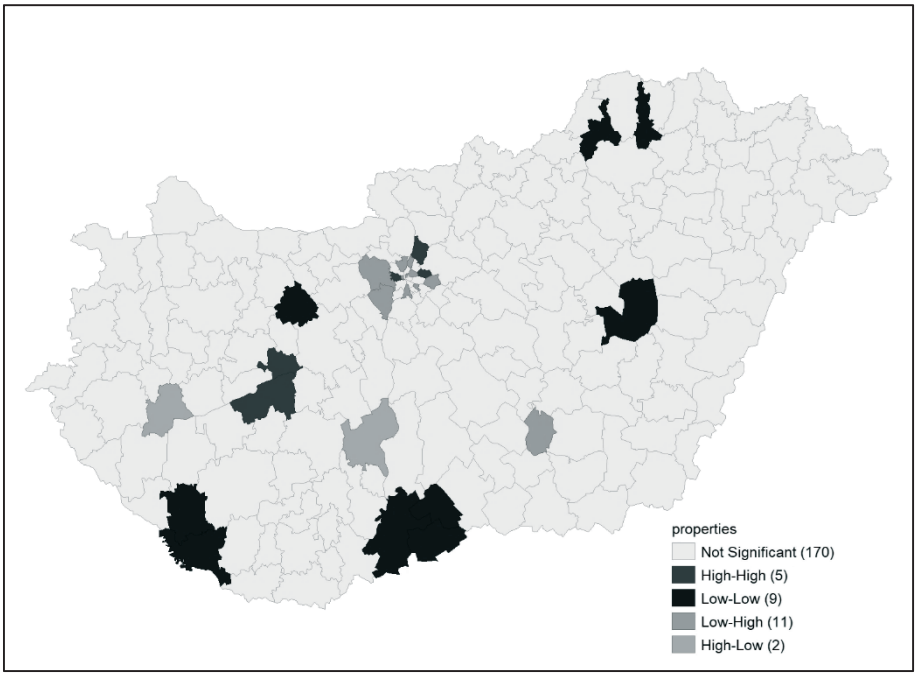


Source: own editing based on CSO data

Figure 6. Moran I index in the case of specific built residential properties in the districts of Hungary (2010)

To eliminate random errors, the analysis was performed with a high number of permutations (999). The value of the probability variable p is low, but the standard deviation (z score) of the values is high, which proves that autocorrelation exists. The Moran Scatter plot created during the analysis classifies the territorial units into four main types of territorial autocorrelation. The upper right (High-high cluster) and lower left (Low-low cluster) corners of the figure correspond to positive regional autocorrelation, negative autocorrelation values are also shown in the lower right (High-low cluster) and upper left (Low-high cluster) illustrates.

Figure 7 illustrates the cluster map of Local Moran's I calculation. No significant autocorrelation can be detected in 170 of the 197 territorial units included in the study, the remaining 27 territorial units can be divided into four categories. Examining the data from 2010, 5 territorial units can be classified into the category in which the analysed neighbourhoods and their neighbours had values of built residential real estates per ten thousand people that were significantly above the average. The high - high category (territorial units with a high value, the neighbourhood of which also has a high value) includes the districts of Balatonalmád, Siófok, Dunakeszi and the 12th and 16th districts of Budapest. The districts of Barcsi, Nagyatád, Baja, Jánoshalm, Bácsalmás, Mór, Karcag, Szikszó, Kazincbarcika are in the low-low group (territorial units of low value, in which case the neighbourhood also has a low value) in terms of the number of built residential real estates per ten thousand people. In the low-high category (territorial units of low value, in the case of which the neighbourhood has a high value.) there are the Érd, Budakeszi, Csongrád districts and the 1st, 4th, 14th, 18th, 21st districts of Budapest. The two areas located in the high-low cluster are the districts of Keszthely and Paks.



Source: own editing based on CSO data

Figure 7. Neighbourhood effects – weak spatial autocorrelation (2010)

For the year 2020, the autocorrelation of the built residential real estates is again tested using several neighbourhood matrices. Table 8 summarizes the results for the year 2020.

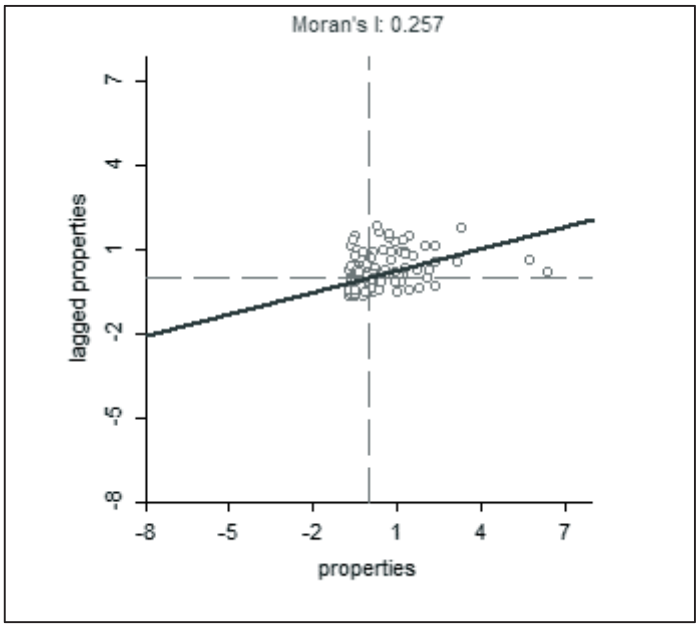
Table 8

Local Moran's investigation of the districts of Hungary in 2020

	Leader neighbourhood	**Nearest neighbourhood method**	**Threshold distance method**
Moran I	0,241	0,257	0,252
number of permutations	999	999	999
pseudo-p value	0,001	0,001	0,001
z score	5,6860	6,1082	5,5265
Local Moran clusters are created	high-high: 15 low-low: 33 low-high: 8 high-low: 2	high-high: 15 low-low: 32 low-high: 4 high-low: 1	high-high: 31 low-low: 31 low-high: 12 high-low: 1
significance level	95-99,9%	95-99,9%	95-99,9%

Source: Own editing

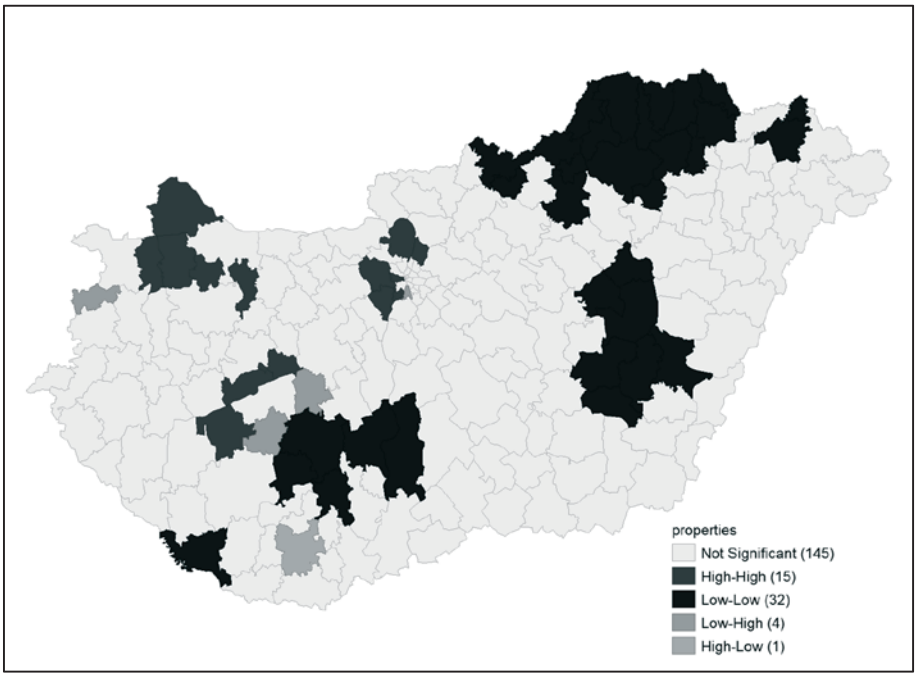
Figure 8 illustrates the values of the Moran I index in the districts of Hungary in 2020 for the built residential real estates per ten thousand people. The value of its index is 0.257, which means a weak positive autocorrelation (from 2013 to 2020, the strength of the autocorrelation increased significantly). In other words, in the case of built residential real estates, neighbouring areas have a small influence on each other. The autocorrelation of the areas is weak, as the number of built residential real estates per ten thousand people in each area is not strongly related to each other.



Source: own editing based on CSO data

Figure 8: Moran I index in the case of specific built residential properties in the districts of Hungary (2020)

To eliminate random errors, I again performed the analysis with a high number of permutations (999). The value of the probability variable p is low, but the standard deviation (z score) of the values is high, which proves that autocorrelation exists. Figure 9 illustrates the cluster map of Local Moran's I calculation.



Source: own editing based on CSO data

Figure 9: Neighbourhood effects – weak spatial autocorrelation (2020)

No significant autocorrelation can be detected in 145 of the 197 territorial units included in the study, the remaining 52 territorial units can be divided into four categories. Examining the 2020 data, 15 territorial units can be classified in the category in which the analysed neighbourhoods and their neighbours had values of built residential properties per ten thousand people that were significantly above average. The members of the high-high cluster are the districts of Mosonmagyaróvár, Csorna, Kapuvár, Tét, Pannonhalma, Szentendre, Dunakeszi, Budakeszi, Érd, Fonyód, Balatonfüred, Balatonalmádi, as well as the 1st, 12th, 22nd districts of Budapest.

The low - low cluster includes those territorial units with a lower-than-average value in terms of the number of built residential properties per thousand people, as well as their neighbours. These areas are mostly located in the north-eastern part of the country. The cluster is made up of 32 territorial units: all but two districts of the Borsod-Abaúj-Zemplén county (Mezőkövesd, Mezőcsát districts) belong to it, as well as Záhony, Kisvárda, Tiszafüred, Karcagi Kunhegyes, Mezőtúr, Gyomaendrőd, Szeghalom, Szarvas, Eger, Bélapátfalva, Salgótarján, Bátonyterenye, Barcs, Dombóvár, Tamási, Bonyhád, Paks, Kalocsa districts.

The areas of the low-high cluster are Kőszeg, Tab, Enying, Budapest 21st district. The area located in the low-high cluster is the Pécs district.

Comparing the 2013 and 2020 maps, can be established that the number of districts belonging to the high-high and low-low categories has increased significantly.

At the neighbourhood level, contiguous areas with similar situations that differ positively (relevant parts of Central Hungary, Northwestern Hungary, Balaton's elbow) or negatively (a part of Northern Hungary, the middle of the Great Plain, the area affecting Southwestern Hungary) from the average in terms of the specific values of the built apartments have become more extensive. This presupposes a kind of similarity and cohesion at a narrower regional level, while at the national level it leads to growing differences between larger regions.

CONCLUSION

Even though there is no uniform internationally accepted concept for the concept of real estate, the legislation and with the help of actors from scientific life, we can clarify its most important characteristics. We can also state that, in accordance with the importance of the topic, many specialized literatures have been produced in recent decades, but relatively few articles focusing specifically on territorial connections have been produced. In our country, the residential population reached its maximum at the beginning of the 1980s, in the period from the 1920s to the present, it has been continuously decreasing, while the growth of the residential real estate stock is continuous. The reason for this is that there is a demand for newly built residential

properties even in a period of declining residential population, while residential property closures are not typical in our country.

It can be concluded that the high values of built residential real estates of the decades before the regime change are not expected soon, and the 2015 data, which is considered outstanding, is significantly lower than the average of previous decades. In the decades following the system change, very significant fluctuations can be observed regarding the number of built residential properties.

With the help of a correlation coefficient, we clarified the known relationship between real income and the number of built residential properties and found that the data on built residential properties 3 years later move the most with changes in real income. We also found that there are still significant differences in the comfort of residential properties in the regions of our country. Throughout the 2010-2020 period, the share of housing transactions between private individuals far exceeded the population ratio of the Central Hungary region. From 2013, this high share decreased significantly (from 66.4% to 42.1%) by 2017, except for 2011, and started to increase again in the following years. However, it can be concluded that the positions of the region were improved by the period of decline rather than by truly favourable trends. From 2013 to 2020, the number of built residential properties almost quadrupled, and at the same time, the number of settlements where at least one residential property was built also increased significantly. The township maps clearly illustrate that in the country's least developed regions there is essentially no meaningful positive movement. The previously only guessed connection was confirmed by the Moran I index area autocorrelation calculations for districts and the map representation. The results show that the areas where the neighbours of territorial units with high values also have high values, or the areas where the neighbours of territorial units with low values have low values, have become more extensive.

Author's contribution

Zsolt Péter's contribution to the study is 50%, Dániel Orosz's contribution to the study is 50%.

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Abuses in Public Administration and Their Perception

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SUMMARY

Corruption not only hinders economic growth, but also undermines trust in public institutions, increases public spending and threatens the functioning of democracy. In addition to the financial damage, corruption in public administration has a serious social impact: it determines the trust of members of society in public governance and the civil service, it has a close impact on the fair and efficient use of public funds, and it affects the international image of the country. We aim to provide an overview of how corruption is present in public administration, how it differs from corruption in the private sector and how it can be intertwined with the public and private sectors. To identify methods to prevent corruption in public administration and to find out how public officials experience the functioning and effectiveness of these methods in practice.

Keywords: public administration, corruption, integrity, professional ethics
Journal of Economic Literature (JEL) codes: K 39, L30, H89
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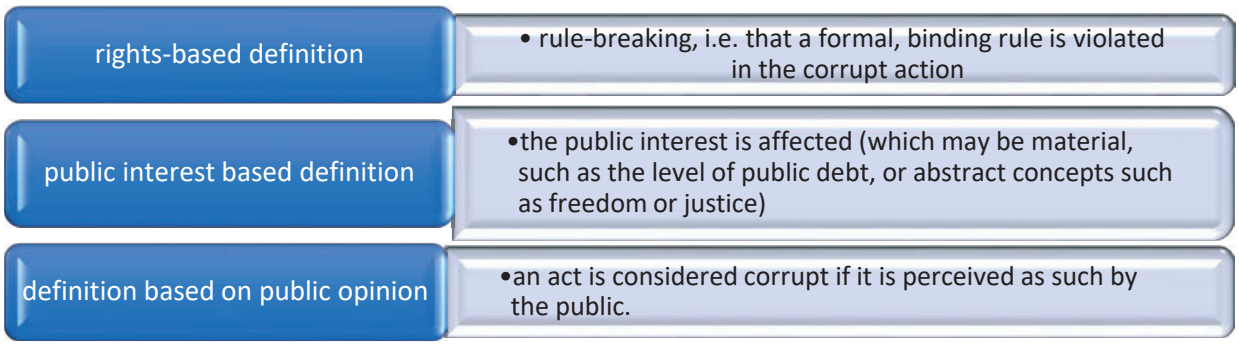
INTRODUCTION

Corruption is a word of Latin origin, which means to corrupt, to corrupt, to bribe and to corruptible. There are many definitions that attempt to give a general meaning to corruption. Although corruption is one of the most visible problems in the developing world and is an integral part of everyday life (within Europe, the level of corruption poses an especially large challenge in Hungary, and in the Central and Eastern European region – Bartha & Tóthné Szita, 2015a, 2015b), there is no single agreed definition. The concepts are the same in that corruption is an act against the law or public morality, committed in order to obtain an unjustified advantage.

DEFINITION OF CORRUPTION

The concept of corruption, like the phenomenon itself, is difficult to define, vague and unclear. Although there has been and is still a large amount of research on the subject, there are many conceptual definitions and typologies, but no uniform and comprehensive definition has been found. Defining a definition is a fundamental problem in studies of corruption. Most scholars on the subject agree that corruption requires the presence of at least two actors, a conscious decision by the actors to engage in corrupt activity, the pursuit of private interest as opposed to the pursuit of others or the public interest, and of course there is agreement that corrupt transactions are all considered illegal activities.

Corruption is defined by Daniel Kaufmann (1997) as the abuse of official power for private gain. In Kaufmann's view, the more the state regulates economic life, the greater the potential for corruption, and the more discretionary these rules are (i.e. they depend on the goodwill of the person in authority to apply them). According to Balázs Hámori (2003), however, it can be extended beyond the state bureaucracy to all principal-agent type relationships. He justifies this by arguing that the agent is able to outwit his principal because he is able to represent the interests of others. The many different definitions can be grouped into three categories according to their main elements (Figure 1):



Source: own editing based on Gulyás, (2004)

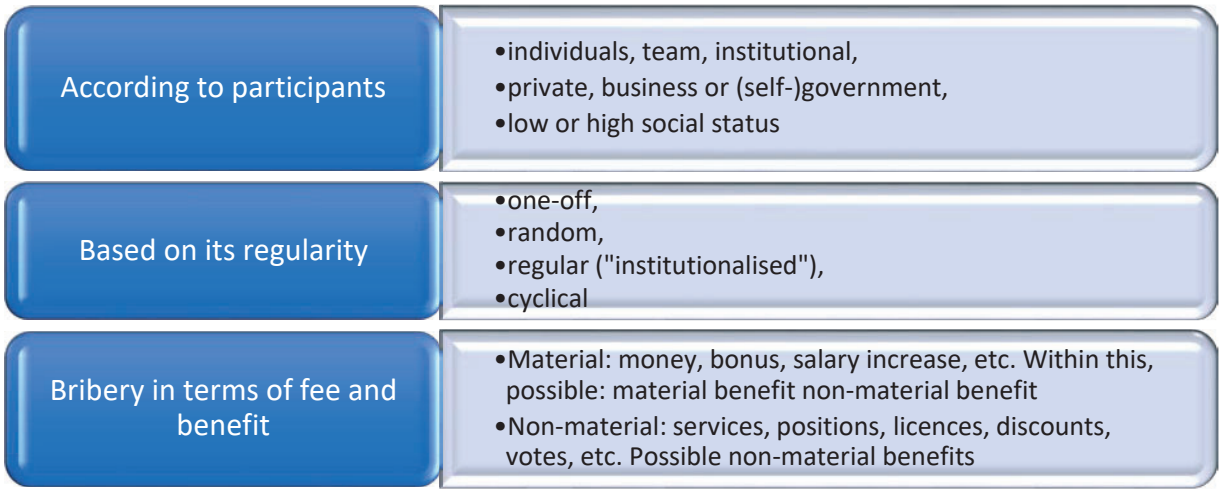
Figure 1. Classification of the definition of corruption

Types of corruption

The most common types of corruption are bribery, extortion, misappropriation, and fraud. These can best be analysed using the principal-agent-client model: we can understand the motivations of the parties, the individual and peer effects of actions and the relationships between actors. The model incorporates public interest/private interest and enhancing the effectiveness of incentive and punishment systems. In the model, the principal gives the agent the power to perform a task, then sets the rules for performing the task, in return for which the agent receives some form of remuneration, and the agent is therefore loyal to the principal and performs the task within a set framework, following formal rules. Corruption occurs when one party (typically the principal) breaks the rules for its own benefit, thereby harming the interests of the other parties. The problem is caused by the fact that the actors have different levels of information, and this situation is used to exploit private information to achieve individual interests (Varga, 2017).

Another important question is what are the motivational factors that encourage the stakeholders to take the risk of corruption. The risk may differ depending on the type of corruption: in bribery and extortion, both parties (principal and client), while in misappropriation and fraud, all risks are borne by the principal (Szántó et al., 2011).

However, corruption can also be typified in other ways:



Source: own editing based on Tóth and Szántó (2008)

Figure 2. Classification of corruption according to other aspects

There are many types of corruption, which can take many forms. The variety of types also shows how widespread corruption is and how many different ways it can manifest itself, whether we are talking about private individuals, economic actors or institutional workers.

Areas of corruption

Corruption is felt to varying degrees in different segments of society and the economy, especially in areas where the number and scale of financial flows are significant. Some of this corruption is linked to the public sector, but it is also observed in the economic sphere. Corruption in the public sector is more significant because of the scale of the damage caused and its greater social impact. According to various studies and surveys, public administrations and political parties are the most corrupt. Therefore, the success of the fight against corruption depends largely on cleaning up the political system. From a social point of view, political corruption is more significant because political parties and politicians are elected to carry out their duties in the public interest and are thus given the right to exercise power and use public funds to influence the lives of citizens. Corruption risks depend significantly on the degree of interconnectedness between parties and their supporters (Takács et al., 2011).

Transparency International conducted the Global Corruption Barometer survey in 2022. It shows that the sectors most affected by corruption are public procurement, construction, oil and gas, heavy industry, mining, real estate and property development. These are followed by the moderately affected sectors, which include health, energy, defence, utilities, pharmaceuticals, transport, telecommunications, warehousing and hospitality, while the least affected sectors are agriculture, fisheries, light industry, information technology and finance.

International experience shows that privatisation and public procurement are particularly vulnerable to corruption. As roughly 70 percent of government spending is spent in the form of some form of contract, decision-makers have considerable power and influence, and the winners of contracts also have considerable influence. Corruption in public procurement is also particularly harmful to society because it distorts competition, i.e. it prevents basic human needs from being met and wastes scarce resources. The cost of public procurement procedures is estimated to increase by 20-25% as a result of corruption, and inferior or unnecessary procurement is also common. Experts believe that the fight against corruption should focus on transparency, making contracts public and curbing patronage (Takács et al., 2011).

In addition to the public sector, corruption can also be found in the corporate sector. In 2014, the MKIK Institute of Economic and Business Research conducted a survey on the means companies use to combat abuse and corrupt behaviour, the prevalence of corruption and the views of Hungarian business leaders. According to the managers of the companies surveyed, personal relationships play an important role in dealing with public authorities, obtaining various permits or winning public contracts, among other things. According to the business leaders surveyed, personal relationships play the most important role when bidding for public and municipal contracts, while they are less important when dealing with tax authorities and settling disputes (GVI, 2016).

In business-to-business transactions, corruption can manifest itself in non-written agreements that are not accountable because of their informal nature but are still very much present in the economy and can cause serious damage, up to billions of forints. These types of agreements can take several forms (Barna et al., 2018):

- Perfect collusion: firms agree among themselves on market allocation or on the same price. One of the most typical forms of this is the arm's length agreement. This agreement can also take place at the organisational level, for example by setting up management bodies that coordinate the activities of the individual firms, thereby creating a monopoly on the market and eliminating competition altogether.
- Perfect collusion: in such a case, there are leading and follower firms, and the decisions of the leading firms determine the behaviour of the follower firms. In such a case, the firms aim to limit competition in the market for similar products or services in a way that leads to an advantage for themselves or to higher profits.
- "Independent action model": In this case, there is no collusion between firms, and they make their decisions independently, thereby creating efficient market mechanisms, but firms may also gather information or use existing information about competing firms to gain an advantage.

According to the findings of the Hungarian Competition Authority, cartels in Hungary are mainly created for some purpose related to public procurement, which hinders the efficient and economic use of public funds and can also be considered as misappropriation of public funds, ultimately harming consumers. Specific action against public procurement cartels is therefore particularly important.

There is also serious corruption in export relations between companies. A Transparency International study (Exporting Corruption 2020) looked at how companies that used corruption to get ahead abroad were sanctioned in each country between 2016 and 2019. The research

found that the US, the UK and Switzerland were the most active in enforcing the law when it came to monitoring corruption cases abroad. Firms that have a presence in more than one country have different business cultures and control systems, as well as different operating principles in different countries.

Hungary was a particular case in point, as the previous minimum level of activity has completely dropped during the period under review. Some of the commitments made in the legislation have not been implemented in reality, nor do they provide real protection for whistleblowers in principle, and therefore the number of abuse reports is low. The lack of a system of checks and balances in the Hungarian prosecution service was seen as a problem, with a two-year time limit for investigations, which in practice is not sufficient time to identify international business relationships (Szalai, 2020).

Measuring corruption

Detection of corruption is a key prerequisite for taking action against corruption, but corruption cannot be measured directly, nor can the political structure that gives rise to corruption. Corruption is essentially a hidden, hidden phenomenon and its extent can therefore only be estimated indirectly. The accuracy of the measurement also depends to a large extent on the method of measurement. The most commonly used method to measure corruption is the Corruption Perceptions Index (CPI), but other methods are also available to examine and statistically analyse the corruption exposure of countries and within countries in different areas.

The index defines corruption as the personal gain from the abuse of public office, i.e. it focuses on corruption in the public sector. The surveys include questions that form the basis for the calculation of the index, which examines the abuse of public power and the strength of anti-corruption policies. The methodology relies on the opinions and experiences of professionals who are directly confronted with corruption in a given country, as they believe they can provide a more accurate picture than trying to compare different data. The Corruption Perceptions Index is a so-called composite index, i.e. it is based on the aggregation of the results of other surveys of corruption rather than on a stand-alone data set. Looking at the value of bribes, the number of prosecutions or the number of court cases in a country would not reveal the true level of corruption, but rather the work of the courts and judiciary (Ligeti, 2016).

An analysis of the number of corruption offences does not give a true, complete picture of corruption because, as we have seen in the discussion of types of corruption, certain types, such as misappropriation or fraud, do not formally fall into the category of corruption offences. Furthermore, it does not include cases that are not formally considered criminal offences (Ligeti, 2016). One criticism of the method is that those involved in corruption - who provide the data for the survey - may have an interest in underestimating corruption (Golden & Picci, 2005)

Several new methods are being experimented with in order to develop a more accurate measure of corruption, even complementing the CPI. One of these is the Bribe Payers' Index (BPI), which literally means the number of people who pay bribes. The BPI measures corruption on the supply side by country and by sector. Another survey based on public opinion polls is the Global Corruption Barometer (GCB), which measures and compares corruption as perceived and experienced by ordinary people in 60 countries (Takács et al., 2011)

In addition to the CPI, the World Bank's Perception Indicator, published since 1996, is also widely used to measure corruption, and is compiled for more than 200 countries. The Control of Corruption Index is based on questionnaires to companies and individuals, as well as on assessments by commercial and economic experts, NGOs and public institutions. Similar to the Corruption Perceptions Index, this index is not able to provide a fully comprehensive and realistic picture of the extent of corruption (Kaufmann et al., 2011).

In addition to the indicators mentioned above, questionnaire-based attitudinal surveys, such as the Eurobarometer, the World Values Survey or the European Social Survey, are also very helpful in providing information on corruption. The extent of corruption can also be inferred by observing objective data, such as the survey of parking violations by diplomats enjoying immunity. A new way to analyse corruption risks is to look at circumstances that may facilitate corrupt transactions, assuming an intention to defraud. However, favourable conditions do not clearly mean that corruption has occurred (Tóth & Hajdu, 2018).

These methods are therefore largely based on estimates, with little quantifiable, definitive data. At the same time, corruption cannot be measured by purely statistical methods, as there are many undetected cases, and even in those that are detected, the full extent of corruption is not quantified.

ANTI-CORRUPTION MEASURES IN HUNGARY

Anti-corruption measures are aimed at preventing corruption situations and bringing to justice the perpetrators of detected corruption. With Hungary's accession to the EU, it was necessary to transpose the requirements of international anti-corruption conventions into the domestic legal system and to commit to strengthening the transparency of public operations. To this end, the government's anti-corruption

policy and the first anti-corruption government resolution were adopted.

In the National Anti-Corruption Programme (2018), the Hungarian government formulated the principles and directions of government action against corruption, laid down the methodological foundations, objectives and the issues of connection and delimitation. The programme aims to make the management of public funds more transparent, to establish regulations to promote clean business, to improve official procedures, to expand education and training, to shape attitudes and to create the human and material conditions for an effective fight against corruption. It stresses that the fight against corruption requires not only punitive measures, but also the introduction of effective preventive measures, so that effective action against corruption requires a balance between repressive (punitive) and preventive (preventive) measures.

As regards the prevention of corruption, it is important to note that, although corruption is overall a harmful social phenomenon, its complete elimination is not the optimal level, as the economic and social costs of fighting corruption are significant. The optimal level is therefore achieved when the costs of fighting corruption do not exceed the damage it causes. Tools for anti-corruption efforts (Dávid & Hollán, 2017):

- Protection of organisational and personal integrity, as corruption is usually aimed at influencing some individual or group decision, so one of the tools to avoid corruption is to regulate the filling of positions, to pay officials appropriately and fairly, to regulate conflicts of interest, and to develop codes of ethics.
- Developing rules on decision-making and customer relations, including reducing state interference, eliminating decision monopolies, simplifying procedures, providing adequate information to customers, automating decision-making, sharing responsibilities, involving more people in decisions and rotation, and reducing corrupt customer relations.
- To strengthen detection, control and sanctioning through: integrity checks, mass data collection, documentation of procedural processes and decisions, public involvement in decisions and reasoning, incentives (rewards) for whistleblowers and preventive remedies.

On this basis, corruption prevention should therefore focus on the imperfections of the institutional system, the misbehaviour of officials and bad social practices that make corruption acceptable. In order to prevent and reduce corruption, ensuring ethical behaviour of the individual plays a key role, which is served by the (amended) Code of Ethics of the Hungarian Faculty of Government Officials in force from 18 December 2020. In addition, two new laws help to detect and avoid corruption: Act XXVII of 2022, which established the Integrity Authority, the Anti-Corruption Working Group and made it responsible for the investigation of existing anti-corruption measures and the development of recommendations on corrupt practices, and Act XXV of 2023, which provides for procedural rules for state and local government officials on reporting misconduct.

Professional ethics as a tool to prevent corruption

Professional ethics is the set of principles and values that define the written and unwritten rules of conduct for those who serve the public (Kiss, 2021). The state employs public officials to serve the public and to create the public good, and their task is to represent and promote the public interest in their work, so professional ethics is particularly important. The work of officials is of moral importance, as their work has an impact on the use of public funds, and the ethical standards expected of them are therefore particularly high. Civil servants must conduct their work in accordance with the rules of professional ethics.

In the ever-changing external economic, political, and social environment of the public sector, there are many forms of conflicts of interest for individuals and communities which are at the centre of public attention. A conflict of interest is a situation in life where a public servant, in the course of his or her work, is concerned with the public interest, but in certain situations or events, the public interest is overridden by private interests. Such conflicts of interest can give rise to situations of corruption when individual interests cross a line in the official's official activities. It is therefore important to recognise these conflicts of interest and to develop a common methodology for dealing with them (Dávid & Lóczy, 2013).

The existence of a conflict of interest situation does not automatically mean that corruption has occurred, but there is a risk that a situation may arise which may require certain sanctions. At the organisational level, the following methods are available to reduce the risk of conflict of interest (Hazafi, 2006): mandatory reporting based on the principles of impartiality and integrity, restriction of access to information e.g. databases, transfers within or between organisations, transfer of job with change of appointment, temporary withdrawal of authority, resignation from employment, performance appraisal and monitoring.

In addition to the various measures and organisations involved in the fight against corruption, an ethical approach in public administration also plays an important role. The ethics of the civil service convey democratic, professional, moral, and human values, requiring officials to be prepared, impartial, efficient, to serve the public interest, to behave in an exemplary manner and to show respect and fairness to citizens. It includes organizational integrity (transparency and accountability), individual integrity, the fight against corruption, the sanctioning of misconduct, continuous training, and the avoidance and elimination of conflicts

of interest and conflicts of interest. Codes of ethics set out the conduct expected of civil servants (Kiss, 2021).

In 2013, the Code of Ethics for Government Officials came into force, which, in addition to containing rules on ethical procedure, sets out principles on reporting misconduct, maintaining impartiality, conflicts of interest, accepting gifts, taking undue advantage, high liability of managers, ethically dishonourable behaviour, among others (Vargha, 2020).

Integrity as a modern tool for corruption prevention

The word integrity is of Latin origin, meaning incorruptibility, purity, uniformity. The concept of integrity and the way it works were introduced to the public administration profession in 2009 through the Integrity Project launched by the State Audit Office of Hungary (SAO) and later introduced into government decision-making. Integrity is defined by Government Decree No 50/2013 (25.II.) as "the proper functioning of a public administration body in accordance with the objectives, values and principles set by the head of the public administration body and the governing body". The concept of integrity also includes organisational, personal, relational and professional integrity, i.e. it implies following the rules and behaving ethically and fairly, in accordance with the professional ethics of public officials (Báger, 2015).

There are two types of approaches to anti-corruption strategies: a compliance-based approach and a value-based (preventive) approach. The rule-following approach focuses on norms and rules, uses hard management methods, is based on the assumption that individuals are prone to commit crime, aims to combat integrity-related offences, and relies on the practice of repression (reaction). In contrast, a values-based approach is based on principles and values rather than rules (honesty), uses soft management methods, assumes that individuals are honest, aims to encourage good behaviour, relies on the practice of prevention.

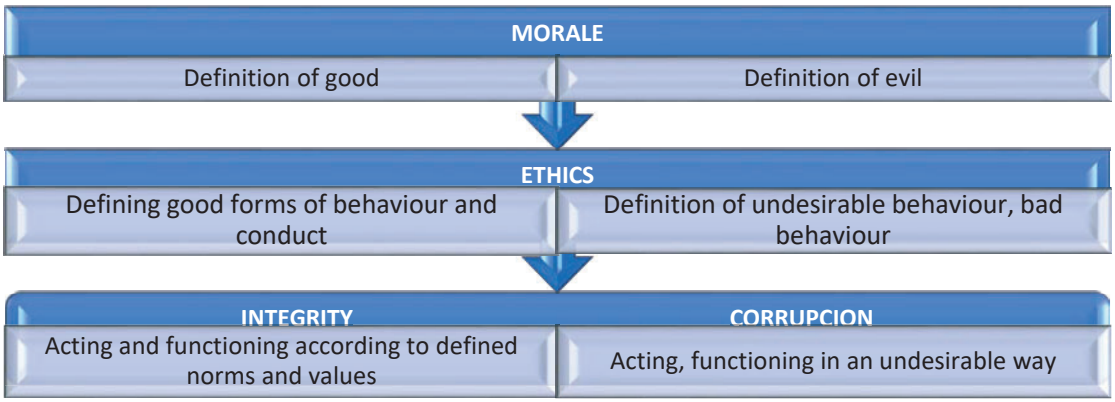
Effective anti-corruption requires the development of a balanced approach in which both approaches are applied in appropriate proportions. The concept of integrity, in addition to these two approaches, also draws attention to another dimension of anti-corruption action, which is constituted by the vulnerability to corruption and human behaviour, on the basis of which the two approaches are complementary depending on whether we are talking about the system or people type (Báger, 2015)

Integrity in terms of organisational governance means that the organisation has a positive set of values that are aligned with societal expectations and operates accordingly (Domokos et al., 2016).

Key elements of an integrity approach (Barna et. al, 2018):

- At the organisational level: prevention and risk management: public administrations seek to mitigate risks through detailed internal regulations and operational specifications, based on prior risk assessments. Incidents that have already occurred are investigated and proposals are made for their management and prevention, and high-risk areas are identified.
- At the individual level: strengthening the integrity of public administration employees: the efficient and effective functioning of public administration depends on public servants sworn to serve the public good and public interest, and therefore the main means of promoting integrity is to strengthen the ethics of public service and the related legal measures and training.
- Responsibility: according to the new approach, the fight against corruption is not only the responsibility of law enforcement and law enforcement, but a shared responsibility of other organisations and their members (Dargay, 2015).

Integrity is thus closely related to ethics and morality, and the difference between the three concepts is illustrated in Figure 3 below. Morality clarifies the concepts of right and wrong, ethics clarifies the behaviour associated with the concepts of right and wrong, and integrity refers to the practice of good behaviour as defined by morality and ethics (Domokos et al., 2016).



Source: own editing based on Domokos et al. (2016)

Figure 3. The relationship between morality, ethics and integrity

Integrity management ensures that the organisation operates with integrity, has the resources to do so, and that management is committed to the values set out. Its four main pillars are transparency and accountability, professional ethics, professionalism and the exclusion of corruption. Developing integrity requires a range of competencies in the organisation: a commitment to serving the public interest, putting the public interest before the individual interest, compatible individual organisational goals, professionalism, openness to innovation, continuous learning, seeking new solutions, risk analysis, and organisational intelligence, i.e. the ability to understand the context and change in the way the organisation works (Vargha, 2020).

Ensuring integrity is important in the organisation, and the means to achieve this can be in the internal control system (Klotz & Sántha, 2013):

- General controls: integrity policy, risk analysis, recruitment/selection of staff, management of integrity violations, accountability, control and audits.
- Hard controls: assignment of responsibilities, legislation, integrity policy, internal control group, security.
- Soft controls: setting values, principles and norms, professional standards, awareness, attitude of managers, organisational culture.

Integrity can also be violated, and the following types of integrity violations are distinguished: fraud, bribery, corruption, conflict of interest, nepotism, overstepping authority, discrimination, threats, misuse of information, waste of resources, and conduct that is detrimental to the public interest beyond working hours (Kohthoff et al., 2009).

There is also a need to focus on developing integrity, which aims to prevent corruption and to ensure that public administrations operate effectively and efficiently, and that they operate in a way that enables them to use the resources entrusted to them effectively and fairly. Integrity development must strike a balance between rulemaking (to correct institutional failures) and building values and norms (to change individual drives and societal perceptions) (Pallai, 2015).

CORRUPTION IN PUBLIC ADMINISTRATION BASED ON PRIMARY RESEARCH

First, what is meant by public administration. In the literature, we can find definitions from many different perspectives, but one of the most prominent scholars of Hungarian public administration, Zoltán Magyary (1942), in his still current definition, stated that public administration is nothing more than the administration of the state, i.e. the organisation of the state which performs public tasks in accordance with the methods defined by law. Modern public administration can be defined as a state activity which, first and foremost, performs executive functions, prepares and implements legislative decisions, and, in addition, exercises administrative functions in the public interest, making decisions which are binding on all, providing and organising public services. It carries out its activities in subordination to legitimate politics, law and public authorities, and its tasks are carried out by administrative bodies operating on the basis of specific principles, employing professional, dedicated, loyal and impartial civil servants (Veszprémi, 2012).

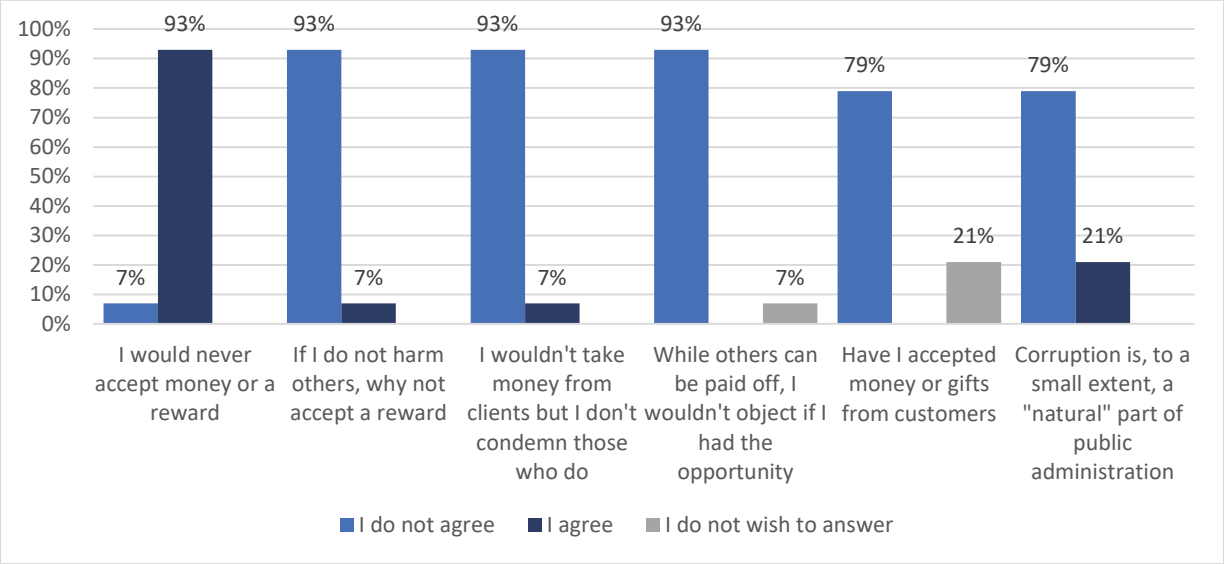
Public administrations thus perform an activity in the public interest, which in most cases is accompanied by public authority. Corruption, which is the abuse of power to favour an individual interest, is therefore particularly relevant in the public administration, where the public interest is represented, and public funds are used. In the following research, we looked at public administration employees' own experiences of corruption.

Research findings

We conducted an online questionnaire survey to assess the experiences of public officials regarding corruption in public administration, to find out how corruption is perceived by public officials, how effective they consider measures to prevent it to be, and what the general perception of corruption is according to public officials based on their own experiences and opinions. The questionnaire was completed by staff from 4 public administrations, 97% of whom were senior managers, 21% middle managers and 72% junior staff.

93% of the respondents have more than 11 years of experience in public administration, so they have the insight to judge the answers to the following questions. Based on their assessment of corruption activities, a significant majority of them consider the listed corruption activities to be very serious. Misappropriation and fraud are considered the most serious, followed by extortion and accepting bribes, and the least serious is considered by respondents to be influence peddling. One of the respondents considered that influence peddling is not a crime at all, the respondent with the least experience in public service (less than 5 years). Only 7% of respondents considered accepting bribes, influence peddling and extortion as less serious or not a crime at all: both respondents had experienced corruption in their immediate environment.

Respondents' attitudes towards the different corruption situations yielded the following results (Figure 4).



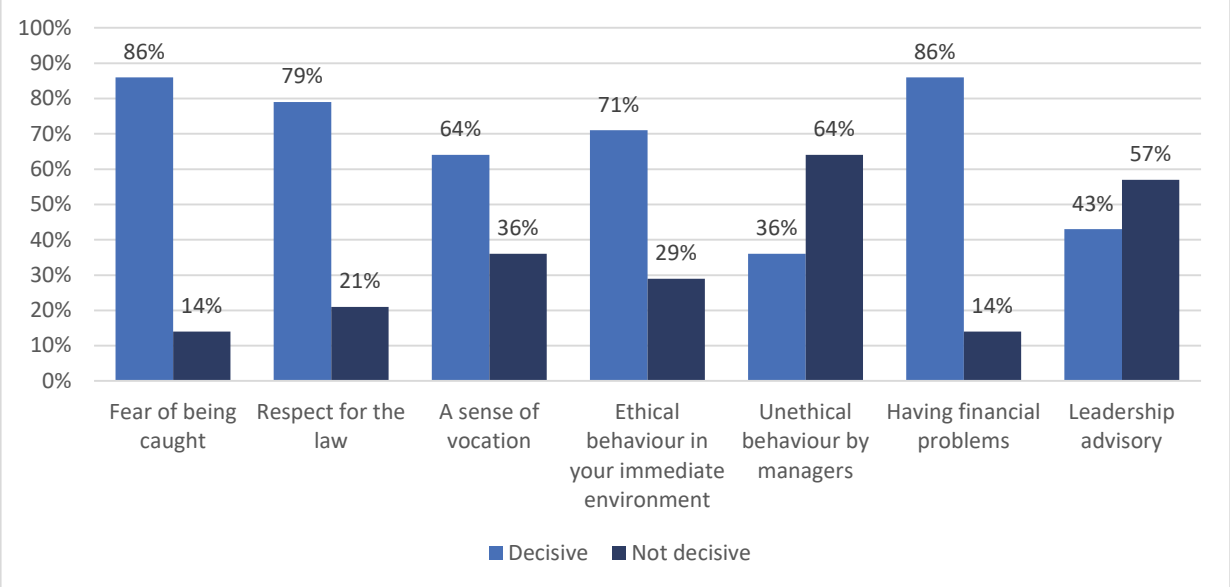
Source: own editing

Figure 4. Survey respondents' attitudes towards corruption situations

With one exception, they agreed with the statement that they would never accept money, or accept money or rewards even if it meant no harm to anyone. The next statement asked whether they would condemn others for accepting money from clients if they themselves did not. Only one respondent would not judge, the rest of the respondents did not think this was correct. As long as others can be paid off, I would not object if given the opportunity statement was abstained by one person, while the other respondents disagreed. As to whether they have ever accepted money or gifts from customers, 21% declined to answer, while 79% stated that they have not accepted anything from customers.

Regarding the punishment of corrupt activities, 7% of respondents think that there should be no punishment, half of the respondents think that the current punishments are adequate and half of the respondents think that they are inadequate, and 64% think that there should be more severe punishments than the current ones.

The factors influencing involvement in corruption were then examined, i.e. the extent to which the given factors - personal characteristics (law-abiding, sense of duty) or behaviours (fear of being caught, ethical behaviour in the immediate environment, unethical behaviour of managers, financial problems, managerial direction) - influence the likelihood of a public administrator being involved in corruption (Figure 5)



Source: own editing

Figure 5. Analysis of factors influencing participation in corruption

According to the responses, fear of being caught and the participant's own financial problems are the most decisive factors, followed by respect for the law, ethical behaviour in the environment, professional ethics, management instructions and least decisive is the unethical behaviour of managers. These responses are closely related to our hypothesis that public officials agree that the extent of corruption is significantly determined by the individual moral values and sense of vocation of public officials, but this can be overridden by financial worries or fear of being caught. However, this also means that if civil servants are adequately remunerated and corruption is properly monitored and punished, this, combined with an ethical attitude among civil servants, can go a long way to curbing corruption.

The final question of the questionnaire is the extent to which public administrators consider integrity to be effective in the fight against corruption. Half of the respondents consider it an effective tool, while 35% do not find it effective and 14% are not familiar with the concept of integrity. These individuals work in different fields, but both have more than ten years of experience in the public sector, so they must have encountered the concept of integrity in their work. Their lack of familiarity with the concept suggests that perhaps there is a lack of awareness among civil servants and that more training is needed within organisations to familiarise staff with tools and methods to help them reduce corruption.

Corruption is felt to varying degrees in different segments of society and the economy, particularly in areas where the number and scale of financial flows are significant. Some of this is linked to the public sector, but it is also observed in the economic sphere. Corruption in the public sector is more significant because of the scale of the damage caused and the greater social impact. The analysis of the areas of corruption has also shown that there is a high level of corruption in business-to-business relations and that corruption in the corporate environment is closely linked to the work of public offices, state and municipal bodies, where power and influence in the management of public funds is significant.

CONCLUSION

Anti-corruption measures in Hungary are aimed at preventing corruption situations and bringing to justice the perpetrators of detected corruption. To assist in this task, an Integrity Authority, the Anti-Corruption Task Force, was set up in 2022 to review existing anti-corruption measures and develop recommendations on corrupt practices. The ethical behaviour and professional awareness of individuals, as confirmed by the results of the questionnaire, also play a key role in detecting and reducing corruption, and are reinforced by the revised Code of Ethics of the Hungarian Government Officials.

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From Three-Factors Model of Sustainability to the Integrated Model of Sustainability

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SUMMARY

In addition to the three classical dimensions of sustainability, environmental, social and economic other aspects have emerged in recent years in both literature and practice such as culture, human capital, technology, industry and business, politics and good governance, and peace. Therefore, the aim of this paper is to present these factors as well as multidimensional models of sustainability, which fit perfectly with the classical model of sustainability, they merely complement and fine-tune it. Ultimately, this study synthesises and integrates these into an eight-factor model of sustainability. Finally, it sets out a further line of research, focusing on how these dimensions affect the understanding and implementation of corporate sustainability.

Keywords: classical sustainability; cultural sustainability; political sustainability; technological sustainability; corporate sustainability
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INTRODUCTION

One of the most used terms of the 21st century is sustainable development, or sustainability, which became known worldwide in 1981 following the work of Lester R. Brown, who, in his study of the development of a sustainable society, concluded that population growth can only be sustained while preserving the natural environment, taking into account both quantitative and qualitative aspects (Faragó, 2002).

A few years later, in 1983, the UN World Commission on Environment and Development commissioned the then Prime Minister of Norway, Mrs Gro Harlem Brundtland, to develop a programme to address the global environmental crisis. In 1987, the International Commission published a report entitled 'Our Common Future', which defined the concept of sustainable development (harmonious development) and laid down principles to ensure that future generations can continue to enjoy the Earth's current resources and opportunities (Faragó, 2002). The report identified the need to mainstream these three dimensions (environmental, social and economic) into local, national and global development strategies.

This theme was the central theme of the World Conference on Environment and Development held in Rio de Janeiro in 1992, where Agenda 21 was drawn up, which contains twenty-seven principles for sustainable development and serves as a guide for the challenges of the 21st century. It emphasises that the whole economy (production, consumption, population policy) must be subordinated to these requirements, but that individual countries must assume common but differentiated responsibilities (UN, 1992).

LITERATURE REVIEW

Sustainable development or sustainability can be determined at global, macro (Earth-wide), meso (regional, national), micro (organisational) and individual levels. This paper will focus on the broader interpretations. The international literature uses the following best-known approaches to define sustainable development. In the words of the Brundtland Commission (Brundtland, 1987, 41 p.):

'Sustainable development is development that meets the needs of the present without compromising the

ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs'.

The concept of sustainable economic, ecological and social development is understood as a unity. The essence of this formulation is that what is a gift and an opportunity for us today should be left to future generations, so that future generations are not worse off than we are now. According to this view, sustainable development means a harmony of economic, environmental and social values, with equal emphasis on securing economic performance, preserving the state of the natural environment and maintaining social norms, needs and solidarity. However, the purpose and extent of development are not specified.

Dimensions of sustainability

In the following, I will look beyond the classical dimensions of sustainability to consider additional aspects that have been integrated into the standard model of sustainability in the literature and/or in practice.

Classical sustainability ─ environmental, social and economic sustainability

Sustainability generally has three main pillars, which are the following:

1. *Environmental/ecological sustainability* that aims at preserving the natural environment and biodiversity, combat climate change and reduce environmental damage. These include reducing greenhouse gas emissions, increasing water and energy efficiency, preserving forests, protecting natural habitats, and promoting recycling.
2. *Social sustainability***:** to meet people's current and future needs, the social dimension focuses on people's well-being, health, education, equal opportunities, and social equality, including ensuring decent work and wages, reducing social exclusion and poverty, improving access to health care and raising the quality of education.
3. *Economic sustainability* which aims at promoting economic growth, innovation, efficient use of resources, economic stability, and social well-being in the long term. This includes assessing economic development from a sustainability perspective, efficient use of resources, green economic practices and improving quality of life.

The relationship between these three factors is interpreted in three ways. One is when it is likened to a three-column tympanum (with three pillars), saying that if any factor is broken, the balance, the sustainability is upset. The other is when they are three equally important aspects, their common intersection representing overall sustainability. The third is to present the three systems in a hierarchy, it is called strong sustainability. Mozsgai (2011) puts it this way: the society is part (subsystem) of natural environment, and the economy is a subsystem of society, and not vice versa. This is because the present state of affairs is unsustainable under these conditions, and only if we follow the original order of the world, i.e. the economic subsystem is responsible for meeting the needs of society (the economy grows in size as society grows in size and needs). The satisfaction of social needs and demands is limited by the carrying capacity of the environment (the quantity and quality of the natural resources available) (Mozsgai, 2011, 8 p.). Or as Bulla (2013, 63 p.) puts it: - 'the goal of development is social well-being, - one of the means of achieving it is the economy, - and the limit is the carrying capacity of environmental resources.'

Balancing and combining these dimensions is essential to achieve full sustainability. It is in the interaction and balance between society, economy and environment that the potential for a sustainable future lies.

However, some approaches also mention additional pillars such as cultural sustainability, human sustainability, political sustainability, technological sustainability and corporate sustainability.

Cultural sustainability

Since the beginning of the century, various parts of society, from international institutions to academia such as UNESCO, the World Summit on Sustainable Development and many researchers, have begun to question the validity of the current definition of sustainable development. They have argued that economic growth, social equality and environmental protection no longer reflect the complexity of contemporary society and have suggested that policies for sustainable development should be complemented by a cultural dimension. The Executive Office of the United Cities and Local Governments (UCLG) supported the application of the fourth pillar and endorsed the policy statement 'Culture as the fourth pillar of sustainable development' on 17 November 2010, in the context of the World Summit of Local and Regional Leaders in Mexico City (UCLG, 2010).

The document does not consider culture as a 'fourth' pillar or dimension in a hierarchical system, but rather as an advocacy document that promotes culture as a specific pillar or dimension of sustainable development, fully interlinked with the other three pillars, compatible with all of them and equally important.

This new approach addresses the relationship between culture and sustainability in two dimensions. Firstly, strengthening and developing the cultural sector itself, such as heritage protection, art, cultural tourism, and secondly, ensuring that culture is given its rightful place in all public policies, particularly those related to the education, the economy, the science, the communication, the environment, the social cohesion and the international cooperation. In other words, creativity, knowledge, diversity and beauty are fundamental values closely linked to human development and freedoms (UCLG, 2010).

Throsby (2010) identifies five key sustainability principles as part of cultural sustainability, which originally support sustainable management of natural resources, but which are also applicable to cultural heritage management because of their similarities. After all, if the protection of natural resources is central to environmental sustainability, then the protection of cultural assets should be given the same priority for cultural sustainability, i.e. it is suggested that similar principles should be applied to cultural heritage management. Thus, these are:

- ensuring equality of access to cultural resources for present and future generations;
- promoting cultural diversity;
- applying the precautionary principle in the management of cultural heritage to prevent irreversible damage or loss;
- the need to raise awareness of the interconnectedness of cultural, economic, social and environmental systems and
- to take into account the impact of the cultural heritage management decisions on other sustainability aspects (Throsby, 2010).

Cultural sustainability is about protecting and maintaining the world's cultural heritage (tangible and intangible). It is about ensuring that future generations can be brought up on the same traditions as those of today (Simon, 2023).

In this way, culture has been included in the sustainable development model (Loach et al., 2017), (Sabatini, 2019), (Pop et al., 2019), suggesting that all sustainability-related decision-making should take cultural sustainability into account. Ultimately, culture shapes the way we think and defines the values we believe in, thus shaping what we mean by development, but it also determines how we behave in the world. In other words, it is through culture that we learn about economic, social and environmental issues and develop our ideas about how society should address them (Duxbury & Jeannotte, 2011).

Although cultural sustainability was originally considered by many to be a component of social sustainability, arguing that culture is essential for a sustainable society, it is now often seen as a separate factor of equal importance to the three classical sustainability aspects. In my opinion, it is also the most correct way to represent it as a fundamental element of sustainability, which permeates all sustainability aspects.

Human sustainability

Some research (Gretchen et al., 2012) identifies social sustainability as human sustainability. The term human sustainability is also used in the literature to complement the classical sustainability dimensions. In this approach, social sustainability is split into human and social sustainability, with cultural sustainability sometimes being understood as part of the latter (Ortúzar, 2019). Thus, sustainability is divided into four distinct areas: human, social, economic and environmental. The four pillars offer an alternative perspective on sustainable development, with a greater emphasis on the human factor. Human sustainability specifically focuses on the importance of human capital. Representatives of this 'school of thought' Simon (2023) and Suri (2023) interpret social and human sustainability as follows.

- *Social sustainability* aims to ensure the well-being of society, the improvement and cohesion of social relations, peace, equality and development. In a broader sense, social sustainability encompasses the world we live in, including communities and cultures. In other words, culture is seen as part of social sustainability (Ortúzar, 2019). The social pillar of sustainable development supports the creation and development of thriving communities with prosperous social relations and increased economic opportunities, while respecting the environment.
- *Human sustainability* is at the heart of promoting the well-being of society and improving the quality of human life. Human sustainability aims to maintain and develop human capital in society. 'Human sustainability includes access to food, water, health care, education, justice, decent working conditions, skills development and respect for human rights in general' (Simon, 2023). Sustainability is the ultimate goal. But this cannot be achieved without efforts and strategies to conserve resources and improve the quality of human life. This is where human sustainability comes in. Human sustainability ensures that human life is not only preserved but also improved. So human sustainability is about maintaining and

improving human resources, human capital and culture within society.

This is why, as Suri (2023) puts it, 'investing in human capital is an essential element of sustainable development, as it promotes economic growth, social development and environmental sustainability'. In other words, a key element of the development strategy of countries, nations, regional and local governments is to support education and health. In addition to the economic benefits, education and skills development provide people with access to better job opportunities, thereby improving living standards and reducing poverty and inequality.

Simon (2023) mentions cultural sustainability in addition to human sustainability in her understanding of sustainability, while others identify other dimensions or dimensions in addition to human sustainability, in addition to the classical pillars. One such example is politics.

Political (institutional-governance) sustainability

In their study, Burford et al. (2013) include political and institutional factors among the pillars of sustainability. Political-institutional-governance factors can be classically understood as part of economic sustainability but have recently been highlighted as a separate dimension due to their importance. The use of the institutional-policy dimension as the fourth pillar of sustainability (Pfahl, 2005; Spangenberg, 2002) has become widely accepted within the European Commission and the United Nations, as the Committee on Sustainable Development (CSD) has incorporated institutional indicators into the 1995 indicator framework used to assess the implementation of Agenda 21 (UN, 2001).

Political sustainability means that institutions and governance systems must work properly to achieve sustainability goals. This includes effective and transparent decision-making processes, efficient and equitable allocation of resources, and the development and maintenance of appropriate legal and regulatory frameworks that contribute to environmental protection, social justice and other sustainability goals. Policy processes and decision-making should involve different stakeholders and social groups. Political sustainability balances the reconciliation of different interests and the needs of present and future generations, and aims to ensure that policy and governance move towards sustainable development. This 'pillar' is therefore important because policy and governance fundamentally determine how we use and manage social and natural resources.

However, it should be made clear that the political dimension of sustainability and governance, although strongly interlinked and overlapping, are not the same. Governance is a broader concept that encompasses the political system, institutions, legal frameworks, decision-making processes and the ways in which a country or regional entity, such as a city, is governed. The political dimension of sustainability, however, is a specific aspect of governance that aims to ensure that the political system and government institutions follow sustainability goals and principles and apply them to the sustainable development of society and the environment. Political systems and institutions create rules, laws and policies that promote sustainability. For example, governments should develop sustainability strategies, promote environmentally friendly measures, encourage the use of renewable energy sources and participate in global efforts to combat climate change. So governance is the toolkit we use to achieve sustainability goals, and it involves coordinating political, economic, social and environmental factors to achieve balance and sustainability. The political dimension of sustainability is therefore part of governance and aims to ensure that policy systems, institutions and decision-making processes are responsive to the needs and interests of present and future generations.

While some research treats politics and local governance separately in the interpretation of sustainability (Zen et al., 2012), others (Burford et al., 2013; Ortúzar, 2019) include good governance in the fourth pillar, the political-institutional dimension. Burford et al. (2013) not only consider politics and governance as pillars of sustainability, but also identify culture as a separate dimension, as mentioned earlier, to create a five-dimensional model of sustainability.

Technological sustainability

Although the standard concept of sustainability includes three main dimensions, nowadays other dimensions are added, including technological sustainability. Technological sustainability is also considered by most approaches as part of the economic pillar, but today technology has an impact on all three classical pillars, with Raihan & Tuspekova (2022) and Lopolito et al. (2022) identifying it as a separate factor.

This is because technology supports environmental sustainability in different ways by promoting sustainable resource use, supporting the development and deployment of environmentally friendly technologies, and the more efficient use of renewable resources such as solar, wind, hydropower and geothermal energy. Energy production based on these technologies reduces the use of fossil fuels and carbon dioxide emissions, contributing to the fight against climate change (Schoor et al., 2023). The technology also enables energy efficiency (Horváth et al., 2023) in buildings, industry and transport. By stimulating the development of digital technology, smart home systems and efficient manufacturing processes will help to reduce energy and resource demand. Innovative

technologies support the circular economy (Mattiasich-Szokoli & Szóka, 2022) and sustainable manufacturing using green technologies, consideration of the whole life cycle of the product, and sustainable value creation (Vacchi et al., 2021).

Innovative technologies can also help to manage waste in a more environmentally friendly way, recycling plastics and other waste and reducing the amount of waste generated. In addition, technology can support greener and more sustainable transport by promoting electric and other sustainable transport solutions, reducing air pollution and emissions. Information technology and big data analysis will enable a better understanding of environmental problems and more effective planning and implementation of measures to combat climate change. Innovative technology and related developments are therefore key to promoting sustainable environmental practices and achieving environmental sustainability. In addition to environmental sustainability, technological sustainability also supports the achievement of social sustainability through information and communication systems, as their development and accessibility improves people's quality of life, healthcare, education and access to information. Online educational platforms and digital tools also help to educate for sustainability and raise awareness in society. Technological innovation and development also contribute to sustainable economic development. Smart and green technologies, digitalisation and more efficient production enhance the sustainability of the economy. Technological sustainability is therefore a comprehensive approach in the overall context of sustainability, as it has a fundamentally positive impact on the three classical pillars of sustainability (economy, society, environment), helping to balance them and achieve the sustainability goals.

Digitalisation is an important element of technological sustainability. Technological sustainability seeks to use the benefits of technology to support and promote sustainability in the ecological, economic and social dimensions. Integrated and smart technology solutions are key to achieving sustainability goals, as technology contributes to all pillars of sustainability. The appropriate and responsible use of technology is the basis for achieving and maintaining sustainability goals for future generations. The key importance of digitalisation is emphasised in a number of studies (Bereczk et al., 2022; Lipták et al., 2023), by the European Commission in its Decision that Europe should exploit the potential of the digital switchover, i.e. 'to deploy and invest in digital technologies that put sustainability at their core and contribute to a sustainable, circular and climate-neutral economy and society in line with the European Green Deal' (EU, 2022). 'Digital technologies such as artificial intelligence, 5G, cloud computing, edge networking and the Internet of Things can accelerate and maximise the impact of climate and environmental policies. Digitalisation also offers new opportunities for remote monitoring of air and water pollution, and for monitoring and optimising the use of energy and natural resources' (European Commission, 2019). The role of digitalisation in achieving sustainability is reinforced by the European Commission's Communication on 'Aligning the green and digital transition in the new geopolitical environment' (EESC, 2023).

Innovation, technological progress and the integrated and judicious use of digitalisation are key to achieving sustainability goals. The appropriate use of technology helps to reduce environmental pressures, optimise resource use and contribute to global sustainability goals. For this reason, some studies include human sustainability (Glenn, 2023) or cultural sustainability (Schoor et al,. 2023) among the pillars of sustainability, alongside technological sustainability. This is because the way technology is used to achieve sustainability depends on the values, perceptions and ultimately the culture associated with sustainability.

Corporate sustainability

Nasrollahi et al. (2020) assess sustainability along five dimensions, adding technology to the classic three aspects of environment, society and economy, and introducing the importance of industry as a new factor. Obviously, in a different approach, it is part of the economic pillar, while technology is seen as a component of industry. Closely related to this is a research conducted in Australia on the understanding of sustainability (Greenland et al., 2022). A survey of business and law students was conducted and evaluated using factor analysis, and a five-pillar model of sustainability was developed. This model includes the pillars of the traditional three- and four-pillar conceptual model of sustainable development, plus a new fifth pillar, corporate sustainability. The research identified a hierarchy of pillars in order of perceived importance: social, political, environmental, corporate and economic. Corporate sustainability is defined as the sustainability of the company, as defined by Kantabutra & Ketprapakorn (2020) went beyond the concept of CSR to define it as the management and governance approach that a company adopts to grow profitably while achieving social, environmental and economic outcomes. In other words, corporate sustainability is understood as more than CSR. For more details on the different interpretations of corporate sustainability, see Hernádi (2012).

Corporate sustainability is based on principles and practices that aim to balance the impacts generated by companies with economic growth, social responsibility and environmental sustainability. It is important that companies do not only focus on maximising profits, but also take into account social and environmental impacts.

Corporate sustainability includes, among others:

1. *Environmental sustainability in business*: Companies should be responsible for the natural environment, minimise harmful environmental impacts and contribute to sustainable environmental practices such as promoting environmental protection, sustainable product design and green technologies and innovations.
2. *Social sustainability in business*: Companies must take responsibility for the well-being of people, communities and workers. This includes ethical business practices, respect for human rights and a decent working environment, and reasonable pay for employees. It also means supporting local communities through philanthropy.
3. *Economic sustainability in business*: Companies must strive for sustainable economic growth and financial stability. This includes long-term planning, efficient use of resources and sustainability of the business model.

Corporate sustainability is therefore an important dimension of sustainability and contributes to sustainable development within the economic sector. Companies need to balance their economic interests with their social and environmental responsibilities to create a more sustainable future.

THE 5 P MODELS OF SUSTAINABILITY

At the UN summit in September 2015, the world's 193 member states pledged to end poverty, fight injustice and tackle climate change. The 2030 Agenda (United Nations, 2015) was adopted, setting out sustainability goals in 17 areas.

These are as follows (Figure 1).

Source: UN website

Figure 1. Sustainable development goals

The 17 goals have been broken down into 169 sub-targets and 231 specific indicators that serve as a 'compass' for countries, regions, organisations and companies on how to achieve planetary protection, social and economic well-being. The 17 goals are divided by the UN into five so-called pillars, covering the three classical dimensions of sustainability: social, economic and environmental. Each of the five pillars begins with a letter P in English, as people, prosperity, planet, peace, and partnership (United Nations, 2015). This partially corresponds to the social (people), economic (prosperity) and environmental (planet) aspects, with the exception of the last two areas, peace and partnership, which are a separate group because they are highly relevant to all the other goals (Lekagul et al., 2022).

The 5 P models of sustainability (United Nations, 2015):

1. *People:* 'People' represents the human dimension of sustainability, which is linked to society. This includes people's well-being, health care, education and equality. This first 'P' dimension focuses on ending poverty and hunger, ensuring equal opportunities for all people and that they live in dignity and a healthy environment. The first five goals of the SDGs fall under the category of people, which emphasise the importance of livelihoods for all (Carlsen, 2023). The first two goals address basic subsistence, while the third and fourth goals set targets in the areas of health, well-being and education. And Goal 5 addresses one of the key societal issues, equal opportunities for women.
2. *Planet:* The second 'P' focuses on protecting the planet from destruction, including through sustainable consumption and production, sustainable management of natural resources and urgent action to tackle climate change so that it can meet the needs of present and future generations. The challenges facing our planet are presented in Goal 6, 12, 13, 14 and 15. Goal 6 says that all people should have access to clean and safe water and sanitation. As we know, water management is critical to saving the world and our planet, as all life forms need water to survive. Goal 6, Goal 12 address the strengthening of adequate and proportionate production and consumption. Goals 13, 14, 15 directly address the protection of the ecosystems around us and the climate, which are key to the survival of our planet.
3. *Prosperity:* The third 'P' focuses on a life of well-being for all, and on economic, social and technological development in harmony with nature. Prosperity represents the economic dimension of sustainability, focusing on sustainable economic growth, job creation and income distribution. Goal 7 aims at achieving an appropriate and sustainable balance in energy use by reducing the negative impacts of overconsumption, as we cannot save the planet without addressing energy use. In addition, Goals 8, 9, 10 and 11 are also included, covering decent work, industry, innovation, infrastructure, reducing inequalities, sustainable cities and communities.
4. *Peace:* The fourth 'P' calls for peaceful, just and inclusive societies, free from fear and violence, because, as it affirms, there can be no sustainable development without peace, and no peace without sustainable development. Goal 16 therefore shows that the international community must unite to promote and protect peace worldwide.
5. *Partnership:* The fifth 'P' refers to partnerships, cooperation and global collaboration to achieve sustainable development (supporting the implementation of the 2030 Agenda), with a special focus on the needs of the poorest and most vulnerable, involving all countries, all stakeholders and all people. That is, it enables the sharing of resources, knowledge and experience and collective action to achieve sustainability. In other words, SDG 17 supports the achievement of the other 16 SDGs by involving all actors in society.

This model organises the pursuit of sustainable development around five aspects, such as people, economic development, environmental preservation, peace and partnership, which it defines as the pillars of sustainability. In the classical understanding of sustainability, these 5 P's can be mapped as follows. The human pillar is the social aspect, the planet is the natural environment, prosperity is the economic aspect (Lekagul et al., 2022), peace is defined by the UN as good governance (UN DESA, 2019), while partnership is the system-wide aspect, involving and collaborating at global, regional, and national levels to achieve sustainability.

Multidimensional models of sustainability integrating the above factors are presented in Table 1.

Table 1

Multidimensional models of sustainability -

Factors of sustainability	Model of sustainability	Authors
Classical sustainability	Environmental + social + ecological sustainability	Brundtland (1987)
Cultural sustainability	Environmental + social + ecological + cultural sustainability	UCLG (2010), Loach et al. (2017) Sabatini 2019, Pop et al. (2019)
Human sustainability	Environmental + social + ecological + human sustainability	Suri (2023)
	Environmental + social + ecological + human + cultural sustainability	Simon (2023)
Political/institutional/ governance sustainability	Environmental + social + ecological + political/institutional sustainability	UN 2001, Spangenberg (2002), Pfahl (2005), Vázquez et al. (2015), Grindheim et al. (2019)
	Environmental + social/cultural + ecological + political/institutional sustainability	Ortúzar (2019)
	Environmental + social + ecological + political + institutional sustainability	Zen et al. (2012)
	Environmental + social + ecological + cultural + political/institutional sustainability	Burford et al. (2013)
Technological sustainability	Environmental + social + ecological + technological sustainability	Raihan & Tuspekova (2022), Lopolito et al. (2022)
	Environmental + social + ecological + technological + human sustainability	Glenn (2023)
	Environmental + social + ecological + technological + cultural sustainability	Schoor et al. (2023)
Corporate sustainability	Environmental + social + ecological + technological + industrial sustainability	Nasrollahi et al. (2020)
	Environmental + social + ecological + political + corporate sustainability	Greenland et al. (2022)
Peace and partnership	The 5 P model of sustainability (people, planet, prosperity, peace, partnership) → environmental + social + ecological sustainability + governance + partnership	United Nations (2015) UN DESA (2019) Lekagul et al. (2022)

Source: own editing

RESULT AND DISCUSSION

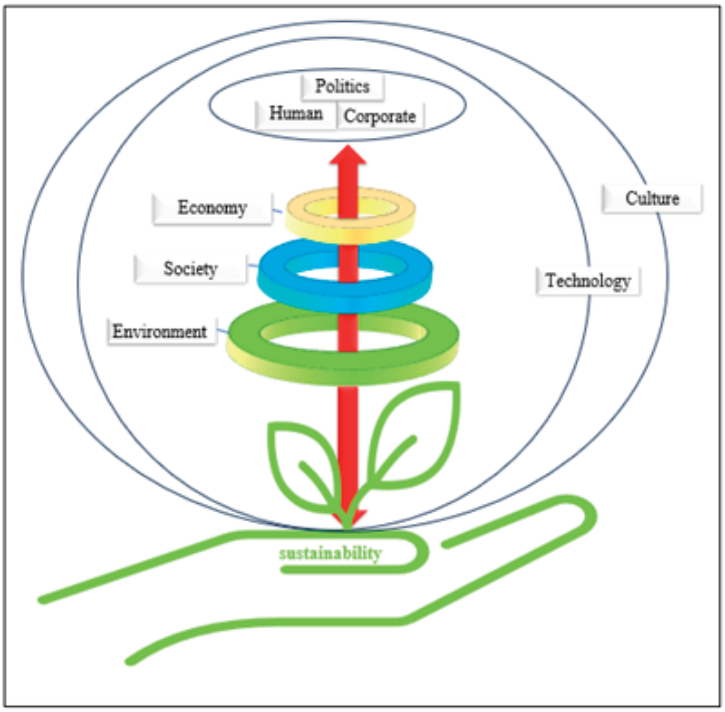
The classical concept of sustainability, which includes economic, social and environmental sustainability, has been complemented in recent years by other factors relevant to sustainability. Sustainability therefore not only has the three classical dimensions, but also human, cultural, political-institutional-governance, technological and corporate sustainability. These can be understood as separate but overarching aspects of sustainability. There is a wealth of research and arguments as to why these factors play a particularly important role in achieving sustainability goals. It is therefore fair to say that each of these dimensions has a place in a complex model of sustainability. Of course, these dimensions are not new in the sense that they have always been part of the three classical pillars, but what is new is that the above-mentioned approaches attribute to these aspects a separate and independent impact in the implementation of sustainability.

Therefore, a complex model of sustainability along the eight aspects mentioned above can be described as follows.

The basic elements of sustainability are culture and technology, which permeate and influence all dimensions of sustainability, including economic, social and environmental sustainability. These classical dimensions of sustainability are interlinked and interact. In addition, political/governmental, corporate and human sustainability add new levels of understanding and implementation of sustainability. The importance of these dimensions and their role in the context of sustainability can be summarised as follows:

1. *Cultural and technological sustainability:*
    - *Cultural sustainability***:** Culture determines people's values, attitudes towards the environment and their relationships with each other. Values and habits shape sustainable lifestyles and consumption, and the way we treat natural resources. This dimension focuses on the preservation, promotion and development of human culture, traditions, identities and cultural heritage.
    - *Technological sustainability:* Technology enables innovation and more efficient use of resources, helping to develop sustainable solutions to achieve sustainability goals such as energy saving, recycling, smart waits and digitalisation.
2. *Economic, social and environmental sustainability:*
    - *Economic sustainability* means sustainable economic development and efficient use of resources.
    - *Social sustainability* focuses on people's well-being and social justice.
    - *Environmental sustainability* focuses on preserving natural resources, maintaining ecological balance and combating climate change.
3. *Human, political/governance and corporate sustainability:*
    - *Human sustainability:* Maintaining and improving people's well-being is the key to sustainability. Education, health and equality are important elements of this dimension, as well as ensuring that people can live a fair and fulfilling life now and in the future.
    - *Political/institutional sustainability good governance:* The policy dimension focuses on the analysis and development of policies, institutions and decision-making processes related to sustainability. The development of effective policy frameworks is essential to achieve sustainability goals.
    - *Corporate sustainability:* Business and other organisations must take responsibility for society and the environment and promote ethical and sustainable business. Sustainability should also be part of the corporate culture and business model.

Each dimension is partly interdependent and together they form the whole of sustainability. An integrated approach and a balance between the dimensions are important to fully understand and achieve the sustainability goals. The following figure illustrates the integrated model of sustainability and helps to understand the place of the sustainability dimensions and how they interact with each other (Figure 2).



Source: own editing

Figure 2. Eight dimensions of sustainability

The dimensions of sustainability presented in this study fit perfectly with the classical model of sustainability, but only complement and fine-tune it. These factors have been given special attention because the more countries, organisations and individuals commit themselves to the ideal of sustainability, the more they integrate it into their actions and behaviour in their decision-making, and the more they see the additional means without which they cannot achieve the goals set by the UN and without which they cannot achieve full sustainability. Thus, the integrated model of sustainability, an eight-factor model, in which one 'axis' is the classic three aspects of sustainability (strong interpretation), the environment, which includes society, which includes the economy, and the other 'axis' is the partners (partnership in the 5P model), i.e. all those who influence the achievement of economic, social and environmental goals in their decisions. These must contribute to sustainability, both individually and collectively, and are affected by the classical dimensions, both individually and collectively. These 'partners' are at the level of countries (political sustainability), companies (corporate sustainability) and individuals (human sustainability). And culture and technology permeate and support the whole sustainability framework, as they are both the basis and one of the tools for achieving sustainability. Culture is also understood by international organisations as a distinct aspect of the dimensions of sustainability, and technology and with it digitalisation has been given a prominent place in the EU's objectives, claiming that without it we will never achieve full sustainability. Levels of cooperation (individual, organisational, governmental), which are effectively also levels of implementation, are also undoubtedly essential elements of sustainability efforts.

CONCLUSION

In addition to the classic three pillars of sustainability, which include economic, social and environmental sustainability, in recent years other areas have been identified in terms of sustainability. Therefore, the study provides an overview of the other dimensions of sustainability based on the literature and practice, presenting their role and impact in the realization of classical sustainability goals. The article also maps which factors expand the standard model of sustainability into four, five or even more pillar concepts. Based on this, it identifies five additional areas, which it combines together with classic sustainability aspects in an integrated model. Thus, it develops the three-dimensional standard model of sustainability into an extended eight-dimensional model.

This points the way forward for further research, as the achievement of sustainability goals needs to be continuously measured and evaluated. Sustainability performance can be assessed at global, national, corporate and individual levels. There are efforts to do so, e.g. at the corporate level through various sustainability reports, e.g. the EU's taxonomy regulation facilitates the assessment and comparison of companies' sustainability efforts. This, in turn, may require looking at the additional factors mentioned above when interpreting sustainability at the company level, which may also lead to a refinement of the term ESG as it is used today.

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Sectoral Differences in Emission Reduction in Hungary

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SUMMARY

The European Union sets ambitious environmental and climate protection targets. The Emissions Trading System (ETS), launched in 2005, is seen as one of the main tools for reducing emissions. The system is currently in its 4th phase of operation. This article looks at the emission reductions achieved by 114 Hungarian installations of 84 companies covered by the EU ETS during the 17 years of operation of the ETS. The analysis builds on verified emissions data from the Union Registry between 2008 and 2022. The present study provides a descriptive picture of the CO2 emission results of these companies. The methodology is limited to a simplified presentation of time-series results. The analysis shows that the installations have achieved an overall reduction in CO2 emissions of around 37% from 2005 to 2022, with the most significant contribution from companies in the energy sector. Installations in the energy sector have almost halved their total verified CO2 emissions, while manufacturing has reduced emissions by only 3 percent.

Keywords: decarbonisation, CO2 reduction, EU ETS
Journal of Economic Literature (JEL) codes: Q54, Q50
DOI: https://doi.org/10.18096/TMP.2023.02.09

INTRODUCTION

Since the turn of the millennium, the European Union has been setting increasingly ambitious environmental and climate protection targets. The current cornerstones are shaped by achieving the objectives agreed upon in the 2015 Paris Agreement. The Paris Agreement is one of the most significant agreements in the world, with countries agreeing to limit the global average annual temperature increase to below two °C above pre-industrial levels and to pursue efforts to reach 1.5°C. In line with this objective, the EU has set itself the objective of reducing CO2 emissions by 55% by 2030 compared to 1990 and achieving climate neutrality by 2050 (ET, 2023a). Hungary made progress in emission reduction until the 2010s, but experts warned about the potential threats of the Hungarian industrialisation strategy to the emission targets of the country (Bartha & Tóthné Szita, 2015a, 2015b).

The emissions trading scheme launched in 2005 is considered one of the main tools for reducing emissions. EU-wide CO2 emissions in the sectors covered by the ETS decreased by 41% between 2005 and 2020. Currently, the system is in its 4th phase of operation. The conditions of the scheme have become stricter during each trading period. However, new financial resources have been opened up under the ETS to support investments in energy efficiency and climate protection. The reform of the system is part of the Fit for 55 package. In EU ETS sectors, a 62% reduction is planned for 2030 instead of the previous GHG reduction target of 43% (ET, 2023b).

The research question of this article is: How many emission reductions have Hungarian installations covered by the EU ETS achieved during the 17 years of system operation so far? How has emission reduction developed in each sector of the national economy?

Section 1 of the study contains a literature summary. Section 2 presents a summary of the data collection and methodology. Section 3 describes the results of the analysis. Subsection 3.1 presents the aggregated CO2 reduction results of 114 installations of the 84 companies examined, while Subsection 3.2 presents the results achieved by sectors. Chapter 4 contains the main conclusions.

LITERATURE REVIEW

In recent decades, aspects of corporate social responsibility and corporate sustainability have come into the focus of scientific research with increasing intensity (see, for example, Hódiné, 2022; Piskóti &

Hajdú, 2013). The analysis and approach to environmental impacts are relevant for this study. Economic theories also deal with these questions more and more often. Pearce and Atkinson (cited in Kerekes 2007) distinguish between weak and strong sustainability based on three types of capital (artificial capital, human capital, and natural capital). Weak sustainability starts from the assumption of neoclassical economics that capital goods are infinitely interchangeable. There is a substitutability between natural and artificial capital in the case of weak sustainability. In the interpretation of strong sustainability, there is no possibility of substitution between capital elements, i.e. natural and artificial capital complement each other but do not replace each other. From an economic point of view, only achieving weak sustainability appears as a possible option; the economy cannot meet strong sustainability criteria, but at most, an attempt can be made to approximate it (Kerekes, 2007). In economics, environmental economics and ecological economics deal with the management of environmental problems. The topic of this article is closer to the principles of environmental economics, which is based on the principles of neo-classical economics and approaches environmental problems based on the principles of weak sustainability. It starts from the assumption that environmental problems can be solved with the tools of the economy (Kiss & Pál, 2006).

Environmental and climate pollution caused by industrial facilities can be identified as negative production externalities for society. Negative externalities mean that the company, through its activities, unintentionally creates an adverse external economic impact that reduces well-being (Kiss & Pál, 2006; Kerekes, 2007). The idea of dealing with external economic effects (externalities), i.e. the theory of internalization of externalities, can be linked to the name of the English economist Pigou. The essence is that adverse external economic effects caused by companies, such as the costs caused by pollution, must be internalized for the polluter. Related to this is the emergence of „the polluter pays" principle in environmental measures, first introduced by the OECD in 1972. Since then, it has been used more and more widely, for example, as one of the basic principles of EU environmental policy. By applying the principle, polluters are encouraged to avoid or reduce environmental damage and, where they cause pollution, to bear the financial burden thereof (European Court of Auditors, 2021).

There are various measures to optimise social damage resulting from pollution (i.e. internalisation of externalities), depending on whether the evolution of the price or quantity of pollution is determined by state regulation or market mechanisms. Based on this, Kocsis (2002) distinguishes 4 cases, which he depicts in the pollution control matrix (Table 1). The present study does not aim to present the matrix in detail. However, one means of reducing environmental pollution is the so-called emission rights market, where emission trading schemes, including the EU ETS system, can be classified. In the case of these systems, achieving the objectives set is formed through a combination of state regulation and market mechanisms.

Table 1

Pollution control matrix

		The AMOUNT of pollution is determined by the…	
		STATE	MARKET
The PRICE of pollution is determined by the…	STATE	Direct control devices (e.g. command and control, ban, norm, punishment)	Pigou (e.g. taxes, subsidies)
	MARKET	emission allowances market (e.g. emissions trading scheme)	Coase (e.g. market solutions)

Source: Kocsis (2002)

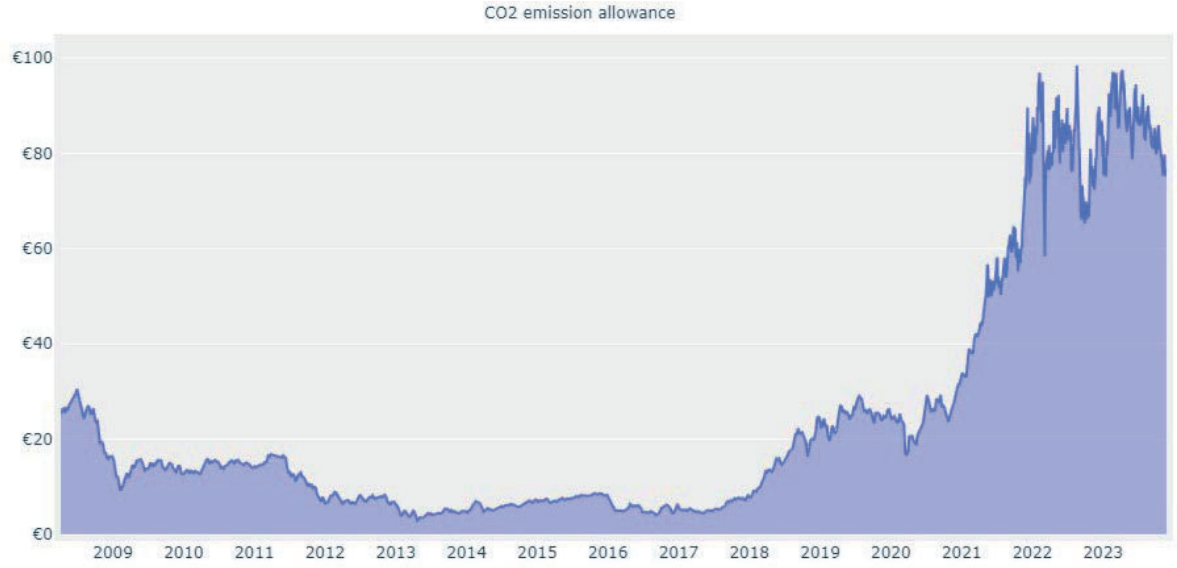
This study aims to present in a simple descriptive way the CO2 reduction results achieved so far by Hungarian installations covered by the EU ETS. Therefore, this chapter briefly presents the operation and main characteristics of the system.

The European Union Emissions Trading System (EU ETS) was launched in 2005 under Directive 2003/87/EC of the European Union. This system operates based on a cap-and-trade mechanism, which capped greenhouse gas emissions. Emission allowances, known as quotas, accompany this quantity. A quota entitles its owner to emit one tonne of CO2 (or CO2 equivalent). Companies must be able to account for a quota volume corresponding to tonnes of their emissions each year. The facilities covered by the scheme receive the necessary quota volume through free allocation, auction or trading (stock exchange or over-the-counter) and can sell their excess quotas. If the company does not have sufficient quotas, it must consider covering the deficit by purchasing quotas or taking measures to reduce

emissions. The operation of the system is divided into trading periods. The first phase covered 2005-2007, the second phase covered 2008-2012 and the third phase covered 2013-2020. We are in the fourth trading phase, valid for 2021-2030 (Nyikos, 2022; EC, 2022).

The system's success (i.e. its contribution to achieving emission reduction targets) depends on several factors. The most essential cornerstones are:

1. The total quota quantity allowed. The system helps meet emission reduction targets by reducing the emission ceiling, i.e. the maximum allowable emissions, year on year.
2. Allocation of quotas. Installations received the initial quota volume through free allocation in the first two phases. From the third stage onwards, the gradual reduction of the quota allocated free of charge began. In addition to free quota allocation, companies increasingly receive their initial quota volume through auctions (except in sectors subject to carbon leakage, where free quota allocation still applies).
3. The price of quotas. The price of quotas is fundamentally determined by supply and demand. In the case of oversupply, the price of quotas decreases, while in the case of overdemand, it rises. If quota prices are too low, the original objective of the system will be undermined, as it will be cheaper for companies to buy the necessary amount of quota than to take measures to reduce emissions. Over-quotas can be avoided by reducing the emission ceiling and creating a market stability reserve to regulate the amount of quotas in circulation. Figure 1 shows the evolution of quota prices from 2008 to the present. From 2018 onwards, the price of CO2 quotas started to rise, and after a short decrease due to COVID-19 (2020), the price of CO2 quotas increased rapidly.



Source: Carbon Price Viewer. https://sandbag.be/carbon-price-viewer/

Figure 1. Evolution of the CO2 quota price from 2008 to 2023

Based on the experience of the first two trading periods, the system was gradually tightened from the third trading period onwards. As part of the Fit for 55 package, the system has been reformed to enable the EU to meet its Paris Agreement commitments by 2030 and 2050. The EU ETS is considered the main instrument of the EU's climate protection policy, which can best help achieve emission reduction ambitions through its stimulating effect. Several studies examine the effects of the ETS system(s). So, for example, Bolat et al. (2023) examined the macroeconomic carbon rebound effect of the EU ETS, and their results show that the positive economic spillover effect of the ETS may hamper efforts to meet climate goals (Bolat et al., 2023).

In addition to analysing macro-level results, it is worth examining the effects of the system at the sectoral and company levels. By pricing CO2 emissions, the ETS system can generate costs for companies or revenue by selling unnecessary quotas. This can encourage investments in energy efficiency and low-carbon technologies, affecting companies' competitiveness, profitability and productivity. Yu et al. (2022) examined the evolution of emission reductions and financial performance in connection with the pilot introduction of the Chinese ETS. Their investigations focused on

whether the companies concerned could improve their financial performance by taking responsibility for emission reductions, a win-win combination of environmental and economic outcomes. The results show that the introduction of the pilot ETS improves the financial performance of the firms examined (Yu et al., 2022). Koch and Themann (2022) examined the impact of the EU ETS on companies' productivity. They conclude that the impact of the ETS on productivity depends on the company's technological development. It increases productivity for technologically advanced companies but slows down the catch-up of lagging companies (Koch & Themann, 2022). Purcel (2023) analysed the impact of the EU ETS on environmental spending. A positive effect was demonstrated in the short term, but no statistically significant correlation was found for long-term investment decisions. Their results conclude that the EU ETS is a viable instrument that is a critical incentive for companies to undertake environmental spending (Purcel, 2023). It is essential to analyse sectors subject to carbon leakage. This is the process by which companies relocate their activities to a third country to escape the scope of the EU ETS. Lagouvardou and Psaraftis (2022) looked at the issue from the perspective of the maritime sector, as in 2021, it was proposed to include this sector in the ETS's scope. Their analysis showed that even with relatively low quota prices, there is a real risk of relocation of loading nodes (Lagouvardou & Psaraftis, 2022).

The ETS focuses on achieving decarbonisation targets. It brings together the sectors that contribute most to CO2 emissions. Thus, most installations covered by the EU ETS are in the energy sector or energy-intensive sectors (EC, 2022). In addition to the conditions of the EU ETS and the general global economic environment, the sectoral specificities will largely determine the results that can be achieved.

The simple question posed by this study is how much emission reductions have been achieved between 2005 and 2022 by the Hungarian installations covered by the EU ETS. How has the emission reduction been developed by sectors? Investigation of the causes and means is out of the aim of this study; this may be the subject of further research.

DATA AND METHODS

This study briefly overviews the emission reduction results of Hungarian installations covered by the EU-ETS from the start of the system's operation to the present day.

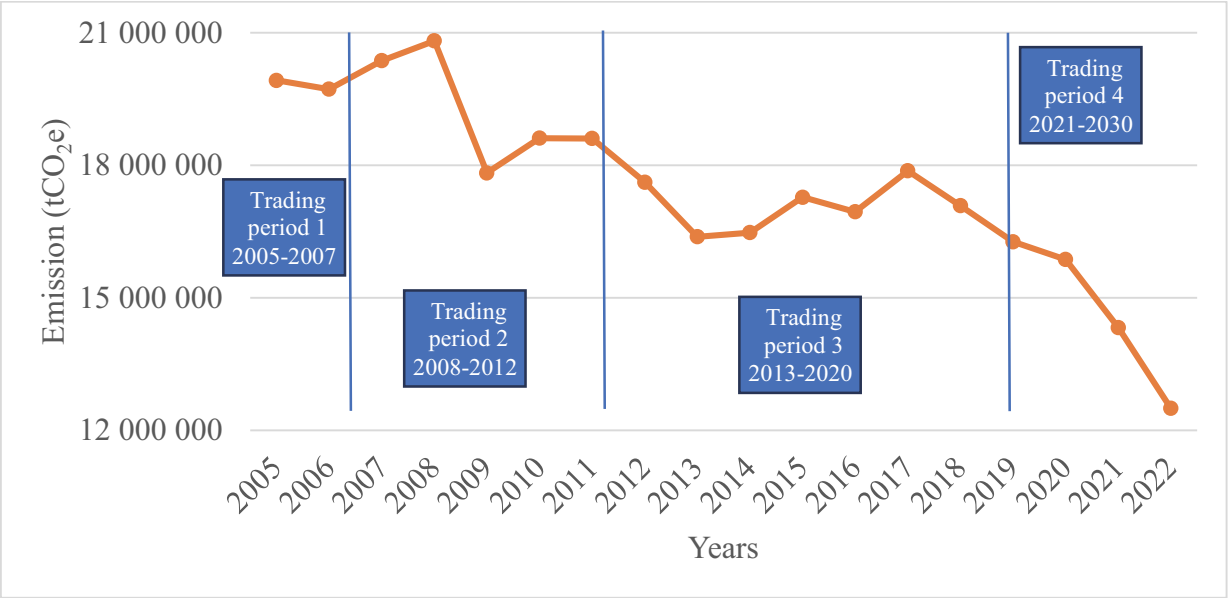
"Since the start of Phase 4 in 2021, the EU ETS has covered 27 EU Member States and European Free Trade Association (EFTA) countries such as Iceland, Liechtenstein and Norway, and power plants in Northern Ireland. The EU ETS regulates emissions from a total of 8 757 electricity and heat generating power plants and production facilities (stationary installations), as well as 371 aircraft operators flying between airports in the European Economic Area (EEA) and from the EEA to Switzerland and the UK. These installations represent around 36% of total EU emissions." (EC, 2022, pp. 4-5). The sectors concerned are, therefore, mainly electricity and heat generation, energy-intensive sectors and aviation. Installations in these sectors are covered if their emissions reach a certain threshold.

In compiling the database for the analysis, this study relied on data from the Union Registry, an online database containing the accounts of operators of fixed installations and aircraft (since January 2012). In order to participate in the EU ETS, companies need to open an account in the EU Registry. This registry ensures accurate accounting of allowances issued under the EU Emissions Trading System (EU ETS) (EC, 2023). This database collected the annual verified CO2 emissions of the examined installations. The Hungarian facilities covered by the EU-ETS were identified in the first step. The list of facilities published in 2023 (EC, 2023a) includes 313 facilities of 210 companies in Hungary. Excluding companies whose licenses have been revoked, 190 installations from 140 companies are listed as active.

From now on, facilities with active status were examined in this study. Collecting verified emission data for installations with active status followed this step. The EC (2023b) database provided the basis for this, which contains verified emissions data from 2008 to 2022. The data from 2005-2007 (checking their consistency with the EU Register) were taken from a database published by Mura et al. (2021a,b). Given that the study aims to present the results from the beginning of the scheme to the present, the analysis will be further limited to those installations for which emissions data are continuously available in 2005-2022. It, therefore, does not cover installations that became covered by the scheme after 2005 or that have since ceased to be covered. In this way, the analyzed database is ultimately based on emissions data from 114 installations of 84 companies from 2005-2022. The present study only provides a descriptive picture of the CO2 emission results of domestic installations covered by the EU ETS. Thus, the methodology is limited to a simplified presentation of time-series results.

RESULTS

This section presents the results of the analysis. Subsection 3.1 presents the aggregated CO2 reduction results for 114 installations of the 84 companies analysed, while subsection 3.2 shows the results by sector.



* n=84 companies, 114 installations; the filtered database includes only those companies and installations that were continuously covered by EU ETS between 2005 and 2022, and their emissions data are available

Source: own calculation based on EC (2023a), EC (2023b) and Mura et al. (2021)

Figure 2. Total emissions of Hungarian installations covered by the EU ETS in the period 2005-2022*

Results based on aggregated data from installations examined

114 facilities of the 84 companies examined emitted a total of about 314.5 million tCO2eq into the atmosphere during the 17 years of operation of the system (2005-2022). From 2005 to 2022, their total emissions decreased from 19.92 million to 12.5 million tCO2eq, i.e. by 37.2 per cent (Figure 2).

The EU ETS is currently in phase 4. In Figure 2, the blue lines indicate the closing year of each trading period (except for Section 4). Chart 2 and Table 2 show how the aggregate output of the companies under review changed over trading periods. In the first phase, there was still an increase in emissions figures. From 2008, there was a marked decrease, which, in addition to the more efficient operation of the ETS system, is also related to the consequences of the 2008 global economic crisis. In the first half of the post-Kyoto phase (phase 3), there was an upward trend; after 2017, the aggregate emissions of domestic facilities decreased. The tightening of climate protection ambitions and the conditions of the ETS system can partly explain this reduction. It can be seen that entering stage 4, we see a sharp decrease in the first two years. In addition to the further tightening of the ETS system, the COVID-19 pandemic, rising energy prices, and the economic consequences of the Russia-Ukraine war are the reasons for this significant decline. Output increased in 18 companies compared to 2005. Data from other companies shows a decline.

Table 2

Changes in emissions from installations covered by the EU ETS in Hungary over the trading periods of the scheme

Trading periods	Period	Number of years	Change in total emissions from all installations compared to the last year of the previous period (%)	Annual average of the change in total emissions of the examined installations (%)
Phase 1	2005-2007	2	+2.25	+1.12
Phase 2	2008-2012	5	-13.51	-2.7
Phase 3	2013-2020	8	-9.93	-1.24
Phase 4	2021-2030	2*	-21.2	-10.1

*number of years so far

**n=84 companies, 114 installations; the filtered database includes only those companies and installations that were continuously covered by EU ETS between 2005 and 2022, and their emissions data are available

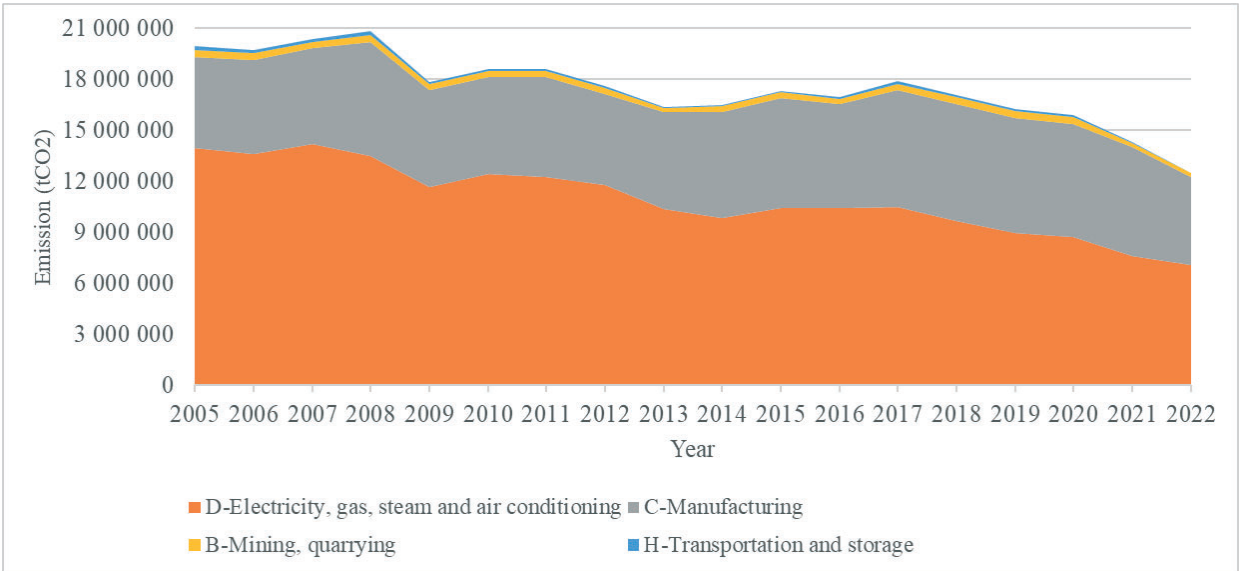
Source: own calculation based on EC (2023a), EC (2023b) and Mura et al. (2021)

Results by sector

Of the 114 installations of the 84 companies examined, 52 belong to the energy sector (predominantly in the electricity generation and district heating sectors). 53 are in the manufacturing sector, from which 25 installations are classified in the non-metallic mineral products manufacturing sector. The other nine facilities operate in the field of mining and transportation.

Figure 3 shows that the dominant part of the emissions of the Hungarian installations covered by the ETS comprises companies belonging to Section D-Electricity, gas, steam and air conditioning. The second largest share of CO2 emissions can be attributed to C-Manufacturing companies. Compared to these, B-Mining, quarrying and H-Transportation and storage appear negligible (with a total share of about 2-3 percent each year). What is noteworthy, however, is the transformation in the emissions structure. While in 2005, 70 percent of the total emissions of the 84 companies examined were emitted by companies of the Electricity, Gas, Steam and Air Conditioning sector, and about 27 percent were accounted for by the manufacturing industry, in 2022, the share of companies of the Electricity, Gas, Steam and Air Conditioning Supply Section in total emission decreased to 56.5 percent, while the share of manufacturing industry increased to 41.3 percent.

This structural change is because the Electricity, gas, steam and air conditioning supply section reduced its emissions more significantly (by about 49.4 percent) during the period under review than the manufacturing industry, where only a 3.17 percent decrease in emissions can be observed. The output of companies belonging to sections B and H also decreased. Thus, the energy sector contributed the most to the 37.2 percent reduction in emissions of the 84 companies.



* n=84 companies, 114 installations; the filtered database includes only those companies and installations that were continuously covered by EU ETS between 2005 and 2022, and their emissions data are available

Source: own calculation based on EC (2023a), EC (2023b) and Mura et al. (2021)

Figure 3. Emissions of Hungarian installations covered by the EU ETS broken down by activity in the period 2005-2022*

Based on 2022 data, 73 installations belonging to 8 sectors account for 90 percent of emissions. In the first place are 13 installations of electricity generation (NACE 35.11), which account for 39.4 percent of 2022 emissions. Typically, these are power plants. These facilities reduced their emissions by about 50.6 percent from 2005 to 2022. Power plants in Hungary still benefit from the derogation clause of Article 10(c) of the EU ETS Directive. Generally, electricity generation can no longer benefit from free quota allocation. However, Article 10c (1) of the EU Emissions Trading Directive (Directive 2003/87/EC) states that 'Member States whose GDP per capita in euro at market prices in 2013 was below 60 % of the Union average may temporarily allocate free allowances to installations generating electricity for modernising, diversifying and sustainably transforming the energy sector. The investments supported shall consistently contribute to the transition

to a safe and sustainable low-carbon economy, the goals set out in the Union's 2030 climate and energy policies and the long-term objectives of the Paris Agreement." (EU, 2023, Article 10c, p. 46) The possibility of temporary free allocation also exists in phase 4, subject to stricter conditions. It shall not be mandatory for the Member State to apply it. In addition to Hungary in Phase 4, only Bulgaria and Romania apply Article 10c (EC, 2022).

The Production of electricity sector is followed by 38 installations (district heating suppliers and district heating producers) of the Steam and air conditioning supply sector (NACE 35.30) with a share of 16.6 percent, significantly reducing their emissions by 47 percent during the period. The third largest emitting sector is Manufacture of refined petroleum products (NACE 19.20), where certified emissions have increased by 11.4% over the past 17 years. The other major emitting sectors (about 20 installations) are Manufacture of other organic basic chemicals (NACE 20.14), Manufacture of cement (NACE 23.51), Manufacture of fertilisers and nitrogen compounds (NACE 20.15), Manufacture of basic iron, steel and ferroalloys (NACE 24.10) and Manufacture of bricks, tiles and construction products, in baked clay (NACE 23.32). All but one sector has seen reductions in CO2 emissions. The most significant decrease (60.8 percent) was in the manufacturing sector of basic iron, steel, and ferroalloys (NACE 24.10).

CONCLUSIONS AND RECOMMENDATIONS

In the context of increasingly ambitious energy and climate policy targets, the need for emission reductions is exceptionally high in the sectors that contribute most to climate pollution. As such, the energy and energy-intensive sectors (as well as other ETS sectors) are under increasing pressure from society and regulators to reduce their emissions. The introduction of the EU ETS is a vital tool for climate policy. The present study aimed to show the emission reduction achievements of Hungarian installations covered by the EU ETS between 2005 and 2023 and to identify sectoral differences in the results achieved.

Based on the analysis, the aggregated CO2 emissions of the 114 installations examined have decreased significantly (by 37%) during the 17 years of operation of the EU ETS system so far. The potential for CO2 emission reduction in each sector depends on several factors, with sector-specific factors being the most important. Sectors differ considerably regarding product differentiation, technologies used and geographical concentration. Aggregated emissions from Hungarian energy installations have fallen by around half during the examined period. However, installations in the manufacturing sector have seen a more modest decline (3%).

Further research must be conducted to identify the causes and tools of emission reductions since it does not matter whether the decrease results from efficiency improvements or production declines. The primary goal is to reduce emissions while maintaining (or even increasing) production, which is when we can discuss efficiency gains.

As CO2 emission is determined as a multiplication of the amount of energy used and its emission factor (Takácsné, 2023), the following options for CO2 reduction can be highlighted. Using zero- or low-emission energy sources can be one of the tools of decarbonization. For example, in the case of electricity generation, there is a high potential for a positive transformation of the energy mix and an increasing use of renewables. Policy decisions such as the decision to phase out coal from electricity generation by 2030 (PPCA 2019) or stricter rules for the sector within the ETS (EC 2022) are encouraging this process. The need to reduce CO2 emissions is becoming increasingly visible in the strategies of energy companies. They are progressively shifting their energy mix from fossil fuels towards alternative energy sources and looking for innovative technological solutions (Aastvedt et al. 2021, Jarboui 2021, Latapí et al. 2021, Horváth et al. 2022, RWE 2022, Uniper 2022, etc.)

Another important way of decarbonisation is a shift towards more energy-efficient technologies with lower specific CO2 emissions. The opportunities for technology shift may vary from sector to sector, depending on the degree of technology lock-in. In the steel industry, for example, the shift from the coal-based Blast Furnaces-Basic oxygen Furnaces (BF-BOF) to Electric Arc Furnaces (EAFs) with more favourable energy characteristics or Direct Reduced Iron (DRI) technology represents a breakthrough in energy efficiency (Yu & Tan, 2022; Zhang et al., 2022). In sectors with less potential for renewables, carbon capture and storage technologies can contribute to climate goals (Lee et al., 2022; Horváth et al., 2023).

Analysis of specific indicators (unit of production) and carbon intensity indicators would give a more accurate picture of the results. The absence of specific and other company data can be identified as a research limitation.

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Digital Intensity and Technology Adoption in European Enterprises: Comparative Analysis Using NRI and DESI 2023 Data

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SUMMARY

A number of targets aimed at promoting digital transformation have been set up within the framework of the 2020-2030 Digital Decade. An abundance of scientific research has shown the importance of digital technologies and the impact they have on the competitiveness of businesses. The objective of this study is to conduct a comparative analysis of the digital technology applications used by European Union enterprises in an effort to identify any potential linkages. This study primarily analyses the use of artificial intelligence (AI), cloud services, and Big Data, as well as the current level of digital intensity and skills. In addition, the research evaluates the extent to which the strategy document 2030 Digital Compass of the European Union, which delineated the goals pertaining to technology applications, has been achieved so far. The purpose of this assessment is to provide guidance for the subsequent seven years of the development stage. The evaluation is conducted with data acquired from the Network Readiness Index (NRI) and the Digital Economy and Society Index (DESI) for the year 2022.

Keywords: Big Data, digital economy, digital intensity, digital skills, cloud service, artificial intelligence
Journal of Economic Literature (JEL) codes: M15, O33, Q55
DOI: https://doi.org/10.18096/TMP.2023.02.10

INTRODUCTION

The classic form of digital divide, namely the lack of access to the Internet, as well as computers and smart devices, are almost nowhere to be found nowadays, while new gaps and challenges are emerging, such as data protection and cybersecurity (Bánhidi et al., 2023; Bruno et al., 2011). One of the largest industries, the global information and communication technology (hereinafter ICT) market is projected to reach €6 trillion in 2023. However, the position of the European Union (EU) in the global ecosystem could be significantly improved. The EU's share of the global ICT market revenue has fallen drastically over the past decade, from 21.8% in 2013 to 11.3% in 2022, while the US share has increased from 26.8% to 36%. Currently, the EU relies on foreign countries for digital products, services, infrastructure and intellectual property (European Commission, 2023a). The Digital Economy and Society Index (hereinafter DESI), an annual indicator measuring the development of the digital economy and society, measures EU Member States' progress towards a digital economy and society based on Eurostat data and specialist studies. The four main dimensions are Human Capital, Internet Access, Integration of Digital Technology and Digital Public Services, which are key measurement and benchmarking tools in the implementation of the European Commission's Digital Decade 2030 strategic programme. DESI helps countries to identify strengths and weaknesses in their digital ecosystems and informs strategic decision-

making to achieve a digitally advanced society. DESI can be seen as a measure of digital development. Several studies carry out analyses using the indicator to measure the overall progress of EU Member States on the path of digitalisation. Summarizing the studies, this indicator is applied in several approaches as it provides a comprehensive snapshot of a country's digital landscape and helps policymakers to assess their nation's digital readiness and competitiveness. In another approach, it is seen as a supporter of innovation and used as a quantitative framework for assessing the level of digitalisation of EU Member States, which plays a key role in fostering innovation and competitiveness by monitoring variables such as internet access, digital skills and the use of online services. In this approach, the index is a catalyst for innovation-led economic growth, providing the basis for evidence-based policy-making (Skare et al., 2023; Bruno et al., 2023). In summary, DESI is an EU policy assessment tool for monitoring the progress of the EU member states in digital transformation. The index covers many aspects of the digital economy and society and provides insights into areas requiring targeted interventions. It mainly contributes to policy decisions aimed at fostering digital innovation and ensuring a fair distribution of digital benefits. It is a critical tool for assessing digital inclusion and goes beyond economic aspects as it takes into account social and cultural factors when measuring digitalisation. DESI highlights the importance of digital accessibility, affordability and digital skills in promoting an inclusive digital society (Ghazy et al., 2022; Oloyede et al., 2023).

The index itself was established by the European Commission in 2014. It is a composite measurement containing 33 indicators, a benchmark for digital transformation. DESI reports always show the results of the previous year's data, i.e. DESI 2023 represents the results of 2022. DESI summarised Europe's digital performance indicators between 2014 and 2022 and analysed the relative progress of the member states based on their initial situation against the results of the last five years. In 2021, the European Commission amended the previous methodology and aligned it with its policy objectives, resulting in the reduction of the previous five key aspects to four and the recalculation of the results of previous years. In line with the Digital Decade Policy Programme, it was revised again in 2023 and has since been incorporated into the State of the Digital Decade 2030 report and is currently used to monitor progress towards the digital targets. 11 of the 2022 DESI indicators measure the objectives set in the Digital Decade (DESI, 2023). The revised data was published in October 2023 at the time of writing so the study includes analyses of the previous structure and that of the new data at the same time. On 9 March 2021, the European Commission presented the Digital Compass 2030: A European path to the Digital Decade, which sets out the vision, goals and main tools and areas for the digital transformation of Europe and the European Union. On 8 December 2022, the European Parliament and the Council adopted the Digital Decade Policy Programme (COM, 2022).The Digital Compass strategy focuses on four areas and sets the following objectives for the year 2030 (COM, 2023).

1) **Digital skills development objectives:**
   - According to the strategy, at least 80% of the total adult population should have basic digital skills;
   - increase the employment rate of women in the ICT sector;
   - at least 20 million professionals to be employed.
2) **Digital transformation of businesses:**
   - *Technology deployment: 75% of EU companies should use cloud services, artificial intelligence or Big Data;*
   - Innovators: scale-up, strengthen and increase funding for innovative companies to double the number of unicorns, i.e. start-ups worth at least USD 1 billion, in the EU;
   - *Late adopters: in terms of digital intensity, more than 90% of small and medium-sized enterprises (SMEs) should reach at least basic level, at least 75% of EU enterprises should be based on cloud-based artificial intelligence and Big Data services; strengthening scale-ups.*
3) **Secure and sustainable digital infrastructure:**
   - Connectivity: everyone should have gigabit internet access;
   - Cutting-edge semiconductors: doubling the EU's share of global production;
   - Data-edge and cloud: 10,000 climate-neutral, highly secure edge nodes;
   - Computing: the first computer with quantum acceleration.
4) **Digitalisation of public services:**
   - Key public services: 100% online;
   - eHealth: 100% of citizens should have online access to their health data;
   - Digital identity: 100% of citizens should have access to a digital ID.

The Network Readiness Index (NRI) is a system of indicators designed to assess countries' digital development and examine the economic and social impacts of digitization. The Network Readiness Index is annually published by the Portulans Institute in Washington, D.C. NRI analyses data for 130 countries to help to compare and prioritise digital network readiness. The NRI's 60 indicators are grouped under a

total of four main pillars – technology, people, governance, impact – and 12 sub-pillars. The first pillar of NRI is Technology, which is also essential for laying the foundations of the network economy. This pillar comprises three sub-pillars (Access, Content and Future Technologies), which contribute equally to the assessment of the level of technological development. The second pillar (People) concerns the measurement of ICT use at three levels of analysis: Individuals, Companies and Governments. The third pillar of the NRI is Governance, which reflects the effectiveness of the systems underpinning activities within the network economy and also has three sub-pillars: Trust, Regulation and Inclusion. Finally, the fourth pillar measures the impact of digital technologies on society as a whole along three sub-pillars: the Economy, Quality of Life and the contribution to the Sustainable Development Goals (SDGs) (Bánhidi, Tokmergenova, et al., 2023).

5) **Digital skills development objectives:**
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MATERIAL AND METHOD

The digital technology practices of EU businesses are presented using data from the Digital Economic and Social Index (DESI) and Network Rediness Index (NRI). DESI data consists of the DESI 2023 database (covering the period between 2014 and 2022), downloaded from the European Commission's website, while NRI data reflects the NRI 2022 database requested and received on the Portulans Institute website in Washington. The study uses the methodology of comparative analysis and correlation analysis. First, the relationship between the DESI 2022 dimensions was examined, then the technology applications of enterprises in each country were compared to each-other based on the latest DESI Digital Transformation dimension analysis data (Artificial Intelligence, Cloud and Big Data Usage) in 2023. Then similar data of the NRI index on future technological dimensions (Adoption of new technologies, Robot density, Investment in new technologies, Expenditure on

computer software) were compared. Digital intensity was also examined by comparing two DESI indicators.

To analyze the relationship between DESI factors, Pearson's correlation was chosen. The Pearson correlation coefficient quantifies the strength and direction of the linear relationship between two continuous variables. It evaluates how well a change in one variable can be predicted by a change in another.

The formula for calculating the Pearson correlation (r) between the variables X and Y is as follows:

$$r=\sum i=1n(Xi-X)2\sum i=1n(Yi-Y)2\sum i=1n(Xi-X)(Yi-Y)$$

Where:

- r is the coefficient of the Pearson correlation;
- Xi and Yi are values of data points with the same index;
- X and Y are the averages of the variables X and Y,
- n is the sample size.

Table 1

Correlation of DESI 2022 and its individual dimensions

	DESI	Human capital	Internet access	Integration of digital technologies	Digital public services
DESI	1				
Human capital	0,91	1			
Internet access	0,72	0,57	1		
Integration of digital technologies	0,88	0,82	0,52	1	
Digital public services	0,90	0,75	0,49	0,70	1

Source: Own calculation based on DESI (2023)

Human capital, digital technology integration and digital public services have a particularly strong positive correlation with DESI, indicating that they play a key role in reducing a country's digital lag. It is also worth noting that although internet access is slightly lower compared to human capital, digital technology integration and digital public services, it is an essential factor in promoting skills, technological integration and digital services. A strong positive correlation of 0.91 between DESI and Human capital indicates a strong relationship, which means as a country's human capital improves, the overall digital economy and society index tends to increase significantly. Human capital includes factors such as digital skills, education and adaptability of the workforce to digital technologies. Human capital displays strong positive correlations with the integration of digital technologies (0.82) and digital public services (0.75) too. A high level of Human capital seems closely associated with better-integrated digital technologies and advanced digital public services. This suggests that enterprises with a well-educated workforce tend to adopt and utilize digital technologies more effectively, leading to more sophisticated digital public services. Promoting education and skill development among the population could contribute to a more tech-savvy workforce, consequently positively impacting the digitalization of services. Internet access exhibits moderate positive correlations with the Integration of digital technologies (0.52) and Digital public services (0.49). Areas with higher internet access tend to demonstrate more significant integration of digital technologies and better-developed digital public services. Ensuring broader internet access could be pivotal in enhancing the implementation and utilization of digital technologies across various sectors. Improved internet accessibility might be linked to the provision of better digital public services, emphasizing the importance of bridging the digital divide for more comprehensive digitalization. The Integration of digital technologies and Digital public services also shows a strong positive correlation (0.70). Enterprises effectively integrating digital technologies often tend to offer well-developed digital public services. It appears that the successful integration of digital technologies makes a substantial contribution to the availability and progress of digital public services. This highlights the connection that exists between the integration of technology and the supply of services. These findings can guide policymakers to focus on improving these key areas to enhance overall digital development.

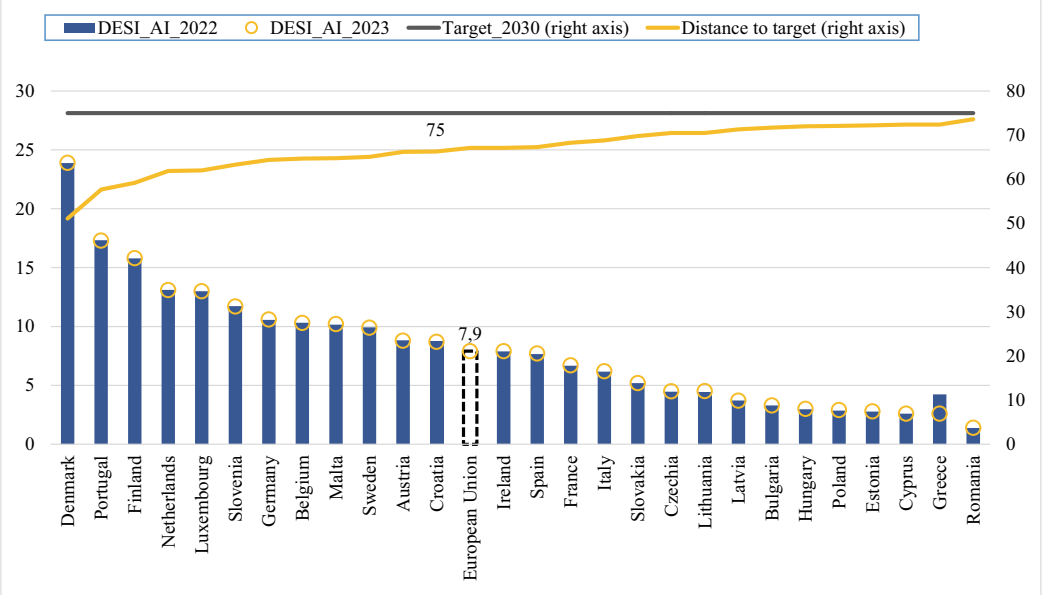
Digital Divide in Technology Applications for Businesses in the European Union

The first State of the Digital Decade report, published on 27 September 2023, provides a comprehensive picture of progress towards achieving digital transformation. The report takes stock of the EU's progress towards a successful digital transformation of people, businesses and the environment by 2030 (European Commission, 2023a). The report highlights the need to accelerate and deepen joint efforts, including policy measures and investment in digital technologies, skills and infrastructure, which are critical geopolitical, social, economic and environmental factors.

The indicators on digitalisation of enterprises that are part of DESI 2023 fall into three categories: 1) measuring the digital intensity level of SMEs, 2) digitalisation of enterprises and 3) e-commerce. The study analyses the following indicators that make up the objectives of the Digital Decade: SMEs with at least basic digital intensity and the percentage of companies using Big Data, cloud computing and artificial intelligence. The strategy document identified the following strategic steps related to the areas examined. To create the necessary preconditions for the development and uptake of AI, room has to be made for the proliferation of AI in the EU where excellence flourishes from laboratory to market. A necessary requirement is to ensure that AI works for people and benefits society and build strategic leadership in high-impact sectors. Cloud computing is crucial for emerging technologies such as artificial intelligence, Big Data and digital ledger technologies, as well as many industrial and entertainment applications. In order to reap the full economic benefits of the data economy, the cloud has the potential to be game-changer, requiring at least twice as many European businesses to start using advanced cloud computing by 2030, which is particularly important for SMEs. Advanced cloud services enable businesses to build a truly sustainable and competitive advantage with this technology. Businesses are increasingly realising that business transformation and performance depend on better use of data. The estimated share of the impact of the data economy on GDP in the EU27 increased from 3.7% in 2021 to 3.9% in 2022. According to the latest estimates, the EU27 data economy is expected to remain slightly below the €1 trillion threshold in 2023 and reach a compound annual growth rate of 5.5% in 2025-2030. SMEs account for 98% of all data-using companies in the European Union. In 2022, the EU data economy reached the €500 billion threshold and showed an annual growth rate of 8.7% in 2021. As a result of positive trends in the EU data economy as a whole, the number of companies using data in the EU7 increased to more than 579 000 companies in 2022. It is estimated that data-using companies will account for more than 905 000 companies by 2030 (COM, 2023; Micheletti et al., 2023).

OUTCOMES

Member States and the Commission have agreed to ensure that by 2030 more than 75% of EU businesses use artificial intelligence technologies, Big Data or the cloud. Support for artificial intelligence solutions plays a prominent role in the digital economy. Based on DESI 2022 data (Figure 1), only 7.9% of EU businesses use AI technology, i.e. one in 12 companies have adopted AI technology.

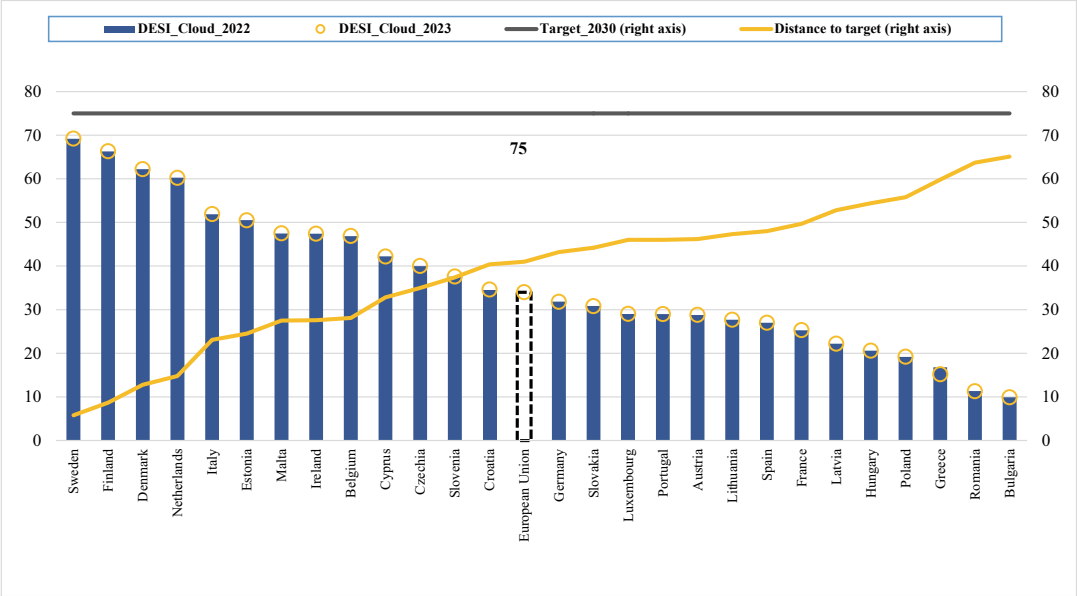


Source: Own editing based on DESI (2023)

Figure 1. Use of artificial intelligence (% of enterprises)

According to the results, a year earlier, in 2021, there were more countries where making use of artificial intelligence was higher than in the case of others. Denmark currently has the highest take-up rate at 24%, followed by Portugal (17%) and Finland (16%). In seven countries it ranges from 10% to 13% (Netherlands, Luxembourg, Slovenia, Germany, Belgium, Malta and Sweden) and from 5% to 10% in seven other countries. The use of artificial intelligence is less than 5% in the following surveyed countries: The Czech Republic, Lithuania, Latvia, Bulgaria, Hungary, Poland, Estonia. Greece, Cyprus and Romania. The take-up rate appears to vary widely between Member States, ranging from 1% to 24%. The difference between SMEs and large companies is striking, as four times as many large companies use AI technologies as SMEs. In addition, twice as many medium-sized businesses use AI as small businesses. If we look at the sector overview, the ICT sector is clearly well ahead in the use of AI technologies: 25% of businesses use AI, followed by the publishing sector with 18%. Other sectors, such as real estate and manufacturing, are lagging behind with only 7% of businesses using AI. The transport, warehousing and construction sectors are the least likely to use such technologies. To change the current low level, all national AI strategies set out policy measures to increase and support it.

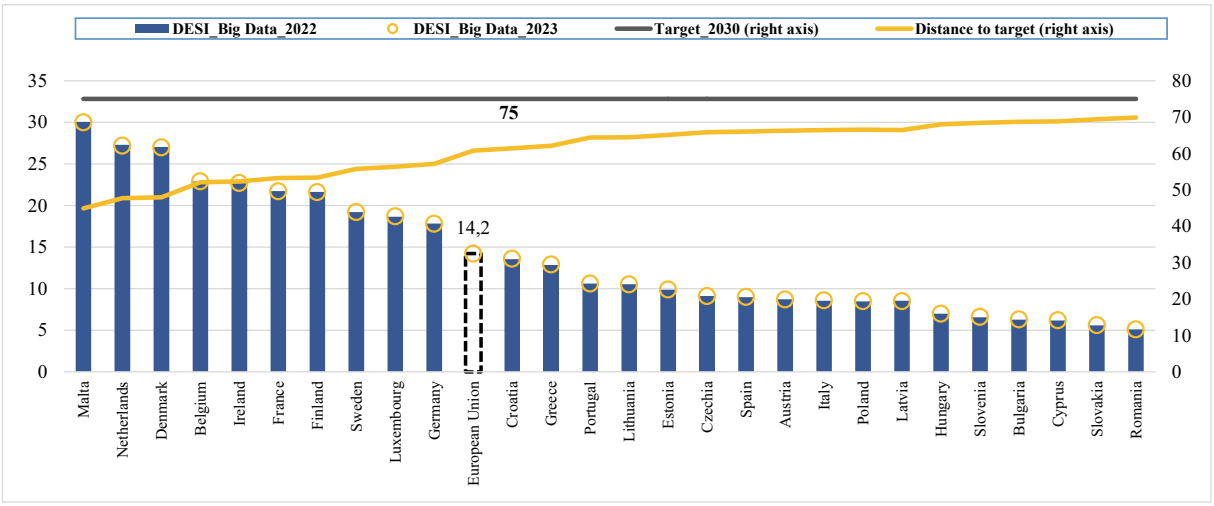
Cloud computing is now considered a core technology. Its availability today far exceeds file storage and email, which are still the most common cloud application scenarios for European companies today. Figure 2 shows the proportion of companies using cloud services. It can be seen that, on average, only one in three companies in the European Union uses cloud computing services. Companies in the Nordic countries are at the forefront of adopting cloud services. In Sweden, Finland, Denmark and the Netherlands, more than 60% of businesses purchased such services. Italy and Estonia follow with more than 50%. However, the gap between the best and the low performers remains wide with Bulgaria and Romania scoring below 15%. There are significant differences (up to 62 percentage points) between businesses of different sizes and between different types of cloud services used. Cloud adoption by enterprises (60%) is almost double than that of SMEs (33%) in 2021.



Source: Own editing based on (DESI, 2023)

Figure 2. Cloud computing usage (% of enterprises)

The three global cloud providers, Amazon Web Services, Microsoft Azure and Google Cloud account for two-thirds of the European cloud market. If we look at cloud use by sector, two-thirds of ICT companies have already purchased such a service. The least cloud-consuming sectors are construction, transport and manufacturing. Businesses across the EU and across sectors are constantly adapting to new technologies for collecting, storing and analysing data. Big Data, i.e. managing Big Data, can be a key and competitive advantage for businesses. Big Data is complex, comes in different formats and forms, and many factors determine their usability and turn them into real competitive advantages. According to the DESI survey (Figure 3), 14% of companies carried out Big Data analysis in 2020 (no more recent data is available).

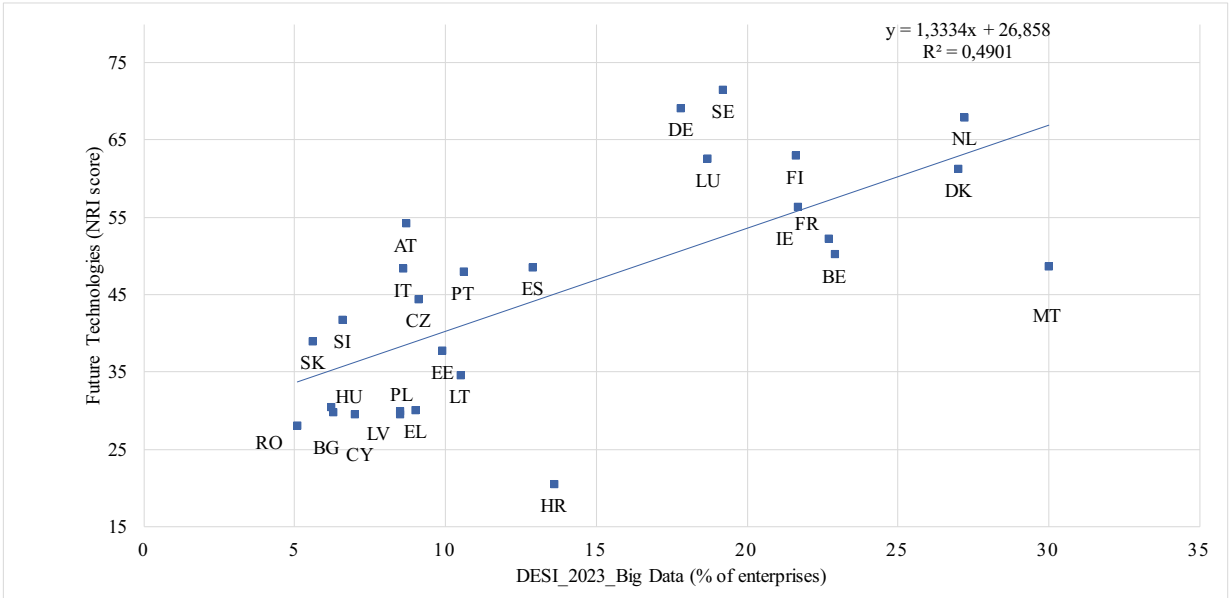


Source: Own editing based on (DESI, 2023)

Figure 3. Share of companies performing Big Data analysis (%)

In Malta, almost a third of businesses have already analysed Big Data. The Netherlands and Denmark follow closely behind with 27%. At the other end of the spectrum are companies in Romania, Slovakia, Cyprus and Bulgaria where only 5-6% have analysed such data. There are significant differences according to the size of enterprises, while one-third of large companies accept Big Data analysis, one in five medium-sized companies and one in 10 in the case of small businesses are ready to carry out such analysis. On a sectoral basis, companies in travel agencies, tour operator reservation services and related activities, publishing activities and ICT are more likely to analyse Big Data. Big Data adoption is expected to be slow at first but then accelerate over time, which is likely due to very small companies that have less incentive to adopt Big Data technologies.

The three technology applications analyzed above were compared with NRI data (Based on the total scores given to Future technologies such as Robot density, Investment in new technologies, Expenditure on computer software, a correlation analysis was performed between the individual factors. Analyzing the three technologies, no strong correlation can be detected in either case, the strongest connection was seen in the case of Big Data (Figure 4). Countries with higher NRI - Future technologies are also likely to use Big Data more actively.



Source: Own editing based on (NRI, 2022, DESI, 2023)

Figure 4. Big Data use in relation to future technologies

Countries can be divided into three groups. The first group includes countries such as Belgium, Denmark, Finland, France, Ireland, Luxembourg, Malta, the Netherlands and Sweden, which have high Big Data and NRI values, suggesting that these countries are leaders in technological development and data use. The second group includes Austria, Germany, Spain, Italy and Portugal, where Future Technology values are high but the use of Big Data is lower. The third group with the largest digital divide includes Bulgaria, Croatia, Cyprus, the Czech Republic, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Slovakia, where both Big Data and Future Technology values are low.

Correlation analysis (Table 2) was used to compare the sub-pillars of future technologies (Adoption of new technologies, Robot density, Investment in new technologies, Expenditure on computer software). Correlation between adoption of new technologies and AI is 0.60, indicating that the increase in adoption of new technologies goes hand in hand with the growth of AI. If we look at the correlation between Robot density, Investment in new technologies, and AI, they are in a moderately positive relationship so with the increase of that factor, AI will also grow. The correlation matrix also shows that there is a moderate positive relationship between Big Data and New Technology Takeover, Robot Density, Investments in New Technologies, and AI. So these factors could potentially affect the growth of Big Data. The adoption of new technologies, robot density, investment in new technologies, the promotion of AI and Big Data can all contribute to increasing the value of cloud use, as there is a moderate positive relationship between the factors.

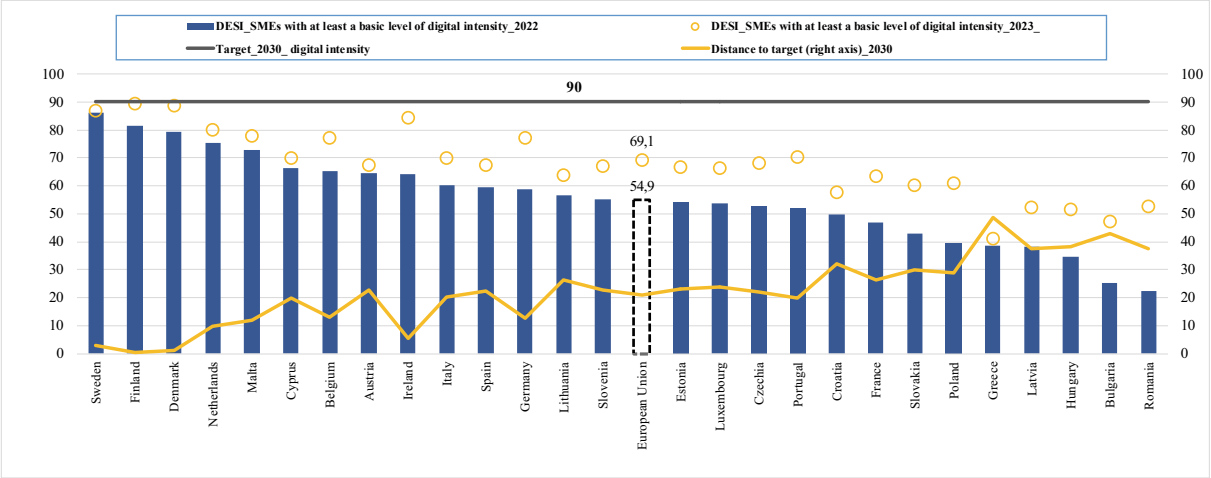
Table 2

Relationship between DESI and NRI indicators

	Adoption of new technologies	Robot density	Investing in new technologies	Expenditure on computer software	AI	Big Data	Cloud
Adoption of new technologies							
Robot density	0,57						
Investing in new technologies	0,94	0,48					
Expenditure on computer software	0,37	0,45	0,28				
AI	0,60	0,48	0,55	0,39			
Big Data	0,65	0,43	0,66	0,49	0,63		
Cloud	0,60	0,48	0,58	0,33	0,57	0,61	

Source: Own calculation based on DESI (2023) and NRI (2022)

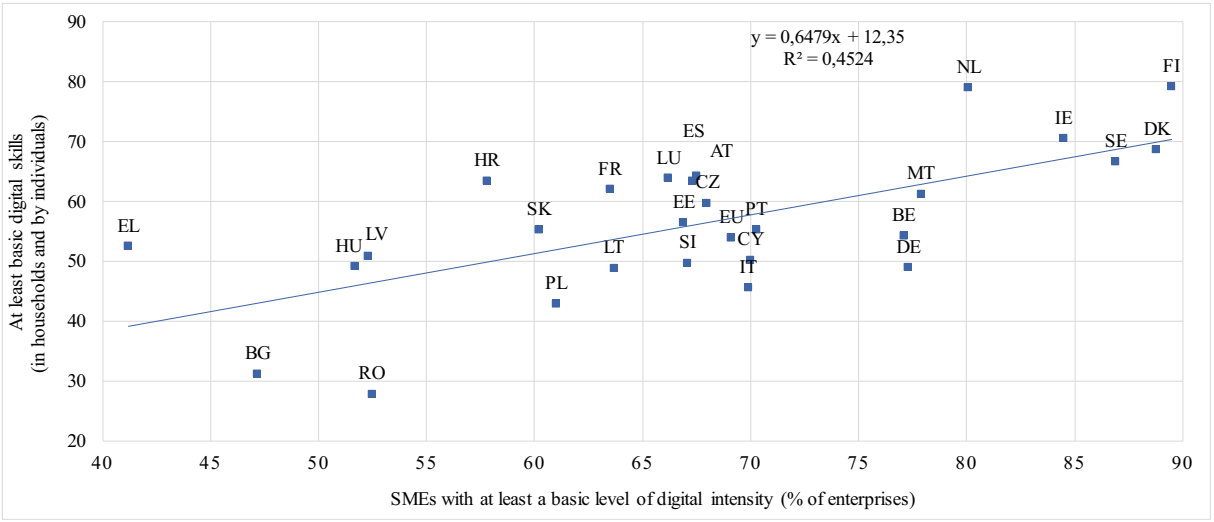
Looking at some more potential relationships, the digital intensity of businesses was examined. Figure 5 shows the proportion of SMEs with basic digital intensity. In four Nordic countries (Finland, Denmark, Sweden and Ireland), at least 80% of SMEs have reached at least basic digital intensity while in Greece and Bulgaria this level is below 50%.



Source: Own editing based on DESI (2023)

Figure 5. Basic digital intensity (% of enterprises)

While in recent years the proportion of businesses with at least basic digital intensity has averaged around 50%, it jumped to 69% at EU level in 2022. This is a positive development that could signal the beginning of an upward change in the trend. However, the digital intensity indicator fluctuates from year to year, as the components of the indicator (questions asked from businesses) alternate every two years. In addition, countries are still far from reaching the target of 90% of SMEs having basic digital intensity by 2030, as indicated by the line in Figure 5. Currently, only a few countries have made significant progress, which can be seen from the distance between circles and columns. Large companies are more likely to adopt new technologies. For example, electronic information sharing through enterprise resource planning software (ERP) is much more common in large enterprises than in SMEs. Social media is used by more than twice as many large companies as SMEs, while the latter also make limited use of e-commerce and online sales opportunities. They should also take advantage of many other technological opportunities, such as cloud services, AI or Big Data analysis. There are common factors that play a critical role in enabling and boosting the uptake of cloud services, Big Data, and artificial intelligence, such as the availability of staff with advanced digital skills. Almost one in two European citizens lacks the basic digital skills needed to access opportunities online. Digital skills are measured by Eurostat's index, which refers to the five digital competences of the EU Digital Competence Framework (DigComp): Information and data literacy skills, Communication and collaboration skills, Digital content creation skills, Security skills and Problem-solving skills. All competences are assessed from a digital perspective. At least to achieve basic digital skills, people need to know how to carry out at least one activity related to each digital competence. According to DESI data, only 54% of adults in the European Union had at least basic skills in 2021, which is still far from the target of 80% by 2030. The differences between countries are sharp (Figure 6). The Netherlands and Finland are close to achieving this goal, where 79% of adults had at least basic digital skills. However, eight Member States still have at least basic digital skills below 50%, including Bulgaria, Romania, Poland and Italy, Lithuania, Hungary, Germany and Slovenia (European Commission, 2023b).



Source: Own editing based on NRI (2022) and DESI (2023)

Figure 6. Basic digital intensity in relation to digital skills

CONCLUSION

Digitalisation in Europe is sub-optimal. The European Union's Digital Decade 2020-2030 policy programme has set numerous objectives for promoting digital transformation. The analysis of digital technology applications in European Union enterprises, based on data from the 2022 Digital Economy and Society Index and the Network Readiness Index, reveals important correlations. The study highlights that only 54% of adults in the European Union had at least basic digital skills in 2021, which is still far from the target of 80% by 2030. Furthermore, the analysis shows correlations between the Adoption of new technologies, Robot density, Investment in new technologies, Expenditure on computer software, AI, Big Data, and cloud adoption. These correlations provide more precise evaluation on the present situation of digital technology implementations in firms of the European Union. The uptake of digital technologies by businesses remains uneven, varies depending on the technology concerned and varies significantly between Member States and economic sectors. The use of Big Data and AI will fall significantly short of the objectives set. The use of cloud computing services has grown significantly in recent years, reaching 34% of EU businesses in 2022. The uptake of Big Data analytics and artificial intelligence technologies remains significantly more limited, with only 14% and 8% of businesses using them, respectively. Achieving the goals of the Digital Decade will require significant efforts by member states through comprehensive and integrated policies to reduce the lack of specific skills, increase technical expertise and diminish the barriers to use more AI, Big Data and Cloud technologies. The integration of basic or advanced digital technologies would require developing knowledge related to digital technologies, developing digital skills and increasing technical expertise, especially among employees. A large amount of research confirms that the ability to extract information from data using advanced data analysis techniques will be fundamental to the competitiveness of any economy. Cloud computing is also at the heart of the data economy to keep businesses competitive against their international competitors. Using advanced big data analysis by 75% across sectors would allow European companies to keep pace with the growth of data use globally and take full advantage of new ways of exploring and interpreting data using artificial intelligence. For example, it is recommended for businesses to grow Big Data effectively to extend data sources, including enterprise systems, user activities, and IoT devices. Efficient optimisation of data processing and storage is essential to manage growing amounts of data, which requires the use of modern Big Data technologies and data storage solutions. Although these solutions appear to be excellent, the inquiry remains as to how. While the presence of technology is undeniably significant, the proficiency of its operators may be even more determining. "Increase appropriate competence and training" would rank among the most essential key phrases. Consequently, a more in-depth mapping of digital abilities will be the further direction for this research in the future.

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