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Municipalities and cities in the center of the digital and green transition

Summary: Digital and green transformation are being guided not only as a result of central government's policies, but also other stakeholders are actively contributing. Municipalities and cities often implement unique and innovative solutions in this regard, with the overall intention of increasing the inhabitant's quality of life. Moreover, communal self-governments increasingly reflect the social impact of the implemented digital and green solutions, fulfilling the essence of the triple transition. The study contributes to the scientific and scholarly debate on twin and triple transition by providing theoretical backgrounds, and case study examples from six concrete municipalities and cities from the Slovak Republic.

Keywords: Municipalities, Cities, Twin transition, Triple transition, trends and challenges in the public administration

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A. Introduction

Municipalities and cities face a variety of trends and challenges in the exercise of their competencies, the occurrence and strength of the impact of which can vary in intensity. All trends and challenges present municipalities with factories that are pressing on them. They affect the quality of the management of municipalities and towns, and they also affect the quality of the public services that are provided, the character of the relationships that municipalities develop externally or internally. Theory and practice offer several approaches that are used by municipalities and cities to deal with and respond to these external influences, among the established urban management approaches are Smart City, Green City, Resilient City, Happy City, Functional City Region or triple-helix models and its variations, innovation ecosystems and many other approaches respectively (OECD, 2024; Mitaľ et al., 2023; Chew and Show, 2022; Zhu et al., 2022; Kuzior and Kuzior, 2020; Ručinská and Fečko, 2019; Wiking 2019; Ručinská and Fečko, 2017). Local government units are affected by different trends and challenges to different degrees and therefore apply different approaches in different ways. We consider twin transitions, consisting of digital and green transitions, to be key trends and challenges that municipalities and cities need to respond to. Twin transition is the result of combining the creation, use and benefits of tools and measures that can simultaneously address the digital and green challenges of municipalities and cities. At the same time, however, there is now a gradual emphasis on triple transition, which enriches digital and green solutions with their potential positive impact on the social dimension of local communities.

The ambition of the study is to examine measures and activities implemented by cities that respond to digital and green transition, mainly those activities that reflect twin and triple transition at the same time. The study aims to answer the research question of how digital and green transition influences also the social aspects of communal life. With the use of the case study method, this study examines measures adopted by selected cities in the Slovak Republic. Six case studies from six cities in the Slovak Republic were analyzed covering the period 2021-2024.

B. Municipalities and cities - approaches to trends and challenges

Municipalities and cities are complex environments. The needs of different stakeholders, such as individuals, communities, private companies, or non-governmental organizations usually influence local governance and policy-

making. From a theoretical and practical point of view, different approaches have evolved and been implemented to satisfy the stakeholders' well-being at the communal level. We perceive approaches as a form of reaction and a combination of tools, measures and actions that help municipalities and cities in responding to contemporary trends and challenges.

I. Modern cities and approaches to enhance communal life

The first group of approaches represents the ambition of a municipality and city to reach a specific status, achieve some ambitions, or conditions. These approaches express the determining quality of a particular municipality and city, such as a smart, green, circular, or resilient city.

A smart city usually represents an approach that helps municipalities and cities make traditional networks and services more efficient with the use of digital solutions (European Commission, 2024). The Smart City approach also presumes that digital technologies are being used for the benefit of the inhabitants, businesses, as well as municipalities and cities. Smart city initiatives and solutions can be developed as "in-house" solutions by municipalities and cities, but also can come from the private and non-profit sectors as "readymade" solutions (Ručinská and Fečko, 2019).

Green cities are also known as sustainable cities. Green cities represent the intention of municipalities and cities to achieve urban sustainability thanks to the maximization of the ecosystem's functioning (Steele, et al., 2020). Green cities represent an approach focused on lowering the environmental impacts caused by daily human activities, mainly thanks to waste reduction, promoting recycling, and lowering emissions (Chew and Show, 2022).

The circular city approach contributes to the development of cities together with smart and green city concepts. The circular city concept is based on several principles, mainly on the principle or ability of the city to regenerate, share, optimize, loop, virtualize and exchange flows, materials, or processes (Prendeville et al., 2018). The strategic planning in a circular city must consider the partnerships and collaboration between various stakeholders (city, community, industry, business, …), while these interactions produce different systems at different scales (energy recovery systems, water recycling process, updates of spatial plans, reuse of circular waste, production of recycled materials, etc.) (Williams, 2023).

Resilient municipalities and cities can absorb, recover and prepare for future shocks (OECD, 2024). Resilient cities concern processes, preparedness, know-how, and responsibility throughout the system, which acts autonomously to respond to exogenous and endogenous shocks (Baibarac and

Petrescu, 2019; Welsch, 2013). In this regard, the strengthening of partial aspects of communal resilience, mainly participation and inclusion, must be seen as a key part of modern cities and municipalities and robust local democracy.

Other approaches focus on the collaboration among stakeholders at the communal level. Helix models are built on the assumption that knowledge and innovation have the potential to integrate and manage increasing interactions of multiple societal subsystems (König et al., 2020). These models aim to build and foster collaboration in territories that produce innovations. The triple helix model highlights collaboration between the local government, business environment and higher educational institutions (Cai and Etzkowitz, 2020). Quadruple helix is another approach that describes interactions involving the local government, business environment, higher educational institutions, and the society (Kuzior and Kuzior, 2020). An additional viewpoint of this approach adds the impact of media as another key interaction in contemporary societies (Sumarto, et al., 2020).

These approaches reflect the intention of municipalities and cities when responding to trends and challenges. The selected combination of approaches influences the formulation and implementation of policymaking at the communal level. The decisions of municipalities and cities concerning the applied approach must be made by the key stakeholders in the territory, such as the elected representatives, administrators, citizens, businesses, non-governmental organizations, and many others. The scope of involved stakeholders may lead to better outcomes and outputs of policymaking. Municipalities and cities should involve all the relevant stakeholders to make proper decisions on which trends and challenges are important for the local community.

II. Trends and challenges shaping the future of municipalities and cities

The exponential development of modern society creates and accelerates many challenges and trends. The four key trends identified by the OECD represent a systematic evolution, rather than the introduction of brand-new concepts: new forms of accountability for a new era of local government, new approaches to care, new methods for preserving identities and strengthening equity, and new ways of engaging citizens and residents (OECD, 2023a). Municipalities and cities in the European area are also transforming in order to ensure satisfaction with living in the city, safety and cohesion, housing, earning and living, mobility and commute, culture, public spaces and healthcare, healthy cities, as well as the quality of local public administration (European Commission, 2023). The commutation of different trends

and challenges may cause negative impacts on the quality of life in the local community. Municipalities and cities should ensure positive outcomes of trends and challenges.

The abovementioned approaches help municipalities and cities respond to challenges and trends with different degrees of success. Theory and practice identify multiple lines to defining trends and challenges that influence local governments (Eggers et al., 2023; OECD, 2023a; Rowley 2022). We argue that municipalities and cities should find useful solutions to handle challenges and trends that improve the perceived quality of life, but they face several challenges and trends (Figure 1): Digitalization, sustainability, citizen participation, diversity, artificial intelligence (AI), professionalization of public services and public management and agile administration, expectations of higher transparency and openness of public administration, information overload and tendency to dataism vs. data sharing. However, none of the lines or listing of trends and challenges is the final one, even ours. As well as cities and municipalities as smaller territorial units with partially limited resources, both types of territorial units are under the influence of the trends and challenges we have identified.

Figures 1a) and 1b) show the variety and difference in the scope of the challenges and trends. The same challenges and trends can be perceived differently by each particular municipality and city. Therefore, each of them has its own mix of trends and challenges that affect it. The way the identified factors are arranged in the form of trends are unique to each town and municipality, for example some municipalities are very strongly influenced by some trends and conversely for some municipalities they may not have any influence at all. The size of the bubbles in the figures represents the strength of the factor affecting the municipality, and the proximity of the bubbles to the municipalities tells how responsive the territorial unit is to the stimulus.

The importance of challenges and trends perceived by the relevant stakeholders is usually transformed into policies and strategies. The challenge that is seen as the most important one by a city with 200,000 citizens, can be identified as less important by a city with 5,000 citizens.

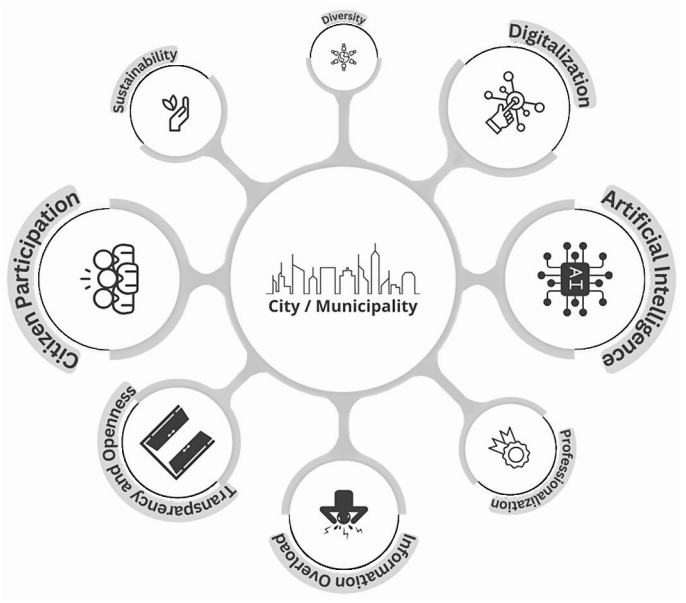
Trends can be defined as general directions for changes and development in the spheres of society. Municipalities and cities can be influenced by some trends but may be avoided by others. However, municipalities and cities can be proactive, because if some trends do not influence communal life in particular self-government units now, it may probably impact municipalities and cities in the future. In this regard, foreseeing adaptation to trends can be beneficial for self-government units and the public as well.

Figure 1a: Trends and challenges at the communal level

Challenges are usually perceived as a competitive situation or an obstacle that tests the ability of municipalities and cities to execute their competencies. Challenges represent a set of practical issues that municipalities and cities cannot avoid. Responding to trends cannot prevent challenges from arising. However, the preparedness of municipalities and cities can increase the number of anticipated challenges and decrease the level of unexpected sets of issues.

Digitalization and green sustainability, regardless the size of municipalities and cities, are integral parts of policymaking at the communal level. Municipalities and cities integrate individuals, capacities, industries and business activities; thus, municipalities and cities are the leaders in digital and green transition (Ma et al., 2023; Manjon et al., 2022). Digital and green transitions share the broader goal of a more sustainable future, and lead to the transformation of the society´s subsystems (Müller et al., 2024). In this

Figure 1b: Trends and challenges at the communal level



Source: Authors

regard, digital and green transitions can improve the quality of life at the communal level.

C. From digital and green transition towards triple transition

I. Digitalization of public services

Digitalization as a doctrine improves the execution of governance and competencies, mainly through the extensive use of ICT and innovative solutions. Digitalization in municipalities and cities is an ongoing process that is deeply challenging and requires more and more sophisticated approaches (Toll, et al., 2023). Digitalization of municipalities and cities is perceived as a necessary step towards a higher quality of life, both from citizens´ and local authorities´ points of view. Digital transformation and the use of digital technologies are transforming the provision of public services through new

opportunities that expand and enrich the execution of competencies (Frennert, 2019). Digitalization helps the different types of municipalities to solve various issues with no negative effect on the quality, or at least the influence will be relatively small compared to the current situation (Wokoun et al., 2023).

The implementation of innovative digital solutions is frequently supported by the acceptance and contribution of the different local stakeholders, such as businesses, civil society, or higher education institutions. The municipalities that develop ecosystems like digitalization, via collaboration and innovative approaches, are further ahead of other municipalities in digitalization, and provide public services of higher digital quality (Nesse a Erdal, 2022; Chang et al., 2020). Digitalization modifies the existing practices and also creates entirely new ones in entities across society (Grabara, et al., 2023). Digital solutions require the stakeholders´ feedback to maximize their benefits. Thus, citizens participate in the design and functionality of digital solutions, to maximize the positive impact of these solutions on the perceived quality of their individual lives.

II. Environmental issues and climate change

Municipalities and cities should ensure that digital transition is implemented environmentally friendly and emphasize its positive impacts on climate change. Modern municipalities and cities seek to improve the quality of life of their citizens by developing both digital innovations and green sustainable solutions (Delitheou et al, 2019). Digitalization makes information and data more accessible for the citizens, thus decentralized decision-making processes in the environmental aspects of public policies are easier and more efficient (Balogun et al, 2020). A significant part of green solutions can also be seen simultaneously as a digital solution. The separation of these dimensions is sometimes difficult.

As the global trend towards environmental sustainability continues, municipalities and cities naturally transmit climate change topics into communal strategies. Green cities can respond to environmental sustainability challenges, especially through energy and climate strategies (Bibri, 2020). Digital technologies produce solutions focused on the reduction of pollution hazards, traffic jams, resource usage, energy consumption, or public safety (Almalki, et al., 2023). However, the contribution of communities is also very important, as was proven by many cases, e.g., individual cooling strategies that help to reduce the effects of hot weather and heat extremes (Jay et al., 2021), or the importance of the gardens´ contribution to urban green spaces (Hanson et al., 2021). Green solutions require the active partici-

pation of the stakeholders, because the behavior and actions of individuals and businesses directly impact the sustainability of the local community.

III. Twin and triple transition

Digital and green transition reinforce each other, but to make the most out of twin transition, proactive and interactive management is needed (Muench, et al., 2022). Twin transition combines digital and green goals to unlock the benefits in terms of efficiency and productivity and to achieve the sustainability goals (Blüm, 2022; Killeen, 2022).

Twin transition highlights the potential synergies between the green and digital transitions, with potentially wide-ranging impact on inequalities at the economic, social and geographical levels (Diodato et al., 2023). The benefits of digital and green transition must be supplemented by a healthy environment that supports the collaboration among the stakeholders (Paiho, et al., 2023; Rehman, et al., 2023). However, socio-economic conditions, challenges and risks are mostly perceived as secondary for digital and green transitions.

Triple transition is continuously converting into an approach that exceeds the original meaning of digital and green aspects of society. Twin transition cannot be successful without addressing the social dimension of the transformation, while focusing on reducing social and territorial inequalities (Schmerber, 2024). Digital and green transitions appear necessary but insufficient to break social, economic and environmental imbalances and conflicts (Council of the European Union, 2023; OECD, 2023b). Governments are forced to manage a triple transition in the areas of digital transformation, climate change and social evolution (Schwarzer, et al., 2022). Triple transition can be seen as a starting point for policymakers to protect society against a vast array of imminent socio-economic and demographic risks (Petmesidou and Guillén, 2022). In this regard, triple transition concentrates the attention of municipalities and cities on brand-new social issues, but also offers municipalities innovative solutions for traditional and common social issues.

Both, twin and triple transitions help municipalities and cities to overcome crises, such as pandemics, economic, energy, or ecological crisis (Leuzzo, 2023; Muench et al., 2022). However, twin and triple transition cannot be perceived as a multi-purpose fix for issues, challenges and trends, but can be seen as an appropriate set of tools that helps municipalities and cities to adapt to the dynamic development of our society.

D. Results and discussion

I. Methodology

The study examines the measures and activities implemented by cities that respond to digital and green transitions, mainly those activities that reflect twin and triple transition at the same time. Before of this analysis, the study examines, in a theoretical way, approaches that help municipalities and cities to respond to twin and triple transitions. The study aims to answer the research question of how digital and green transitions influence the social aspect of communal life. With the use of the case study method, this study examines measures adopted by selected cities in the Slovak Republic.

The research sample was selected purposefully, taking the spatial fragmentation of the Slovak Republic, the cities´ competencies, and their roles in the territory into consideration. Municipalities and cities are often perceived as initiators of innovative solutions in the Slovak Republic's conditions. The main difference between cities and municipalities is determined by the fact that cities realize key activities focused on the provision of public services both for their residents and residents from the nearest region. Six case studies from six cities in the Slovak Republic were analyzed covering the period 2021-2024. The case studies represent the appropriate tool, which was used to demonstrate how cities respond to twin and triple transitions.

II. Cases

The following case studies demonstrate the digital and green activities of the selected cities that go–beyond twin transition. Each of the six case studies includes a basic explanation, the description of the adopted solutions, and the impacts of the implemented solutions on communal life.

1. Climate and energy plan of the city

As a reaction to climate change, the city of Piešťany has an ambition to elaborate the Climate and energy plan of the city of Piešťany. The formulation of basic issues began in 2021, and the final version of the document and action plan will be prepared in 2026 (Piešťany, 2024). The document presumes that digital and green solutions will help to mitigate the negative impacts of climate change in the city.

The city of Piešťany aims to use digital solutions mainly to increase the energy and water efficiency of public buildings owned by the city, modernize streetlights, foster ecologic transport, and disseminate the importance of

circular economy and waste management, as well as support and protect the citizens affected by social and energy poverty, and increase the awareness of the various stakeholders on collaboration in mitigation measures (Piešťany, 2022).

The importance of the social dimension was already clearly stated in the formulation phase of the document. Educational and awareness-raising activities focused on climate change and mitigation measures are necessary for collaboration in the city. The ambition of the city to support and protect its citizens negatively affected by social and energy poverty is also a significant sign of the wider social impact of the climate and energy plan.

2. Smart streetlights

The city of Košice continuously modernizes the system of streetlights in the city districts. Restoring the streetlight system with smart streetlights confirms the importance of smart and digital technologies. The new smart lights use LED technology and smart switches with remote control, what will lead to the saving of financial resources in the future.

The modernization of the streetlight system has a wider impact on the quality of life in the city. The city of Košice aims to increase the safety of its citizens because the priority is to add new smart streetlights in places with insufficient coverage (Košice, 2024).

The new smart streetlights represent an ideal example of digital and green transition. This solution combines digital and ecologically friendly measures adopted at the communal level. Contrary to old streetlights, this solution increases the citizens´ safety thanks to better luminosity and lower failure rate.

3. Low carbon strategy

As a result of the negative impact of climate change, a low carbon strategy was adopted by the city of Trnava. The strategy also emphasizes the importance of digital solutions as an integral part of mitigation measures. The low carbon strategy of the city of Trnava for the years 2022-2027 identifies the current state, priorities, and future activities in the fields of local government buildings, residential buildings, streetlight systems, industry, transportation, smart city, climate change, and also describes planning, regulation and the position of the public (Trnava, 2022).

The strategy reacts to climate change but strongly incorporates digital solutions that lead to energy efficiency and carbon footprint reduction. Simultaneously, the strategy underlines the importance of the public and other stakeholders in the territory. The city declares that the successful

implementation of the strategy is directly influenced by the behavior of citizens and business activities. In this regard, the strategy presumes communication, guidance, and education.

4. Smart platform for socially responsible behavior during a crisis

The digital solution adopted by the city of Prešov was the first of its kind among the cities in the Slovak Republic. A similar mobile app is currently used only by the Mountain Rescue Service and Air Rescue Service in Slovakia. The platform called "Safety" allows the use of multimedia communication to be added to the standard emergency call. After the initialization of the emergency call, the individual will receive an SMS message with a specific link from the operator of the emergency center. When the individuals click on this link, they confirm sharing their location, and start a video call after allowing access to the phone´s camera. The platform also includes a chat function with the possibility of translation to 30 languages (Prešov, 2024).

The digital solution adopted by the city of Prešov demonstrates the ability of the city to connect the digital and social aspects of its competencies. This case study confirms that a smart app can be focused on the citizens´ basic social needs - a safe and secure environment. The application is also inclusive, because the benefits of the application can be perceived by different types of groups regardless of age, education, or social status, and without previous registration or authorization. The citizens benefit from the use of this digital solution because it can strengthen their ability to react in a socially responsible way, according to legal acts, social norms, and public interest.

5. Circular map of the city

The functioning of the local circular and shared local economy is easier thanks to the interactive circular map of Bratislava. The interactive map helps the citizens to find different goods and services in the city. The circular map of Bratislava provides information on different aspects of the circular and shared economy in the city, for example, zero-waste packaging-free stores and markets, second-hand shops, collection places and yards, car and bike-sharing solutions, rental and repair services, services and repair shops, community gardens, community compost sites (Bratislava, 2024).

The implemented solution is another successful example of a twin transition. Moreover, the selected solution strengthens the networking among communities in the city. The digital and green dimension of the interactive circular map also builds awareness of the circular economy.

Table 1. Comprehensive summary of the examined case studies

	Twin transition		
	Triple transition		
	Digital solution	Green solution	Social impact
Case 1 Climate and energy plan of the city	x	x	x
Case 2 Smart streetlights	x	x	x
Case 3 Low carbon strategy	x	x	x
Case 4 Smart platform for socially responsible behavior during a crisis	x	-	x
Case 5 Circular map of the city	x	x	x
Case 6 Green and blue infrastructure	-	x	x

Source: authors

6. Green and blue infrastructure

The city of Banská Bystrica declared its ambition to improve the green and blue infrastructure in the territory. Green and blue infrastructure usually combines the elements of greenery and water in the urban territory of the cities. As it is proclaimed by the city document, the green and blue infrastructure increases air humidity, provides shades, reduces noise, dust and temperature, supports the regeneration of the organisms, contributes to education, and improves the environment and conditions for adaptation to climate change (Banská Bystrica, 2021).

The wider social impact of the mentioned ambition of the city of Banská Bystrica can be seen in several dimensions. Green and blue infrastructure improves the quality of life. Citizens can perceive the benefits through the improvement of their physical and mental health. Simultaneously, the relatively high financial investments in the following years will burden the city budget to a smaller extent than the elimination of the negative impacts of climate change in the future.

III. Discussion

The examined case studies showed that the analyzed solutions implemented by the cities also have a wider social impact. Table 1 provides a comprehensive summary of the analyzed cases focusing on the adopted solutions as parts of twin and triple transitions.

The case studies showed that the selected Slovak cities implemented digital and green solutions in different fields of communal matters. Four case studies confirmed that the cities proactively reflect the trend of triple transition. The examined cases of digital and green solutions also have a wider impact that positively influences the social aspect of communal life. Simultaneously, the wider impact on the social aspect of communal life was identified in one digital solution and also in one green solution.

The trend of triple transition is the reaction to the development of a continuously transforming society. As proven by the theory and the examined case studies, triple transition can be described with the feature of transformability. In the case of twin transition, digital solutions were implemented as a priority but they were subsequently also applied in the process of solving the sustainability and climate change adaptation issues. Digital solutions can still be implemented as stand-alone solutions, but municipalities and cities use them to solve necessary and key green issues. The same situation is currently repeating in the case of the evolving triple transition. Municipalities and cities reflect the need to solve social issues at the communal level, and simultaneously satisfy the digital and green needs of their citizens.

E. Conclusion

Triple transition can currently be perceived as a natural and pragmatic evolution of twin transition. Twin transition is basically a common part of policymaking at the communal level today. However, the relevant stakeholders gradually begin to perceive the need to solve and mitigate social imbalances, inconsistencies, and conflicts.

Both theory and research have confirmed that digital and green solutions can have a wider impact, thanks to which they help municipalities and cities deal with challenges in the social field. However, these complex solutions are not yet possible to characterize at the level of municipalities and cities as prevailing. The purpose of our research was to point out the ever-increasing tendency of municipalities and cities to respond to trends and challenges with complex local policies, and the study also serves as a platform for the dissemination of examples of good practices in Slovakia.

The direction of future research will reflect the rising occurrence and scope of social issues in society. Future research will identify the potential modification of the existing twin transition solutions and also the development of brand-new triple transition solutions.

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