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Assessing the impact of commuting migration and suburban development on road network congestion in Yekaterinburg

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This paper assesses the contribution of commuter migration and suburban development to chronic congestion within the Yekaterinburg agglomeration. Utilizing official statistical data, urban planning documents, transportation indices, and labor resource balance assessments, we reconstruct the scale and temporal structure of «suburb-to-core» commuting patterns. These patterns are then correlated with the overloading of radial transportation corridors. The research demonstrates that tens of thousands of commuters generate severe peak-hour load demands. Furthermore, it is shown that peripheral expansion up to 2045 will exacerbate dependence on private vehicle usage. We propose management scenarios: an inertial scenario, a transit-oriented development (TOD) scenario incorporating a rail ring, and a polycentric-digital scenario.

Keywords: Yekaterinburg agglomeration, commuting migration, suburban development, road network congestion, motorization, land-use — transport interaction, commuter rail, transit-oriented development, polycentric development.

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Оценка влияния маятниковой миграции и пригородной застройки на перегрузку дорожной сети Екатеринбурга

В статье оценивается, как маятниковая миграция и пригородная застройка способствуют хроническим заторам в Екатеринбургской агломерации. На основе официальной статистики, градостроительных документов, транспортных индексов и оценок баланса трудовых ресурсов мы реконструируем масштабы и временную структуру поездок по схеме «спутник — ядро» и связываем их с перегрузкой радиальных транспортных коридоров. Показано, что десятки тысяч коммьютеров формируют жесткие пиковые нагрузки, тогда как периферийное расширение до 2045 года усиливает зависимость от личного автомобиля. Предложены сценарии управления: инерционный, транзитно-ориентированный (железнодорожное кольцо) и полицентрично-цифровой.

Ключевые слова: Екатеринбургская агломерация, маятниковая миграция, пригородная застройка, перегрузка дорожной сети, автомобилизация, транспортное планирование, пригородная железная дорога, генеральный план, полицентричное развитие.

Introduction

Urban transport problems in contemporary Russia are inseparable from everyday mobility between large cities and their suburban belts. In agglomerations commuting migration, or pendulum labour migration in the Russian terminology, connects residential and employment locations through rigidly timed flows that load the road network with a high degree of spatial and temporal concentration. Sokolova's analysis of national census and labour force survey data shows that in Russia the predominant part of such movements is internal to the region and accounts for roughly three quarters of all employed persons who regularly work outside their settlement of residence, while only about one fifth commute across regional borders. In other words, the key pressure on transport systems arises inside agglomerations themselves, rather than between distant regions.

The work of Logacheva and co-authors, based on big data from social networks for 14 major Russian agglomerations, adds important nuance. Pendulum migrants from satellite towns to agglomeration cores are predominantly men of active working age, roughly between 29 and 43 years, whereas reverse flows from centres to satellites and especially to rural surroundings are more feminised and age-diverse. This age and gender asymmetry translates into a pronounced peak-hour loading of radial corridors: the «classic» commuting contour is home in a satellite, job in the core city, daily trips along a limited number of road or rail axes.

Against this conceptual background Yekaterinburg occupies a special place. It is the fourth largest city in Russia by population, the core of a multimillion agglomeration in the Urals and an important node of the Trans-Siberian corridor. The city's car fleet grew extremely rapidly during the 2000s and 2010s. By 2014 more than 437 000 cars were registered in the city, and the level of motorisation reached about 410 passenger cars per 1 000 residents by 2015 with yearly growth rates in the range of 6–14%. By the mid-2020s local media, drawing on municipal and expert estimates, spoke of an even higher figure near 460 cars per 1 000 inhabitants, noticeably above the values for Moscow and Saint Petersburg. In parallel Yekaterinburg consistently appears among the most congested cities in international ratings based on floating-car data. According to the TomTom Traffic Index for 2021, drivers in Yekaterinburg lost on average 98 hours per year in congestion and the mean congestion level reached 43%, which placed the city 15th in the world ranking for that year.

At the same time the Yekaterinburg agglomeration continues to grow spatially. Statistical and transport sources describe an agglomeration with almost 2,2 million residents by the beginning of 2024, including the core city and a ring of neighbouring towns such as Verkhnyaya Pyshma, Berezovsky, Revda and others. The core holds about 60% of this population, while about 8% live in the first belt of satellite towns within roughly 30 km. Suburban residential construction, including large new districts inside the municipal boundary such as Akademichesky in the south-west, proceeds at a very high pace. The recently approved general plan of Yekaterinburg up to 2045 foresees an increase of the city's population to 1,9 million and an almost twofold expansion of the housing stock from about 42 million m² to approximately 85–86 million m².

From the transport perspective this combination of rapid suburban residential growth, strong centripetal concentration of high-skilled jobs, and extraordinary motorisation creates a structural precondition for persistent congestion. The central research question of this article is therefore quite concrete. To what extent do commuting migration and ongoing suburban development in the Yekaterinburg agglomeration contribute to the present and future congestion of the road network, and under what planning and management scenarios can this contribution be reduced rather than amplified.

The study addresses this question by linking three strands of analysis. First, theoretical and empirical work on commuting and suburbanisation in Russia and abroad is used to position Yekaterinburg within broader stadial models of agglomeration development, from classical urbanisation through suburbanisation to possible reurbanisation and counterurbanisation, as discussed for example by Geyer and Kontuly in their theory of differential urbanisation and by Makhrova in relation to Moscow. Second, available statistical, planning and transport information for Yekaterinburg and its satellites is interpreted through the lens of commuting migration. Third, planning documents and investment programmes are read as implicit scenarios that can either lock in auto-dependent commuting or open alternatives based on rail and polycentric development.

Methods

The research relies on a combination of normative-legal, statistical and spatial-analytical methods, complemented by expert interpretation of transport and planning scenarios. It is in essence a synthesis work grounded in open data and peer-reviewed studies, without claims to produce a full-scale transport model of the agglomeration [9].

The normative-legal component focuses on the framework that structures urban and transport planning in Russia and in Sverdlovsk oblast. At the federal level the Town-Planning Code of the Russian Federation (Federal Law No. 190-FZ of 29 December 2004) defines the hierarchy of planning documents from the territorial planning schemes of subjects of the federation and municipal general plans down to detailed land-use and zoning rules, and explicitly requires coordination between planning of settlement structures and transport infrastructure. The Federal Law No. 172-FZ of 28 June 2014 «On strategic planning in the Russian Federation» further introduces the logic of strategy documents and target indicators, while the Spatial Development Strategy of the Russian Federation up to 2025, approved by Government Order No. 207-r of 13 February 2019, identifies large agglomerations, including Yekaterinburg, as key «growth poles» whose transport connectivity must be enhanced. At the regional level the territorial planning scheme of Sverdlovsk oblast and its updates fix the role of Yekaterinburg as an interregional transport hub and emphasise the importance of strengthening intra-agglomeration links. At the municipal level the research considers the General Plan of Yekaterinburg to 2025, initially approved by Decision of the City Duma on 6 July 2004 No. 60/1, and especially the new General Plan up to 2045, adopted by the regional Ministry of Construction and Infrastructure Development by Order No. 335-P of 1 June 2023 and amended in 2025 [11].

The statistical and spatial-analytical component combines several groups of sources. Demographic and economic characteristics of Yekaterinburg and its agglomeration, including population size, employment and car ownership, are taken from the official statistical service, from the municipal passport and from the synthesised description of the city in the Russian-language encyclopaedic article, which provides, among other things, data on the dynamics of the car fleet and the level of motorisation. Information on agglomeration population and the structure of suburban settlements is also drawn from these sources and from transport industry publications [3].

To characterise road congestion levels the study uses the TomTom Traffic Index database in its 2021 release, presented in secondary compilations that list global rankings of cities by congestion and report the percentage congestion level and annual hours lost in traffic for Yekaterinburg. These indices, while based on private floating-car data, are widely used in comparative analyses of urban congestion and provide an empirically grounded baseline for the discussion [4].

The commuting migration dimension is reconstructed using several complementary sources. On the national scale Sokolova's 2023 article on the scale and consequences of commuting, based on census and labour force survey data, allows one to understand the relative weight of intra-regional and inter-regional commuting flows and their economic effects. For the multi-agglomeration context the study draws on the 2024 paper by Logacheva, Uskova and Salomatova, which analyses pendulum labour migration in 14 Russian agglomerations using anonymised data from about 396 000 VKontakte users and describes the age and gender structure of commuting flows between cores and satellites. Long-term suburbanisation and migration between large cities and suburbs are interpreted using the findings of Karachurina and Mkrtchyan, who analysed exchange flows between 137 Russian cities and their suburban zones over the period 2011–2020 and showed

that in aggregate large cities lose about 50 000 residents per year to surrounding suburbs, with especially intense exchanges in the nearest belt [2].

The most important local approximation of daily commuting into Yekaterinburg itself is borrowed from an independent analytical work by Reissig, who used municipal registers of the working-age population and data on the number of personal income tax declarations (form NDFL-5) by municipality to estimate the balance between labour force and workplace counts in the municipalities forming the Yekaterinburg agglomeration. According to his calculation the difference between the working-age population and available jobs in adjacent municipalities amounts to about 55 000 people, and this difference is interpreted as the order of magnitude of daily commuters travelling to work in Yekaterinburg. The same work, relying on the comprehensive transport survey PRKTI for Yekaterinburg, reports that approximately 25% of the working-age population work near their place of residence and commute on foot[1], while the remaining majority use either private cars or public transport; and that the morning peak hour between 7 and 8 a.m. accounts for roughly 10% of the total two-way daily passenger flow.

On the transport development side the study examines the project of the Yekaterinburg Central Passenger Ring (ECPK), a planned two-route orbital commuter rail system that should connect the core city with key suburban nodes and the airport. A transport-industry publication provides a detailed description of the planned Yekaterinburg Central Passenger Ring (ECPK): the Novokoltsovsky route is 38.6 km, includes 16 stops, and targets peak headways of up to 10 minutes; the South-Western route is 43 km, includes 22 stops, and targets peak headways of about 6 minutes. This project serves as a basis for one of the management scenarios discussed below.

Methodologically the analysis proceeds in three steps. First, the normative framework and planning documents are read with a focus on how they conceptualise agglomeration, commuting, and the relationship between land-use and transport. Second, quantitative indicators are assembled for four subsystems of the agglomeration: population distribution between core and satellites, labour market and employment concentration, car ownership and congestion, and current and planned transport infrastructure. Third, three contrasting but realistic management scenarios are formulated for the horizon of the General Plan to 2045, and their likely impact on the contribution of commuting migration and suburban development to road congestion is assessed qualitatively, informed by international literature on the effects of rail transit and land-use policies on traffic volumes [10].

Results

The first set of results concerns the demographic and spatial structure of the Yekaterinburg agglomeration and the scale of commuting migration. The agglomeration is often described as one of the most advanced post-industrial agglomerations in Russia, together with Moscow and Saint Petersburg, with Yekaterinburg itself concentrating around 60% of the agglomeration population and acting as the dominant employment and service centre. The first belt of satellite towns within roughly 30 km of the core, including Berezovsky, Verkhnyaya Pyshma, Sredneuralsk and Aramil, contains about 8% of the agglomeration's residents, while outer belts extend along several radial axes, which coincide with major highways and rail lines. Within this polycentric-looking but functionally monocentric system high-value jobs in advanced services, higher education, research and increasingly also in IT are concentrated in the core city. The large Ural Federal University campus alone hosts more than 40 000 students, many of whom travel from other parts of the agglomeration[2].

Reissig's reconstruction of labour balances shows that adjacent municipalities of the agglomeration have a structural deficit of jobs relative to their working-age population, on the order of 55 000 positions. Interpreting this difference as commuting migration into Yekaterinburg, one can infer that at least several tens of thousands of residents of satellites perform daily trips to the core, primarily oriented towards employment in industrial zones, office clusters and large retail centres. Although this estimate includes only those with stable employment reflected in tax declarations, and therefore likely underestimates informal and self-employment, it already establishes commuting as a phenomenon of agglomeration-wide significance.

The intensity of commuting is further amplified by long-term residential suburbanisation. Karachurina and Mkrtchyan's analysis of migration exchanges reveals a net loss of about 50 000 residents per year by large Russian cities to their suburbs, with especially efficient migration patterns in the nearest suburban belt. For Yekaterinburg this means that some part of the working population that previously lived and worked in the core now resides in surrounding municipalities while retaining employment in the city, adding to the pool of commuters. Logacheva's work confirms that, across Russian agglomerations, commuters travelling from satellites to cores are mostly men in the 29–43 age group, which corresponds to the most active tiers of the labour market and thus to the most time-sensitive daily schedules[3].

The second group of results relates to the road network and the measured congestion levels. Yekaterinburg's street and road network has developed historically along a radial-ring pattern, where several major roads lead from the centre to surrounding settlements and industrial areas, while the city is crossed by the Trans-Siberian railway and by federal highways linking it to Perm, Tyumen, Chelyabinsk and other regional centres. The Ekaterinburg Ring Road (EKAD), conceived as a bypass for through traffic and heavy trucks, was only completed in stages and does not fully remove transit flows from the inner network. At the same time the inner network suffers from structural constraints: many radial corridors pass through densely built-up areas and have limited opportunities for widening without massive demolition.

With the motorisation level already above 400 cars per 1 000 inhabitants by 2015 and rising to about 460 per 1 000 by the mid-2020s, Yekaterinburg effectively entered the category of highly motorised cities by European standards. Yet the road capacity did not keep pace. As a result TomTom's 2021 Traffic Index assigned Yekaterinburg a congestion level of 43%, meaning that average travel times were 43% longer than they would be under free-flow conditions, and calculated that drivers lost about 98 hours per year in traffic jams, placing the city among the twenty most congested in the world. These figures are significant not only as relative rankings but as indicators of systemic overloading of the road network. When drivers lose the equivalent of more than four full days per

1 Рейссиг А. Матрицы маятниковой миграции и метро (Екатеринбург в центре региона) // LiveJournal. 15.03.2020: [сайт] — URL: https://reissig.livejournal.com/14713.html (дата обращения: 12.01.2026).

2 Градостроительный кодекс Российской Федерации: Федеральный закон от 29.12.2004 № 190-ФЗ (ред. от 31.07.2025) // Собрание законодательства РФ. 2005. № 1 (ч. I): [сайт] — URL: https://legalacts.ru/kodeks/Gradostroitelnyi-Kodeks-RF/ (дата обращения: 12.01.2026).

3 Федеральный закон «О стратегическом планировании в Российской Федерации» от 28.06.2014 № 172-ФЗ (последняя редакция) // Собрание законодательства РФ. 2014. № 26 (ч. I): [сайт] — URL: https://www.consultant.ru/document/cons_doc_LAW_164841/ (дата обращения: 12.01.2026).

year in congestion, the external costs of commuting, in terms of time, fuel and emissions, reach a level where they influence economic productivity and the perceived quality of life[4].

The third group of results concerns the trajectory of suburban development fixed in the planning documents and its implications for future commuting. The General Plan of Yekaterinburg up to 2045, approved in 2023, explicitly positions the city as the centre of a wider agglomeration and projects an increase of the city's population to 1,9 million by the end of the planning period. The same document and related municipal programmes foresee a near doubling of the housing stock to approximately 85–86 million m², with an additional 40–43 million m² of residential floor area being constructed between 2024 and 2045. If one divides this additional volume by the target housing provision norms of about 45–52 m² per person, also cited in municipal planning documents, it becomes clear that the new housing could physically accommodate up to 800–900 thousand residents, although the demographic forecast suggests that only about 400 thousand additional permanent residents will actually be present. This indicates that a considerable part of new housing is intended to improve housing conditions for existing residents and to create a reserve for further agglomeration-scale population growth, rather than solely to host new migrants[5].

Spatially the General Plan emphasises several directions of residential expansion. On the north, the city is expected to merge with Verkhnyaya Pyshma, effectively turning this rapidly growing satellite into a continuous urban zone with Yekaterinburg. On the south-west, the Akademichesky district, which already has around 300 000 inhabitants and is projected to reach about 500 000 by 2030, continues to expand. New quartiers also appear on the eastern and south-eastern outskirts, often along major radial roads. From a commuting viewpoint these directions of growth matter because they either lengthen the average journey to the main employment zones or, in the case of coalescence with satellites, dramatically increase potential commuting volumes along shared corridors[6].

The ECPK project represents a crucial counterbalance in this picture. As presented by railway industry sources, the central passenger ring would connect Yekaterinburg with major suburban nodes and the Koltsovo airport through two looping routes with lengths of about 38,6 km and 43 km, 16 and 22 stations respectively, of which many would be new, and planned headways in peak hours as low as 6–10 minutes. If implemented in full and integrated with urban public transport, this system could take on a notable share of commuting flows that today rely on cars or buses. However, as the cost estimate of more than 235 billion roubles and the need for federal co-financing show, the project lies at the boundary of regional financial capabilities and is vulnerable to delays or scope reductions[7].

How, then, do commuting migration and suburban development numerically feed into congestion. Based on Reissig's estimate of about 55000 workers commuting daily into Yekaterinburg from satellites and the PRKTI figure that the morning peak hour accounts for roughly 10% of the daily two-way passenger flow, one can expect that the order of magnitude of inbound commuting flows in the critical 7–8 a.m. interval lies around 5–6 thousand persons, even without counting reverse flows and intra-urban commuting. Given the small number of main radial roads that connect satellites to the city and the tendency of commuters to converge towards a few large employment clusters, these flows concentrate on certain segments to a degree that brings them close to or beyond their practical capacity, especially when combined with inner-city car traffic. The contribution of commuting migration to congestion cannot be directly expressed as a simple percentage of total traffic volumes without a full origin-destination matrix and detailed traffic counts. Nevertheless, the available evidence supports the conclusion that commuting from suburban towns and new peripheral residential areas forms one of the backbone components of peak-hour traffic, and that its role will grow if the current development trajectory continues[8].

Discussion

Interpreting the findings through the lens of agglomeration theory and transport planning allows us to articulate several important points about the nature of congestion in Yekaterinburg and similar Russian cities.

First, the city clearly operates in a stage that can be characterised as advanced suburbanisation without completed reorganisation of the transport system. In the terms of differential urbanisation theory, after a period of strong concentration in the core, population and housing growth shift towards the suburban belts, while economic functions, especially high-level services, remain anchored in the centre. The work of Makhrova and colleagues on the Moscow region shows how, under such conditions, pendulum migration grows both in scale and in spatial reach, often turning previously peripheral rural areas into daily commuting zones. For Yekaterinburg, the observed deficit of workplaces in satellites, the projected residential construction in peripheral districts and the still dominant pull of the central labour market indicate a similar configuration, albeit at a smaller scale.

Second, commuting migration in this context plays a dual role. On the one hand, following Sokolova's analysis, it provides a flexible mechanism for matching labour supply and demand across municipal boundaries, compensating for the lack of jobs in some localities and mitigating the pressure on housing markets in the core. On the other hand, when the only realistic mode of commuting for many workers is the private car, the same mechanism becomes a major generator of repetitive, time-rigid traffic flows that overload the radial road network and generate high indirect costs. Logacheva's finding that the main cohort of commuters from satellites to cores consists of men in their thirties and early forties suggests that these flows are tied to segments of the labour market that are relatively insensitive to

4 Правительство Российской Федерации. Распоряжение от 13.02.2019 № 207-р «Об утверждении Стратегии пространственного развития Российской Федерации на период до 2025 года» // Собрание законодательства РФ. 2019. № 8: [сайт] — URL: https://docs.cntd.ru/document/552378463 (дата обращения: 12.01.2026).

5 Закон Свердловской области от 8 декабря 2006 г. № 77-ОЗ «О схеме территориального планирования Свердловской области» (с изм. на 30 октября 2024 г.): [сайт] — URL: https://docs.cntd.ru/document/802082695 (дата обращения: 12.01.2026).

6 Министерство строительства и развития инфраструктуры Свердловской области. Приказ от 01.06.2023 № 335-П «Об утверждении Генерального плана городского округа — муниципального образования «город Екатеринбург» на период до 2045 года»: [сайт] — URL: https://pravo.gov66.ru/39108/ (дата обращения: 12.01.2026).

7 Администрация города Екатеринбурга. Постановление «Об утверждении Программы комплексного развития транспортной инфраструктуры муниципального образования «город Екатеринбург»» // Официальный портал правовой информации. 2018: [сайт] — URL: https://docs.cntd.ru/document/558875314 (дата обращения: 12.01.2026).

8 На наземное метро в Екатеринбурге потребуется ₽193 млрд // RBC Екатеринбург. 2023. 16 нояб.: [сайт] — URL: https://ekb.rbc.ru/ekb/freenews/6555d2c39a7947d9dfe8faf9 (дата обращения: 12.01.2026).

flexible schedules or telework, which further increases the rigidity of demand in the peak.

Third, the trajectory of suburban development fixed in the General Plan of Yekaterinburg up to 2045, if pursued without strong transport and land-use coordination, risks reinforcing the auto-dependent pattern of commuting. When new large residential districts are placed at considerable distances from the main employment cores and are primarily oriented towards multi-lane radial roads, even high nominal housing provision does not automatically translate into better accessibility to jobs. The projected coalescence with Verkhnyaya Pyshma and the expansion of Akademichesky, while understandable from the perspective of land availability and real estate markets, require a transport framework that can move tens of thousands of people daily without simply adding more cars to already congested roads.

Fourth, the ECPK project, together with existing lines of suburban rail and metro, forms the backbone of a potential shift from an auto-dominated to a rail-supported commuting regime. International literature on the impacts of suburban rail and metro on urban traffic, including works by Vuchic and numerous empirical case studies in Europe and North America, shows that when high-capacity rail is combined with dense development near stations and effective feeder systems, road traffic on parallel corridors can be stabilised or even reduced despite population growth. For Yekaterinburg, the planned ring and its frequent services create a rare opportunity to channel a significant share of commuting migration onto rail. Yet this opportunity is contingent on several preconditions: integrated ticketing and timetables with urban public transport, coordinated land-use decisions that place new residential and employment areas near stations, park-and-ride facilities tailored to realistic driving distances in the agglomeration, and tariff policies that make rail competitive with the private car in both monetary and time cost.

Fifth, the contribution of commuting migration from satellites to congestion must be viewed together with internal commuting within the core city. Reissig's use of PRKTI data shows that only around a quarter of the working-age population can reach work on foot; the rest depend on motorised modes. Many of these trips originate in inner suburban neighbourhoods inside the municipal boundary that share similar functional characteristics with outer suburbs. In effect Yekaterinburg exhibits not a simple centre versus satellite dichotomy, but a more continuous ring of residential areas with varying degrees of car dependence. Policies that address only cross-municipal commuting will therefore be insufficient.

These considerations lead naturally to the formulation of management scenarios. Without pretending to exhaust all possibilities, it is useful to contrast three archetypal scenarios that are already implicit in existing policies and debates.

The first scenario can be called inertial or business as usual. In this variant residential suburbanisation continues along current trajectories, with strong emphasis on large-scale housing construction at the periphery of the city and in satellites, but without a qualitative breakthrough in high-capacity public transport. Road infrastructure is incrementally expanded, bottlenecks at junctions are removed, and some sections of the ring road are upgraded. However, the growth of the car fleet, stimulated by rising incomes and insufficient restrictions on car use, outpaces these improvements. Under such circumstances commuting migration from satellites and new peripheral districts not only maintains but gradually increases its contribution to congestion, especially in the morning and evening peaks. The structural asymmetry between concentrated employment zones and dispersed residential neighbourhoods remains, and each additional suburban household with two cars reinforces the existing pattern.

The second scenario is a transit-oriented agglomeration. Here the central passenger ring and related suburban rail projects are implemented in their full scope, with high service frequencies and direct interchanges to the metro, tram and bus networks. New residential development concentrates in station areas, where higher densities and mixed uses reduce average distances to services and jobs. Parking standards are kept moderate, and car access to central business districts is managed through pricing and physical restrictions. At the same time, municipal and regional authorities pursue a deliberate policy of placing public and private employment clusters near rail nodes in satellites, thereby turning them into secondary centres rather than pure «bedroom communities». In such a scenario commuting migration does not disappear; on the contrary, daily flows between core and satellites may even grow as labour markets integrate further. However, the modal split of commuting shifts towards rail, and the contribution of commuting to road congestion is stabilised or reduced. Under the dense radial-plus-ring rail network envisaged by the ECPK, the most loaded corridors can be given over to high-capacity public transport and priority lanes, while car traffic is redirected to ring segments and less sensitive routes.

The third scenario corresponds to a polycentric and digitally mediated agglomeration. It assumes not only investment in transport infrastructure but also targeted policies to develop local employment bases in satellites and to support remote work and flexible schedules. Here the insights of Karachurina and Mkrtchyan on the efficiency of migration in the nearest suburban belt become particularly relevant: if nearby satellites such as Berezovsky or Verkhnyaya Pyshma offer a broader spectrum of jobs, net migration losses of the core are partially offset by a reduction in the necessity of daily commuting into the centre. In this case the contribution of commuting migration to congestion decreases not so much through modal shifts as through a reduction in average commuting distances and an increase in the share of trips within satellites themselves, which can be served by local public transport and non-motorised modes. Digitalisation and the spread of hybrid work forms after the pandemic, though uneven across sectors, provide a technological basis for this scenario. However, its realisation demands active industrial and innovation policy at the regional level, which goes beyond the remit of traditional transport planning.

None of these scenarios is likely to be realised in a pure form. The current trajectory of Yekaterinburg contains elements of all three. Yet the choice of priorities over the next decade will largely determine whether commuting migration and suburban development remain a source of accelerating road congestion or become part of a more balanced agglomeration system.

Conclusions

The analysis carried out in this article allows us to formulate several conclusions that are important both for the understanding of Yekaterinburg's development and for the broader debate on Russian agglomerations.

Commuting migration in the Yekaterinburg agglomeration is not a marginal phenomenon but an integral structural component of the labour market. At least tens of thousands of residents of satellite municipalities commute daily to jobs in the core

city, and their share is likely to grow under continuing suburbanisation. This commuting represents a rational adaptation of households and firms to the spatial distribution of housing affordability and employment opportunities. At the same time, under conditions of high motorisation and insufficient high-capacity public transport, it generates concentrated peak-hour flows that significantly contribute to the overloading of the radial road network.

Suburban development, as currently envisaged in the General Plan to 2045, reinforces this pattern. The projected near-doubling of the housing stock, combined with the coalescence of the city with neighbouring towns and the expansion of large peripheral districts, objectively increases potential commuting distances for many residents. Without a corresponding redistribution of jobs or a robust rail-based transport framework, new suburban housing will translate into additional car kilometres on already congested roads. The fact that the planned housing capacity exceeds the demographic forecast underlines that part of the new housing stock will function as a resource for the entire agglomeration, attracting residents and commuters from a wide catchment area.

The contribution of commuting migration and suburban development to road congestion is mediated by the design and performance of the transport system. Today Yekaterinburg exhibits all the symptoms of an agglomeration that has entered a high-congestion regime: very high car ownership, structurally constrained road capacity, and peak-hour losses of time that reach several dozen hours per driver per year. The planned ECPK and related rail projects provide a realistic, though financially demanding, opportunity to change this trajectory by transferring a significant share of commuting flows from roads to rail. Without such a shift even ambitious road expansion and bypass projects will at best slow down, but not reverse, the growth of congestion.

From the standpoint of policy and planning, the key implication is that commuting migration should be treated not as a secondary «transport externality» of housing and labour market dynamics, but as a central dimension of agglomeration development. This implies at least three practical directions. The first is the integration of commuting considerations into strategic and territorial planning documents at all levels, in line with the requirements of the Town-Planning Code and the strategic planning law, with explicit quantitative targets for modal split and peak-hour loadings on key corridors. The second is the prioritisation of projects that structurally alter the relationship between residence and workplace, such as high-capacity rail lines and polycentric employment nodes, over projects that merely increase road capacity. The third is the development of monitoring systems, using modern data sources from mobile networks and digital platforms, to track commuting flows in real time and to evaluate the effects of interventions.

For Yekaterinburg, with its strong industrial and educational base and its role as a gateway between European and Asian Russia, the stakes are particularly high. If commuting migration continues to be channelled primarily through private cars on an overburdened radial-ring road network, congestion will increasingly act as a brake on economic and social development. If, however, the city and region manage to combine a rail-oriented transport strategy with a more balanced spatial distribution of jobs and housing, commuting migration can become an asset that integrates the agglomeration rather than a source of chronic traffic jams. The window of opportunity for choosing between these trajectories is open now, during the first decade of the new General Plan, when the most capital-intensive decisions on infrastructure and land-use are being made.

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