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Traffic Mitigation Through Urban Form and Public Transport: The Case of Tirana

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Abstract This study investigates the link between urban form and traffic congestion in Tirana, Albania's capital and largest metropolitan area, where residents spend an estimated 50–60 hours per month in traffic. The problem is intensified by rapid urbanization across the Durrës-Tirana-Elbasan-Krujë corridor, which houses nearly half of Albania's population and places immense strain on Tirana's infrastructure. The city's monocentric structure funnels economic and social activity into a single core, creating bottlenecks and overwhelming a road network designed for a much smaller population. Contributing factors include narrow, poorly maintained streets, high car ownership, inefficient public transport, limited parking, and weak traffic management. The study hypothesizes that urban form directly shapes traffic patterns and proposes a shift to a multicentric model, inspired by cities like London and Paris. This would involve developing new urban nodes outside the historic center, connected by a redesigned public transport network. Using traffic modeling software and GIS tools (QGIS), the research simulates various multicentric schemes, analyzes traffic convergence zones, and tests optimal configurations. These interventions aim to redistribute traffic, enhance urban integration, and improve quality of life. Ultimately, the study offers a transferable framework for other monocentric cities, addressing mobility challenges while promoting spatial equity and sustainable urban development.

Keywords Infrastructure, Multicentric Structure, Public Transport, Traffic Congestion, Urban Form

1. Introduction

According to INSTAT 2024 data, the municipality of Tirana covers an area of about 1,110 square kilometers. The population of Tirana municipality in 2024 was approximately 758,513 inhabitants. Based on this information, the population density of Tirana is roughly 684 inhabitants per square kilometer. These figures reflect the expanded administrative boundaries of Tirana municipality that include both urban and rural areas [1]. Only one century ago, Tirana had a population of around 10,000 inhabitants, and taking into consideration a huge number of city users as commuters and tourists, we can assert that the population of the city has been a hundred fold. The notable growth is attributed to factors such as internal migration and territorial reform, resulting in various impacts including heightened urban density, suburban expansion, increased informality, greater demand for transportation and public services, traffic congestion, and significant pressure on the city's infrastructure and urban functionality.

According to Dino [2, p.134], Tirana's urban form evolved from an organic, monocentric structure in 1921 to a planned, compact city with high connectivity during the socialist era in 1989, and later to a fragmented, dense urban

fabric with unregulated growth in the post-socialist period by 2018. Dino [2] also shows in her thesis that the infrastructure expanded significantly over time, but post-socialist development introduced deepened networks with many dead-end streets, reducing accessibility and navigation efficiency.

Although the city has undergone numerous transformations in its urban form over the past 35 years – resulting in a "fractured" city with "Urban Slates," as highlighted by Kumaraku, Istrefaj, and Idrizi [3] – from the perspective of urban structure, we are still witnessing a dominant central core that has governed Tirana's entire expansion. Despite its growth and development since its inception, Tirana retains a monocentric structure.

Due to its monocentric structure, economic, social, and institutional activities are concentrated in a single core. This has led to an overload of the road system and public transport, creating infrastructural, functional, and environmental urban crises. The existing infrastructure, designed for a smaller population, has not adapted to the demographic growth and intensive urbanization of the past decade.

Public transport is directly affected by the uneven distribution of the population and internal migration towards urban centers. As mentioned above, population density has created overloads in the existing transport infrastructure, while in depopulated rural areas, we see a reduction or closure of transport lines. These dynamics require a review of the infrastructure of the transport system, orienting them towards flexible and integrated models taking into account the needs of the population.

According to INSTAT in Tirana, on October 29, 2024: The length of the road network in use is 3,606* km, classified by categories, such as highways, main interurban roads, secondary interurban roads, urban roads and local roads. Secondary interurban roads occupy about 74.2% of the length of the road network. In the third quarter of 2024, the total number of road vehicles with "active" and "temporarily deregistered" status circulating in the territory of the Republic of Albania until September 2024, was 939,152. In the category of road vehicles by type, the largest percentage of the total number of road vehicles is occupied by "Cars" (80.8%), "Vehicles for mixed transport" (6.0%) and "Motorcycles" (5.7%).

If we look at the data from Instat, the rate of motorization in road transport by variables and year from 2014 to 2023 has increased (Fig. 1).

Also, if we look at the modes of transportation, classified according to the use of commuters, we will see that the largest percentage of travel is taken up by public motorized transportation and private vehicles (Fig. 2).

The main issues include an insufficient road network, a high number of private vehicles, inefficient public transport, and poor traffic management. These combined factors result in high time costs, especially during peak hours. To resolve this situation, Tirana must transition from a monocentric model to a multicentric one, where new urban centers function as "planets" gravitating around the main core, yet maintaining functional independence.

The identified research problem relates to severe traffic congestion caused by rapid urbanization and population growth. The current infrastructure, designed for a smaller population, cannot accommodate the increase in vehicles, resulting in longer travel times and rising pollution. This article aims to address the issue through formal urban reconceptualization and public transport management, in order to eliminate traffic congestion and improve residents' quality of life.

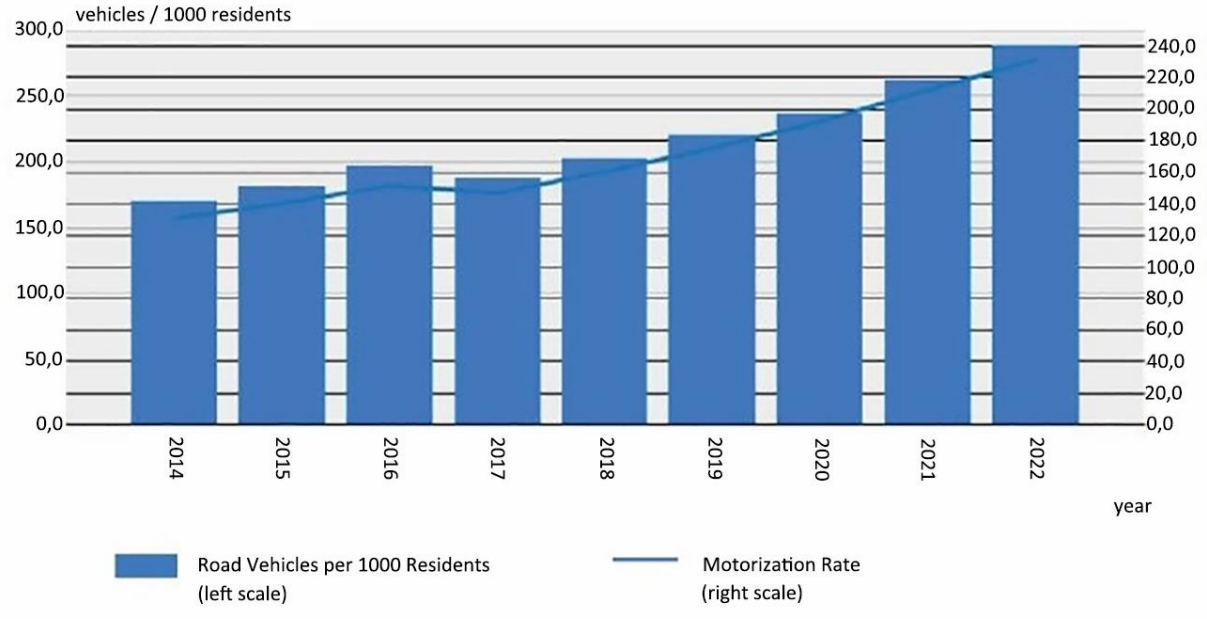

Figure 1. Motorization rate in road transport by variables and year. Source: [Instat]

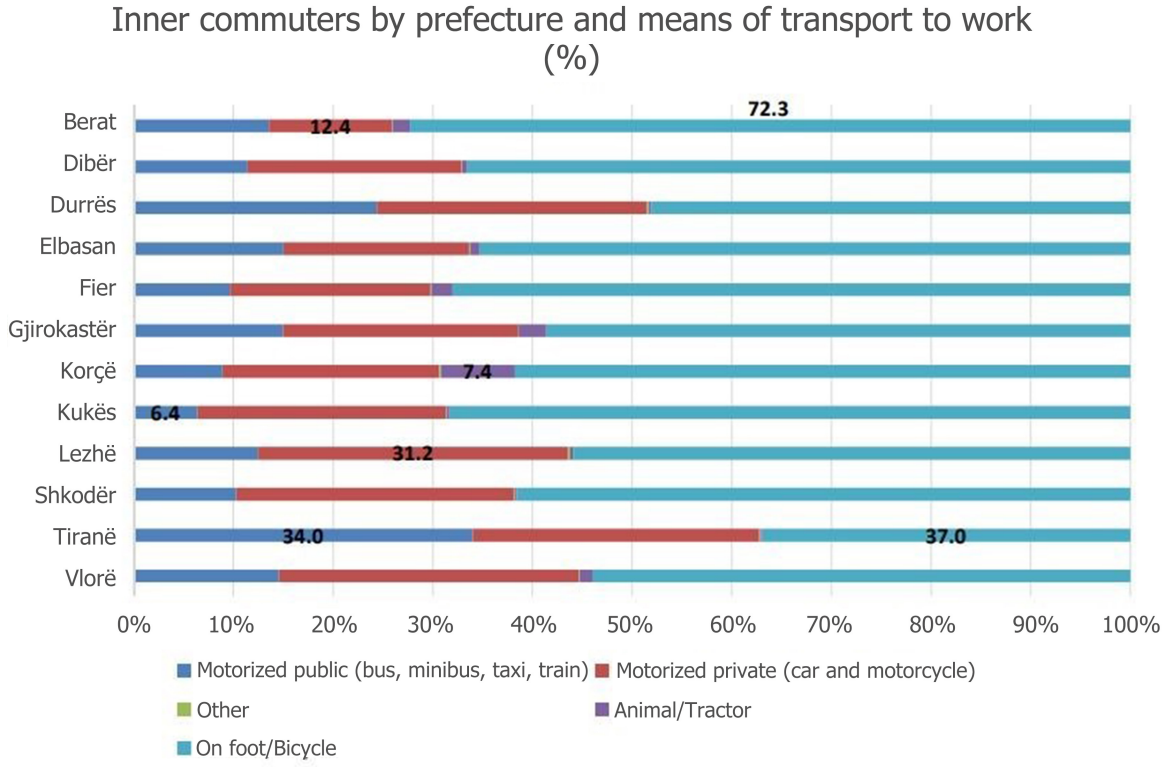

Figure 2. Inner commuters by prefectures and means of transport to work. Source: [4]

The objective of this article is to propose a formal reconceptualization of Tirana to eliminate traffic congestion. This will be achieved through the study of successful examples, analysis of the current situation, and the proposal of changes in the city's form and public transport system.

By observing Tirana's monocentric urban structure, a tendency is noted whereby all transport flows converge in the center, causing traffic congestion at this point. Our hypothesis is that traffic is caused precisely by the accumulation of flows at a single point, and that if we create a system of new centers gravitating around the main one, this flow will be decentralized and distributed across these new centers.

The article's objective is to present a formal configuration of Tirana's urban structure capable of alleviating traffic by dispersing it from a single center to several gravitational centers. Additionally, the objective includes determining the optimal physical location of these centers within Tirana's territory and how they should be interconnected in terms of infrastructure and public transport.

The article has been developed through a methodology structured in four interrelated phases. Initially, a thorough historical, territorial, and urban analysis of Tirana was conducted, based on archival sources, planning documents, and statistical data, with the aim of creating an integrated database for the urban context. In the second phase, the existing road infrastructure and its connection to the city's formal structure were analyzed to identify critical load points and functional obstacles. Subsequently, innovative urban reconceptualizations were proposed, supported by sustainable planning theories and international practices, aiming to reduce the need for vehicular movement and increase spatial efficiency. In the final phase, the current urban transport system was analyzed, and an alternative scheme was designed to operate in accordance with the proposed new city form, promoting modal integration and sustainable mobility. This methodological approach has enabled a comprehensive treatment of Tirana's traffic issues.

This article aims to offer an alternative solution to Tirana's traffic problem by focusing on restructuring the urban form and redesigning the public transport network, rather than traditional road expansion. The proposed approach seeks to reduce dependence on the historical center and ease movement flows by distributing functions within a multicentric network. The main contribution lies in the proposal of a multicentric model with new functional centers, connected by an integrated public transport network. This will improve mobility, reduce traffic, and enhance the quality of urban life. From the abstraction of Tirana's case, the goal is to develop a conceptual scheme that can be applied in similar formal and cultural contexts.

2. Materials and Methods

2.1. Historical Background

Tirana, situated at the geographic center of Albania and strategically positioned at the intersection of major national (Fig. 3) and international transportation corridors, has undergone significant urban growth and transformation. Over the course of approximately one century, its population has increased from around 10,000 inhabitants in 1920 to an estimated 925,000 residents in the Tirana District, according to INSTAT data. This represents a nearly hundredfold demographic expansion. Naturally, to accommodate this growth, the city has seen a substantial increase in buildings and road infrastructure. However, the central urban nucleus has remained unchanged, continuing to be defined by the area stretching from the Old Mosque to Skanderbeg Square.

According to historical evidence presented by Frashëri, the area surrounding Tirana has been inhabited since antiquity, with traces dating back to the Paleolithic period. A key example of this early settlement is the Cave of Pellumbas [5, p.18]. During the Middle Ages, a series of fortifications were constructed, primarily intended to provide defense in times of conflict.

The earliest recorded traces of villages located in the region of present-day Tirana – then registered under the Vilayet of Kruja – are found in the Ottoman defter of 1431–1432. This defter, published in 1954, documents several villages situated predominantly along the main riverbanks [5, p.53].

Based on a cartographic analysis (Fig. 3) presented by Frashëri, six principal road axes leading to Tirana can be clearly identified, originating from all major directions: Kavaja, Durrës, Shkodra, Mat-Dibra, Shëngjergj, and Elbasan [5, p.72]. All of these routes converge at the city's historical center, specifically in the area where the Old Bazaar was once located.

The earliest recorded appearance of the name "Tirana" on a topographic map is found in a chart processed by Castelli in 1689, where the name is clearly identified for the first time. It is likely that during this period, only the initial urban nucleus of Tirana had been established, organized around the Old Mosque, built by Sulejman Pasha Bargjini in 1614. A second nucleus – chronologically following the first – was formed around the Fira Mosque, reconstructed in 1859 by Selman Beshiri, located at the site of today's "Sami Frashëri" school [6, p.18].

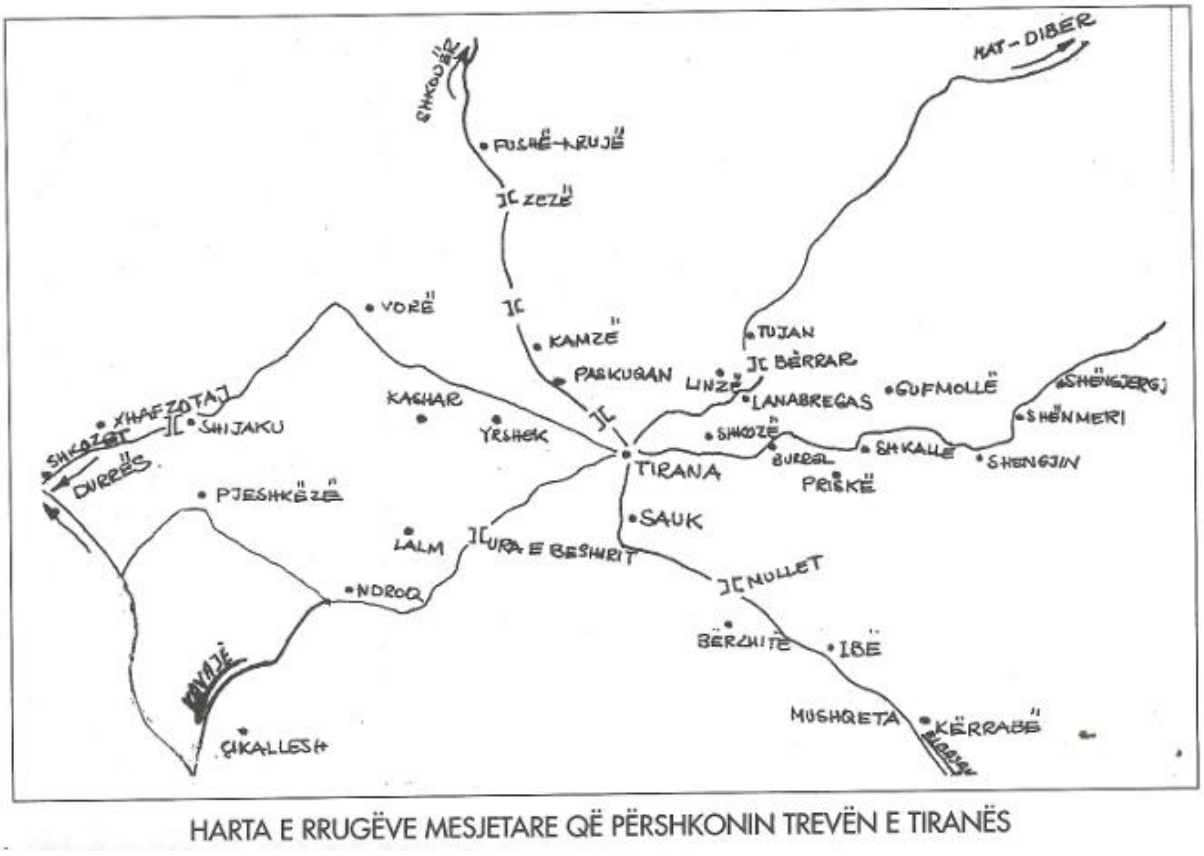

Figure 3. Main road axes converging in the city of Tirana, connecting it to major inhabited centers across Albania. Source: [5, p.72]

According to Aliaj et al. [6, p.17], the urban structure of Tirana from the 17th century until the early 20th century was organized around nine principal mosques, which served as focal points around which residential areas were developed. The gradual expansion of these centers contributed to the city's growth during the first three centuries of its existence, up to the beginning of the 20th century.

By the late eighteenth century, the city of Tirana featured a series of sacred religious structures – mosques and tekkes – around which typical dwellings were organized. These houses were primarily constructed in stone and, in some cases, in adobe, several of which can still be observed in the old alleyways [5, p.180; citing Hahn, 1853, p.85]. The principal religious buildings served as focal points for the aggregation of Tirana's modest adobe dwellings. The Old Center of Tirana is clearly structured around the Sulejman Pasha Bargjini Mosque, whose origins date back to 1614 and coincide with the founding of the city. The Old Mosque was located at the site now occupied by the Plaza Hotel (TID Tower).

In the nineteenth century, Tirana's road infrastructure consisted of six principal axes converging around the Old Bazaar, along with one main thoroughfare – Çarshia Street – along which the majority of religious buildings were located. Çarshia Street began at the Old Mosque, with the Old Bazaar situated to its west, and extended toward what is now known as Barrikadave Street. Along this axis, most of the city's religious structures were concentrated, functioning as organizational nuclei for Tirana's urban form.

An analysis of the historical map (Fig. 4) reveals that the roads from Kavaja, Durrës, and Shkodra converged near the Karapici Mosque, joining together as they passed north of the Old Bazaar. Upon intersecting with Çarshia Street, the route continued as the road to Dibra. From the south, the road from Shëngjergj crossed the Lana stream via the Tabak Bridge, while the Elbasan road, after crossing Lana via the Terzi Bridge, merged with the Shëngjergj road. The continuation of this merged route formed Çarshia Street, which ran with the Old Bazaar on its right-hand side.

Viewed through this lens, Tirana's urban scheme resembles a classical cardo-decumanus structure, with the intersection of the two main axes forming a central forum – represented in this case by the Old Bazaar quarter.

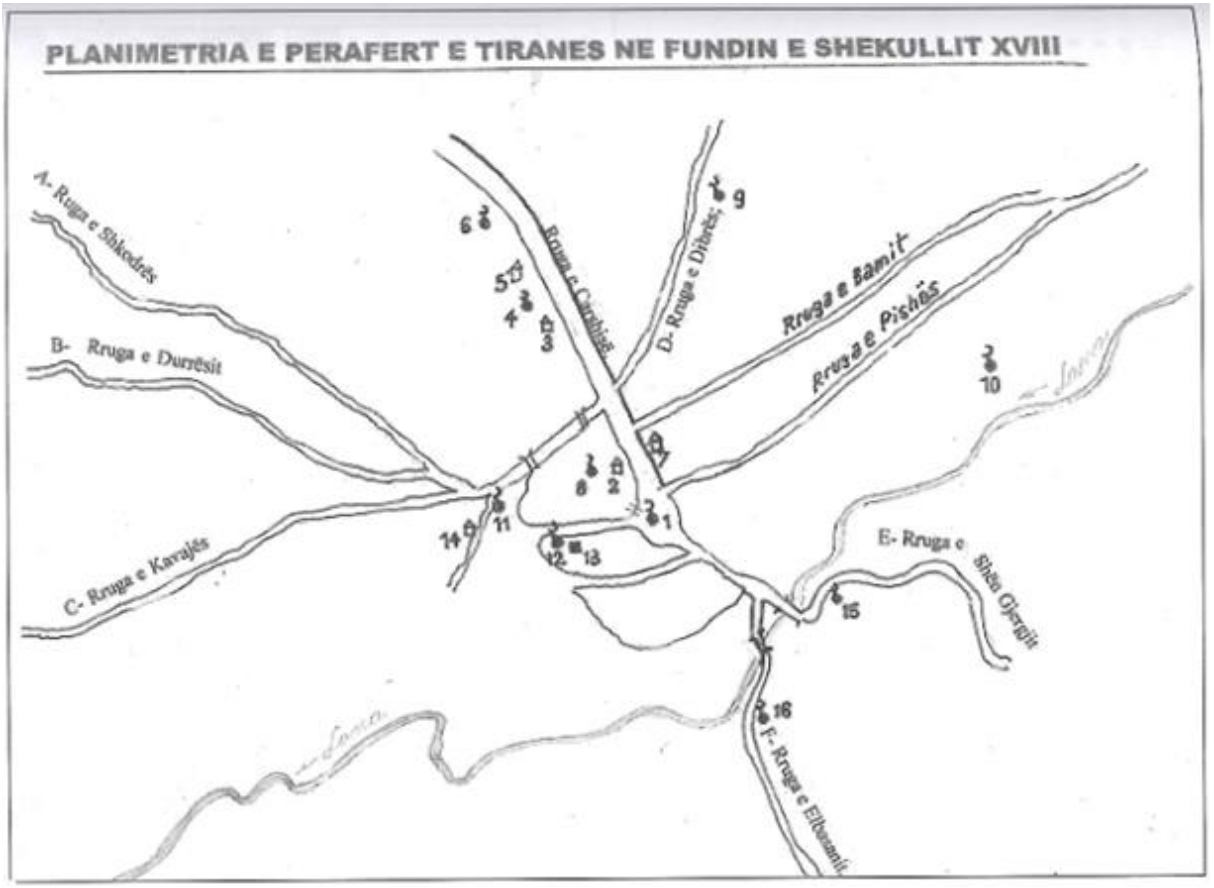

Figure 4. The historic center of Tirana (the çarsia) was organized around mosques and tekkes during the 18th century. Source: [5, p.172]

In 1920, Tirana was proclaimed the capital of Albania, and over the past 105 years, its urban center has evolved – initially organized around the Çarshia and later around Skanderbeg Square. This central area has consistently functioned as a gravitational point for the morphological organization of the entire settlement, with a prevailing tendency for urban development to concentrate toward the center.

This dynamic is clearly reflected in the development of the Astir neighborhood, which formerly belonged to the municipality of Kashar. The earliest construction permits and residential blocks in Astir were issued and developed along the main artery of the New Ring Road, primarily due to its proximity to Tirana's central square – Skanderbeg Square – rather than to the administrative center of Kashar.

As a result, over the past decades, efforts to decentralize Tirana's urban centers have remained largely unrealized. The city has yet to achieve a multicentric structure – a goal that constitutes the central focus of this article, particularly in relation to addressing the persistent issue of traffic congestion.

2.2. Theoretical Framework

The structure of urban form in Albania, in relation to road infrastructure, has previously been addressed in a study by Kumaraku and Prifti [7], which analyzes the formal connection between urban development and the evolution of the road network. However, this study does not treat urban form as a kind of panacea capable of solving the city's problems, including traffic issues. For this reason, our analysis is supported by other studies from various international authors.

Cervero [8] emphasizes that investments in transport infrastructure have a direct impact on urban form and traffic dynamics, particularly in developing cities where strong regional planning is lacking. He argues that in cities such as Mexico City and Santiago, the construction of metro systems has encouraged urban sprawl and decentralization, increasing travel distances and traffic congestion.

From this perspective, it can be said that public transport - such as the metro systems mentioned above - cannot be considered a solution for reducing traffic. In contrast, Bus Rapid Transit (BRT) systems in Bogotá and Curitiba demonstrate that public transport can contribute to traffic reduction and balance.

Nevertheless, the author here considers traffic reduction as a solution achieved through public transport services, which for us represents a subordinate aspect of urban form.

On the other hand, Waters [9, p.26] describes the multicentric city as an urban form with corridor, star-shaped, or satellite morphology, which aims to control urban expansion, create spaces for biodiversity, promote vibrant and diverse neighborhoods, and reduce travel time by concentrating development near accessible areas. The goal is to combine the benefits of both sprawling and dense cities, focusing on centers of social and commercial activity that form communities built around multiple neighborhoods.

Rogers [10] proposes a sustainable urban approach based on multicentric development models. According to him, the creation of distributed centers within a territory contributes to a better functional balance in the city, reducing dependence on private vehicles, lowering pollution, and promoting a lifestyle oriented toward the local community. He emphasizes the importance of mixing urban functions - housing, work, and services - as a way to bring the city closer to its inhabitants.

However, the author underscores that implementing a multicentric structure requires careful planning and effective interaction between different levels of governance. In the absence of a coordinated approach, the development of new centers may lead to socio-economic shifts and urban fragmentation. For this reason, Rogers places particular importance on community participation in planning processes and the formulation of urban policies, considering it a fundamental condition for the success of such a model.

Implementing such a model is not easy. The main challenges include the lack of coordination between different levels of governance. The development of a multi-centered system requires sustained institutional and political cooperation to ensure coherence in planning and investment [11].

The aforementioned authors have emphasized the importance of multicentrism as a means to achieve a more functional and spatially just settlement. However, none of them have addressed it in relation to traffic reduction and mitigation in connection with urban form. From this perspective, we will analyze below the traffic management strategies presented in the book Great Cities and Their Traffic.

2.3. Cases and Strategies of Traffic Management

Cities have long served as demographic magnets, commercial hubs, and condensers of physical energy. Today, Tirana acts as Albania's strongest urban attractor, channeling flows from four major axes into a single gravitational point. Its future trajectory evokes a cosmological "Big Bang," anticipating a shift from monocentric to multicentric structure, akin to planetary systems orbiting a core.

European cities initially operated as monocentric entities, but over time expanded into decentralized nodes. London exemplifies this transformation: once centered around the historic "City of London," it now comprises multiple autonomous centers. Population growth and urban expansion gradually reshaped its structure. The arrival of motor vehicles and rapid demographic shifts rendered its scale unprecedented. London's development was shaped by

two historical coincidences - being the birthplace of the railway and the epicenter of industrialization - both of which enabled massive urban growth [12, p. 269].

Railways significantly increased central city capacity, prompting employers to concentrate investments in the core and raising central rents. Residents moved to the suburbs, as the center remained accessible. Offices replaced homes, creating a spatial division: employers in the center, employees in peripheral rings. In the 1930s, the Green Belt was introduced to curb urban sprawl, yet it did not serve as a rigid boundary - new towns emerged to relieve central pressure [12, p. 270]. Thomson's traffic limitation strategy aimed to place the city center atop a hierarchy of sectoral centers, each defined by central location theory, optimizing accessibility and minimizing unnecessary travel [12, p. 264].

Paris exemplifies the transition from a monocentric to a multicentric urban and regional structure, driven by the need to alleviate pressure on its historic core and by transport developments linking center and periphery. Its dominant national role is reinforced by France's transport system - roads, railways, and air routes all converge toward Paris [12, p. 170]. Recognizing the physical and social constraints of the central city, the French government promoted development beyond the inner ring, aiming not only to reduce traffic congestion but also to foster new economic and residential zones. This strategy included circular connections and a radial ring network, enabling movement between centers without passing through the historic core.

According to Thomson, maintaining Paris's functionality and sustainability requires a strong center supported by robust radial transport [12]. The strategy combines a powerful central core with efficient radial infrastructure, ensuring that peak-hour car travel matches public transport quality. Strategic subcenters emerge along these radial lines, forming a network that reinforces rather than fragments the central structure. This approach suits cities with consolidated monocentric forms, balancing central reinforcement with controlled decentralization along transport corridors [12].

Thomson examines the urban dynamics of major metropolises such as London and Paris, highlighting the stark differences in their approaches to urban development and traffic management. London, he argues, has allowed uncontrolled suburban expansion without the deliberate creation of autonomous urban centres, thereby maintaining dependence on the historic core for employment and services. Efforts to improve traffic have been fragmented and delayed, leaving the city congested and functionally inefficient [12, p. 170].

By contrast, Paris has pursued a deliberate multicentric strategy, establishing new urban centres such as La Défense to decentralize core functions and alleviate pressure on the historic centre. These centres are connected through an integrated public transport network, contributing to a more balanced spatial and functional urban system. The French strategy, known as the strong-centre model, aims to ensure that new centres are not merely by-products of spontaneous development but are purposefully planned nodes with defined functions and sustained investment [12, p. 264].

In the context of Tirana, the city is undergoing a transitional phase from a monocentric structure toward a more distributed urban model. Central congestion, the absence of independent urban centres, and the lack of an integrated public transport system place Tirana in a position similar to that of London in previous decades. The risk of uncontrolled suburbanization could lead to spatial fragmentation and unequal resource distribution.

The French model offers a more suitable alternative for Tirana, advocating for the creation of new centres with specialized functions, connected via ring roads and public transport. A hybrid strategy that combines elements from both models may support the development of a more sustainable and accessible urban structure, where public transport planning plays a key role in guiding urban growth.

2.4. Tirana Urban Structure

Currently, Tirana is following a monocentric ring-road structure that further accentuates the centrality of Skanderbeg Square. Over the past century, the city has expanded through the addition of a series of concentric rings encircling its core. The city continues to operate as a single center where all major functions and flows converge.

- Urban proliferation and systemic inequity

In recent decades, Tirana has developed in a disjointed and irregular manner, resulting in a "cellular" urban configuration that finds it challenging to align with modern mobility requirements. The city's monocentric structure has resulted in an asymmetric configuration, characterized by a densely congested center core and inadequately connected, weak peripheral regions. This disparity has resulted in significant infrastructural strain, prolonged commuting durations, and spatial inequities between the urban core and the periphery.

- Identification of prospective sub-centers

A spatial and functional study found multiple outlying zones as prospective urban sub-centers that could sustain a polycentric structure. The locations comprise Kombinat, Kamza, Paskuqan, Shkozë, TEG, QTU, and the Airport vicinity. Each of these regions has partial functional autonomy and strategic access to primary transportation corridors. Kombinat and Kamza possess robust residential and industrial roles, whereas TEG and QTU function as burgeoning commercial centers. Shkozë and Paskuqan possess possibilities for mixed-use development, incorporating residential, commercial, and public amenities.

- Urban influence zones and accessibility

An "urban influence zone" was defined for each proposed sub-center by GIS research. These zones delineate the gravitational influence of each center and their intersecting catchment areas. The analysis indicated that six strategically located locations would enable about 90% of Tirana's population to access a comprehensive array of urban services within a 15-minute commute. This validates the efficacy of a polycentric approach in diminishing reliance on the historical core.

- Scenario modeling and assessment

Four development scenarios were evaluated using QGIS-based spatial simulation, featuring 4, 6, 8, and 10 urban centers. Each scenario was assessed based on territorial coverage, accessibility, and network connectivity. The six-center arrangement emerged as the most balanced choice, guaranteeing equitable spatial distribution and preventing excessive overlap among influence zones. This model was consequently chosen as the most suitable framework for Tirana's future development.

- Integration with the public transportation network

The proposed sub-centers are intended to be linked via an integrated public transport system that enhances the current radial routes with additional transversal links. This strategy seeks to convert Tirana's mobility framework from a centripetal model, where all traffic converges in Skanderbeg Square, into a networked system that facilitates cross-city transit without necessitating passage through the center. The approach aims to alleviate congestion, boost accessibility, and improve spatial equity by decentralizing flows and redistributing activity.

The final version of the regulatory plan from the late 1980s envisioned a city composed of five monocentric rings. At present, Tirana has three major active ring roads that extend beyond the spatial scope of that plan: 1) the ring surrounding Skanderbeg Square, 2) the Old Ring, and 3) the New Ring. The construction of these ring roads was premised on the assumption that they would contribute to traffic reduction.

But as Banister [13] discusses in his review of Michael Thomson's work, Thomson (1969) argued that the proposed 'ringways' would not only destroy London as a city and fail to achieve substantial congestion reduction, but also be more likely to increase it by encouraging more car traffic.

To substantiate that traffic solutions cannot be reduced merely to investments in new road infrastructure, the Mogridge Conjecture offers valuable insights.

According to Clément [14], the Mogridge Conjecture states that: "any new investment in road infrastructure in a congested urban area would have the effect of reducing the average speed of the public transport system and the road system". This theory suggests that a continuous investment in the road system would not provide a sustainable solution to the problem of congestion. Instead, such an approach could be considered a failure because it would ultimately lead to degraded average speeds.

From this perspective, the case of Tirana exhibits analogies with the argument advanced by Thomson as early as 1969. It is evident that, even after the construction of the New Ring Road - operational since late 2024 - traffic congestion in Tirana remains present and, in fact, has intensified. Moreover, recent interventions and investments in infrastructure appear to have exacerbated traffic conditions, contributing to further congestion.

Although Clément proposes public transport investment as a potential solution, arguing that public transit can alleviate traffic blockages, Tirana presents a specific challenge due to its monocentric urban organization. In such a configuration, public transport inevitably converges toward the city center. In this context, the solution we propose and seek to simulate involves the decentralization of flows toward secondary centers - dispersing not only traffic but also public transport, services, economic activity, and other urban flows. This, we argue, would effectively address the issue of congestion.

Therefore, beyond the implementation of ring roads and infrastructure investments, Tirana must adopt a network of additional urban centers capable of redistributing services and traffic. These centers already exist but lack a strong urban character.

Within the framework of Tirana's multicentric planning strategy, the selection of new urban centers has been guided by a functional and spatial approach aimed at creating independent urban poles beyond the boundaries of the Outer Ring. The objective is to reduce dependence on the traditional city center and improve the distribution of services and traffic. Key selection criteria include: existing squares with consolidated or potential community functions; vacant land with strategic positioning relative to road infrastructure and public transport; and the presence of significant facilities that have historically generated settlements and functional urban networks.

To assess how many centers are needed to effectively redistribute traffic in Tirana, four simulation scenarios were developed, each featuring a different number of urban centers (Fig. 5):

Scenario 1: a settlement with 4 centers
Scenario 2: a settlement with 6 centers
Scenario 3: 8 centers
Scenario 4: 10 centers

As part of Tirana's transformation from a monocentric structure to a multicentric urban organization, spatial modeling plays a key role in identifying alternative scenarios for urban development. The primary goal is to achieve a balanced use of urban space, reduce reliance on the historical center, and improve internal circulation. The four proposed scenarios are based on the principle of daily accessibility within a maximum travel time of 15 minutes by car, aligned with the "15-minute city" concept.

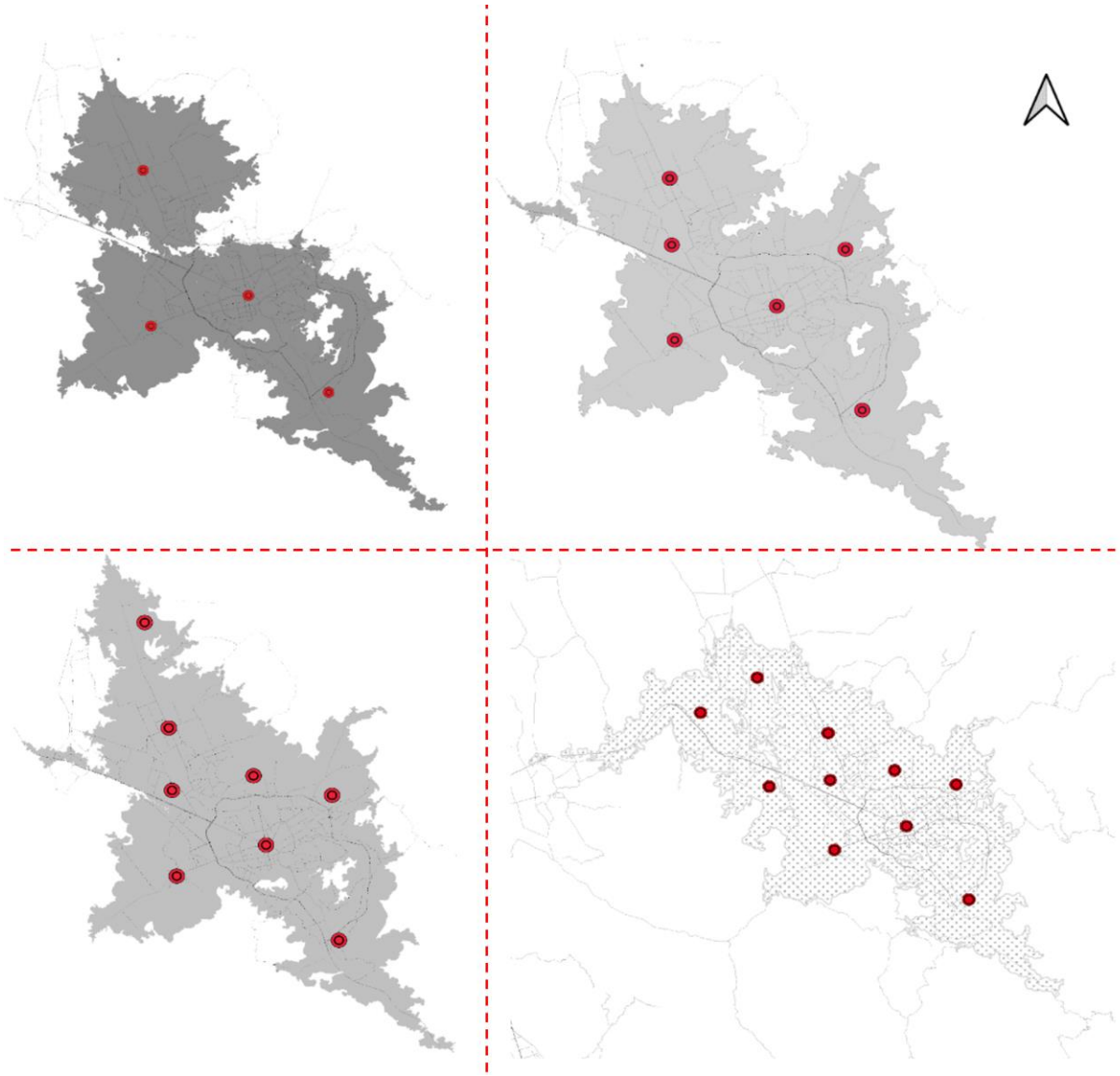

Figure 5. The four simulations developed encompass scenarios with varying configurations of urban centers: the first scenario envisions four centers, the second includes six, the third comprises eight, while the fourth proposes a model with ten urban centers

In the four-center scenario, strategic points include the historical center, Kombinat, Kamza, and the TEG area. This model offers a simple and efficient infrastructure management structure and maintains a quadrilateral pattern of urban distribution. However, it is limited by insufficient coverage of peripheral areas, particularly in the eastern and southwestern directions, thereby hindering the full realization of 15-minute accessibility.

The six-center model advances territorial coverage and the distribution of urban functions. In addition to the historical center, it includes Kombinat, Shkoza, Kamza, QTU, and TEG, creating a more balanced and functional structure. This configuration reduces average travel time for residents in the city's periphery and minimizes overlap between the influence zones of each center. Furthermore, it maintains infrastructure manageability and respects existing urban boundaries, offering a compromise solution between sustainability and operational complexity.

The eight-center scenario represents an advanced multicentric model aimed at achieving optimal distribution of functional weight across Tirana's expanded urban territory. By incorporating key nodes such as Kashar and Paskuqan, this scenario ensures comprehensive territorial coverage within a critical travel distance of 15–18 minutes by car. The development of this denser network facilitates access to essential services and functions, alleviates pressure on the historical center, and encourages the emergence of distinct local identities. However, the increase in the number of centers introduces challenges in defining the functional role of each node, as well as risks of fragmentation and uneven service distribution - issues that require careful management.

The ten-center scenario, although designed to maximize territorial coverage, results in excessive urban fragmentation and inefficient functional dispersion. This model extends beyond formal urban boundaries and

generates uncontrolled horizontal development (urban sprawl). From a planning perspective, the proliferation of centers at this scale undermines the effectiveness of urban agglomeration and creates barriers to socio-economic integration, while also increasing infrastructure costs and negative environmental impacts.

In conclusion, the eight-center scenario (Fig. 6) offers a sound balance between spatial distribution, favorable service accessibility, and sustainable urban management. It enables the realization of the multicentric city concept in a functional and pragmatic format, while avoiding excessive fragmentation or overburdening individual nodes. Furthermore, it holds potential for sustainable development, improved urban quality of life, and socio-economic integration across diverse urban zones. Therefore, this scenario is considered the most suitable for Tirana's long-term development and the implementation of a fully functional multicentric urban structure. In this study, to enable the evaluation and comparison of alternative spatial configurations, two simple indicators have been used: the accessibility index, which is determined by the surface area of the urban territory and the number of population reachable/possible within a 15-minute travel distance from each proposed center, and the second indicator is the Coverage Index, determined by the extent of non-overlapping areas served by these centers. These indicators were made possible to derive through GIS spatial analysis and visual interpretation, without dynamic traffic modeling. The results show that the eight-center scenario is the scenario with the most balanced distribution, ensuring the highest territorial coverage and accessibility, and avoiding the observed fragment with 10 centers.

2.5. The Hybrid Strategy in the Case of Tirana and Public Transport

As noted in the preceding paragraph, the solution to traffic congestion in a monocentric city such as Tirana cannot be achieved solely through the construction of new ring roads or additional investments in expanding road surface area.

Based on the preceding analysis and simulation concerning the development of a multicentric city, the most favorable scenario emerged as one comprising eight centers - one of which corresponds to the current core of Tirana, located within the new ring road, while the remaining seven are situated in its periphery. The configuration of these centers, along with the strategy underpinning their establishment, draws upon a synthesis of two principal archetypes identified by Thomson [12] and Banister [13]. In practice, the hybrid model adopted in Tirana integrates elements of the C–Strong Centre archetype Strategy together with the E–Traffic Limitation Strategy archetype. These two models form a composite scheme that integrates the principles of a Strong Centre with those of traffic mitigation. This hybrid configuration may be referred to as the "Strong Centre and Traffic Limitation Strategy," wherein the two aforementioned archetypes are interwoven and superimposed.

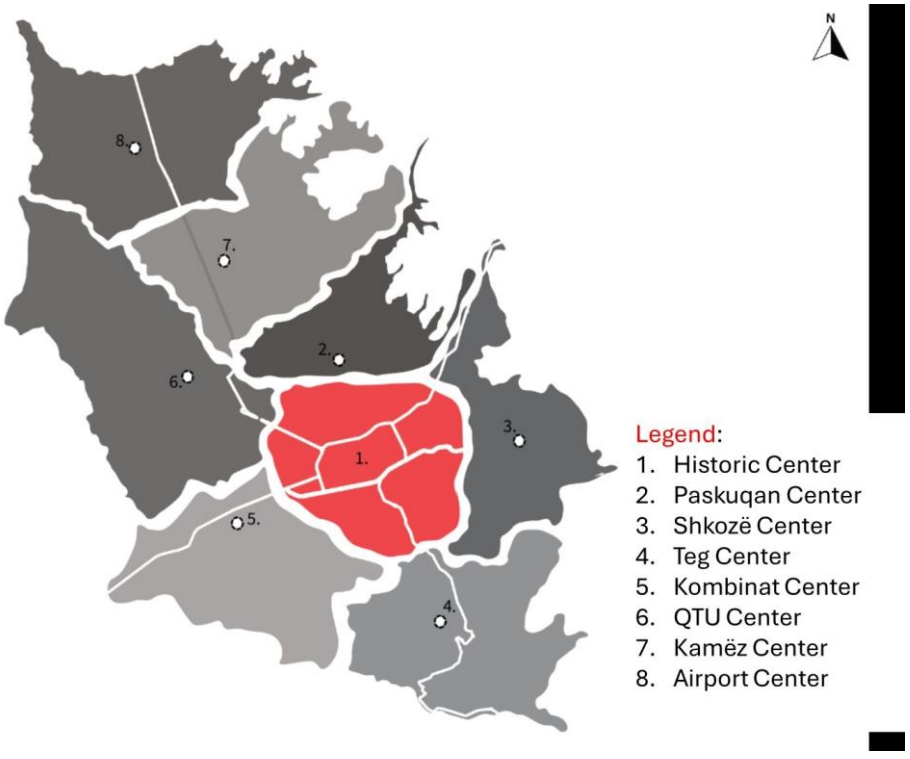

Figure 6. The scenario that proved most suitable following simulations conducted with QGIS was the one featuring eight urban centers. In this configuration, the boundaries and newly proposed urban centers of the City of Tirana are clearly delineated. Source: Authors

In the case of Tirana - an approach potentially applicable and verifiable in similar urban contexts - rail-based transport has been supplanted by road-based systems, specifically through the implementation of a Bus Rapid Transit (BRT) network. The hybrid archetype derived from Tirana's experience is illustrated in Fig. 7.

The proposed scheme outlines a multicentric urban form, advocating for a ring-structured development with multiple interconnected centers. It serves as a foundational framework for the planning of public transport lines aimed at linking new centers and peripheral neighborhoods via urban roads and dedicated transit corridors. This model aligns with the principles of transit network design, employing radial, diametral, tangential, and ring routes to construct an efficient transportation system for Tirana (Fig. 8).

Based on this model - where the central core is connected to emerging poles through the BRT system, and each pole is likewise linked to the others in a ring-like configuration - a public transport network is established that enables direct inter-pole connectivity. This system enhances accessibility and contributes to the reduction of urban traffic congestion.

Historically, the city of Tirana has exhibited a radial structure, in which the city's primary roads extend radially from the center toward the periphery. This model proved functional when Tirana was smaller in scale; however, with population growth and urban expansion, the radial system has become insufficient. Exclusive reliance on radial corridors has led to congestion in the historic core and increased traffic burdens, resulting in delays for residents. This reality underscores the need for a more sophisticated transport network capable of meeting the demands of a multicentric urban structure such as Tirana's.

In this context, the maintenance and reinforcement of radial lines remain essential for connecting the central area with peripheral zones. Nevertheless, these must be complemented by dedicated public transport routes. The proposal for a ring line is pivotal to this effort, as it would facilitate interconnection among peripheral areas, alleviate pressure on the city center, and enable direct access to emerging urban hubs without necessitating passage through the historic core.

Another significant initiative is the new railway line, part of Tirana's General Local Plan, which will connect Tirana with Durrës and integrate with the city's urban public transport network. This will offer an effective mobility alternative, reducing dependence on private vehicles and mitigating traffic congestion.

Existing terminals, currently serving intercity routes, are incorporated into the proposed multimodal network, thereby facilitating modal interchange and enhancing the coordinated operation of the system as a whole. The Airport Terminal and the North–South Terminal will enable direct connections between rail and bus services.

A critical dimension of the plan is the inclusion of peripheral settlements that are presently isolated and reliant on private automobiles. The proposed diagonal lines will provide these areas with access to public transport, promoting social equity and a more inclusive approach to urban services. Based on this approach, the transformation of the structure of the city of Tirana into a multicentric structure cannot be seen only through the lens of a technical solution for the elimination of traffic but also in the social dimension of urban planning, as an all-encompassing instrument. As a result, it makes cities more resilient and improves the lives of the people who live there. This new system aims to establish a more accessible, functional, and integrated transport network to support sustainable urban development in Tirana.

Urban transformations in Tirana and changes in the public transport system are evident but almost always inadequate for the pace and intensity of population growth. Although the bus fleet has increased significantly from 114 vehicles in 2010 to 311 in 2025, this is insufficient to meet the public transport demands of a population of 62% who reside in the central area and surrounding units, concentrating key services and activities in the historic zone. The high centralization has contributed to increased traffic and delays, thereby limiting the urban quality of life.

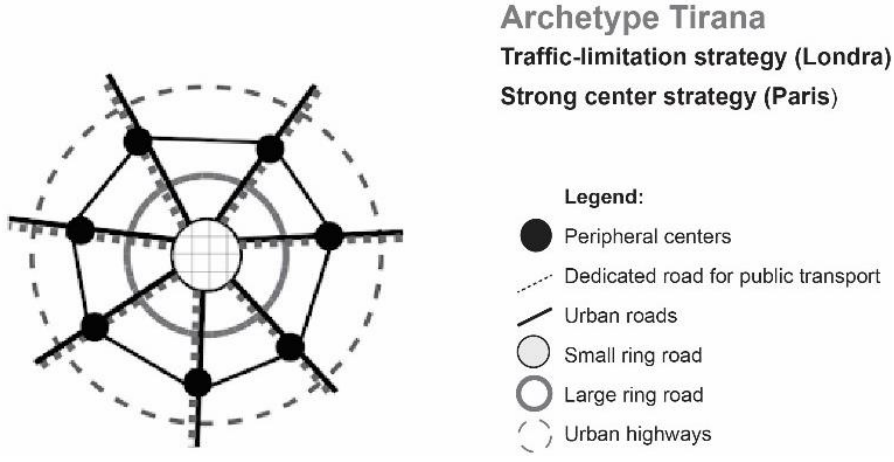

Figure 7. The hybrid archetype derived from Tirana. Source: Authors

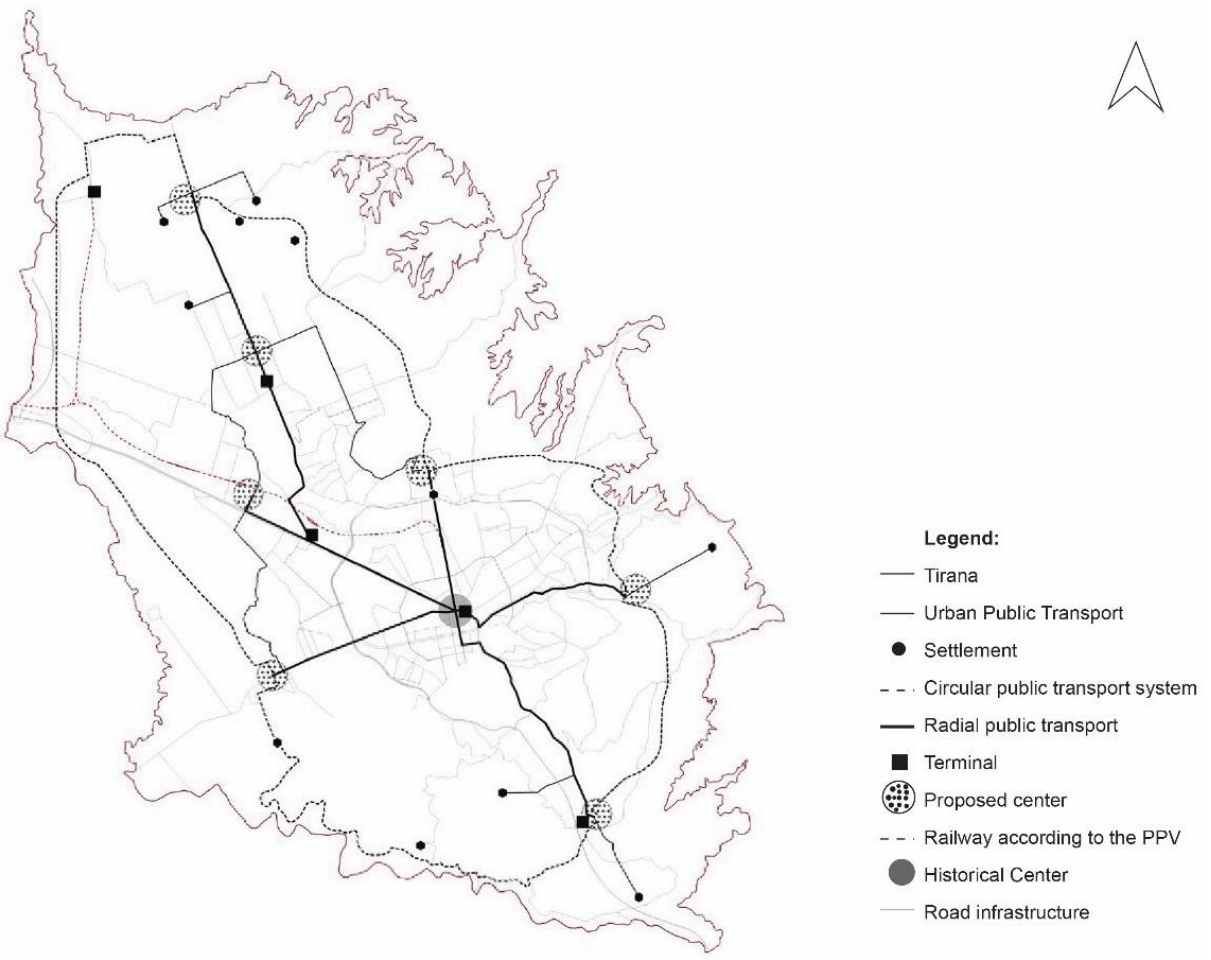

Figure 8. The newly proposed urban centers of Tirana are integrated with the infrastructural network and the envisioned public transport system. Source: Authors

The radical and monocentric public transport network, where all lines converge in the center, has resulted in a lack of direct connections between peripheral areas and inefficient accessibility, especially for settlements that have expanded away from the center. This situation compels residents to rely on private vehicles and reinforces dependence on the historic center for primary urban functions, complicating traffic management and increasing the burden on central roads and urban areas.

In response to these challenges, the study proposes a hybrid multicentric model that integrates London's traffic restriction strategies and Paris's strong center model, adapted to the specific urban context of Tirana. This model envisions the construction of an infrastructural ring linking new urban centers such as Kombinati, Kamza, the Airport, TEG, QTU, Paskuqani, Shkoza, and others through an integrated and multimodal public transport network. This network would distribute traffic flows, minimize the load on the historic center, and promote a more equitable distribution of urban functions. Testing various multicentric scenarios included models with 4, 6, 8, and 10 new centers, with the 8-center option deemed most appropriate due to its balance between territorial coverage, connection to existing infrastructure, and distribution of urban services.

3. Conclusions

This study addresses the main traffic challenge in the city of Tirana by analyzing the relationship between the urban form and the current public transport system, with the aim of transforming the city structure from a monocentric model to a multicentric one. Through simulations carried out with QGIS, four scenarios of multicentric models were tested with configurations that included four, six, eight and ten urban centers, while maintaining the historical center within the "New Ring". The comparative analysis of these scenarios showed that the eight-center model turns out to be the most suitable for the sustainable and functional structuring of the urban form of Tirana.

Through a comparative analysis with multicentric cities such as London and Paris, the study highlights the benefits of the multicentric model in spatial organization and traffic management, suggesting that the suburbs of

Tirana be interconnected through a new orbital road that connects all the centers of these settlements. At the operational level, it is recommended that the new centers have direct connections via public transport lines, eliminating interruptions and access gaps. Ring connections between the suburbs contributed to relieving traffic pressure in the urban core and provided easier access to the new urban centers, while radial networks remained the main axes connecting the center, being strengthened specifically for public transport.

From a methodological perspective, the study faced significant limitations, especially due to the lack of detailed data for dynamic traffic modeling, which hindered the use of advanced simulation tools such as SUMO or PTV Visum. In the absence of accurate Origin-Destination matrices, the simulations relied mainly on spatial analyses and visual models built with GIS software (QGIS), which nevertheless provided important insights and a solid basis for the theoretical discussion and practical implementation of multicentrism in Tirana. This alternative methodology enabled the identification of the potentials and limitations of the current network and the proposal of a reorganized urban structure.

In conclusion, this study provides a theoretical and practical framework for the reconceptualization of the urban form and public transport network in Tirana. This study provides a valuable conceptual basis for understanding the evolving urban structure of Tirana and serves as a pilot model for future empirical research on multicentric development. Its findings suggest the need for spatial planning strategies that recognize emerging centers, promote balanced investments in infrastructure, and promote sustainable urban development. In an attempt to be applicable, the study provides a roadmap for local authorities to promote a more coherent, flexible, and adaptive metropolitan form that enhances quality of life and reduces stress resulting from traffic congestion.

3.1. Partial Modeling and Validation Methodology

Dynamic traffic simulation tools like SUMO or MATSim were not utilized due to data constraints (lack of Origin-Destination matrices and comprehensive travel-time information); instead, a partial modeling approach was executed utilizing QGIS-based spatial analysis. The spatial simulations created in this study signify a conceptual phase of modeling, intended to validate the theoretical framework and evaluate the spatial logic of the offered scenarios. This method facilitated the display and comparison of accessibility, geographic coverage, and interconnectedness among centers.

Subsequent efforts will expand upon this initial modeling by including open-source traffic simulation platforms like SUMO or MATSim to assess travel-time efficiency and flow redistribution within the eight-center arrangement.

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