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Article

The prospects of the automotive sector in the regional development of Hungarian counties: A human resource perspective

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Abstract: This study aims to examine the role of automotive industry development in the regional growth of Hungarian counties. Through word frequency analysis, the counties were grouped, and their unique characteristics were highlighted. Some counties already play a prominent role in the domestic automotive industry hosting established Original Equipment Manufacturers (OEMs), a significant number of automotive suppliers and high R&D and innovation potential. Another group includes counties that currently lack a significant automotive industry and did not identify it as a key focus area for future development. Additionally, an intermediate group has also emerged, including counties where the automotive industry is either in its early stages of investment, or such development is prioritized in regional planning documents. The study details the direction of automotive development in counties where the industry plays a significant role, focusing on labor market characteristics and human resource development. The findings have significant implications for the future of the automotive industry in these counties, underlining the urgent and immediate need for well-managed and well-established human resource development and ensuring effective partnership to realize its full potential in the automotive industry.

Keywords: automotive industry; human resources development; Hungary; labor market; regional development

1. Introduction

This study aims to examine how developments in the automotive sector are reflected by counties' regional development concepts, with a focus on employment and human resource development. In addition to presenting and evaluating the current situation, the research highlights the value of these concepts as rich sources of data, as they provide valuable information for plans due to their multi-faceted approach.

The joint analysis of the two areas—the automotive industry and regional development—is also crucial because it ensures consistency between horizontal and sectoral policies. This development can have different effects on areas with different characteristics; therefore, industrial development also needs to be spatially aware, and the consequences of any interventions need to be assessed. In this study, special attention is given to the labor market, employment policies, and related human resource development, which are key aspects of county-level development strategies related to the automotive sector. The availability and developmental potential of human resources in a given area—as endogenous resources—are crucial factors that shape a country's or a county's long-term development prospects.

Due to the link between regional development and industrial policy, demographic changes, the industrial structure, housing issues, labor market trends, and their potential evolution should also be taken into account. Consequently, planning should

consider specific regional needs and characteristics (Sági and Engelberth, 2018).

The research examines the role of the automotive industry in Hungarian counties, with a particular focus on human resources, and explores potential avenues for development. It is important to clarify that both the labor market and the automotive industry are influenced by numerous predictable and unpredictable factors. Although these factors fall outside the immediate scope of this study, they will be addressed in later chapters, where they will be analyzed in the context of specific county characteristics.

Some of the most important trends on the supply and demand side of the labor market include:

- technological change, digital transition, artificial intelligence;
- sustainability, green economy, climate change, expected scarcity of natural resources;
- growing social inequalities, challenges for certain social groups (e.g., women, youth);
- political uncertainties, geopolitical power issues, social disruption;
- rapid urbanization, concentration of jobs, housing inequality;
- demographic change, ageing societies, social problems;
- globalization, emerging market challenges, consumer ethics, data protection (Bakhshi et al., 2018).

All of these factors affect the automotive industry, which, as the largest manufacturing sector, is undergoing a major transformation that will also bring about changes in human resource management. In addition to general trends, there are also sector-specific changes, such as the rise of autonomous vehicles and electromobility, influencing the demand-supply gap in the labor market. All these changes affect industrial policy and related planning mechanisms (Aiginger-Rodrik, 2020). The challenges posed by these factors can only be addressed effectively in the long term through the collaborative efforts such as those discussed in later chapters of this study (e.g., business-education, domestic-foreign companies, etc.) (Iwasaki and Ueki, 2022).

Although it is evident that manufacturing is undergoing revolutionary changes, there is no consensus within the scientific community on the exact number of people employed in the automotive industry or the number of jobs being impacted by technological advancements (Makó et al., 2018). This lack of agreement makes planning much more difficult, especially at the level of smaller regions, where precise statistics are often unavailable.

The current labor market projections related to the automotive industry focus on broader employment trends within the sector. A study by PricewaterhouseCoopers (PWC, 2018) predicts a decline in demand for labor and a change in the skills required of employees, with a shift towards professions that were previously uncommon, such as data scientists, software engineers, and vehicle engineers specializing in emerging vehicle technologies. Additionally, the use of industrial robots and collaborative robots (cobots) is expected to increase to perform tasks alongside employees. As technological advancements accelerate, the time between R&D and implementation will be halved. These changes will significantly impact companies' workforce management and, as a result, the broader labor market.

A recent study by the International Monetary Fund (IMF, 2023) points out that combustion engine cars and electric vehicles are currently produced concurrently, leading to a higher demand for labor. However, this situation is expected to change in the future. Technological advancements, such as automation, robotics, and artificial intelligence, are likely to further reduce labor requirements in various areas, including logistics, assembly, and painting operations. From a labor market perspective, workers with secondary education are particularly vulnerable, as their roles are more susceptible to technological replacement. Additionally, younger workers, due to their limited experience, and older workers, who may struggle to adapt to new technologies, are also at risk of job displacement. While it is certain that these changes will have widespread effects, it is extremely difficult to estimate the impact due to the cross-sectoral nature of the industry's supply chains. Not only will large original equipment manufacturers (OEMs) be affected, but other members of the supply network as well.

The International Labour Organization (ILO, 2021) highlights a significant gap between the skills of the currently available workforce and those that will be required in the future. Similar to the findings of the PwC study, the ILO notes a growing demand for professionals such as application developers, artificial intelligence specialists and cybersecurity experts. To prevent labour shortages, the ILO underlines the need for continuous education and training, and lifelong learning, supported by broad collaborations and a focus on educational initiatives. Their research emphasises the critical role of time in this process: the slower the education system can react to the evolving needs, the higher the cost will be for both the industry and society in the long run.

The research uses keyword analysis to group counties based on the importance of the automotive industry in line with their regional development concepts. Following this grouping, the future development directions for the automotive industry are presented for counties that prioritize automotive development, with a detailed content analysis focusing on human resource development. The research seeks to address the following questions: What are the differences and similarities between counties in terms of how they perceive the role of the automotive industry in their local economies? What opportunities and threats have been identified for the industry? How does labor market and human resource development align with the county's automotive objectives and long-term visions?

The paper is structured as follows: The introduction is followed by a review of the relevant literature, primarily focusing on the main motivations behind the establishment of automotive firms after the regime change and current trends within the industry. The literature review also explores the role of central economic policy in the expansion of the domestic automotive sector and provides a brief description of the relationship between regional development and industrial policy. Following the literature review, the paper outlines the research methodology and presents a case study. The first step in the case study involves identifying the counties to be examined in detail using word frequency analysis. For the counties identified as most relevant in the keyword analysis, issues related to the automotive industry are presented, with details on areas related to human resource development. The study concludes with a summary of findings and suggestions for future research directions.

2. Literature review

After briefly introducing the history of the Hungarian automotive industry, the literature review will describe the industry's current characteristics and prospects based on the relevant literature. Elaborating the topic, particular attention is given to current and expected labor market trends and issues related to human resource development.

2.1. Motivations and effects of foreign direct investment (FDI) on the Hungarian economy

In the Central and Eastern European countries, industry became important after the Second World War, before which agriculture was typically the leading national economic sector. Socialism advocated the promotion of heavy industry, thus increasing the proportion of people employed in industry (Hardi, 2012). Before the regime change, Hungarian road vehicle production had its traditions in and around the capital, Győr and Székesfehérvár. Since then, some companies have changed their profile, others have gone out of business, and some have successfully adapted to industrial change (Kukely, 2005). FDI from the 1990s has positively impacted economic development in Central and Eastern European countries. As the main investors, automotive companies have linked the region's countries into the European and global bloodstream (Pavlínek, 2017). The prominent role of the automotive industry in the region is partly a legacy model. However, it is undeniable that it has also been shaped by multinational companies relocating to Central and Eastern European countries (Pavlínek et al., 2009).

Numerous studies have looked into the motivational factors behind location choices. In the 1990s, automotive companies began to prefer Central and Eastern European locations, seeing greater scope for realizing their production goals, also referred to in the literature as the "escape" from Western over-regulation. They have retained some of their successful operating models from the West but have insisted on low wages and flexible forms of employment in the East. They wanted to retain skilled labor but also relocated lower-skilled jobs eastwards (Jürgens and Krzywdzinski, 2009). Factors related to a location are also the determinants of day-to-day operations today, such as proximity to historically important automotive centers, the distance between FDI source and recipient countries, distance to export markets, transportation costs of delivering the product to market and the size of the internal market (Horbulák, 2019; Molnár, 2012), distance from suppliers, location of economic hubs and proximity to other countries in the region (Sass, 2020). Some of these factors basic requirements to achieve just-in-time production (Rugraff and Sass, 2016).

The major investors in the region are Germany and the United States. The share of investment from outside Europe is steadily increasing, mainly from Asian countries (Sass, 2020), seeking a place in the EU's growing market and becoming part of the established supply chains. In most cases, firms moving into Europe are being followed by their suppliers into the region and integrated into the vehicle manufacturing industry in Central and Eastern Europe (Völgyi, 2020).

These days, some factors have become more valuable, others have disappeared, and new ones have appeared. Developed infrastructure is still an attractive factor, but

besides that cheap labor has created a demand for skilled workers, which has justified the creation of partnerships and collaborations between businesses, educational and research institutions (Molnár, 2013). These cooperative possibilities are fundamentally required to increase innovation potential, raise the level of digitalization, and develop and introduce new technologies (Pelle et al., 2021). Governments have a prominent role in development through economic policy, as they stimulate innovation and meet training needs by creating the proper infrastructure, education system, and technological development (Kovács, 2017). A new challenge for the future industrial policy is to manage the effects of technological change in such a way that makes an industry more environmentally friendly and labor-friendly, too (Aiginger and Rodrik, 2020).

2.2. Characteristics of the automotive industry in Hungary

In 2021, the automotive industry contributed 24% to Hungary's manufacturing output. Passenger cars and car parts were the top two export products by value, both showing increases compared to the previous year, although this growth was partly due to the previous year's decline caused by the COVID-19 pandemic. The largest export growth was seen in electric car engines. Imports were also dominated by automotive parts and accessories, rising nearly 12% from the previous year. In the manufacturing sector, electrical equipment production has expanded significantly due to the rise of electric motors. However, overall automotive production faced a sharp decline, primarily due to the global chip shortage and the negative effects of the pandemic (HCSO, 2022). According to the Hungarian Central Statistical Office, by 2024, vehicle production accounted for 27% of manufacturing output. However, production volumes have continued to decrease, highlighting the industry's slowdown and its significant impact on employment (HCSO, 2024).

As of 2024, Hungary is home to four major vehicle factories: Audi Hungária Ltd. in Győr (Győr-Moson-Sopron county), Mercedes-Benz Manufacturing Hungary Ltd. in Kecskemét (Bács-Kiskun county), Stellantis Szentgotthárd Ltd. in Szentgotthárd (Vas county), and Suzuki Hungary Ltd. in Esztergom (Komárom-Esztergom county). Additionally, a BMW factory is currently under construction in Debrecen (Hajdú-Bihar county), and BYD is planning a new investment in Szeged, (Csongrád-Csanád county).

In Hungary's automotive industry, production is organized regionally, with a notable spatial divide between the northern and central counties and the eastern-south-eastern and south-western counties of the country (Nagy and Molnár, 2018). Northern Hungary's dominance is primarily due to its proximity to the border and to the automotive industry centers in the neighboring countries, which is particularly important for supplier connections. Mercedes-Benz Manufacturing Hungary Ltd. chose Kecskemét for its location because, after the early 2000s, it became clear that the availability of labor in the northern counties might become limited due to the significant investments in the manufacturing sector. Kecskemét and its surroundings had a tradition in the machinery industry, and the region is well-connected to Western Europe via motorways (Molnár, 2013). Despite earlier pessimistic forecasts, FDI has not bypassed Eastern Hungary and has increasingly targeted regions further east (Józsa,

2016). After 2005, multinational companies started looking for sites in the eastern part of the country (Török and Konka, 2019). The city of Košice in eastern Slovakia was also considered as a possible location for the BMW factory, but Debrecen was ultimately chosen. This decision was influenced by the lack of motorway access to eastern Slovakia, which would have required the use of Hungarian motorways for transport and logistics (Horbulák, 2019).

In the past decade, the countries of the Central and Eastern European region have been engaged in constant competition to attract automotive companies using advanced technology (Rechnitzer, 2016), as the competitiveness of regions with automotive industries "on average significantly exceeds that of regions without automotive industries", with lower unemployment rates, higher income-generating capacity and higher levels of economic activity (Dusek, 2012, p. 288). For this reason, it is also crucial for companies to embed themselves into the local environment by establishing relationships with various institutions (Rugraff and Sass, 2016), as it is not FDI-based vehicle assembly plants that are the key to the success of the Hungarian automotive industry, but domestic companies that add higher value and are capable of integrating into production chains (Molnár et al., 2020). The government will face two challenges in shaping the future budget support system. On the one hand, it is not enough to support the strengthening and growth of supplier networks financially, but it is also necessary to design development programs in line with market demand. On the other hand, fostering the growth of new businesses focused on innovative supplier industries and advanced technologies should be prioritized (Halmosi, 2021). These measures are particularly critical because only a small number of domestic suppliers have the financial and human resources necessary to pursue higher value-added activities (Szalavetz, 2022).

Between 2008 and 2018, the number of people employed in the automotive sector in Hungary increased by 35%. Employment growth has been spatially differentiated, except for a few counties (e.g., Győr-Moson-Sopron, Fejér or Veszprém), mainly in manual jobs. Employment growth indicates that Hungary continued to be a destination for investment during the period, but after 2019, there was a decline in demand for labor. The leading companies providing employment are located in Győr-Moson-Sopron, Vas, Veszprém, Borsod-Abaúj- Zemplén, Bács-Kiskun counties, with the largest employers being original equipment manufacturers (OEMs) and key foreign suppliers. Győr is the national leader in automotive R&D, followed by Budapest, which serves as a center for business and other services in Hungary (Molnár et al., 2020).

The transition to electromobility also raises several questions for the automotive industry. Companies will also face changes in employment, not only in assembly plants but also supplier networks. In many areas, this shift is already evident. After years of steady growth followed by stagnation, the number of employees has been decreasing for several years, with labor demand hitting record lows in recent years. This decline is mainly due to three main factors: (1) a reduction in production volume, (2) a decrease in the number of components for vehicles, (3) an increase in the technological sophistication of manufacturing processes (Rísquez Ramos and Ruiz-Gálvez, 2024). The transition to new production processes should likely be preceded by years of continuous skill development to ensure that the shift occurs as smoothly

as possible (Szalavetz, 2022). Predicting the actual impact is also difficult because the automotive supplier base is diverse and connected to various industries, making it difficult to clearly define or assess due to its lack of concentration (Schito, 2020).

2.3. Development trends in the Hungarian automotive industry

In the Central and Eastern European countries, the automotive industry plays a significant role in manufacturing, making their economies heavily reliant on this sector. This dependency carries risks, as economic crises can heighten vulnerability, emphasizing the need for proactive government intervention (Pavlínek and Zenka, 2010). The automotive industry in Hungary has been largely shaped by substantial government support in recent years, influencing the level of foreign working capital inflows, research and development, technology transfer and the development of supplier networks. In Hungary, the automotive industry plays a key role, with a significant support of the government. During re-industrialisation, the priority is to support higher added-value activities. Foreign companies should develop strong relationships with the local supplier networks, fostering knowledge and technology transfer that can also benefit other sectors (Halmosi, 2021). However, despite considerable efforts, government interventions to close regional development gaps often have limited impact (Kocziszky and Szendi, 2021). This presents a persistent challenge for policymakers: deciding where to focus support and economic strategies. For Hungary's automotive industry, the core dilemma revolves around either reducing dependence on foreign capital or increasing productivity (Bakacsi, 2019).

The development of counties requires area-specific economic interventions, depending on the area's potential. A different set of instruments should be used where there is scope for knowledge-based development, and different expectations should be set for the development of rural areas (Varga and Lengyel, 2018). However, it is nearly impossible for the Hungarian counties to break out of their assigned roles through self-driven efforts alone, raising constant questions during the development process about how a county can attract investment and what assets it can leverage to enhance its appeal (Török and Konka, 2019).

These days, the development of firms already firmly embedded into the local economy is becoming increasingly important, yet attracting new investments still remains essential. Because of the opportunities available, innovative companies and their suppliers play an important role in regional development and labor market trends due to the opportunities they create (Kukely, 2005). In Hungary, counties with a high concentration of foreign direct investment (FDI) are the primary drivers of economic growth and GDP, rather than those focused on R&D and business services. However, this often leads to special imbalances, where these companies operate in isolation, with low economic embeddedness into the domestic economy. In many cases, the main, and sometimes the only connection to the local economy is through the employment of local workers (Gál, 2019).

The giant companies in the Hungarian automotive industry are mainly export-oriented. Therefore, events in the global economy and the world market have a major impact on the sector and, thus, the domestic industry (Braun et al., 2020). In recent years, counties with a strong presence of export-oriented sectors have had the highest

GDP per capita. However, this reliance on exports raises concerns for the long term, especially in light of recent events (Kocziszky and Szendi, 2021).

Many investments involve the adaptation of foreign technology in Hungary. As a result, the host country faces the urgent task of creating and developing the necessary background and providing the required human resources (Rechnitzer et al., 2017). Policymakers must recognize that by improving education and skills, adverse changes in the labor market can be partly avoided or at least mitigated (Szalavetz, 2020).

In the automotive industry, strong international competition is also reflected in the sensitivity of companies to country-specific advantages and disadvantages when making a decision (Meardi et al., 2013). Human capital is the key factor of industrial development and the foundation of a knowledge-based society. Of all investments made by the state, the development of human resources will provide the greatest return, given the growing labor shortages across Europe, especially for skilled workers (Lux, 2017). Economic policy also plays a crucial role in shaping industrial structures, including employment policy and the integration of domestic micro, small and medium-sized enterprises (SMEs) in the sector's development (Nagy and Molnár, 2018).

2.4. Industrial policy, regional development and automotive industry

Aiginger-Rodrik (2020) underline that regional planning must be a priority in future industrial policy. Rather than the top-down, centralized policy, emphasis will be put on a broader cooperation between the public and private sectors. This model aims to balance productivity with social goals and interests. In essence, it represents a systems approach that integrates regional policy objectives with innovation, circulation and production.

Bianchi and Labory (2019, p. 239) have examined the connections between planning and industrial policy at regional level. Their study highlights four key conditions that foster and support adaptation and development of regional industrial policy at county level, which can be summarized as follows:

"1) Capabilities: R&D investment, skills, university-industry links, infrastructure (communication, energy, transport);

2) Networking: between all actors in the regional system, i.e. firms, universities, research centres, educational institutions, etc., both within and outside the region;

3) Governance: has to be participative; and

4) Coherence: between policy levels and between policy areas."

However, locally-based incentives can only be successful if they are coupled with efforts to strengthen institutions and infrastructure (Ságі and Engelberth, 2018). Beside emphasizing the exclusivity of regional industrial policy, it is important to highlight the national level plays an equally important role in ensuring the coherence of development planning and implementation across different geographical areas and within diverse framework conditions (Bianchi and Labory, 2019).

Recently, there have been several studies on the relationship between industrial policy and the development of the automotive industry. Yülek et al. (2020) compared South Korea and Turkey and analyzed the role of industrial policy in developing the automotive industry. They found that, among many other influencing factors, local

industrial policy also affected the success of development. South Korea placed greater emphasis on developing domestic technologies, industrial capabilities and human resource training, and these areas were much more prominent in the design and operation of industrial policy than in Turkey.

Similarly, Barnes et al. (2017) compared South Africa and Thailand. They found that, in addition to several other factors such as location and favorable trade policies, industrial policy also led to different development paths in the two countries. In the context of Thai policy, it is important to highlight a regulation relevant to this study, i.e., to achieve a balance, the country encouraged the creation of industrial zones in areas away from the capital with the aim of decentralization. However, it is also underlined that even generous sector-specific industrial policy support measures cannot compensate or substitute for deficiencies in areas such as trade policy, skills for competitiveness, infrastructure and public investment.

Trippl et al. (2021) highlight findings from an Austrian study, where interviews with various automotive organizations underscored the critical importance and potential of effective collaboration between automotive companies, support organizations, and policymakers. This cooperation not only facilitated the exchange of ideas but also helped develop the necessary skills to meet market demands - an outcome that hinges on the consistent and effective involvement of support organizations.

However, for effective and efficient local planning and implementation, institutions must be involved at all levels of cooperation. Beyond fostering strong relationships and active participation in development projects and planning teams, they should also evaluate the outcomes of joint efforts and use the lessons learned for further development (Rantala and Ukko, 2019).

3. Material and methods

The importance of comprehensive, holistic territorial analyses is increasing, focusing on a region's development level, trajectory, future opportunities, and plans. Equally important are human factors, - such as education, employment, and other social characteristics—which play a critical role in shaping a region's development and potential (Kocziszky and Szendi, 2021).

The most widely cited definition of content analysis describes it as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (Krippendorf, 2004, p. 18). This method aims to determine the meaning of the text, which can range from a strictly controlled quantitative approach using statistical tools to a more permissive qualitative approach that emphasizes reading, interpreting and classifying the content. In practice, this research approach involves applying existing theories or categories, while maintaining an open mind with the goal of obtaining evidence (Gheyle and Jacobs, 2017). Qualitative content analysis is a flexible method to explore connections with previously formulated questions and the direction of the research. The texts analyzed through content analysis can be diverse with the goal being not necessarily to generalize about an entire population but rather to provide an in-depth understanding of a specific case (White and Marsh, 2006). This kind of analysis involves expanding

small pieces of data through detailed interpretations, allowing for the exploration of different contexts and the generation of meaningful insights. It is particularly effective for organizing large datasets, identifying patterns, and exploring relationships. Qualitative content analysis often combines comprehensive analysis (overview, condensation, and summarization) with more detailed approaches including categorization and structural identification (Flick, 2014).

When analyzing content, it is unnecessary to use tables and figures, as a descriptive analysis of the text can provide deep insights. The most valuable tools are those that link concepts and lead to deductively testable hypotheses (White and Marsh, 2006). Not all social phenomena can and should be quantified and explained solely in terms of numbers, especially when dealing with non-numerical texts that are not structured in ways conducive to numerical analysis. The choice between machine and manual analysis can be influenced by many factors: the scope of the project, available resources (financial and time), and the researcher's preferences and expertise (Basit et al., 2003). The researcher should consider whether automated methods offer advantages over manual ones, such as reducing the time required for analysis or producing more objective results. For small samples, automating the analysis does not lead to efficiency gains, as the preparation phase often requires a significant investment of time that may not be offset during the analysis phase. Moreover, automated analysis of texts requires both pre- and post-interpretation, as well as multiple modifications in the process (de Graaf and van der Vossen, 2013).

In this study, the manual analysis method was chosen due to the relatively small number of documents and the scattered nature of information within them.

As a first step, the county regional development concepts were downloaded from the websites of the county municipalities. The impact assessments of the concepts do not form the basis of this research, as they were either unavailable or, in some cases, a single assessment covered multiple development documents. Additionally, counties vary in how they publish final documents, with some releasing them as a single report, while others publish them separately.

As a second step, the predefined keywords "car" and "vehicle" were identified within the regional development concepts of the nineteen counties. Semantic content analysis was also used in the keyword search to examine the context of these terms. The keywords unrelated to the focus of the research such as "motorway" or "vehicle fleet" were excluded, while terms like "vehicle industry", "vehicle manufacturing", "automotive industry", and "car parts manufacturing" were accepted. The frequency of acceptable terms, based on contextual analysis, was then counted in each document.

As a third step, the figures were used to divide the counties into three groups, and the analysis was complemented by the results of two related studies at county level. The grouping of counties was based on the results of the keyword analysis and the preliminary results of the content analysis.

Step four involved the comprehensive presentation of the groups and the characterization of the counties. Special attention was given to counties that, according to their development concepts, prioritize the automotive industry as a key policy area. For these counties, a detailed analysis was conducted, focusing on the characteristics, challenges, and objectives related to the human resources.

4. Results

Regional development concepts must promote socially, economically, and environmentally sustainable development, while ensuring equal opportunities, and territorial cohesion. The county concept sets out the county's long-term horizontal and comprehensive objectives, development principles, and long-term vision. The regional development concept of the counties consists of two phases. (1) The preparation phase involves organizing, assessing the factors affecting development, as well as examining development directions. (2) The proposal phase elaborates the county's vision and defines the most favorable development direction. A wide range of stakeholders including institutions, public organizations, businesses and other entities are involved in the preparation and consultation of the concept. Once approved, regional development concepts must be published on the county council's website in accordance with Decree 218/2009 (X.6). Additionally, these concepts must align with the objectives of the National Development and Territorial Development Concept. **Figure 1.** shows the main findings of the National Development and Territorial Development Concept related to the vehicle industry.

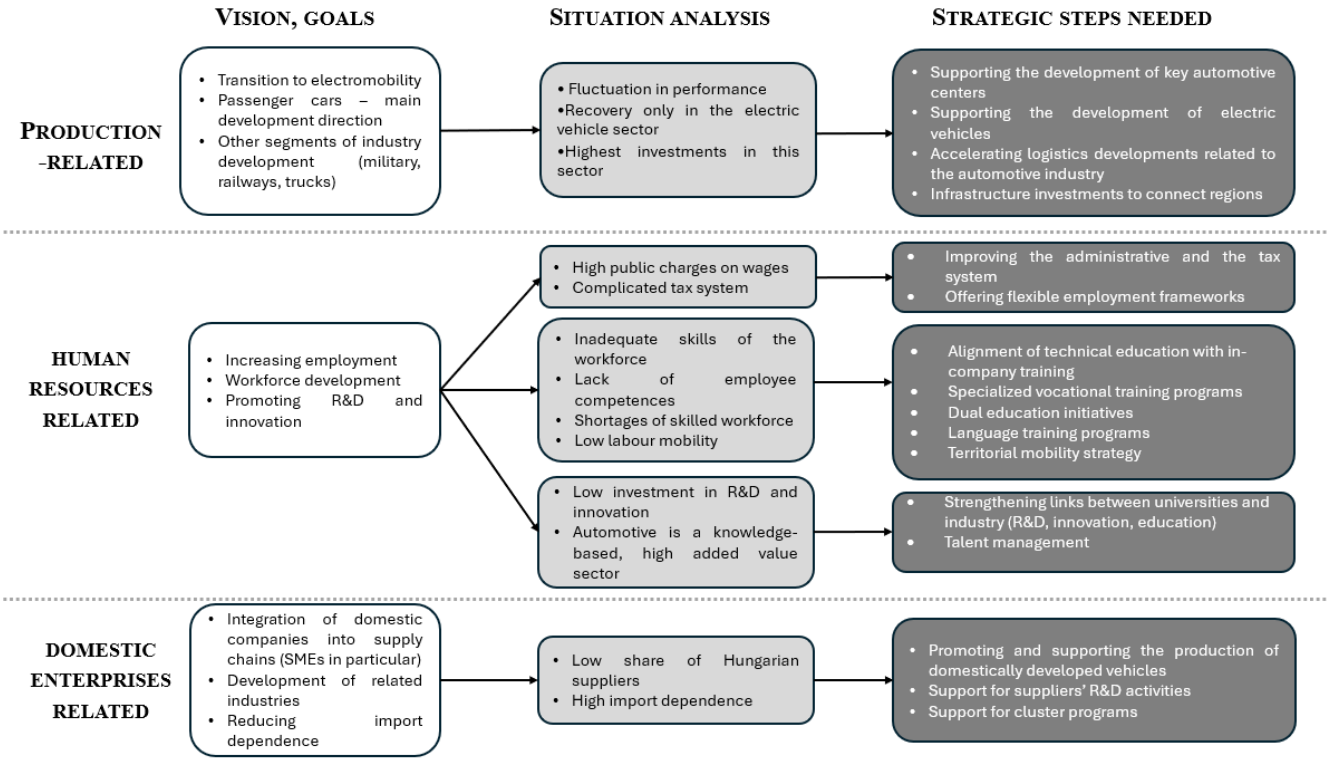

Figure 1. Automotive strategy in the National Development and Territorial Development Concept. (Compiled by the author).

Hungary's Competitiveness Strategy for the period 2024–2030 reinforces the objectives outlined above. By 2030, Hungary is expected to become a key hub between the Western and Eastern automotive industries, a significant testing and manufacturing center at European level and a leading European country in developing the electromobility ecosystem. The key strategic objectives aim at increasing the competitiveness of domestic suppliers through development programs and targeted subsidies, supporting knowledge transfer and development opportunities for the

transition to electromobility, ensuring an associated ecosystem, and developing human resources to improve the quality of training for automotive engineers and technicians (HCS, 2024).

4.1. Word frequency analysis

Table 1 presents frequency of predefined keywords in the regional development concepts of the counties, supplemented by the findings from two previous studies. The first, based on Lengyel and Varga (2018), classifies counties according to their economic development path and role, while the second, by Molnár et al. (2020), shows the share of employment in the automotive industry across Hungarian counties. The validity of keyword analysis as a research tool is supported by the fact that the ranking based on keyword frequency is consistent with the results of the two empirical studies. The differences between the results of the surveys are explored further in the county-specific analysis.

Table 1. Results of the keyword analysis.

Name of the county	Number of the keywords	Type of the county [1]	Share of employees, % [2]	Role of the automotive in regional development
Győr-Moson-Sopron	96	FDI manufacturing	24.4 (1)	Significant
Bács-Kiskun	39	Re-industrializing	8.8 (6)	Significant
Veszprém	34	Re-industrializing	11 (2)	Significant
Pest	28	Centrum	9.2 (4)	Significant
Zala	28	Re-industrializing	1.3 (10)	Significant
Vas	19	FDI manufacturing	8.7 (7)	Significant
Heves	17	Re-industrializing	3.9 (9)	Significant
Komárom-Esztergom	16	FDI manufacturing	8 (8)	Significant
Fejér	15	FDI manufacturing	10.4 (3)	Significant
Szabolcs-Szatmár-Bereg	15	Rural	0.6 (15)	Moderate, growing
Hajdú-Bihar	12	Knowledge center	0.3 (16)	Moderate, growing
Csongrád-Csanád	9	Knowledge center	0.2 (17)	Moderate, growing
Jász-Nagykun-Szolnok	6	Re-industrializing	0.9 (13)	Insignificant
Borsod-Abaúj-Zemplén	5	Re-industrializing	8.9 (5)	Insignificant
Nógrád	4	Rural	0.8 (14)	Insignificant
Somogy	4	Rural	0.2 (17)	Insignificant
Baranya	2	Knowledge center	1.1 (11)	Insignificant
Békés	1	Rural	0.2 (17)	Insignificant
Tolna	1	Rural	1 (12)	Insignificant

[1] Lengyel and Varga (2018, p. 504) (types of counties based on the development path and current role)
[2] Molnár et al. (2020, p. 143) (Share of employees in the Hungarian motor vehicle industry in 2018, % (national ranking position))
Source: Regional development concepts.

Based on the keywords analysis, the counties can be divided into three groups:

The first group includes counties where the automotive industry currently plays a minimal role and is not seen as a significant area for future development. Within this group, the counties can be further divided into two parts. The concepts envisage their

future involvement in the automotive process for three counties. Baranya county has a significant tradition in the machinery industry, numerous industrial suppliers operating in the county, although they are spatially concentrated. However, further development in this area will require significant investment in human resources. The county concept also states that the "possible establishment of a multinational company in the automotive sector" could boost the situation in the county (RDC-BAR, 2020, p. 67). In Jász-Nagykun-Szolnok county, the growing significance of the automotive industry, alongside the electronics sector, is regarded as a potential key driver of economic growth. However, further industrial progress will require increased investment in both infrastructure and human resources (RDC-JNSZ, 2021a, 2021b). Borsod-Abaúj-Zemplén county, while primarily characterized for its significant role in the machine and chemical industries, has a more limited engagement with the automotive sector. Although technological advancements have had a noticeable impact, the automotive industry's influence remains subdued. The high share of employment in the automotive industry likely stems from the presence of related industries with numerous automotive suppliers (RDC-BAZ, 2020a, 2020b). In the case of the other four counties in this group, the potential for automotive and industrial advancement does not even appear at the planning stage. Békés county is characterized by its agricultural focus, with low levels of industrialization and a lack of major industrial suppliers (RDC-BEK, 2021a, 2021b). In Nógrád county, although the automotive industry is of particular importance within the industry, the county has low productivity, far below the national average. The county aims to move beyond the stigma of its industrial past and shifts its focus toward tourism, food and health industry (RDC-NO, 2020a, 2020b). Similarly, Somogy county is not primarily oriented toward industrial development, but rather aims to develop tourism, agriculture and the food industry. The county lacks major industrial employers and dominant foreign companies (RDC-SO, 2021). Tolna county, on the other hand, targets the development of the machinery industry, positioning itself as a supplier of the automotive industry, which would be significantly bolstered by the county's strong economic ties with Germany (RDC-TO, 2021).

The second group includes two counties where the role of the automotive industry was moderately identified in the keyword analysis, yet significant expansions are planned in this sector. Csongrád-Csanád county is set to enhance developments with the Chinese company BYD planning to establish a factory in the region. Meanwhile, Hajdú-Bihar county improves rapidly, as the construction of a BMW factory is already underway, with production expected to begin soon. The automotive industry in Csongrád-Csanád county is only one of the potential development directions (RDC-CS, 2020a, 2020b). The establishment of the BMW factory in Hajdú-Bihar is particularly noteworthy, as it represents a significant advancement for the county, addressing the historical neglect of many areas in the eastern part of Hungary regarding industrial investments since the change of regime (RDC-HB, 2021a). For the two counties identified as knowledge bases, it will be interesting to determine whether they can take advantage of the opportunities offered by prominent universities and research centers to enhance R&D and innovation potential in the automotive industry. Based on the concepts outlined, Szabolcs-Szatmár-Bereg county has been added to this group, due to the significant increase in the automotive industry's role,

which is growing faster than that of previously dominant industries in the region. The county has a robust rubber and plastics industry, creating potential for building a network of automotive suppliers (RDC-SZB, 2021a, 2021b).

The third group includes counties where the automotive industry and related activities play an important role for future development. This group includes four counties which host original equipment manufacturers (OEMs): Bács-Kiskun, Győr-Moson-Sopron, Komárom-Esztergom and Vas. It also encompasses counties with a strong industrial tradition and significant base of automotive suppliers, such as Fejér, Heves and Veszprém. Additionally, the county of Pest plays a vital role in R&D and innovation, while Zala county, known for its strong industrial tradition is also a target for R&D investments in the automotive sector.

4.2. The emergence of human resource factors in counties with a significant automotive industry

In counties where the automotive industry and related developments are part of the future strategy, several common themes can be identified based on the concepts. Employment policy issues are a priority in all situational analyses and target settings. Transforming sectors such as the automotive industry is central to Hungary's economy and impacts various sectors, in addition to the automotive sector. The Regional Development Concept of Fejér County highlights these concerns most effectively, expressing worries about the "slow response, intermittent shutdowns and market losses in the automotive and automotive component manufacturing industry" (RDC-FE, 2021, p.171).

The global transformation of the automotive industry, along with reduced response times is urging national authorities to collaborate and with industry and education stakeholders to develop strategies to transform the training system. The aim is to create a market-driven education system that ensures the continuous availability of a skilled workforce tailored to the needs of the labor market.

The concepts reflect an excessive foreign dominance in the automotive sector, which has strengthened the regions' economies through significant developments after the change of regime and continues to positively influence regional economies and employment. However, this dominance reduces the focus on local interests in decision-making and could lead to further challenges in the event of an economic recession. This concern is particularly relevant for Győr-Moson-Sopron and Bács-Kiskun counties, where both concepts (RDC-BK, 2021a; RDC-GY, 2021a) highlight that, despite the positive impacts, the heavy reliance on the automotive sector poses considerable risks to the labor market. Vas county describes its economy as diversified, yet it remains strongly industrial. The county analysis (RDC-VA, 2021) indicates that while the automotive industry is significant, there is an anticipated decline in the role of the Opel plant both within the county and the region. Nevertheless, the transition to e-mobility and the enhancement of adaptability within the related education sector are also critical areas of focus in Vas county.

The county concepts prioritize the development of domestic enterprises, their integration into the supply chains, as well as the strengthening of small and medium-sized enterprises. One potential strategy to achieve this is through innovative cluster

programs, as formulated in the Pest county Concept (RDC-PE, 2021b). However, it remains uncertain whether domestic SMEs can be integrated into established supplier relationships to such an extent that the dominance of foreign companies can be reduced. The concept of Győr-Moson-Sopron county also highlights the challenges faced by new companies to enter the established value chains noting that it is even more difficult for them to gain foothold and influence decision-making (RDC-GY, 2021a, 2021b). Additionally, there is an aim to increase the efficiency of domestic companies, as the automotive industry often experiences low productivity. This is evident in Veszprém county, where a significant number of workers are employed in the automotive industry (RDC-VE, 2021a).

Labor shortages are a common theme across all development concepts. While many highlight favorable labor market indicators, the outlook remains bleak due to adverse demographic trends and low population retention, particularly among skilled and young individuals. In Győr-Moson-Sopron county, demographic and migration indicators are more favorable than the national average, yet the region faces significant ageing issues (RDC-GY, 2021a). Fejér county experiences both labor shortages and surpluses, characterized by structural unemployment, and has seen an influx of foreign workers in recent years (RDC-FE, 2021). Similarly, foreign workers are also employed in the automotive sector of Bács-Kiskun and Győr-Moson-Sopron counties (RDC-BK, 2021a; RDC-GY, 2021a), as well as in almost every major city in the country. Veszprém county is facing a notable labor shortage in the tourism sector. However, due to the transition to electromobility and other changes, the aim is to mitigate labor shortages in the automotive industry, which is increasingly important to the county's economy (RDC- VE, 2021a). Pest county has not yet experienced labor shortages, but the concept emphasizes the need for proactive measures in high-growth industries through ongoing supply-demand analysis and market-driven training (RDC-PE, 2021a). Additionally, limited labor mobility also causes disruptions, particularly between urban centers and peripheral areas, as automotive companies tend to cluster around major cities for proximity to one another.

Collaboration between educational institutions, automotive companies, government agencies and other key market actors is included in all concepts to avoid future labor market disruptions. In each case, the situation analyses and plans provide insights and proposals tailored to the specificities of the respective counties. For example, a high drop-out rate in vocational education in Bács-Kiskun county should be reduced as a priority to steer economic and social processes in a positive direction. The needs of the economy and education should be better aligned because the current training structure is not tailored to real market needs (RDC-BK, 2021a, 2021b). Similarly, in Komárom-Esztergom county, the concept emphasizes that vocational training should be closely aligned with the economic profile of the region. Additionally, strong external influences from neighboring counties on both education and the labor market present challenges for localized development efforts (RDC- KE, 2021). Fejér county is also affected by the attractiveness of the labor market in Budapest and Pest county, which impacts employment structure in its automotive sector. However, the proximity of Budapest and other significant counties involved in the automotive industry also provides significant economic advantages for Fejér county. While the county's institutional background is adequate for labor market

development, cooperation, dual training and research need further development. Plans to expand the automotive industry in the Mór region are contingent on the parallel development of the education system (RDC-FE, 2021). Vas county also aims to have an innovative workforce linked to the local economy, and the vocational training system has already started to adapt to this goal. While the county would benefit from cooperation with the neighboring Austrian region in various areas, the differences in economic systems hinder this collaboration (RDC-VA, 2021). In Győr-Moson-Sopron county, cooperation with the Széchenyi István University is outstanding, with a well-established network of dual education partnerships enhancing vocational training (RDC-GY, 2021a). Similarly, in Veszprém county, the University of Pannonia also plays a prominent role in R&D and innovation influencing both county-wide and regional development (RDC-VE, 2021a). At the national level, the proportion of unemployed graduates is on a steady rise. For example, Heves county faces a shortage of engineers due to the lack of technical higher education despite being home to two universities. These universities should collaborate with technical higher education institutions to adapt to labor market needs. Efforts are also focused on integrating young people into the education system and offering retraining opportunities for adults, which indirectly aims to alleviate the social problems of the county (RDC-HE, 2021a, 2021b).

The situation in Pest and Zala counties is slightly different from that of the other counties in the group. In Pest county, while the automotive industry plays a notable role in employment, it is not the dominant sector. The county's suppliers perform well, but Pest struggles to attract increased investment in this field because it cannot compete with other counties on subsidies and costs, including labor expenses. As a result, it is less favorable for site selection. In the automotive sector, Pest county aims to attract high-value-added automotive R&D centers, because Budapest, Hungary's business and service hub is in this county. The county's strength lies in its high- value-added manufacturing sector, which benefits from significant investment in R&D and other innovations, primarily driven by foreign companies. Pest county's innovation landscape is characterized by two distinct pillars: a large corporate and industrial segment, and a knowledge-intensive entrepreneurial community, dominated by micro-enterprises. Expanding the number of automotive R&D centers is a key priority, but the shortage of local skilled labor remains a challenge (RDC-PE, 2021a, 2021b).

Zala county has been the target of significant industrial investments in recent years, which explains why its role in the sector's employment has only been prominent recently. The growth of the automotive industry is largely driven by the internationally important ZalaZone Automotive Test Track and new investments which encourage the county's development. Zala county boasts a significant R&D capacity, primarily in the automotive related industries, supported by the higher education institutions in its two largest towns, and collaborative efforts with the Automotive Research Center of Széchenyi István University in Győr. Additionally, Zala county is also a target area for the development of military-related vehicle manufacturing in Hungary. The manufacturing sector's higher-than-national average labor productivity and the presence of machinery, electronics and automotive industries provide a favorable economic environment for growth. Efforts are already underway to coordinate higher education and vocational training in the county, while fostering innovation in

partnership with academic institutions. The county's objectives include attracting working capital investment in the manufacturing sector, expanding R&D capacity, and enhancing the availability of skilled workforce to support ongoing development (RDC-ZA, 2021).

5. Discussion and conclusion

The analysis of the documents provided a comprehensive overview of Hungarian counties' role in the automotive industry, highlighting both current contributions and future development opportunities. Based on the scientific literature and regional development concepts of the counties, it can be concluded that counties with a strong presence of FDI play a prominent role in the national economy and automotive industry. However, these regions still often lack innovative, sustainable growth drivers, and investments in capacity growth provide only temporary economic benefits. In many cases, involving foreign-owned companies in development is difficult (Lengyel and Varga, 2018). The spatial distribution of the automotive industry in Hungary is not homogeneous, leading to varied challenges but also shared issues across regions (Józsa, 2016). The case study underscores the need for broader cooperation among companies, municipalities, government institutions, educational institutions and research centers. Some counties have made notable progress in fostering these partnerships, with joint projects and development initiatives already underway.

Economic diversification is a recurring theme in all development strategies, primarily due to the vulnerabilities associated with a single-industry economy. In counties where foreign-owned enterprises dominate key sectors, the challenge of limited local influence over strategic decisions becomes particularly evident. These concerns are most pronounced in the Bács-Kiskun and Győr-Moson-Sopron county concepts, as past crises affecting the automotive industry have spilt over to the local suppliers, resulting in significant economic downturns at the county level (RDC-BK, 2021a; RDC-GY, 2021a). A diversified economy would provide greater resilience to negative impacts in times of crisis. It is important to underline that diversification does not mean moving away from the automotive sector, but rather complementing it with the development of other industries. This was evident in Veszprém county, where the presence of multiple sectors helped mitigate the economic downturn caused by the pandemic-related decline in automotive production (RDC-VE, 2021a). It is clear that the diversification of the economy will heavily depend on the development of human resources.

With the spread of electromobility, a transformation of the automotive industry has already underway, with significant implications for human resources. R&D and innovation tasks will become increasingly important, while technological progress will require faster responses from the labor market, training institutions, and governments. Bianchi and Labory (2019) argue that globalisation and the Fourth Industrial Revolution are causing significant structural changes in industries, highlighting the need for localized industrial policies.

While the current focus is on the short-term effects of this transformation, there are also medium- and long-term changes that will affect the automotive and related industries in the future (Molnár, 2020). The role of government action will be further

enhanced by the transition to e-mobility, as changes in production structure will also pose significant challenges to the labor market, especially in countries where economic activity is highly dependent on the automotive industry. To address these challenges, a coordinated series of government-led measures will be necessary, along with a broader collaboration across sectors, to mitigate the impacts on the workforce during this transition (Rísquez Ramos and Ruiz-Gálvez, 2024).

One limitation of this research is the challenge of predicting how technological, demographic and other current trends may change the automotive industry at the county level. It is difficult to estimate the impact of future trends on individual counties due to the lack of detailed data and the complexity of factors involved. This only reinforces the study's key point: effective future planning is impossible without broad and inclusive cooperation. Furthermore, as highlighted by Rantala and Ukko (2019), these relationships must be continuously assessed, and a wide range of relevant organizations should be actively engaged in regional planning.

The decline in labor demand is already noticeable, not only in terms of reduced job numbers but also in the shifting allocation of roles within the sector and the growing need for a qualitative transformation of the workforce. It is still uncertain how this transformation will unfold, as it cannot be fully addressed through retraining and upskilling efforts alone (CEDEFOP, 2021).

Battery production will undoubtedly create jobs in the future, but based on current knowledge, the local added value will remain relatively modest (Szalavetz, 2022). Therefore, the concepts analyzed, and Hungary's Competitiveness Strategy aim to strengthen domestic companies and increase local value creation.

Currently, there are four OEMs with a significant supplier network in Hungary. With one new plant under construction and another planned, the importance of the automotive industry will further grow in the country. In addition, the role of battery factories in Hungary is steadily increasing, and further investments are planned. Alongside Western companies, Eastern firms are beginning to establish a presence. The key question is whether new automotive investments will come to Hungary and, if so, which counties or regions will be chosen and what deployment factors will be considered. It is clear that labor market factors and the availability of human capital will undoubtedly play a role in the selection of sites, as mitigating the negative effects of demographic changes on the workforce remains a global concern. In the case of the two factories currently under construction, the question arises whether the neighboring counties—especially those with a less industrialized and more agricultural profile—may or willing to join the development strategies in the automotive sector, benefiting from the positive effects of the investments. Counties with an industrial heritage, such as Baranya and Tolna in southern Transdanubia, may find it easier to integrate into the automotive value chains. In addition, it may be advisable to assess how the emergence of the automotive industry in the counties of Csongrád-Csanád and Hajdú-Bihar may impact economic development and whether increased foreign capital investment becomes a source of concern. Notably, in the case of Hajdú-Bihar, the county views the rise of the automotive industry as a means of diversifying its economy, which has historically been dominated by agriculture (RDC-HB, 2021b).

The potential for further investment is also interesting because companies will increasingly focus on balancing resilience and efficiency when choosing locations.

Strengthening connections between economic actors will also play a growing role in fostering development and positive outcomes (Goreczky, 2021).

According to the Hungarian Government's latest stance, the importance of the automotive industry will not diminish, and it will continue to be seen as key driver of the economy. By 2030, it, along with battery production, could contribute up to 30% of domestic industrial output. However, diversification is also emphasized in the recent strategy. A new industrial plan is being developed, which aims to protect jobs and ensure economic stability (GH, 2024).

By the next programming period, many of the current uncertainties should be resolved. In addition to the concepts, future research could be further deepened by reviewing the programs and other development documents incorporating the results into the findings of this research.

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