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USING ARTIFICIAL INTELLIGENCE (AI) FOR LOCAL TERRITORIAL DEVELOPMENT: DATA-BASED MACHINE DIAGNOSTICS OF LATVIAN MUNICIPALITIES*

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Received 11 September 2024; accepted 9 December 2024; published 30 December 2024

Abstract. The study investigates the application of artificial intelligence (AI), specifically the ChatGPT 4o tool, for data-based machine diagnostics of the local territorial development using Latvian municipalities as a case study. The topic is highly relevant due to the growing demand for precise, data-driven territorial diagnostics to address sustainable development and governance challenges. The study aims to evaluate AI tools' efficiency and contextual adaptability in performing municipalities' SWOT (Strengths, Weaknesses, Opportunities, Threats) analyses based on their annual public reports. Using discourse analysis as the methodological framework, the study focuses on five municipalities representing different typological clusters in Latvia: Riga City Municipality, Yelgava City Municipality, Liepāja City Municipality, Ropazhi County Municipality, and Augšdaugava County Municipality. Empirical results demonstrate the AI tool's ability to conduct detailed SWOT analyses, uncovering nuanced insights such as demographic challenges, economic dependencies, and opportunities for green transition initiatives. Notably, the tool highlighted innovative perspectives, such as the competitive impact of proximity to Riga on surrounding municipalities. The study identifies the AI tool's capabilities, including flexibility in focus, contextual socioeconomic and environmental factors integration, and efficiency in processing complex datasets. However, challenges such as data limitations and the necessity of human oversight were also noted. The findings contribute novel insights into the feasibility and potential of AI for local territorial diagnostics, paving the way for broader applications in regional development planning and policymaking.

Keywords: machine diagnostics; AI tool (ChatGPT 4o); discourse analysis; SWOT analysis; cluster analysis; territorial analytic data (TAD); annual public report; local territorial development; Latvian municipalities

Reference to this paper should be made as follows: Komarova, V., Kudins, J., Sannikova, A., Čižo, E., Ruza, O., Kokarevica, A., Zeibote, Z. 2024. Using artificial intelligence (AI) for local territorial development: data-based machine diagnostics of Latvian municipalities. *Entrepreneurship and Sustainability Issues*, 12(2), 443-459. <http://doi.org/10.9770/y3784695648>

JEL Classifications: R11, R58, O33, Q01

Additional disciplines: data science, computer science

1. Introduction

Data-based machine diagnostics of the local territorial development is a new approach to the monitoring, planning and other processes of managing the development of territories (Simonova & Sykora, 2011a, 2011b;

* This research was funded by Daugavpils University, Latvia.

Arnould et al., 2020; Nadtochiy et al., 2022; Sen et al., 2023). This new approach is vital to the success of policy development and the delivery of programmes, projects and operational services (Cervera, 2021), as well as to control the balance between economic development, social development, and environmental development (Grybaite & Tvaronavičienė, 2008). The absence of data-based general-scale diagnoses is one of the main reasons why policies, lines of action, and strategies do not adequately respond to the dynamics and needs of territories (Aslaeva, 2020; Suárez-Roldán et al., 2024). In Latvia, the poor state of data-based machine diagnostics of the local territorial development is especially relevant for remote municipalities (Abele et al., 2023; Grytten et al., 2024; Komarova et al., 2024).

The research problem concerning data-based diagnostics of the local territorial development is centred on the complexity and multifaceted nature of spatial development issues, encompassing economic, social, environmental, and technological dimensions. For example, Chehabeddine and Tvaronavičienė highlighted the difficulty of creating a comprehensive data-based diagnostic model that incorporates such wide-ranging and evolving factors as indicators and measurement limitations, interconnected security and development issues, impact of technological threats (Chehabeddine & Tvaronavičienė, 2020). Can AI tools help with data-based diagnostics of the local territorial development? Some studies (Laurini, 2023; Yigitcanlar et al., 2024; Xue et al., 2024; Hu et al., 2024) state that AI tools can significantly enhance local, territorial development data-based diagnostics. For example, AI tools can process large datasets to identify patterns and trends in regional development, such as population growth, resource usage, or economic disparities (Laurini, 2023). Machine learning algorithms can forecast future developments, like economic growth or environmental impacts, based on historical data; AI tools can also adapt to local contexts by considering unique regional characteristics, ensuring diagnostics are relevant to specific territories (Xue et al., 2024; Hu et al., 2024). Moreover, AI systems can simulate various development scenarios, helping policymakers understand the potential outcomes of different strategies; decision-support tools can prioritise initiatives based on predicted effectiveness and alignment with sustainable development goals (Yigitcanlar et al., 2024). By integrating AI tools, local territorial development diagnostics can become more precise, efficient, and adaptable to changing needs, ultimately fostering sustainable and inclusive growth.

The purpose of this study is to analyse the capabilities of AI tool (ChatGPT 4o) for data-based machine diagnostics of the local territorial development using the case of Latvian municipalities (N = 43) and based on their annual public reports (2023). This diagnostic includes a SWOT analysis to be carried out to understand the strengths, weaknesses, opportunities and threats associated with each specific municipality in the broader context of their sustainable development (including social, economic and environmental aspects), that is, in the context of typological clusters of Latvian municipalities (within the methodological approach of discourse analysis). The authors proposed the following research hypothesis: AI tool (ChatGPT 4o) is capable and very efficient data-based machine diagnostics of the local, territorial development, and contextual data is a necessary input for such diagnostics. Five Latvian municipalities (one from each typological cluster) are selected for the empirical study: Riga City Municipality (the capital of Latvia, also chosen for the experiment), Yelgava City Municipality (the capital-centred city of Latvia), Liepaya City Municipality (the remote town of Latvia), Ropazhi County Municipality (the capital-centred county of Latvia), Augshdaugava County Municipality (the remote county of Latvia).

The next section will provide a review of scientific studies that contribute to the topic of data-based machine diagnostics of local territorial development, and then the authors will provide the conceptual framework of my own study and research methodology. The research results and discussion section will present the empirical results of data-based machine diagnostics of the development of five selected Latvian municipalities. The final section will provide conclusions, study limitations and recommendations for further research.

2. Literature review

This section overviews the key findings of studies relevant to the analysed issue, contributing to a deeper understanding of the state-of-art and perspectives for data-based machine diagnostics of local territorial development.

The study “A new era for data analysis in qualitative research: ChatGPT” (Sen et al., 2023) contributes to the topic of data-based machine diagnostics of the local territorial development by exploring the potential of AI tools, specifically ChatGPT-4, in qualitative data analysis. It demonstrates how AI can enhance data organisation, coding, and interpretation, essential for understanding complex phenomena like territorial development (Sen et al., 2023). According to the authors, key contributions include: (1) by automating tasks such as creating codes, categories, and themes, ChatGPT can streamline qualitative analysis, allowing researchers to focus on interpreting and applying insights to local territorial development strategies; (2) the proved ability of ChatGPT to identify relationships and provide explanations for generated codes and themes can help uncover underlying patterns and trends in territorial data; (3) the showed AI tool's adaptability to different languages ensures it can be used in diverse local contexts, which is crucial for territorial development studies that often involve region-specific data; (4) ChatGPT offers a faster alternative to traditional qualitative analysis software, making it accessible to researchers without extensive training in qualitative data analysis tools. By integrating such capabilities, this study paves the way for leveraging AI tools to support data-driven decision-making in territorial development, addressing both qualitative and quantitative aspects of machine diagnostics in this field (Sen et al., 2023).

Over time, AI tools have become integral to urban and regional planning, moving from simple mapping and information systems to advanced applications like machine learning, rule-based systems, and knowledge management (Laurini, 2023). According to Laurini, AI helps structure and utilise data, enabling decision-making through tools like ontologies, knowledge networks, and rule-based systems; this method solves new problems by adapting solutions from similar past cases, aiding diagnostic processes and planning decisions; AI models predict trends, optimise resource allocation, and automate processes, such as land-use planning and traffic management (Laurini, 2023). However, there are also real-world challenges, mainly sociological barriers (fear of over-reliance on technology) and technological hurdles (insufficient data representation frameworks). Laurini (2023) emphasises the importance of: (1) holistic data integration to synthesise diverse datasets; (2) dynamic real-time monitoring through IoT-enabled systems; (3) scenario simulations to evaluate developmental impacts; (4) personalised diagnostics tailored to regional characteristics. Hence, the author underscores the transformative potential of AI in fostering inclusive and adaptive governance and addressing interconnected economic, social, and environmental challenges in local territorial diagnostics (Laurini, 2023).

Integrating geographic data (GeoAI) and IoT is highlighted as a powerful approach for monitoring and modelling local development trends (Yigitcanlar et al., 2024). Relevant ideas of the study “Artificial intelligence and the local government: A five-decade scientometric analysis on the evolution, state-of-the-art, and emerging trends” include (Yigitcanlar et al., 2024): (1) AI's ability to predict economic and social trends, optimising resource allocation; (2) customising AI systems for regional contexts to ensure effective diagnostics; (3) using real-time data for responsive and accurate decision-making; (4) identifying sustainable practices to align development with environmental goals. Bertacchini and Bouchet (2016) highlighted the integration of Territorial Intelligence (TI) and Artificial Intelligence (AI) as complementary approaches to understanding and addressing local territorial development. Key findings and ideas relevant to data-based machine diagnostics are (Bertacchini & Bouchet, 2016): (1) TI mobilises resources and fosters collective action, emphasising systemic approaches; (2) "info-obesity" challenges decision-making, and AI mitigates this by processing large datasets; (3) AI-enhanced tools improve visualisation and stakeholder engagement. Relevant ideas for diagnostics include systemic data integration, scenario forecasting, and citizen-centric approaches. Combining TI and AI ensures sustainable, collaborative, and efficient diagnostics, addressing complex regional challenges (Bertacchini & Bouchet, 2016).

Chao and Tao (2023) examined regional integration and AI development in the Yangtze and Pearl River Deltas, offering these relevant insights: (1) holistic resource integration to complement regional advantages; (2) predictive analytics for growth trends and sustainable planning; (3) real-time monitoring to optimise resource allocation and operational efficiency (Chao & Tao, 2023). The study underscores AI's role in overcoming integration challenges and achieving balanced and sustainable development. In turn, the study “Applications of machine learning in national territory spatial planning” (Xue et al., 2024) highlights machine learning's role in enhancing territorial diagnostics, in particular, big-data-driven monitoring of urban and rural dynamics using remote sensing and IoT, dynamic simulations for urban growth and land-use changes, methodological

innovations like spatial modelling and clustering for diagnostics. According to Xue and his colleagues, challenges include the lack of multi-source, high-resolution data. Future directions stress improving small-scale studies, multi-source data mining, and integrating ML in rural innovation (Xue et al., 2024). Overall, the above study emphasises the transformative role of machine learning in making data-based diagnostics more precise, multi-dimensional, and actionable, directly benefiting local territorial development.

The reviewed studies collectively illustrate AI and machine learning's transformative potential in the local territorial diagnostics. By integrating big data, GeoAI, and adaptive governance frameworks, AI tools can enhance monitoring, predictive modelling, and resource optimisation. Challenges like data gaps and societal resistance require continued innovation and stakeholder engagement to realise AI's full potential for sustainable territorial development. A remaining gap that the authors hope to fill with further research is the lack of empirical and experimental case studies that demonstrate the real (not just theoretical) feasibility and usefulness of AI tools for data-based diagnostics of the local territorial development.

3. Conceptual framework and research methodology

According to the authors, the issue of data-based machine diagnostics of the local territorial development is interdisciplinary in nature. The "frame of reference" of this study refers mainly to the sciences of regional economics, computer science and data science and is based on three key terms / terminological constructions: (1) machine diagnostics of the local territorial development (this terminological construction refers to computer science & regional economics); (2) data, in particular, territorial analytic data, TAD (Simonova & Sykora, 2011a, 2011b) (the term refers to data science). Table 1 attempts to systemically present the "frame of reference" and key terms / terminological constructions of the study, including their conceptual understanding within the study, empirical interpretation and referent science.

Table 1. The "frame of references" and key terms / terminological constructions of the study

Terms / terminological constructions	Conceptual understanding within the study	Empirical interpretation within the study	Referent science
Territorial analytic data, TAD	Input data that are periodically gathered and updated to support territorial management processes (diagnostics, planning, decision-making, etc.), helping ensure that these processes consider the current state of natural, cultural, and socioeconomic factors	Annual public reports of Latvian municipalities	Data Science
Machine diagnostics of the local territorial development	A new method for spatial planning that merges machine learning, big data, and spatial analysis to facilitate targeted, sustainable, and data-informed territorial planning, which positioned as a transformative tool for addressing complex spatial planning challenges, offering both technical advancements and practical frameworks for improving local territorial development	SWOT analysis conducted by AI tool using standard techniques of extracting and summarising key points from the analysed document. The task for AI tool (ChatGPT 4o): Based on the attached Public Report 2023 (in Latvian), conduct a SWOT analysis to understand the strengths, weaknesses, opportunities and threats for the municipality.	Computer science & Regional economics

Source: own elaborated based on Simonova & Sykora, 2011a, 2011b; Sen et al., 2023; Xue et al., 2024

Regarding territorial analytic data (TAD) (Table 1), the authors use the conceptual understanding and empirical interpretation of the term proposed by Simonova and Sykora (2011a, 2011b). They define TAD as a crucial tool in territorial planning, describing it as an essential input for creating the "Principles of territorial development" (Simonova & Sykora, 2011a, 2011b). TAD includes data that are periodically gathered and updated to support decision-making processes for regional planning, helping ensure that planning considers the current state of natural, cultural, and socioeconomic factors. The creation and management of TAD are important steps in regional development to achieve sustainable, balanced growth while coordinating public and private interests (Simonova & Sykora, 2011a, 2011b). Simonova and Sykora do not create the term "territorial analytic data" (TAD) themselves. Instead, they refer to it within the context of established territorial planning practices and legal frameworks. They cite regional legislation and strategic documents (for example, European Spatial Development Perspective, Law No. 183/2006 Sb. of the Czech Republic) that use and define TAD as a standard

tool or “default tool” for territorial planning. Specifically, TAD is described as an input for the broader “Principles of territorial development”, aligning with legislative norms and requirements for regional planning (Simonova & Sykora, 2011a, 2011b).

In turn, machine diagnostics of the local territorial development is conceptually understood as a new method for spatial planning that merges machine learning, big data, and spatial analysis to facilitate targeted, sustainable, and data-informed territorial planning (Sen et al., 2023). Artificial intelligence and data processing advances are set to refine diagnostics, enabling more accurate, localised, and actionable territorial insights. While machine learning provides significant advancements, challenges remain in data mining, small-scale spatial studies, and multi-source data integration. Overall, Xue et al. position machine learning as a transformative tool for addressing complex spatial planning challenges, offering both technical advancements and practical frameworks for improving local territorial development (Xue et al., 2024).

Within this study, machine diagnostics of the local territorial development is empirically interpreted as SWOT analysis conducted by AI tool using standard techniques of extracting and summarising key points from the documents – annual public reports of Latvian municipalities (Table 1). The output of this analysis will be SWOT matrixes of territories (European Commission, 2024). According to the definition of the European Commission, SWOT analysis is a strategic tool for use in context analysis. The acronym refers to the domains it considers: Strengths, Weaknesses, Opportunities and Threats. It combines an assessment of the strengths and weaknesses of an organisation, geographical area or sector to evaluate the opportunities and threats the environment poses. SWOT analysis considers internal and external factors to maximise the potential of strengths and opportunities while minimising the impact of weaknesses and threats (European Commission, 2024).

Three interrelated structuring questions (Figure 1) emerged from the conceptual understanding and empirical interpretation of machine diagnostics of the local territorial development (Table 1):

- (1) What are we diagnosing? – Local territorial development.
- (2) How and with what tools do we make diagnostics? – Machine tools for diagnostics.
- (3) On what basis do we make diagnostics? – Territorial analytic data, TAD.

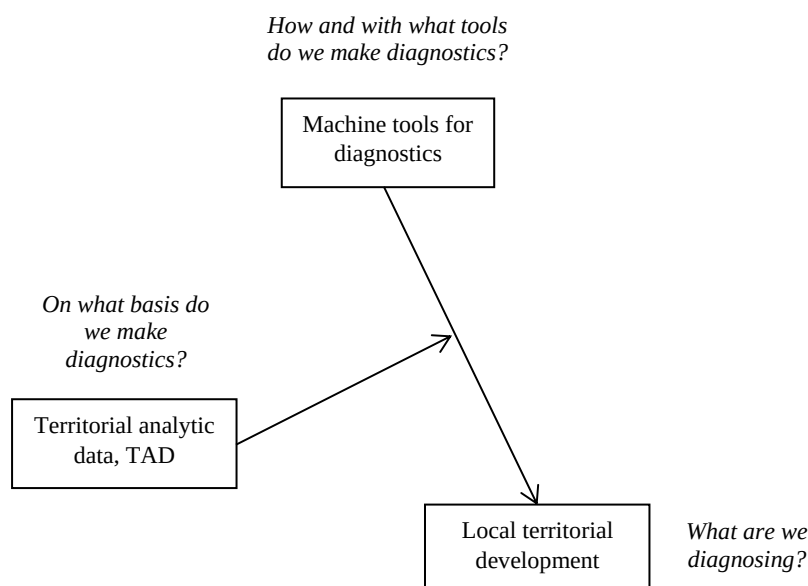


Figure 1. Interrelation of main structuring questions and terms / terminological constructions of the study

Source: own elaborated based on Table 1

In this study, the authors will use the methodological approach of discourse analysis (van Dijk, 1976, 2006; Komarova & Koroļova, 2021; Mietule et al., 2022), placing the diagnosed territories in the broader context of their sustainable development (including social, economic and environmental aspects). Considering the context of local territorial development, the conceptual framework of data-based machine diagnostics of the local

territorial development includes the following sequent mandatory concepts (without them, data-based machine diagnostics of the local territorial development is impossible) (Figure 2):

- (1) Input for diagnostics – territorial analytic data, TAD;
- (2) The subject of diagnostics – the context of the local territorial development and the state of development of territories;
- (3) Method of diagnostics – cluster analysis of territories and SWOT analysis of territories;
- (4) Machine tool for diagnostics - Statistical Package for Social Sciences (IBM SPSS) and Chat Generative Pre-Trained Transformer (ChatGPT 4o);
- (5) Result of diagnostics – developmental types of territories and SWOT matrixes of territories;
- (6) Output of diagnostics – the strengths, weaknesses, opportunities and threats for each territory in the context of the local territorial development.

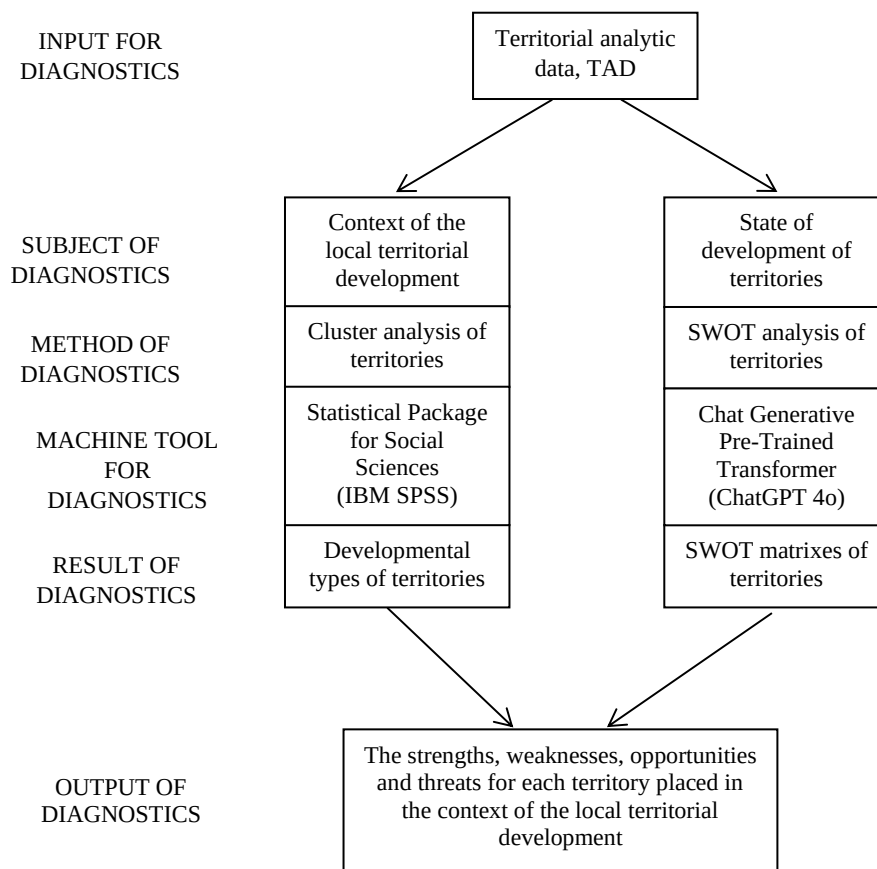


Figure 2. Conceptual framework of data-based machine diagnostics of the local territorial development
 Source: own elaborated based on Simonova & Sykora, 2011a, 2011b; Sen et al., 2023; Xue et al., 2024

The object of this study is Latvian municipalities. The administrative division of Latvia into municipal territories (36 counties and 7 cities of national importance that are not part of the counties) is such from July 1, 2021, in accordance with the Law of the Republic of Latvia “On Administrative Territories and Settlements” (Saeima of Latvia, 2020). All municipalities of Latvia, both counties and cities of national importance, were included in the study sample, which consisted of 43 objects and coincided with the population (in statistical analysis – the entire set of items from which you draw data for a statistical study) of Latvian municipalities. Such a relatively small number of objects can be analysed by statistical methods (Kish, 1965) but requires increased attention to the statistical significance of the results obtained.

Daugavpils University’s researchers highlight the disparities between centred and remote Latvian municipalities, both for the level of cities and counties (Kudiņš & Lazdāns, 2024). Capital-centred territories benefit from proximity to the metropolis and their infrastructure, while remote territories struggle with economic

isolation and environmental inefficiencies (Feng et al., 2019; van Leuven & Hill, 2021). In Latvia, the 100 km area around the capital is a “different world” compared to remote Latvia, located more than 100 km from Rīga. The current geopolitical situation and sanctions/restrictions against Russia and Belarus are not the reason for this situation since remote Latvian municipalities near the borders with Estonia and Lithuania have a similar social, economic and environmental context as remote municipalities near the borders with Russia and Belarus (Kudiņš & Lazdāns, 2024).

Figure 3 shows visual images of five types of territories in Latvia, obtained as a result of a two-level (for cities and counties) cluster analysis (Kudiņš & Lazdāns, 2024), namely:

- (1) Riga, the capital of Latvia and its geographical, logistic, economic, etc. centre of the country (Cluster 1);
- (2) capital-centered cities of Latvia (Ventspils, Yelgava, Yurmala), located close or relatively close to Riga, i.e. in the central areas (with the exception of Ventspils) (Cluster 2);
- (3) remote cities of Latvia (Daugavpils, Liepaya, Rezekne), located far from Riga, i.e. in remote areas (Cluster 3);
- (4) capital-centered counties of Latvia (17 municipalities), located close or relatively close to Riga (Cluster 4);
- (5) remote counties of Latvia (19 municipalities), located far from Riga (Cluster 5).



Figure 3. Cartographic visualisation of the typology of Latvian municipalities

Source: Kudiņš & Lazdāns, 2024

Thus, socially, economically and environmentally developed Latvia can be outlined on a geographical map (Figure 3) using a compass, resting its leg on the point representing Riga. About the rest of the country's territory, if it were not for three relatively large industrial cities (Daugavpils, Liepaja, Rezekne), the political elite of Latvia would most likely prefer to forget completely, since many remote areas of Latvia are impossible to reach by land transport, especially under unfavourable weather conditions and in the off-season (Voronov, 2022; Chmielewski, 2023).

4. Results and discussion

As part of the empirical study, five Latvian municipalities (one from each typical cluster of Latvian territories) were selected for further SWOT analysis of the annual public reports of municipalities, carried out using AI tool and its standard methods of extracting and summarising key points from the analysed document. According to the research methodology, the task for AI tool (ChatGPT 4o) is the following (Table 1): Based on the attached

Public Report 2023 (in Latvian), conduct a SWOT analysis to understand the strengths, weaknesses, opportunities and threats for the municipality.

Table 2. SWOT matrix for Riga City (the capital of Latvia, Cluster 1), 2023

Strengths	Weaknesses
1. Economic Stability: Riga experienced a steady increase in budget revenue, particularly from income and property taxes. The city's budgetary income in 2023 exceeded expectations by €123.7 million, demonstrating a strong fiscal position. 2. Tourism and Transport Hub: Riga is a key destination for tourism, with a growing number of visitors. The city has a well-developed public transportation network, including trams, trolleybuses, and buses, along with an important seaport and proximity to Riga International Airport, which boosts the local economy. 3. Educational Investments: Significant resources are allocated to education, with €468.4 million (36% of the budget) directed towards educational development, ensuring quality and modernised facilities. 4. Strategic Infrastructure Projects: Riga has successfully implemented significant infrastructure projects, including road and transport upgrades, supported by EU funds. This includes projects like the Salu Bridge's reconstruction and the Eastern Highway's development.	1. Ageing Infrastructure: Some sectors, like public transport and urban infrastructure, still require significant upgrades. Persistent delays in construction and high costs hinder swift progress. 2. Demographic Challenges: The city's population has been declining since 2017, with a slight decrease in 2023 despite temporary growth due to migration from Ukraine. 3. Traffic and Congestion: Traffic congestion remains an issue in urban areas, requiring continuous investment and planning to improve mobility and reduce delays. 4. Economic Disparities: There is a noticeable income gap between the public and private sectors, with wages in the private sector trailing behind the public sector, potentially affecting employment dynamics.
Opportunities	Threats
1. EU Funding for Urban Development: The availability of EU funds offers opportunities for sustainable urban development, including green energy projects and public space revitalisation. 2. Tourism Growth: Increasing tourist numbers, especially from foreign countries, present opportunities for economic growth through the hospitality and service sectors. 3. Digital and Green Transition: Initiatives in digitalisation and green energy can position Riga as a leading city in innovation, attracting businesses and reducing environmental impact. 4. Business and Investment: Establishing business-friendly environments and infrastructure development can attract more foreign investment, fostering economic diversification.	1. Global Economic Instability: Economic fluctuations and global crises could impact tourism and investment, potentially affecting local revenue and business growth. 2. Environmental Risks: Climate change and rising sea levels pose risks to Riga's coastal areas, requiring investments in coastal protection and adaptation strategies. 3. Construction and Material Costs: High costs of construction materials and a shortage of skilled labourers may delay or limit the scope of essential urban development projects. 4. Dependence on Traditional Sectors: Reliance on established sectors like trade and transport can make the economy vulnerable to industry-specific downturns or technological shifts.

Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Riga City (Latvia), 2024

This SWOT analysis illustrates Riga's strengths in economic stability, education, and infrastructure while highlighting the challenges of ageing infrastructure, demographic decline, and the need for economic diversification (elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Riga City (Latvia), 2024).

Analysing Public Report 2023 of Riga City Municipality, AI tool (ChatGPT 4o) adequately and based on the data obtained assessed the strengths of Riga City (economic stability, tourism and transport hub, educational investments, strategic infrastructure projects), its weaknesses (ageing infrastructure, demographic challenges, traffic and congestion, economic disparities), opportunities (EU funding for urban development, tourism growth, digital and green transition, business and investment), and threats (global economic instability, environmental risks, construction and material costs, dependence on traditional sectors) (Table 2). According to the authors, this means that AI tools must be actively used in the process of diagnosing local territorial development, as well as in the process of planning it.

The following two tables present SWOT matrixes for two Latvian cities: the capital-centred Yelgava City (Cluster 2) and remote Liepaja City (Cluster 3), located in the Kurzeme region of Latvia, near the shore of the Baltic Sea.

Table 3. SWOT matrix for Yelgava City (the capital-centered city of Latvia, Cluster 2), 2023

Strengths	Weaknesses
1. Industrial Growth: Jelgava has a robust industrial sector with notable strengths in metalworking, mechanical engineering, woodworking, and food production. The processing industry contributes significantly to economic growth, with a high export share (75.7% in 2023). 2. Educational Investments: The city prioritises education, as seen in opening a new engineering-focused high school and modernised kindergartens, aiming to provide a contemporary learning environment. 3. Public Infrastructure Development: Ongoing infrastructure projects, such as road upgrades, water tourism facilities, and social service centres, enhance urban development and quality of life. 4. Strategic Location: Jelgava's location near Riga facilitates access to a larger job market and economic opportunities, making it an attractive place for residents and businesses.	1. Ageing Population: The demographic trend shows a declining and ageing population, which increases the demographic burden and affects the availability of a skilled workforce. 2. Economic Dependence on Traditional Industries: While industrial sectors are strong, there is a reliance on traditional industries, which may limit diversification and innovation in the economy. 3. Low Wage Growth: Jelgava's wage increase was the slowest among other major cities, leading many qualified professionals to seek employment in Riga for better salaries. 4. Infrastructure and Construction Challenges: The city faces delays in infrastructure projects due to high construction costs and a lack of skilled workers.
Opportunities	Threats
1. Expansion of Tourism and Cultural Projects: Jelgava can leverage its cultural and historical heritage to attract more tourists, enhancing its visibility and economy through events and infrastructure projects. 2. Renewable Energy Initiatives: Investments in clean and sustainable energy, such as infrastructure projects aligned with EU sustainability goals, offer a path for economic and environmental benefits. 3. EU and State Funding: Access to EU and state funds for public projects and infrastructure improvements presents opportunities to modernise the city's infrastructure and services. 4. Development of Industrial Parks: The creation of the Zemgale Industrial Park aims to revitalise degraded areas and attract private investments, promoting economic development.	1. Demographic Decline: A shrinking population with a growing number of elderly residents could strain social services and impact the city's long-term sustainability. 2. Economic Vulnerability: Dependency on traditional industrial sectors makes the city susceptible to global market fluctuations, impacting local businesses. 3. Environmental Challenges: As an industrial hub, Jelgava must address environmental concerns to maintain sustainable growth, especially in sectors like manufacturing and energy. 4. Competition from Riga: Proximity to Riga, while advantageous, also means competing for talent and businesses, as the capital city offers higher wages and more diverse job opportunities.

Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Yelgava City (Latvia), 2024

This SWOT analysis highlights Jelgava's strengths in industrial capacity and educational investment while acknowledging challenges related to demographics and economic diversification (elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Yelgava City (Latvia), 2024).

According to the authors, the AI tool (ChatGPT 4o) also adequately and based on the data obtained, assessed the strengths of Yelgava City, its weaknesses, opportunities, and threats (Table 3). Although new for Latvian research (Arhipova & Paula, 2015; Voronov & Ruza, 2018; Grytten et al., 2024) is the fact that AI tool identified proximity to Riga of Yelgava City as a threat rather than an opportunity for local territorial development: "Proximity to Riga, while advantageous, also means competing for talent and businesses, as the capital city offers higher wages and more diverse job opportunities" (4th threat, Table 3).

Table 4. SWOT matrix for Liepaya City (the remote city of Latvia, Cluster 3), 2023

Strengths	Weaknesses
1. Industrial and Economic Growth: Liepāja is the second-largest manufacturing city in Latvia, with a well-established industrial sector that includes metalworking, machinery, textiles, and construction. The city has seen a notable increase in manufacturing output over the past five years. 2. Tourism and Culture: The city is a significant cultural centre with strong tourism potential, attracting visitors with its cultural events, historical sites, and coastal attractions. The construction of new cultural facilities, like the "Liedags" kindergarten, highlights ongoing investment in local infrastructure. 3. Port and Transport Infrastructure: Liepāja has a strategic port that supports logistics and international trade alongside well-	1. Demographic Challenges: Liepāja faces a declining and ageing population, which impacts the local labour force and poses challenges for long-term economic sustainability. 2. Unemployment Issues: The city has a relatively high unemployment rate, particularly among youth and long-term unemployed groups, which may indicate a skills mismatch in the local economy. 3. Economic Dependence on Traditional Industries: The economy heavily relies on traditional sectors like manufacturing and construction, with limited diversification into high-tech or innovative sectors. 4. Infrastructure Maintenance: While there is investment in new infrastructure, the maintenance and modernisation of existing

developed transport infrastructure. This includes enhancements in public transportation and road networks. 4. Educational Investments: The city has prioritised educational improvements, with modernised schools, kindergartens, and investment in professional training institutions that cater to local industry needs.	facilities, especially in older parts of the city, remain challenging .
Opportunities	Threats
1. Green and Sustainable Development: There are opportunities for Liepāja to invest in green energy and sustainable infrastructure aligned with EU funding and sustainability goals. This includes initiatives in renewable energy and waste management. 2. Tourism Expansion: Enhancing tourism through cultural events, coastal development, and improved facilities can drive economic growth, leveraging the city's cultural and natural assets. 3. Foreign Investment and Industrial Parks: Developing industrial parks and attracting foreign investments can boost the local economy, creating more jobs and diversifying the economy. 4. Cross-Border Cooperation: Liepāja's geographical position facilitates cooperation with neighbouring countries, enhancing trade, cultural exchange, and joint projects.	1. Global Economic Volatility: The city's reliance on manufacturing and exports makes it vulnerable to global economic shifts, particularly fluctuations in demand and supply chains. 2. Environmental Risks: As a coastal city, Liepāja faces risks from climate change, such as rising sea levels and extreme weather events, which could impact its port and tourism sectors. 3. Competition from Other Cities: Liepāja faces competition from other Latvian and Baltic cities for tourism, investment, and skilled labour, which could limit its growth potential. 4. Long-Term Demographic Trends: The ageing population and declining birth rates present a long-term challenge for sustaining a productive workforce and maintaining economic vitality.

Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Liepaja City (Latvia), 2024

This SWOT analysis underscores Liepāja's strengths in industry and cultural appeal while acknowledging the demographic and economic challenges that require strategic planning for sustainable development (elaborated by AI tool (ChatGPT 4o) based on the Municipal Council of Liepaja City (Latvia), 2024). According to the authors, the AI tool (ChatGPT 4o) also adequately assessed the strengths of Liepaja City, its weaknesses, opportunities, and threats based on the data obtained (Table 4). The following two tables present SWOT matrixes for two Latvian counties: the capital-centred Ropazhi County (Cluster 4) and remote Augshdaugava County (Cluster 5), located in the Latgale region of Latvia, near the border with Belarus.

Table 5. SWOT matrix for Ropazhi County (the capital-centered county of Latvia, Cluster 4), 2023

Strengths	Weaknesses
1. Population Growth and Engagement: Ropaži experienced strong population growth, particularly in the Stopiņi and Garkalne areas, driven by residential attractiveness and low unemployment. Community engagement is encouraged through each district's participatory budgeting and active consultative councils. 2. Economic Diversity and Business Support: The municipality supports a range of industries, including large and small enterprises, with a solid foundation in trade, processing, and construction. Support programs, such as grants and tax relief, foster local businesses. 3. Investment in Education and Infrastructure: Ropaži allocates a substantial portion of its budget to education and infrastructure, reflected in recent improvements to schools, sports facilities, and public utilities. 4. Commitment to Sustainability: Initiatives in renewable energy, such as solar power facilities and environmental projects, support the municipality's sustainable development goals.	1. Dependence on Surrounding Areas: The municipality relies on proximity to Riga and neighbouring municipalities for economic opportunities and employment, which may impact self-sufficiency. 2. Budgetary Constraints: Limited financial resources restrict the municipality's ability to expand services or fully maintain infrastructure, especially as the population grows. 3. Aging Infrastructure in Rural Areas: While urban centres receive improvements, maintaining and upgrading infrastructure in rural parts remains challenging. 4. Demographic Challenges: Although population growth is robust, the municipality faces long-term issues related to an ageing demographic, which could impact workforce availability and demand for social services.
Opportunities	Threats

1. Enhanced Regional and International Collaboration: Positioned near Riga, Ropaži has opportunities for partnerships on public services, tourism, and economic projects, including collaborations with international partners like Ukraine. 2. Development of Green and Sustainable Infrastructure: Ropaži has the potential for more eco-friendly projects, including green energy and sustainable urban planning, which aligns with available EU funding. 3. Growth in Tourism and Cultural Initiatives: Cultural and recreational projects like the Green Road initiative increase tourism and create new local business opportunities. 4. Digitalisation and Public Service Improvement: Investment in digital services can streamline public administration and increase accessibility for residents.	1. Environmental and Climate Risks: As a geographically diverse municipality, Ropaži faces potential environmental risks, such as flooding, that could impact infrastructure. 2. Economic Dependence on Key Industries: Reliance on specific industries, like trade and construction, exposes the municipality to market fluctuations. 3. Competition for Talent and Resources: Ropaži competes with Riga and other regions for skilled labour and investment, which may limit local growth and economic diversification. 4. Infrastructure Demand and Population Growth: The rapid population increase places pressure on public services and infrastructure, requiring continuous investment that may strain the budget.
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Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Ropazhi County (Latvia), 2024

This SWOT analysis captures Ropaži's strengths in community growth, economic support, and sustainability while noting challenges related to budget constraints and infrastructure demands amidst population growth (elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Ropazhi County (Latvia), 2024).

As in the case of the capital-centred Yelgava City, AI tool identified proximity to Riga of Ropazhi County as a threat rather than an opportunity for local territorial development: "Ropaži competes with Riga and other regions for skilled labour and investment, which may limit local growth and economic diversification" (3rd threat, Table 5).

Table 6. SWOT matrix for Augšdaugava County (the remote county of Latvia, Cluster 5), 2023

Strengths	Weaknesses
1. Diverse Economy: Augšdaugava's economy includes a wide range of industries, such as agriculture (especially mixed farming and grain production), retail, and transportation services like taxi and freight. 2. Investment in Public Infrastructure: The municipality has been actively implementing EU-funded investment projects, including energy efficiency measures, such as in public lighting and the renovation of public buildings. 3. Collaboration with Neighboring Regions: The municipality maintains strong cross-border cooperation with regions in Lithuania, Poland, and Georgia, which fosters opportunities for joint projects and resource sharing. 4. Support for Small and Medium-Sized Enterprises (SMEs): A relatively high number of registered businesses exist in the region, showing entrepreneurial activity and local economic participation.	1. Declining Population: There is a significant demographic challenge, with the number of deaths far exceeding births (97 births vs 525 deaths in 2023), leading to a shrinking and ageing population. 2. High Unemployment: While the unemployment rate in Augšdaugava is 7.7%, it remains higher than the national average (5.7%), and long-term unemployment affects a substantial part of the population. 3. Dependence on Traditional Industries: The economy heavily relies on agriculture and retail, which may limit growth in high-tech and knowledge-based industries. 4. Infrastructure Challenges in Education and Social Services: Some schools and social housing require modernisation, with several housing units reported as unsuitable for living without significant repair.
Opportunities	Threats
1. EU Funding for Sustainable Development: The municipality can continue to leverage EU structural funds to improve energy efficiency, modernise infrastructure, and support local industries. For example, improving public lighting and upgrading public buildings will help reduce energy consumption and emissions. 2. Tourism Potential: The restoration and promotion of cultural and natural heritage sites, such as "Latgales sēta" and Slutišķi 2, can enhance local tourism and economic growth. 3. Investment in Social Services: The municipality is implementing infrastructure improvements for social services, which can increase the quality of life, such as providing housing and care for vulnerable groups. 4. Green Transition: Investments in clean energy, like solar panel installations and electric vehicle infrastructure, offer opportunities for sustainable development.	1. Demographic Decline: With more deaths than births and significant long-term unemployment, the workforce is shrinking, which may pose challenges for sustaining economic growth. 2. Limited Diversification in Industry: The heavy reliance on agriculture and retail makes the local economy vulnerable to external shocks in these sectors. 3. Regional Disparities: The rural nature of many parts of Augšdaugava could hinder access to services, education, and employment opportunities compared to more urbanised areas. 4. Environmental Risks: Projects aimed at cleaning historically polluted sites (like Višķu mazuta glabātava) indicate a potential environmental risk that, if not correctly managed, could harm local health and development.

Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Augšdaugava County (Latvia), 2024

This SWOT analysis highlights the municipality's strengths in infrastructure and partnerships, but also the challenges posed by demographic trends and economic dependence on traditional sectors (elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Augshdaugava County (Latvia), 2024).

Thus, AI tool (ChatGPT 4o) demonstrates a strong and even original (critical attitude towards proximity to Riga as a stimulus of local territorial development) ability for SWOT analysis of annual public reports of Latvian municipalities, while also maintaining the context of local territorial development, i.e. type of Latvian territories, which is reflected in the analysed documents.

The authors also tried an experiment by asking AI tool (ChatGPT 4o) to conduct a SWOT analysis again for Riga City based on the same data (Municipal Council of Riga City (Latvia), 2024), but within separate communication sessions. The following table compares two versions of the SWOT matrixes for Riga City.

Table 7. Comparison of two versions of the SWOT matrixes for Riga City (the capital of Latvia, Cluster 1), 2023

1 st version	2 nd version
Strengths	Strengths
1. Economic Stability: Riga experienced a steady increase in budget revenue, particularly from income and property taxes. The city's budgetary income in 2023 exceeded expectations by €123.7 million, demonstrating a strong fiscal position. 2. Tourism and Transport Hub: Riga is a key destination for tourism, with a growing number of visitors. The city has a well-developed public transportation network, including trams, trolleybuses, and buses, along with an important seaport and proximity to Riga International Airport, which boosts the local economy. 3. Educational Investments: Significant resources are allocated to education, with €468.4 million (36% of the budget) directed towards educational development, ensuring quality and modernised facilities. 4. Strategic Infrastructure Projects: Riga has successfully implemented major infrastructure projects, including road and transport upgrades, supported by EU funds. This includes projects like the Salu Bridge's reconstruction and the Eastern Highway's development.	1. Financial Stability: The municipality showed financial growth, with increased tax revenues such as the personal income tax and property tax, surpassing planned expectations. 2. Infrastructure Investment: Significant capital investments in infrastructure, particularly in transportation, have been made to improve the city's quality of life. 3. Effective Debt Management: The municipality maintained a manageable debt level, adhering to financial strategies that allow continued investments in city development. 4. Positive Credit Rating: An "A" level credit rating with a stable outlook supports investor confidence and indicates financial soundness.
Weaknesses	Weaknesses
1. Ageing Infrastructure: Some sectors, like public transport and urban infrastructure, still require significant upgrades. Persistent delays in construction and high costs hinder swift progress. 2. Demographic Challenges: The city's population has been declining since 2017, with a slight decrease in 2023 despite temporary growth due to migration from Ukraine. 3. Traffic and Congestion: Traffic congestion remains an issue in urban areas, requiring continuous investment and planning to improve mobility and reduce delays. 4. Economic Disparities: There is a noticeable income gap between the public and private sectors, with wages in the private sector trailing behind the public sector, potentially affecting employment dynamics.	1. Declining Population: A steady decrease in population over recent years poses challenges in maintaining a sustainable tax base and workforce. 2. Budget Deficit: Although reduced, a budget deficit still exists, which could affect future investments if not adequately managed. 3. Limited Sectoral Development: Some economic sectors, like industrial manufacturing, have a lower contribution than others, suggesting a need for diversification. 4. Dependence on EU Funds: Heavy reliance on European Union funds for infrastructure projects could pose a risk if future funding decreases.
Opportunities	Opportunities
1. EU Funding for Urban Development: The availability of EU funds offers opportunities for sustainable urban development, including green energy projects and public space revitalisation. 2. Tourism Growth: Increasing tourist numbers, especially from foreign countries, present opportunities for economic growth through the hospitality and service sectors. 3. Digital and Green Transition: Initiatives in digitalisation and green energy can position Riga as a leading city in innovation, attracting businesses and reducing environmental impact.	1. Urban Development: Planned infrastructure projects, including transport improvements and real estate developments, present opportunities for urban growth and increased economic activity. 2. EU and International Funding: The availability of EU funds and other international investments can boost city development, especially in green and sustainable initiatives. 3. Increasing Tourism: A rebound in tourism, focusing on attracting more international visitors, can revitalise the hospitality sector and related industries.

4. Business and Investment: Establishing business-friendly environments and infrastructure development can attract more foreign investment, fostering economic diversification.	4. Public Transport Improvements: Investments in public transportation and mobility reforms can increase accessibility and reduce traffic congestion.
Threats	Threats
1. Global Economic Instability: Economic fluctuations and global crises could impact tourism and investment, potentially affecting local revenue and business growth. 2. Environmental Risks: Climate change and rising sea levels pose risks to Riga's coastal areas, requiring investments in coastal protection and adaptation strategies. 3. Construction and Material Costs: High costs of construction materials and a shortage of skilled labourers may delay or limit the scope of essential urban development projects. 4. Dependence on Traditional Sectors: Reliance on established sectors like trade and transport can make the economy vulnerable to industry-specific downturns or technological shifts.	1. Economic Fluctuations: Global and regional economic instability could impact tax revenues and financial health, leading to potential budget constraints. 2. Inflation and Wage Pressure: Rising wage demands and inflation could increase the cost of public services, impacting budget planning. 3. Aging Infrastructure: Persistent needs for infrastructure renewal, particularly in transport, require constant funding, and delays could worsen the city's condition. 4. Environmental and Climate Risks: As with many urban areas, Riga faces challenges related to climate change, requiring significant investments in green infrastructure.
Summary	Summary
This SWOT analysis illustrates Riga's strengths in economic stability, education, and infrastructure while highlighting the challenges of ageing infrastructure, demographic decline, and the need for economic diversification.	This SWOT analysis highlights the key factors influencing Riga's municipal strategy and planning for future development.

Source: elaborated by AI tool (ChatGPT 4o) based on Municipal Council of Riga City (Latvia), 2024

Recognising the general similarity of the two versions of the obtained SWOT matrixes for the Riga City (Table 7), the authors would prefer to use the first version and reject the second for the following reasons:

- (1) In the second version, the strengths are focused exclusively on financial aspects;
- (2) The ageing infrastructure is not a threat, as suggested in the second version, but rather an internal weakness of Riga City, as presented in the first version;
- (3) The summary of the second version does not contain any specific details for Riga City.

In their further analysis, the authors tried to understand why two different SWOT analysis summaries (Table 7) emerged from the same data and the same question to AI tool. The authors' next question to ChatGPT 4o was the following: Have you applied different techniques or methods for their creation? The first version's answer: "The two summaries provided for the SWOT analysis of Riga are not based on fundamentally different techniques or methods; rather, the differences arise from a variation in focus and language used when generating the summaries" (ChatGPT 4o). The second version's answer: "The two summaries you've mentioned reflect slight variations in emphasis and interpretation, even though they are based on the same document and question" (ChatGPT 4o). The key phrases in both answers are "variation in focus" and "variation in emphasis".

Therefore, the next question for the first version was, "Do you decide this focus yourself?" and for the second: "Do you decide this emphasis yourself?" The first version's answer: "Yes, the decision to focus on specific elements within a summary is made by me, but it is not random; it is influenced by both technical and non-technical factors" (ChatGPT 4o). The second version's answer: "The emphasis in the summaries is not random. It is based on a combination of technical and non-technical factors" (ChatGPT 4o). The last authors' question for both versions of the communication with AI tool was: Can you change your focus or emphasis within one separate conversation? The first version's answer: "No, I don't independently change my focus or emphasis within a single conversation unless prompted by changes in your question, context, or specific preferences" (ChatGPT 4o). The second version's answer: "No, I won't change my focus or emphasis within a single conversation on my own unless you provide new input or specify a shift" (ChatGPT 4o).

According to the authors, the results of this experiment showed that AI tool can choose a different focus/emphasis for the data-based diagnostics of the local territorial development. However, this will remain the same focus/emphasis within a single communication session. This means that the human analyst can select the most correct and relevant focus/emphasis and continue the diagnostics process within the chosen focus/emphasis.

5. Conclusions

This study analysed the capabilities of an AI tool (ChatGPT 4o) for data-based machine diagnostics of the local territorial development, focusing on Latvian municipalities. Based on empirical research involving SWOT analysis of annual public reports for five selected municipalities, the following conclusions were drawn:

- (1) The AI tool demonstrated its ability to conduct comprehensive SWOT analyses, accurately identifying strengths, weaknesses, opportunities, and threats for each municipality. This included unique insights, such as identifying proximity to Riga as a competitive threat rather than an opportunity for some municipalities, highlighting its nuanced approach to contextual data;
- (2) The tool showed flexibility in its diagnostic focus and emphasis, which could be tailored to specific analytical needs. While consistent focus is maintained within a single session, human analysts can steer the tool toward the most relevant emphasis, ensuring precision and relevance;
- (3) AI-driven diagnostics integrated contextual considerations of social, economic, and environmental factors, enabling a more balanced approach to territorial development. The tool also proved capable of identifying opportunities aligned with sustainable growth, such as green energy projects and digitalisation initiatives;
- (4) By providing actionable insights through SWOT matrices, the AI tool offers significant value for policymakers, enabling them to effectively address challenges such as demographic decline, economic dependencies, and environmental risks.

The study also faced challenges and limitations, such as a lack of empirical data and high-resolution inputs for more granular analysis. Additionally, reliance on AI tools requires human oversight to interpret and apply insights accurately within the broader context of regional development.

Beyond Latvia, the demonstrated methodology can be applied to other regional contexts, enabling comparative studies and fostering collaborative approaches to territorial diagnostics and planning. Recommendations for future research are as follows: conduct empirical studies across diverse regions to validate the AI tool's adaptability and accuracy; develop more refined data inputs, including multi-source and high-resolution datasets, to improve diagnostic granularity; explore integration of AI tools with Geographic Information Systems (GIS) and Internet of Things (IoT) for real-time monitoring and predictive analytics; expand use cases for AI-driven diagnostics to include longitudinal studies on the impact of policy decisions informed by such tools; focus on enhancing stakeholder engagement by integrating AI-generated insights into participatory decision-making processes. By addressing these recommendations, future research can further advance the utility and reliability of AI for sustainable local territorial development diagnostics.

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Funding: This research was funded by Daugavpils University, Latvia.

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