The connection between the smart city concept and human resource management, with a special focus on the role of competences and corporate competitiveness

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Abstract

The trend today is that more and more cities are becoming smart. This process can be strengthened if a municipality has a high proportion of well-educated workers with the right competences who can contribute to the excellence of a company by increasing the competitiveness of the organisation and the city. In addition, other economic, environmental and social factors, such as increasing GDP and employment rates, reducing environmental impacts, etc., are necessary to become a smart city. The literature review has clarified the key concepts and highlighted the importance of the topic. Our research has analysed the capital cities of the Visegrad Group in 6 dimensions, using a total of 19 indicators, and has determined their index values per dimension and complexity. The focus of our research was on the people dimension. The aim of this research is to explore the index scores per dimension and the complex index scores of the cities under study. Bratislava scored the highest in this dimension, with Prague coming second. Warsaw came third and Budapest last in the comparison. In terms of the complex index, Bratislava is the smartest of the cities surveyed.

Introduction

Smart city projects usually involve the application of new technologies and digital solutions, innovation and knowledge management, for which it is essential that the people involved have the competences required by the technological environment and are open to lifelong learning. For a company, employees need to be able to use and integrate new technologies and a higher quality workforce can contribute to the development of innovative solutions, which in turn can improve the competitiveness of the company. In addition, good communication, openness to collaboration, improving employee satisfaction and efficiency and secure data management are important.

In other words, a well-trained, competent workforce helps the company to adapt, enables participation in smart city developments and thus supports business success.

Topicality and relevance of the topic

The research topic addresses a topical problem, as both the Hungarian and the European labour market are facing significant challenges. Our ageing society, the emigrating domestic workforce, the aftermath of the Covid-19 epidemic (Hajdú, 2021; El-Meouch et al., 2024), the energy crisis, the consequences of the armed events in neighbouring Ukraine are all serious challenges for companies and in this difficult and challenging economic environment, companies need to find the most suitable and competent employees for their organisation. In addition to this, the accelerating

pace of economic change and technological advances mean that companies need to constantly adapt to changes in their environment and ensure their competitiveness. However, competitiveness depends not only on organisational structures and process efficiency, but also on people. In a globalising economy, the key to competitiveness and success (harnessing intellectual capital to achieve organisational goals) is knowledge, which is the most important asset of 21st century organisations and the foundation for long-term success (Bod, 2021). Knowledge is also an essential element for the success of smart city concepts. For smart projects to have a positive impact on the quality of life and for the initiative to be effective, the population must be open to both innovation and lifelong learning. And if a city has a large number of smart citizens, this is likely to have a positive impact on the competitiveness of the city and the well-being of its citizens, as well as on the competitiveness of the businesses operating in the city.

Based on this line of thinking, we launched a search on the Web of Science to see if any comprehensive research had been done before in a similar context. We typed in three search terms - smart city, comeptence and competitiveness - and got only three results. So we concluded that it is definitely worth looking into this issue.
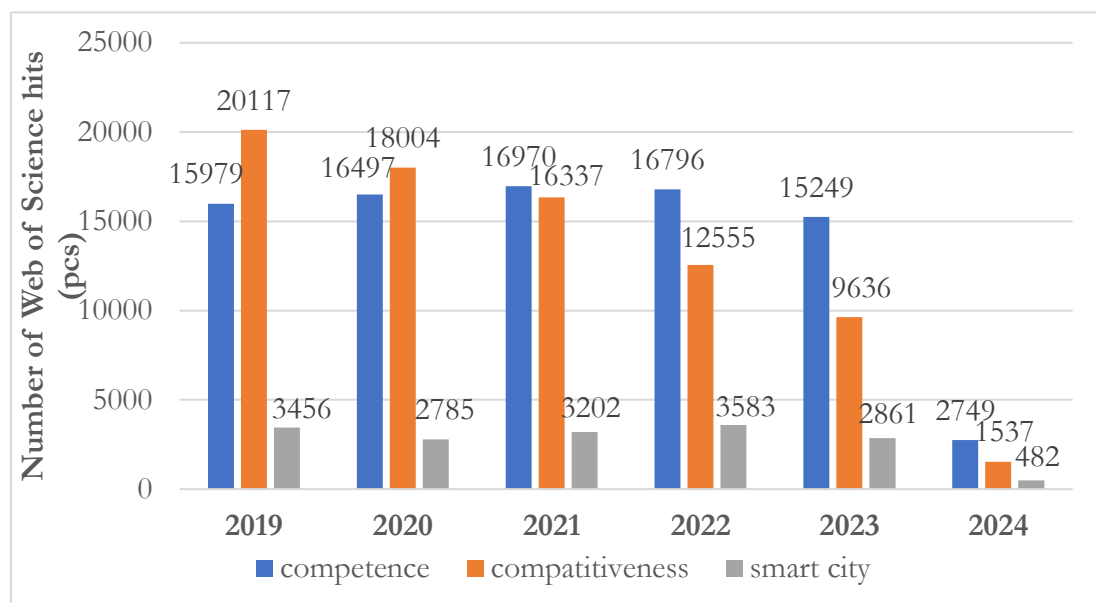
Figure 1: The annual volume of publications on the topic (keywords: smart city, comeptence and competitiveness).

Source: authors' own editing based on Web of Science database, 2024

We then looked at each of the search terms individually (Figure 1), and the results show that the subject areas independently have significant literature. Only publications on competitiveness have shown a permanent downward trend over the last five years.

Literature review

In this chapter, we seek to clarify the concepts of smart city, company competitiveness and competent workforce.
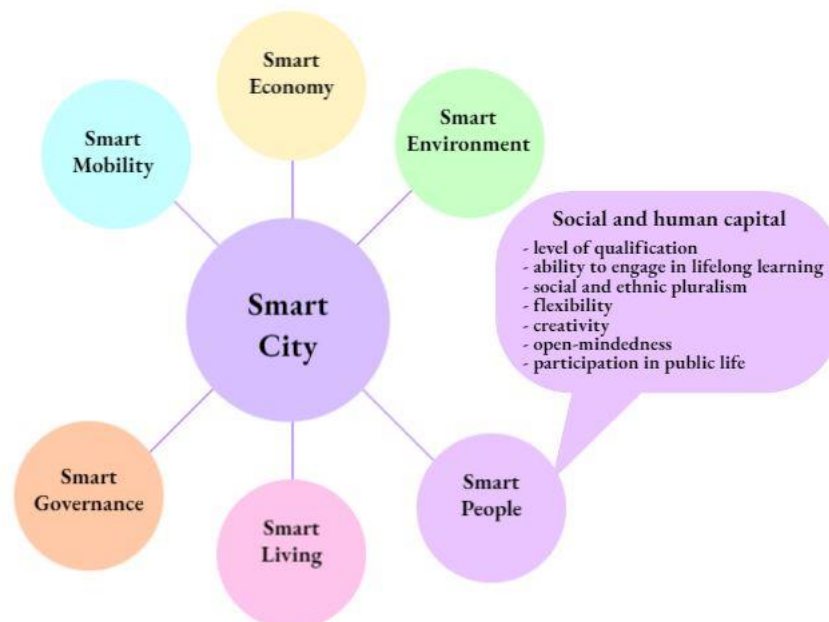
Smart City

The most popular, globally spread urban development concept of the first quarter of the 21st century is the smart city. The concept appeared in the international literature in the 1990s, while in Hungary it appeared and spread in the 2010s (Mahizhnan, 1999; Árvai, 2022). The roots of the smart city concept presumably date back to the pre-digital era. The industrial era was characterised by a focus on data and its processing and efficiency, with the aim of increasing production and economic efficiency (Howard, 1902; Caprotti, 2020; Greutter-Gregus et al., 2024).

The evolution of technology is shaping and transforming the labour market from time to time, creating the need for new approaches, mindsets and competences. In order to gain and maintain a competitive advantage, companies need a workforce and, with it, a human resources strategy that can respond effectively to the changing challenges of the labour market. This requires creativity, flexibility, global vision and often multidisciplinary thinking, i.e. the right competences (Némethy, 2019).

The concept of the smart city came to the fore in the second half of the 1990s, with the rise of information and communication technologies. There is no agreed definition of the term, but there are several smart city concepts in the literature, which vary according to the factors that researchers wish to emphasise (e.g. technology, human capital, etc.). The most widely cited smart city concept in the international literature is that of Giffinger's. In his 2007 study, the author defined a smart city as follows: a smart city is a city that performs well in the areas of people, transport, living conditions, governance, environment and economy, its citizens are capable of autonomous decision-making, independent and aware, able to cooperate and combine their activities in a smart way (Giffinger et al., 2007; Jámbor, 2018).

The intersection of the smart city concept and HR management is Giffinger's smart people subsystem (Figure 2).

Figure 2: Giffinger's smart city concept
Source: authors' own editing based on Giffinger et al., (2007), 2024

The diagram shows that the concept includes six dimensions. Each dimension has a key factor, which in the case of smart people is social and human capital. The subsystem includes the development of the knowledge economy, a competitive workforce and education, as well as measures to achieve a creative and inclusive society. Its defining element is creativity, so people, education, learning and knowledge are central to these cities (Nam – Pardo, 2011; Jámbor, 2018). The smart city is a hub of higher-skilled individuals, with an abundance of skilled labour (Winters, 2010). The economic motivation behind smart city developments is significant, providing opportunities for large technology companies through infrastructure deployment (hardware) and data processing (software) (Söderström et al., Kocsis – Gere, 2021). Other drivers could be the growth of cities in terms of numbers and space, the proliferation of increasingly complex and opaque systems, and the need to gain an advantage in the increasingly competitive environment between cities.

Smart developments can turn cities into economic hubs through modern, well-functioning infrastructure and business environments, attracting the key investments, economic actors, creative and highly skilled workers needed for their operation (Kocsis – Gere, 2021).

Knowledge-sensitive companies (especially tech companies, e.g. Silicon Valley) therefore tend to cluster in such communities. This makes smart places increasingly smart, more attractive to creative people and workers than less smart cities. It should be noted here, however, that this is also a double-edged sword. To a certain extent, a high concentration of knowledge and the clustering of firms in the same field is beneficial to competition between firms and thus to competitiveness. However, when the scales are tipped, an excessively competitive approach has a negative impact on employee performance and hence on the competitiveness of the firm. Such smart communities/cities can disadvantage surrounding less smart cities, causing an influx of population from these cities, creating new challenges.

Almost without exception, the largest companies in the United States have some idea of what the "city of the future" means. These visions usually focus on technological innovations that are specific to that company. Facebook is currently planning to create a classic "company town" for its employees called Willow Village. The initiative has several opponents, who criticise it primarily for its gentrification effect (Streitfeld, 2018; Kocsis – Gere, 2021).

Most studies on the smart city framework highlight the importance of participatory governance and public involvement as key principles of smart city design. They highlight the importance of smart people as a key resource in smart cities and emphasise that creativity and social innovation are the main drivers of smart cities. Unfortunately, despite this, their practical implementation is generally only partially achieved, with European cities being at the forefront of good examples (Giffinger et al., 2007; Chourabi et al., 2012).

Corporate competitiveness

Competitiveness and its "conscious" scientific research came to the fore in the early 1980s, when President Reagan established the President Reagan Commission on Industrial Competitiveness, whose main purpose was to develop proposals to strengthen the weakened market position of the US (Lengyel, 2003). However, competitiveness and its measurement have been in economics for much longer: many authors have interpreted and approached this elusive concept in many different ways. One approach is that of classical economics, whose proponents include Smith, Ricardo, Hechscher and Ohlin, and Krugman. Their approach sought to clarify conceptual problems. In Krugman's view, the concept of competitiveness - as a non-macroeconomic category - cannot be applied to national economies, but only to firms (Krugman, 1994).

Like Krugman in his earlier works, Porter argues that competitiveness is a microeconomic concept, that it can only be understood at the firm level and that it is a competitive advantage over competitors. (Porter, 1990).

Economic approaches came to the fore in the 1990s. The representatives of this approach do not derive the concept of competitiveness from a basic economic theory, but seek to develop and interpret the definition by generalising the characteristics of observable economic processes and corporate strategies (Lengyel, 2003).

The definition of business competitiveness has changed significantly in a 2005 study. According to this study, "corporate competitiveness is the ability of a company to offer consumers products and services that they are more willing to pay for on terms that ensure a profit for the company than those of its competitors, while adhering to standards of social responsibility. This competitiveness requires that the company must be able to anticipate and adapt to environmental and internal changes by meeting market competition criteria that are consistently more favourable than those of its competitors." (Chikán et al., 2009: 9).

Márkus (Márkus et al., 2008) divides corporate competition theories into four groups. Financial, entrepreneurial, industry and resource-based approaches are distinguished. Porter, on the other hand, argues that a firm can gain a competitive advantage by having an internal structure that is best suited to external resources (Porter, 1979).

Today, competitiveness is still a key factor in market functioning. This has become more important with the rise of globalisation, and small and medium-sized enterprises now have to compete on a global scale to survive. The aim is for companies to find the people they need to deliver their business vision, i.e. to find the most talented people despite labour shortages. If the ability to attract talented employees is a function of achieving business objectives, focusing on talent becomes central. Talent management is therefore not just an HR issue, but more of a strategic one. Running a business and talent strategy in parallel clearly contributes to achieving the company's strategic objectives, ensures higher performance in the market, helps retain loyal and talented employees, improves morale and increases productivity (Dajnoki – Héder, 2017).

Competent workforce

It has always been a challenge for organisations to respond flexibly and quickly to changing environmental challenges. The innovative processes of Industry 4.0 and Society 5.0 are also influencing the approach and functions of human resource management. In addition to traditional functions, new areas of activity such as knowledge management, retention management, generation management, competence management, talent management and diversity management have emerged or are being valorised, but HR/employer branding, health promotion and HR controlling have also come into focus, and work experience management is now also being introduced at international level (Dajnoki – Héder, 2017). Competences are an individual's intellectual assets, a source of power that guarantees the acquisition of desirable positions (Varga – Szira, 2018).

The first empirical book presenting research is Boyatzis' The Competent Manager, 1982, in which the author presents his model of competence. He highlighted the relationship between three factors that influence performance: job expectations, the organizational environment and individual competence. He primarily identified leadership skills, attributes and behavioural frameworks. In his work, Boyatzis emphasised what makes a leader outstanding. He also argues that it is of paramount importance to take into account organisational characteristics, so that each company should develop its own competency framework, closely linked to the achievement of organisational

goals. Similar studies have been done before, for example, Harvard Professor McClelland in 1973 sought to find out what makes high performers better than average performers (McClelland, 1973).

According to Spencer - Spencer (1993), three clusters of competencies make up 80-98% of the model, namely performance orientation, influence and personal effectiveness. Ulrich identified eight trends in HR roles that will challenge companies' operations in the longer term. One of these is the attraction, retention and measurement of competencies and intellectual capital (Ulrich, 1996).

Changes in the labour market are also changing perceptions of the relationship between training organised in-house and knowledge acquired outside the company. This fundamentally determines the organisation's requirements for its employees and new entrants. In an economic approach, the employer only supports the acquisition of 'specific' knowledge, i.e. knowledge that can only be used in the particular company, and 'passes on' the acquisition of 'general' knowledge to the individual. In the management literature, however, companies use internal training as a means to adapt to changing market conditions and to address current and future skills gaps (Tóthné Téglás, 2016).

Organisations need to provide their employees with opportunities for continuous learning and development to keep up with the changing business environment and technological advances. Developing competencies, assessing and rewarding employees is also important for employee performance management, as it can improve the competitiveness of the company (Veresné Somosi, 2013). Z. Karvalics and Kollányi summarised the possibilities of analysing the potential of the indicators of competitiveness and human resources management. They build up the relationship along three sectors (Basic, Direct, Indirect) and six modules (Education, Literacy, Knowledge Production, Infrastructure, "Medium", Society) (Z. Karvalics – Kollányi, 2006).

To sum up, competitiveness is in fact a manifestation of strategy, because a good strategy makes an organisation competitive with its competitors (Vörös, 2010: 29). The internal competences that trigger competitiveness can be transformed into real competitiveness and financial performance by a (good, appropriate, fitting) strategy, so human capital is the driving force of corporate action.

Research methodology

The research was structured according to the following scheme:
– Topic selection, research problem definition
– Exploration of research background (literature and other sources)
– Conceptualisation (definition of concepts)
– Defining the research objective, formulating the question
– Data collection (definition of variables)
– Creating a database, analysing and evaluating data
– Examining cause and effect relationships
– Answering the research question
– Draw conclusions, make suggestions, formulate further research options

After reviewing the literature, we designed the research method and formulated the research question. In the research, the capital cities of the Visegrad Group (Czech Republic, Hungary, Poland, and Slovakia) were studied and compared with each other. The secondary research used document and data analysis method and collected quantitative type of data. A complex index calculation of the efficiency of smart cities was carried out. The resulting index values are now comparable.

Research objective

The accelerating pace of economic change and technological progress means that companies must constantly adapt to changes in their environment and ensure their competitiveness. However, competitiveness depends not only on organisational structures and process efficiency, but also on the capabilities of people.

The aim of this research is to explore the index scores per dimension and the complex index scores of the cities under study, thus providing a more accurate picture of the efficiency and performance of cities, in which HR is given special attention through the smart people dimension.

Research database, methodology

The study used a total of 19 indicators to assess the smart performance and competitiveness of the capital cities of the Visegrad Group (Budapest, Bratislava, Prague, Warsaw) for the year 2021, based on the work of Szendi et al. (2020), who complemented the six components of the study by Giffinger et al. (2007) with the definitions of Nam – Pardo (2011), Cohen (2014) and Nagy et al. (2016). In addition to the factors of Giffinger et al. (2007), Lados (2011) and Cohen (2014), the selection of indicators was mainly based on the indicators of the Urban Audit and Urban Audit Perception Survey (European Commission, 2015), similar to the work of Szendi et al. (2020). The data sources were Eurostat, OECD and the own statistical offices of the countries included.

In the calculations, it was necessary to standardise the data, as the units and scaling were different, to ensure comparability of the data. The z-transform, as used by Cohen (2014) and Szendi et al. (2020), was chosen for the procedure. In this method, all indicators are transformed so that their mean is 0 and their standard deviation is 1. The main advantages of the method are that it preserves the original correlations, allows for comparability of indicators with different measures and does not introduce bias. For some indicators, such as the unemployment rate or the concentration of particulate matter, the inverse value of the indicator is used in the calculation of the complex index, since the lower the value, the better the situation of the city under study. The value of each dimension was calculated as the sum of the standardised values of the selected indicators. The complex smart city index of the cities was then obtained as the sum of the values of the dimensions. Figure 3 below shows the dimensions and the indicators used to assess each dimension.
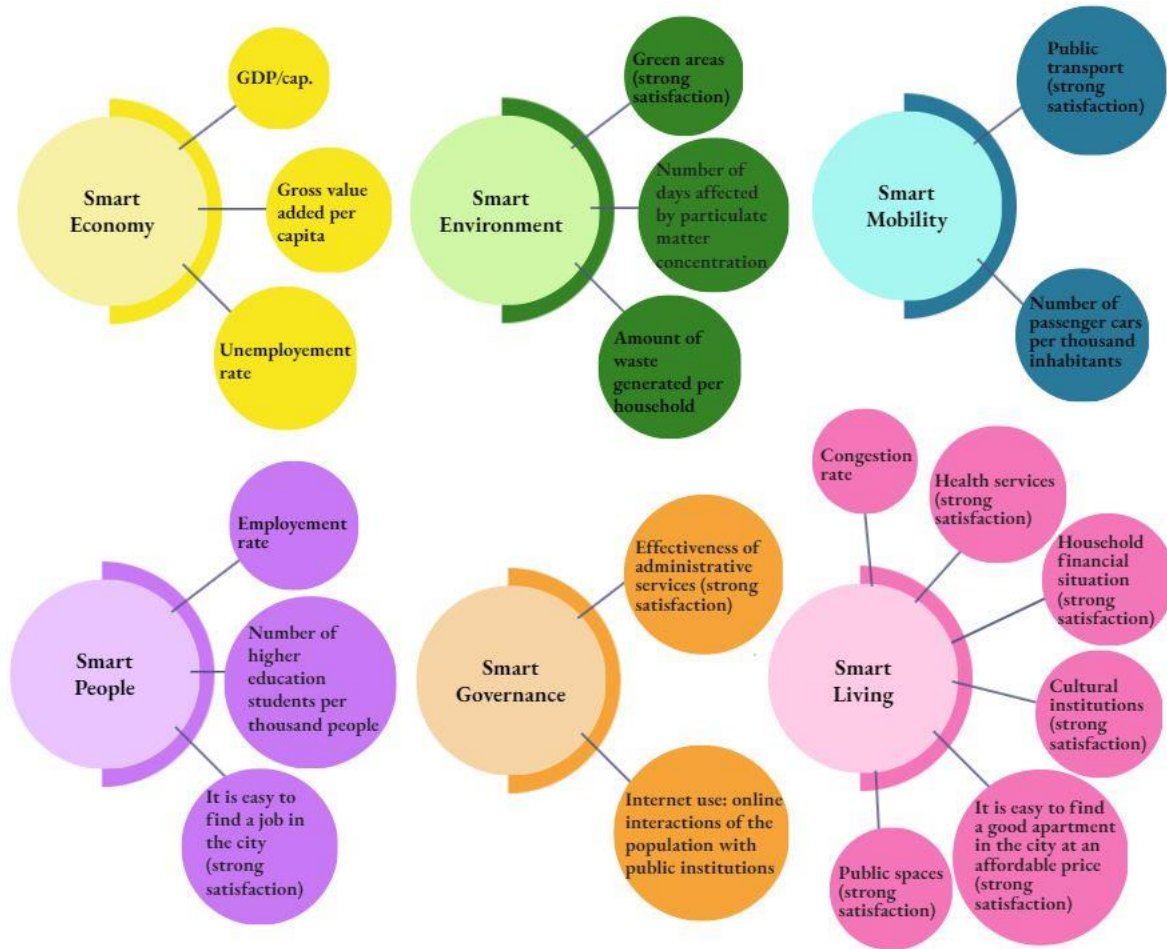
Figure 3: Indicators included in the study
Source: authors' own editing, 2024

Results

In this chapter, the results of the calculations carried out are presented in the form of tables and graphs.

Table 1 shows the calculated values of the six smart dimensions and the complex index for the study year 2021, with the best values highlighted in green and the worst values highlighted in red.

Table 1: The value of each dimension and of the complex indices for the cities studied

|	Smart Economy	Smart People	Smart Governance	Smart Environment	Smart Living	Smart Mobility	Complex Index
Bratislava	-0.16	4.97	3.28	0.45	5.86	2.75	17.16
Budapest	-2.44	-2.44	-1.45	0.10	-3.09	-2.25	-11.57
Prague	2.19	-1.12	-0.27	-1.69	1.42	0.80	1.32
Warsaw	0.41	-1.41	-1.56	1.14	-4.19	-1.30	-6.91

Source: authors' own editing, 2024

The best performing city in the smart economy component was Prague. Its leading position is due to the fact that it has the highest value added per capita and the second highest GDP per capita after Bratislava. Companies such as Siemens, Novartis, Deloitte, HP Enterprise are located in Prague and contribute to its outstanding economic performance. Warsaw is in second place, followed by Bratislava and Budapest in last place. The Hungarian capital was the worst performing city in 2021 for all indicators included.

For the smart people dimension (Figure 4) - the most important indicator for the study - Bratislava performed best. Its employment rate was the second best in the Visegrad Group at 78.5% and its higher education participation rate per capita was the highest. In Bratislava, there are 11 universities to choose from for those wishing to pursue higher education, with courses in economics, engineering, health and national defence (universityguru.com, 2024). Employment after graduation was considered easy by 21% of respondents, the second best result after 27% of respondents in Prague.

Prague takes the silver medal in the dimension, Warsaw the bronze medal, and Budapest the fourth. Although the city had an employment rate of 77%, which is not the worst among the cities surveyed, it was the worst performer in terms of the higher education and access to employment indicators, and therefore came last overall in the analysis of the dimension. The indicators for the top two cities show that cities with competent, well-educated workers have easier access to jobs and thus higher employment rates, making it easier for individual companies to find the right workforce and contribute to the success of both the company and the city.
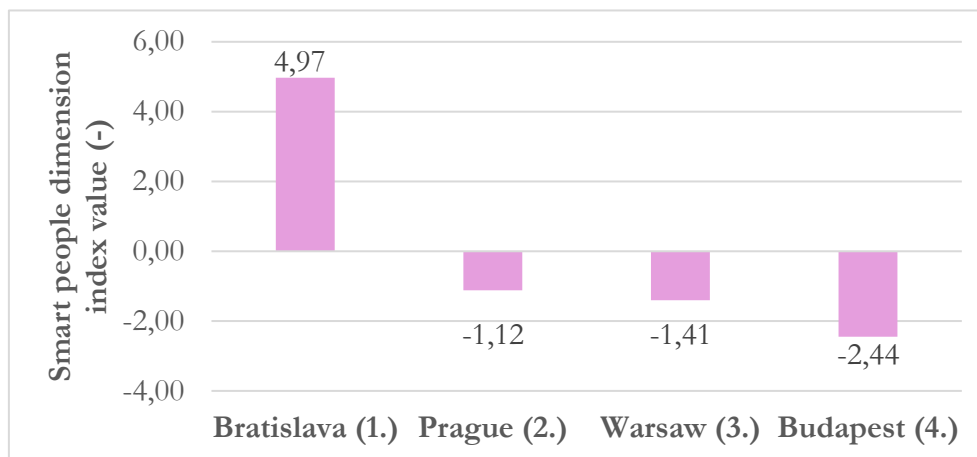
Figure 4: Graphical representation of the index value of the people dimension of cities, city ranking
Source: authors' own editing, 2024

The first place in the smart governance component, as in the people dimension, goes to the Slovak capital Bratislava. Second place went to the city of Prague and third to Budapest. Warsaw came last, due to a poor score on the indicator of the population's interactions with public institutions.

The best performing city in the smart environment dimension is Warsaw. It has a very low per capita waste rate compared to other cities and the most green spaces. Warsaw was one of the first cities to join the Green City Action Plan, which includes 27 steps to reduce waste, cut greenhouse gas emissions by 40%, protect and restore the city's biodiversity, use renewable energy sources and save the city nearly 130 million euro through a range of measures (arup.com, 2024). On the basis

of the indicators included, Bratislava came second, Budapest third, while Prague had the lowest value for the dimension and therefore fourth place. The last city in the ranking was outstanding in terms of green spaces, but this was not enough to achieve a better ranking, given its poor performance on the other indicators.

The winner of the smart living dimension is Bratislava, so it was already the best performer in the third dimension. Its position is due to the financial situation of households and positive opinions about health services. Prague came second and Budapest third. Warsaw is the worst performing city in the smart living dimension.

The top three places in the smart mobility component are Bratislava, Prague and Warsaw. From a mobility perspective (not necessarily a positive one from an environmental point of view), Bratislava scored very well on the passenger cars per thousand inhabitants indicator, placing it in the top position. Budapest again came last, with both indicators much worse than the other cities surveyed.

By summing up the values of each dimension, I obtained the value of the complex index and thus the ranking of the cities studied, which I interpret using Figure 5 below.
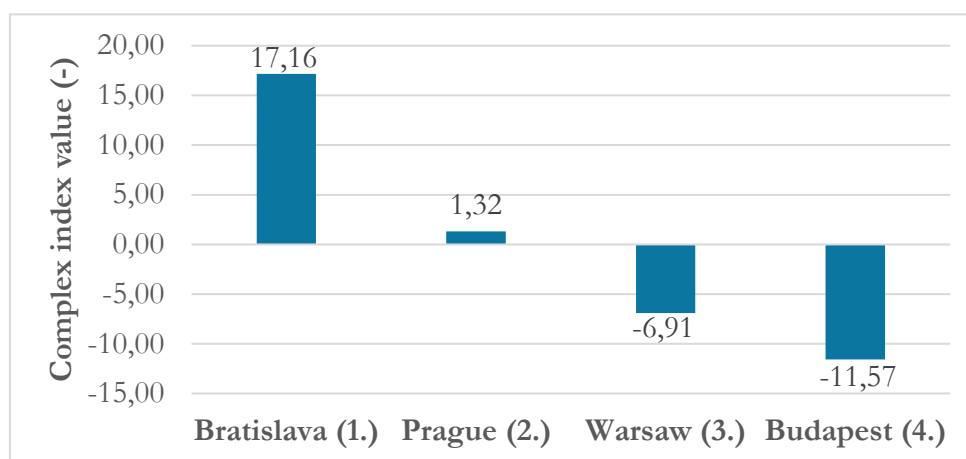
Figure 5: Graphical representation of the complex index of cities, city ranking
Source: authors' own editing, 2024

The overall results show that Bratislava came out on top with an index score of 17.16, the best performing city in four dimensions. Prague came second with an index score of 1.36. Its performance in the smart economy component was the best.

Warsaw came third among cities with an index score of -6.91. Although it performed best on the environmental dimension, it was worst on two dimensions (governance, living) and managed to score two third places and one second place, which was only enough to secure this ranking. Budapest came last in the survey. The Hungarian capital was ranked last in three dimensions and third in three, which was only enough for last place overall.

We compared our results with the IMD 2021 Smart City Index ranking (IMD, 2021), during which analysis Warsaw ranked 75th, Prague 78th, Bratislava 96th and Budapest 97th out of the 118 cities examined. It can be seen that the rankings of the two studies differ for the four cities examined, in the IMD survey, Warsaw ranks first, while Bratislava ranks only third in the complex index. In the case of the smart people dimension, the order is Prague, Warsaw, Bratislava and Budapest. The main reason for the difference in the rankings is the difference in the indicators used during the study.

Summary, conclusions

In our research, we investigated the linkages between smart cities and human resource management, with a focus on employee competences and corporate competitiveness. After a literature review, we analysed the Visegrad Group capitals using 19 indicators in the Giffinger's six smart dimensions. The study clearly reflects the relationship between smart cities and human resources. The results of the smart people dimension show that a well-educated, creative workforce both contributes to increasing the competitiveness of smart cities and companies. Of the cities we examined, Bratislava performed best in terms of both the complex index scores and the people dimension, followed by Prague and Warsaw, with Budapest in last place. For the people dimension, the indicators included also show that a well-educated workforce contributes to the success of both companies and the city. Each dimension was examined separately, and for Hungary it is regrettable that there was no dimension in which Budapest was the best compared to the other three cities.

The topic we are investigating offers further research opportunities. In the future, we would like to compare companies in smart cities in terms of competitiveness and include more cities in the analysis of the values of the complex indices. These analyses could even give direction to business decision-makers on where to locate new plants or where to start production. Last but not least, we believe it is important to help the leaders of the city of Budapest to take measures that will enable the city to catch up with the capitals of the Visegrad Group.

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