

Sustainable Urban Transport for Kyiv

Towards a Sustainable and Competitive City Built Upon the Legacy System and Innovations

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Abbreviations and Acronyms

Acronym	Definition	Acronym	Definition
AFC	automated fare collection	KGGTF	Korea Green Growth Trust Fund
BRT	Bus Rapid Transit	KPT	KyivPasTrans
CBD	Central Business District	KTPS	Kyiv Passenger Transport Company
CO2	Carbon Dioxide	LRT	Light Rail Transit
DCPA	Department of City Planning and Architecture	NATA	New Approach to Appraisal
EBRD	European Bank for Reconstruction and Development	PPHPD	peak passenger flows per hour per direction
ESMAP	Energy Sector Management Assistance Program	PPP	Purchasing Power Parity
GDP	Gross Domestic Product	PR	Public Relations
GHG	Greenhouse Gas	UAH	Ukrainian Hryvnia
GIS	Geographic Information System	UK	United Kingdom
GPS	Global Positioning System	USAID	United States Agency for International Development
GTFS	General Transit Feed Specification	USD	United States Dollars
ITP	Integrated Transport Planning	UTC	Urban Traffic Control
ITS	Information Technology Services	VCR	Volume Capacity Ratio
KCA	Kyiv City Administration	VPT	VynnytsiaPasTrans
KCSA	Kyiv City State Administration		

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EXECUTIVE SUMMARY

This report presents the scope and findings of the Economic Sector Work on Sustainable Urban Transport for the City of Kyiv, financed jointly by the Energy Sector Management Assistance Program (ESMAP) and the Korea Green Growth Trust Fund (KGGTF). The analysis consists of a rigorous evidence-based review of the strengths and weaknesses of Kyiv's public transport system and a proposed plan improve its network and operational efficiency. It directly addresses the City Administration's aim to develop practically-focused proposals for optimizing Kyiv's public transport networks so as to improve their operational and environmental efficiency, minimize costs for operators, and maximize connectivity. These proposals also take into account the future land use plan for the city.

Strengths and weaknesses of Kyiv's public transport network

Kyiv's public transport network is dense relative to many other European cities. It offers high levels of connectivity with the 94% of the population living within 400 meters from a transit stop. The city has a relatively modern trolleybus fleet, which is powered by domestically generated electricity, and efficient metro system that moves over 1.5 million people every day.

The organic growth of minibus—locally called “route taxis” or “marshrutka (маршрутка)”—services, which now represent 56% of all routes and carry 24% of daily PT passengers; has resulted in inefficient service duplication and fragmentation. The marshrutka services (1.1 million passengers per day) are second only to Kyiv's metro in terms of the volume of passengers they carry each day. People choose the metro for the rapid service it delivers from the edge of the city into central areas, but marshrutka services only appear popular for the fast, direct connections they offer to key destinations relative to existing bus, trolleybus and tram services. Excluding tram, the marshrutka fleet is the oldest in the city, and are almost all at EURO II emission standards. As marshrutka vehicles also have a smaller carrying capacity, they are operationally less efficient per passenger and more polluting per passenger.

A lack of priority and segregation from congested street sections, coupled with old infrastructure, limits the average operating speed of buses, trolleybuses and trams on many routes. This is exacerbated by a lack of on-street parking controls or enforcement regulations, which often results in bus lanes and multi-modal interchanges being compromised by parked vehicles.

Current public transport services are now struggling to cater for Kyiv's evolving travel demand patterns. A complex mix of movements within, and between, high density residential areas (particularly in Troieshchyna, Darnyts'kyi and Obolon) combine with demand for travel into the city center (Khreshchatyk and Podil) from all areas. The severance created by the River Dnieper, and the fact there are only five bridging points, further complicates the effective planning of public transport services. The result is that heavily populated areas of Liko Grad, Solom'yansk'kyi district, south-east Darnytski, and north Obolon demonstrate high levels of trip attraction; but are underserved by transit. The low income areas of Frofaniia, Kotibuynske, Troieshchna and Nyzhni are also less well-served than other districts.

The city center is surprisingly poorly served by public transport. The lack of direct transit routes (other than metro) is compounded by a lack of surface transit stops within central areas. This low permeability of ground-based transit into the city center has the effect of disadvantaging people who live in areas not served by metro. It creates an interchange penalty for trips that might involve crossing the city center, and requires transit users to walk longer distances in the city center than in other areas of Kyiv.

Future population growth is projected to occur primarily in Kyiv's outlying towns and villages. This will place greater pressure on edge of city interchange locations that already struggle to cope with the large volumes of passengers transferring between suburban buses and onward metro and surface-based transit connections.

Institutional and financial background

Urban transport planning in Kyiv suffers from lack of coordination between departments and subsidiaries of the City Administration, as well as with its neighboring municipalities. Entities that have powers to shape the city development in their own sectors (housing, roads, etc.) do not necessarily coordinate under a coherent plan. There is neither a strong requirement/mandate to coordinate with other departments/entities, nor a clear instruction how such coordination might be achieved. Moreover, the Kyiv Oblast and its municipalities develop their own plans without coordination at the Oblast level and with Kyiv City; assumptions used in respective master plans are often inconsistent with regard to the future population growth, motorization rate, and their mobility needs and travel patterns. And this is the inherent weakness of the current planning practice.

The right to operate bus services in Kyiv is controlled by a municipal enterprise, owned by Kyiv City State Administration. The formal structure is that the City Administration identifies a route that requires bus services and advertises for operators to tender for the right to operate that service. While the formal processes incorporate most of the key components of an appropriate procurement and regulatory regime, the reality falls short of effective regulation. For existing routes, more than 90% of tender invitations receive a response only from the incumbent provider.

The supervision and enforcement of performance standards in the agreements with private minibuses (marshrutka) operators is minimal, resulting in lack of regulation in their services. The inspection team is understaffed and lacks the means to put in place meaningful sanctions on violating operators. The most serious deficiency in the regulatory regime is that marshrutka operators continue to provide passenger services even when they do not have formal permission to do so and this is tolerated by the City Administration and by police. Further evidence of poor regulation is that licensed bus operators, whose routes originate outside the city, pick up passengers within the city boundaries and offer discount fares. A national inspectorate of public transport has responsibility for regulating these operators but it tolerates irregular practices and the City does not have powers to intervene.

Public transport fares, regulated by the City for both public and private operators, are relatively low; with about 50 percent of passengers do not pay the nominal fares, this results in a serious cost recovery issues. Currently, fares of metro are UAH 4, Kyivpastrans buses are UAH 3 and Marshrutka private operators range from UAH4 to UAH6, highly affordable compared to the income level. The current level of fare discounts or exemptions is a much higher share than what is typically observed in Western European cities, where the share of senior citizens is even higher than in Kyiv. As a result, the city spends a significant portion of its budget on public transport; particularly, over the past 5 years, on average about 6 percent of its total budget went to for operating subsidies. And such large operating subsidies appear to be crowding out other more productive use of the budgetary resources, including timely maintenance and upgrading of the infrastructure and rolling stocks.

Summary of public transport optimization proposals

An evidence-based optimization approach was developed for use in Kyiv. It relied heavily on sound data relating to traveler origins and destinations, and passenger boarding and alighting counts, as well as the supply of public transport service within the city. A transport model was prepared under direct finance and supervision from the KCA. The model benefited from comments and suggestions from the task team and was considered to be robust enough to test the proposed network modifications.

The optimization process involved first identifying scope for new strategic routes to better serve cross-city travel demands which are not currently being met. Existing public transport routes were then assessed to determine their relevance and viability in terms of current patronage levels, the extent of duplication with other routes, whether extending or shortening them would better meet patterns of travel demand, and

whether the route could be realigned to more directly connect key trip origins and destinations. This approach was sequentially applied to 12 districts in Kyiv, with further adjustments to routes based on a holistic consideration of mobility across the whole city.

In developing the optimization scenarios a redefinition of the local hierarchy for surface based public transport services was considered. This proposed that trams should provide fast, strategic connectivity, supported by buses and trolleybuses which can cater for both longer distance routes and shorter hop-on/hop-off services. The smaller-vehicle operated marshrutka services were designated as feeder services to routes with greater carrying capacity, and local hop-on/hop-off services where lower capacity transit vehicles are appropriate.

A total of three different scenarios were defined through the optimization process:

A – Short term transit route changes requiring minimal infrastructure investment.

B – Medium term route changes that need more significant infrastructure works.

C – Identification of possible long term mass transit schemes.

Scenarios A and B focused on low cost, pragmatically-focused, interventions that re-shape Kyiv’s surface public transit networks to better meet local needs. Scenarios A and B were the main focus of the project team’s subsequent analyses, since they are more readily comparable with the current public transport network.

Scenario A proposed the introduction of 16 new strategic routes, modification of 38 existing routes, and the deletion of 107 existing routes. The remaining 168 routes were retained and assigned new operating headways to improve their Volume Capacity Ratio (VCR) during peak travel times, resulting in a total of 222 routes, a reduction on the existing 313 operational routes.

Scenario B requires more significant infrastructure investment. Scenario B presented a further evolution of Scenario A, adding a further 3 new routes, upgrading 6 bus routes to trolleybus, making 8 further route modifications, and deleting 10 additional routes. A total of 198 routes were retained from Scenario A, resulting in a total of 215 routes overall. The amendments proposed in Scenario B require infrastructure investment to: improve public transport priority (signals and segregated bus lanes), extend trolleybus catenary along several lines, reconfiguring some junctions to allow for strategic bus movements that are currently impossible, and enhance the quality and capacity of 24 strategic public transport interchanges across the city. The majority of the route deletions were because there was scope for passengers to be absorbed onto a new route (53% of cases) or because of duplication (31% of cases). Routes being too long, and low patronage volumes were also reasons for route deletions.

Scenario C represented an option-testing exercises to demonstrate the potential viability of much more significant mass transit options. In Scenario C a total of 8 potential mass transit corridors have been identified that would be suitable for either BRT, LRT or Rapid Tram. The transport model for Kyiv predicts that these routes could carry a total of 1.14 million passengers per day, with patronage ranging from 74,000 passengers per day up to 290,000 passengers per day. Implementation of these routes would potentially replace the need for some of the bus, tram, and trolleybus routes proposed in Scenario A and B; but would come at much higher cost. Any routes implemented as Bus Rapid Transit lines could be delivered using trolleybuses, as per the example of Quito in Ecuador, in order to capitalize on local sources of electricity rather than diesel fuel.

Three further rail-based mass transit proposals have also been tested in Scenario C. These have all been shown to support large passenger flows. The rapid tram route extension from Starovokzalna Stn to Lva Tolstoho Sq/Palats Sportu is particularly attractive because the relatively short extension significantly increases passengers on T1 and T3 routes.

Projected impacts of optimization recommendations

A series of high level benchmarks were defined by the project team in order to measure the performance of Kyiv's public transport systems. They covered physical and operational capacity, energy efficiency, accessibility, affordability to the city, and the average number of transfers required per journey to satisfy travel demand identified through O-D survey data. The benchmarking data relating to the performance of Scenarios A and B was calculated by analyzing a combination of GIS datasets, operational cost and emissions data in MS Excel, and outputs from the Kyiv transport model.

The analyses revealed the public transport optimization proposals defined through the project were projected to result in up to:

- ✓ A 44% increase in the average number of passengers carried per Vehicle Kilometer Travelled and a 25% increase in daily average passenger numbers carrier per vehicle.
- ✓ A 25% reduction in total estimated energy consumption and total average energy consumed per passenger km travelled. This is achieved by requiring up to 12% fewer, but larger and more fuel-efficient, vehicles to travel longer operational distances.
- ✓ Between 30% and 50% improvements in accessibility levels for people living in, or travelling from, Khreshchatyk (City Centre), Troyeshchyna, Viradny Industrial Area, and Ocean Plaza.
- ✓ A 15% reduction in generalized annual operational costs associated with carrying the same number of passengers as the current public transport network. This is estimated to be a net annual saving of UAH 348 million, or \$14.67 million (\$3.47m in PPP terms).
- ✓ A 9% reduction in the average number of transfers required to complete a trip using the public transport (which is projected to fall from 1.6 transfers to 1.47).

The proposed optimization changes were forecast to re-balance public transport passenger loads across all modes of urban transit available in Kyiv. In particular this involved moving passengers from overcrowded Metro lines at peak travel times onto more rapid surface transport services that directly serve desired destinations. Reduced public transport vehicle flows achieved while increasing passenger flows across the bridges over the River Dnieper also point to greater efficiency of operation.

A widespread reduction in the highly-polluting marshrutka service vehicles is projected to achieve a reduction in local pollutants of 883 tons of nitrogen oxides per annum and 29 tons of particulates. Rebalancing the public transport service from one that is heavily reliant on Marshrutkas to one that is served by cleaner tram, bus and trolleybus vehicles also creates scope for all routes and modes to carry a more equitable mix of fare paying and concessionary passengers. The overall reduction in vehicle mileage combined with a shift to more electric modes yields a reduction in greenhouse gas emissions of 20% or 38,700 tons annually of CO₂.

Implementation considerations for Kyiv City State Administration

Key implementation aspects need deep consideration and decisions from Kyiv City State Administration (KCSA). The transit network optimization proposals defined through this study offer considerable potential to significantly and quickly improve the efficiency and capacity of Kyiv's public transport network at relatively low investment cost when compared with any mass transit proposals. Before electing to implement these proposals there are a number of factors the project team has highlighted for KCSA's deeper consideration. These include:

- ✓ Undertaking a round of more detailed cost-benefit analysis and feasibility appraisals for any new, or significantly amended, public transport routes. This analysis would help to inform the basis on which

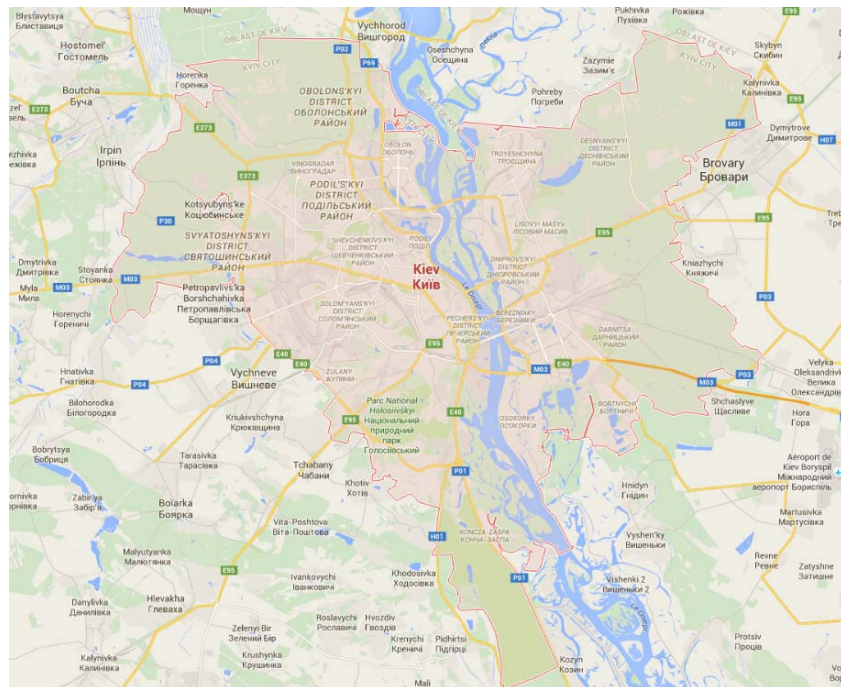
the routes can be implemented and establish more detailed business cases for prioritizing potential local public transport investments.

- ✓ Continue developing and improving the Kyiv transport model through improved calibration, incorporation of travel cost data and development of an operational peak-hour model for more fine-detailed analyses.
- ✓ Supporting this activity through ongoing data collection to enable the City Administration to monitor the impact of implemented changes to Kyiv's public transport system, and ensure their outcomes are desirable.
- ✓ Using further social research and stakeholder engagement techniques to consult local people for their views on proposed revisions to the city's surface public transport networks. This can include stated- and revealed-preference surveys to determine potential uptake among local communities affected by the changes.
- ✓ Adopting a phased corridor-based approach to implementing the proposals, in order to maximize opportunities for integrating public transport revisions with strategic land-use planning and place-making objectives. This form of Transit-Oriented Development has been used effectively in other European cities to direct economic growth into areas of the city that are well connected by public transport.
- ✓ Establishing off-street parking capacity in combination with some form of parking control and enforcement regime to prevent congestion in dedicated bus lanes and at strategic public transport interchanges around the city.
- ✓ Creating mechanisms that ensure very old marshrutka vehicles are scrapped through the process of public transport optimization. Such 'scrappage' or disposal mechanisms are likely to be required in order to prevent the vehicles from reappearing in competition with the city's redefined public transport routes in the future.
- ✓ Setting up driver and vehicle mechanic re-training schemes to ensure employees of marshrutka services affected by the city's optimization proposals are able to find work on new routes, or in related industries.
- ✓ Working with Kyivpastrans and the city's private transport operators to determine appropriate roles for all parties in respect of sustainable competition for the city's public transport. This may include exploring new approaches to franchising routes defined by the City Administration/Department for Transport, so as to stimulate healthy competition within a regulated market for public transport services rather than for that market as a whole.
- ✓ Exploring changes to public transport fare levels, potentially through zonal fare systems that relate public transport costs to distance travelled. These could be implemented on new, longer, routes as they are introduced and be tested through stated preference surveys with people who use public transport in the city. Any fare increases would require careful implementation, and should ideally remain cheaper than the relative costs of car use and parking in Kyiv. Raising fare revenues over time presents an opportunity for the continuing cycle of investment in new vehicles and infrastructure that is commonly required in major cities.

1 INTRODUCTION

Ukraine is the country with one of the highest urbanization rates in Europe, endowed with legacy public transport system. Around 69% of the total population lives in urban areas. In Kyiv, the capital of Ukraine, the total population is 2,847,200 according to the 2013 census data, placing the city as the 8th largest city in Europe. Kyiv covers an area of more than 835 km² and is developing its culture, policies, and strategies to reflect an emerging Ukrainian market economy. The city continues to grow and is experiencing rising levels of private car ownership and use. The Soviet legacy system of public transport includes metro, municipal and private buses, trams and trolleybuses, which are heavily used, often at or near capacity. Except buses, the rest of the public transport network has not much changed over the past decades, except some lines that have been closed due to low demand and dilapidated infrastructure.

Due to the lack of investments in system over the recent years, the condition of the system has deteriorated and the system integration—physical and operational—is weak. Moreover, the city's transport plans, still driven by “command-and-control” approach, have not fully responded to the spatial expansion (suburbanization) of the city, growing motorization and changing mobility patterns. Under these circumstances, the city is experiencing burgeoning traffic congestion, and consequently, deterioration of the air quality, increase in travel time and costs, increase in road traffic crashes and casualties, and loss of productivity.



Maintaining highly subsidized public transport fares has harmed the City Administration's ability to maintain and invest in public transport infrastructure and rolling stock. The trends for rising car ownership, burgeoning traffic congestion, ageing public transport infrastructure and rolling stock; and a policy disconnect between transport provision and urban development; suggest the City Administration's 2014 reforms to municipal transport system infrastructure, ticketing, and fares are a positive step.

The analytical work, requested by KSCA, aimed to support Kyiv City Administration (KCA) in improving the mobility conditions in Kyiv through practically-focused recommendations on public transport service optimization and reorganization. It was initially motivated by KSCA's recognition of the need to establish an evidence-based consensus for enhancing and developing transport infrastructure to meet changing travel demands. It also highlighted the financial constraints, arising from a culture of public transport subsidization, under which such solutions would need to be implemented. In addition, a strong focus was given to improve and strategize urban transport data collection, help understanding the strengths and weaknesses of Kyiv's public transport systems through rigorous assessment and benchmarking and supporting the technical staff of KCA in strengthening their transport planning capacity.

The proposed optimization plans and reforms aim to tackling the operational and capacity deficiencies that are routinely experienced on the local public transport networks during peak hours. In reality, the current funding patterns remain unsustainable, and some degree of optimization existing Public transport systems is a viable short to medium-term option for improving the mobility options and lives of local people.

The analytical work benefited from a solid partnership with KCA and other stakeholders and aim to reflect a common view on the proposed measures and their implementation. Indeed, one of the lines recommended by the team has already been inaugurated and the plans are to proceed with the implementation of the pilot packages. This report summarizes the analyses, findings and recommendations that emerged from the assessment and optimization plans. The remaining of this report is organized as follows:

Chapter 2 presents the assessment of the current mobility conditions in Kyiv. It presents the results of an evidence based and data driven assessment of the demand and supply for public transport and the results of a benchmarking analysis comparing key variables among cities with comparable characteristics.

Chapter 3 presents the optimization plans. It includes the principles applied during the optimization process and the resulting scenarios as well as their estimated impacts on users' mobility, suppliers' operations and the environment.

Chapter 4 discusses key aspects of a sustainable transport roadmap. The chapter discusses issues related to the implementation of the optimization plans as well as broader aspects related to the overall improvement of the mobility conditions such as priority investments, traffic management and control, parking and integrated planning.

2 ASSESSMENT OF KYIV URBAN TRANSPORT

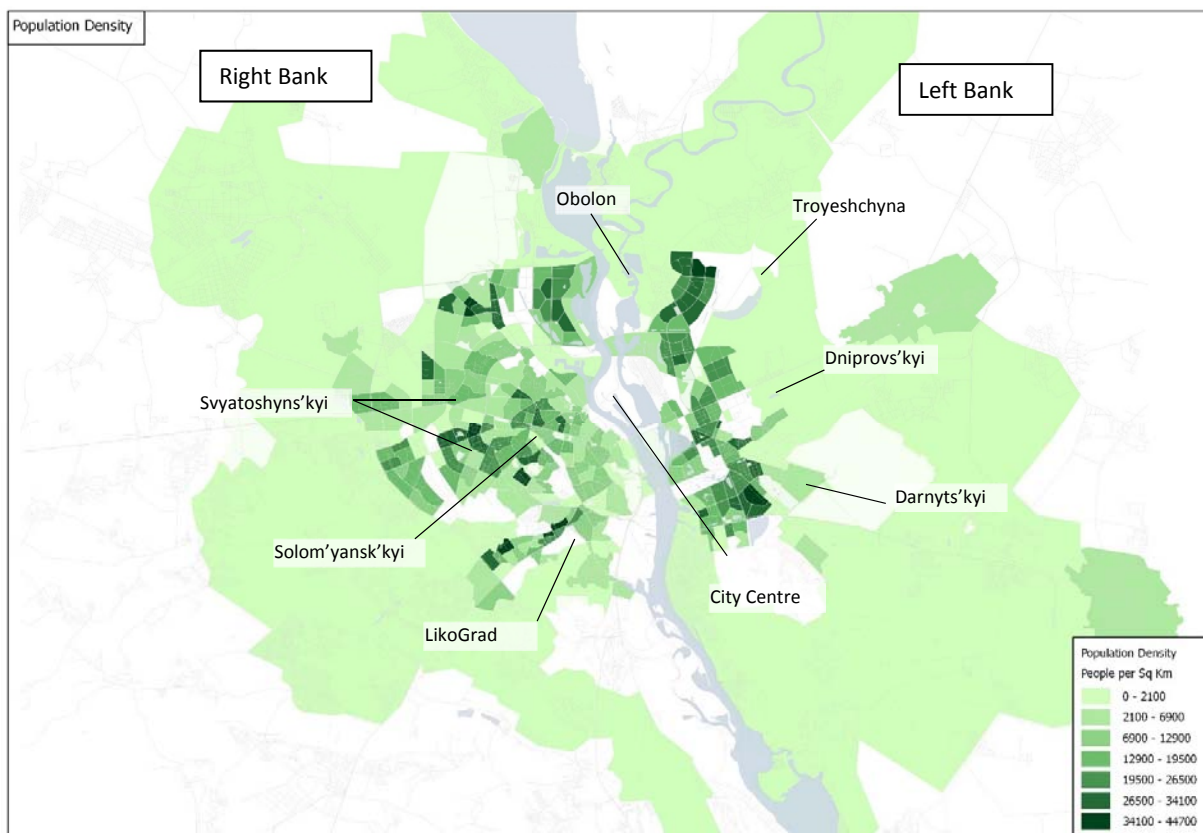
2.1 OVERVIEW OF URBAN MOBILITY IN KYIV

2.1.1 Spatial Overview of Kyiv

Travel demand is derived from the need to engage in various forms of socio-economic activities and opportunities. Consequently the predominant pattern of travel demand is shaped by the distribution of people and jobs, car ownership levels and the range of available transport options that facilitate personal mobility. The location of places for education, healthcare, and shopping are also important. The spatial analysis of Kyiv's urban form is presented below, as a basis of understanding travel demand.

Kyiv does not follow either concentric or polycentric models of population distribution. Instead it features heavily populated, predominantly residential, suburban areas located in the west (Svyatoshyns'kyi District), the north (Obolon), the north east (Troyeshchyna) and the east (spread between the Districts of Dniprovs'kyi and Darnyts'kyi). Figure 2-1 shows these concentrations and also illustrates the extent that the Dnieper River segregates the Left and Right Banks of Kyiv. The city centre is less-densely populated than suburban estates, being made up of historical buildings that provide lower residential densities than the newer tower blocks to the North, East and West of the city. Low density housing areas are primarily to the south of the city.

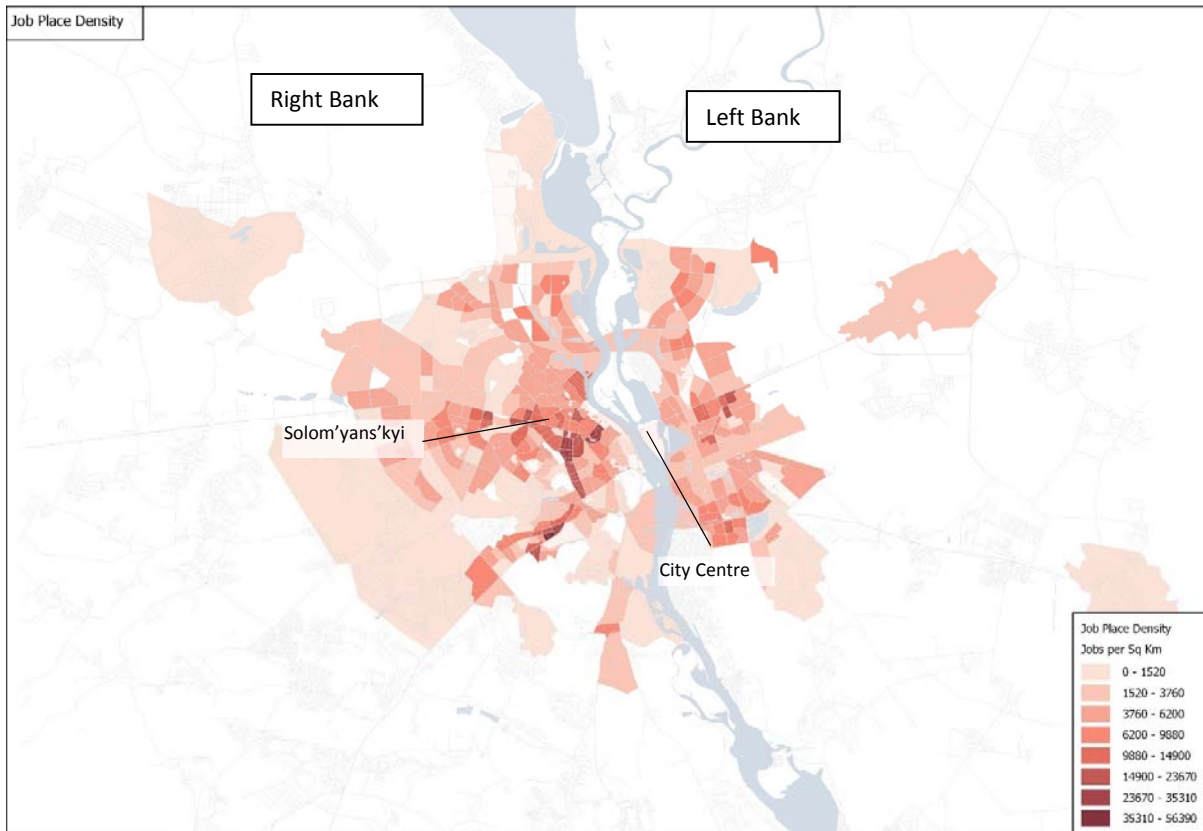
Figure 2-1 Population density in Kyiv (people per Km²)



Source: Kyiv population data from transport model, Kyiv City Administration/A+S 2015

The distribution of jobs in Kyiv is more concentrated than the city's population. Figure 2-2 shows the Right Bank (to the west of the River Dnieper) is where most of the employment opportunities are situated, notably in the city center and the Solom'yans'kyi District. The dense residential areas of Obolon, Troyeshchyna and Darnyts'kyi also provide a large number of employment opportunities.

Figure 2-2: Distribution of employment opportunities

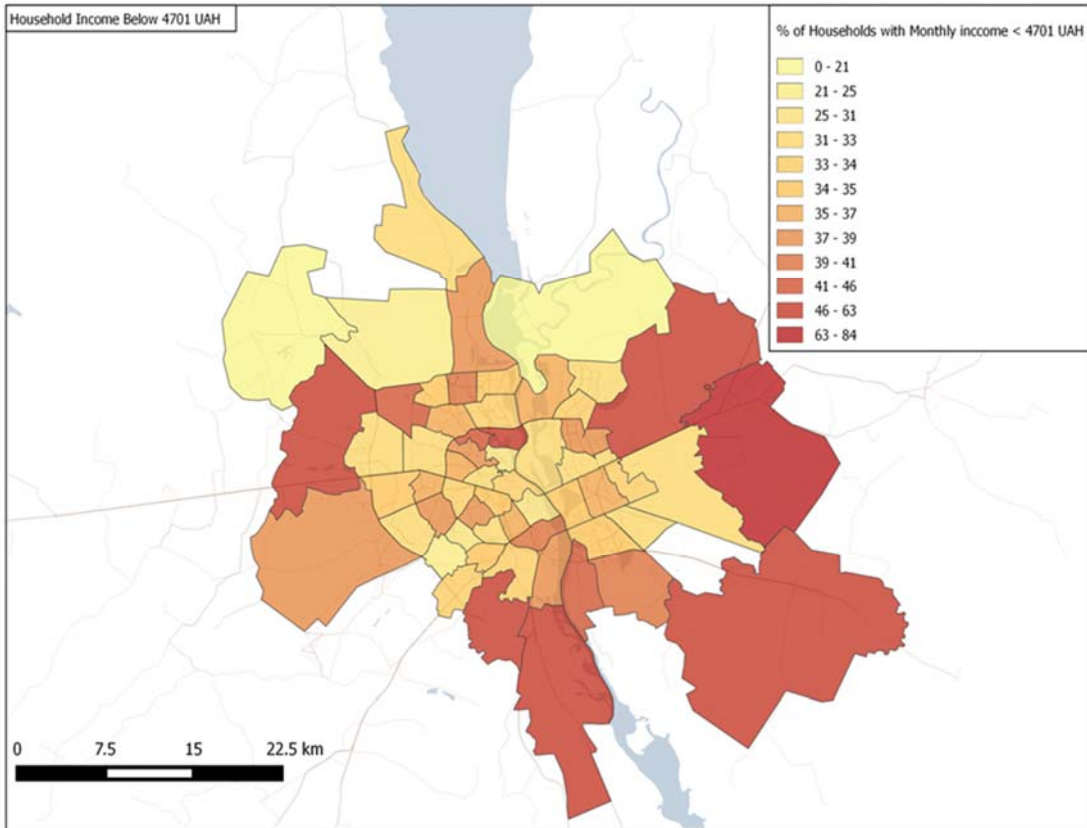


Source: Kyiv employment opportunity data from transport model, Kyiv City Administration/A+S 2015

Spatial disparity with respect to household income levels is clearly visible and used as a basis of understanding accessibility and mobility of various income groups. The areas of Kyiv with lower household incomes (less than UAH 4,701 per month) map closely to the areas of the city with low levels of household car ownership.

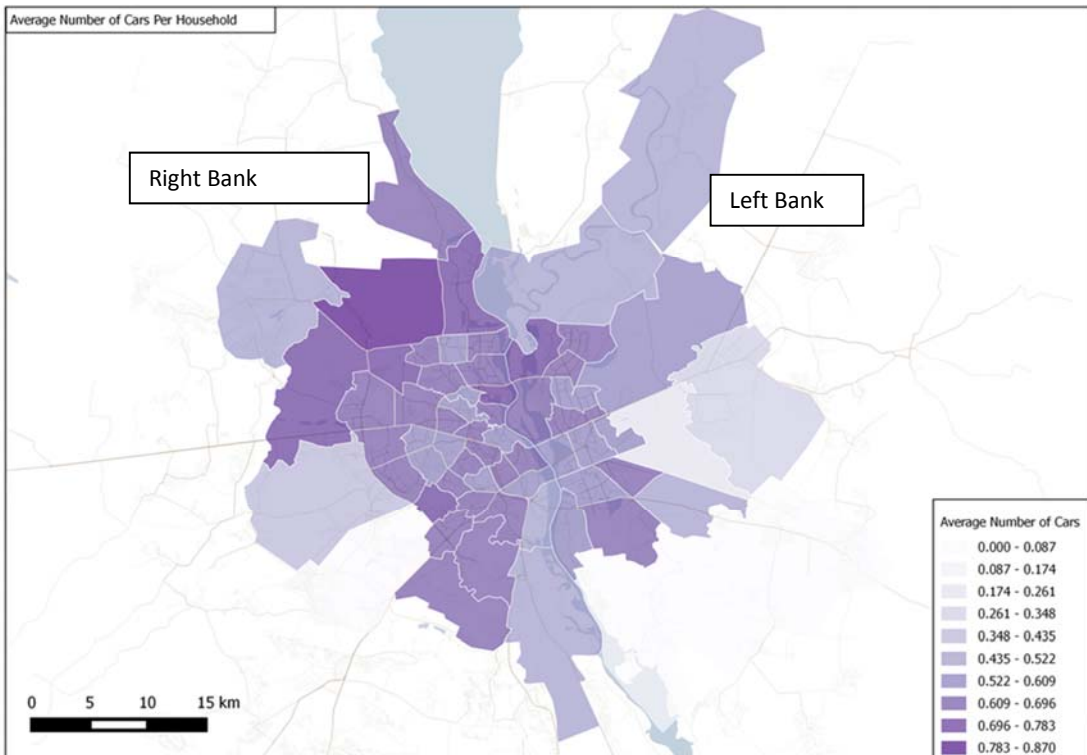
Figure 2-3 shows these locations are predominantly found in Troyeshychna and Dniprovs'kyi to the east of the city center, on the Left Bank; to the south of the city in Khodosivka, Pidhirtsi and Romankiv; and on the western periphery of the city in Svyatoshyns'kyi. Similarly, Figure 2-4 shows that car ownership levels are higher on the Right Bank, and particularly in the areas close to the northwest and western edges of the city. The Right Bank is also where concentrations of high caliber professional jobs and prime retail opportunities are located. Ideally these low household income/low car ownership areas would be well connected by public transport services in order to provide good access to employment and other opportunities. The project team's deeper analysis presented below reveals that this is not currently the case, highlighting scope for improving transport connectivity to these parts of the city.

Figure 2-3: Distribution of households with income of less than UAH 4,701/month



Source: Kyiv household income data from transport model, Kyiv City Administration/A+S 2015

Figure 2-4: Distribution of household car ownership levels in Kyiv



Source: Kyiv car ownership data from transport model, Kyiv City Administration/A+S 2015

2.1.2 Mobility Patterns

Overall, with relatively low car ownership, many trips in Kyiv—which consist mostly of commute trips—are made by public transport. An average household has access to 0.6 cars according to the household surveys, which is a low level of car access by comparison with other European cities. Furthermore, as shown in Figure 2-5, 50% of households in Kyiv have no access to a car. Figure 2-6 shows that journeys to access employment and education represent 55% of all the trips made in Kyiv. However, this data was derived from household interview surveys that did not include children and university students living in dormitories. Students alone are estimated to represent about 14% of the city’s population. From the perspective of their strategic impact on local travel patterns, trips to access employment opportunities tend to be longer in distance than those for education and shopping purposes, which are typically locally-focused on the areas people live.

Figure 2-5: Car ownership

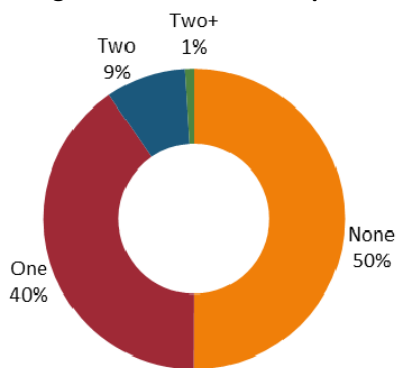
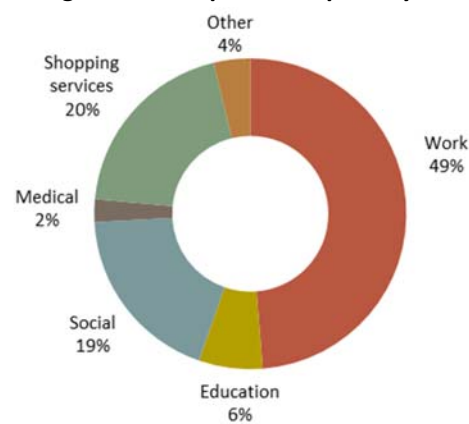


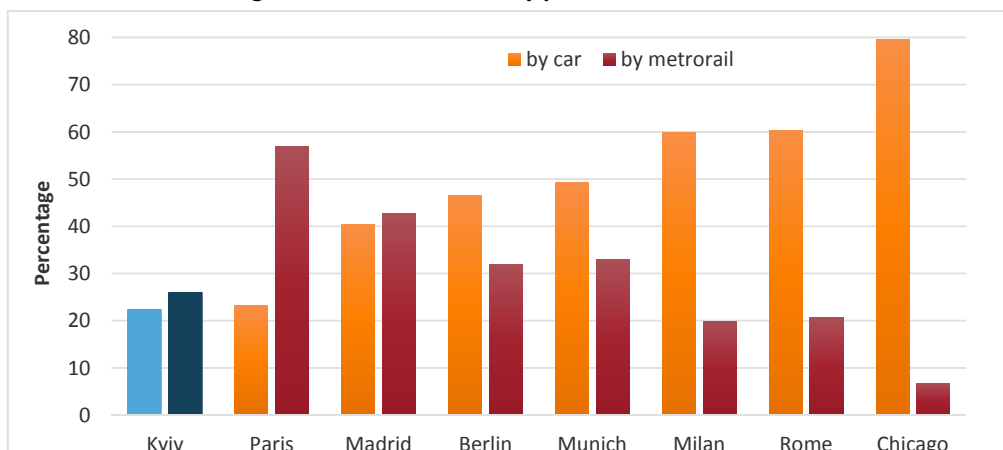
Figure 2-6: Purpose of trips in Kyiv



Source: A+S Household Survey 2014

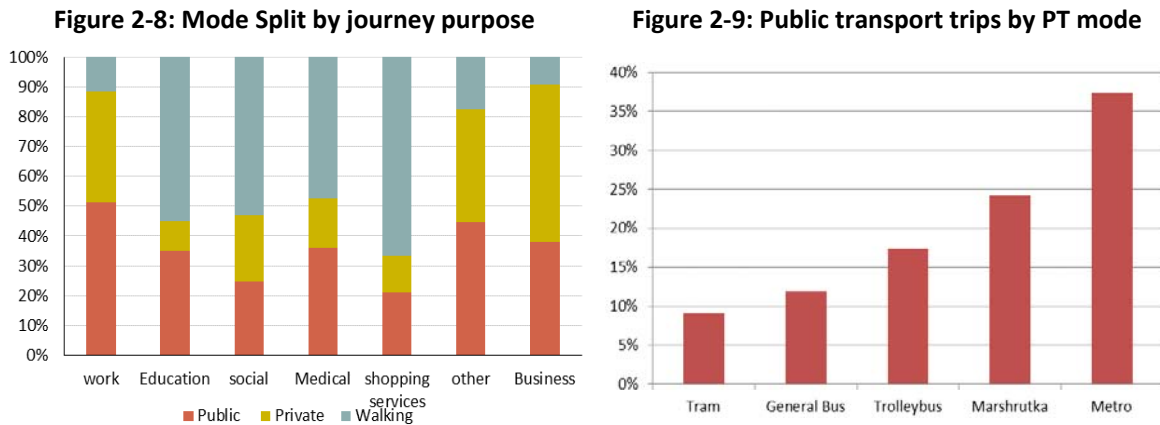
As shown in Figure 2-7, Kyiv city has relatively low mode share by cars and moderate mode share by metro compared to its peers. This is encouraging, especially considering that Kyiv city had under-invested in public transport for many years, especially for Kyiv Metro. It is inevitable that the City’s increased car ownership will put pressure on the current high usage of public transport so measures to retain the competitiveness of public transport with private cars, in terms of journey time and comfort, will be essential to retain the sustainable patterns of settlement and mobility suggested by the diagnostic tool.

Figure 2-7: Modal share by private car and metro



Data Source: <http://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1>

Public transport is the most widely-used mode for motorized trips, it accounts for 57% of these journeys. When walking is included in this analysis (see Figure 2-8), we learn that, it is the primary mode of travel for education, social, medical and shopping journeys. This confirms that residents of Kyiv tend to access these services in their local area, and are able to walk to them. Even so, between 25% and 35% of these trips are completed by public transport. Looking more closely at the modal split of public transport options in Kyiv (**Error! Reference source not found.**) it is clear that the Metro accounts for the largest proportion of trips, followed by marshrutka services (small minibuses operated by both public and private operators). Regular bus, trolleybus and tram services account for around a third of all public transport trips made in Kyiv.



Source: A+S Household Survey 2014

Kyiv’s public transport network is dense relative to many other European cities, offering high levels of connectivity for many of the city’s residents. Table 2-1 highlights the scale of the city’s marshrutka services, which represent 56% of all routes and carry 24.5% of all daily passengers. Figure 2-10 illustrates how many of these services overlap parts of the fixed line tram and trolleybus routes operating in Kyiv, reflecting their organic growth of marshrutka services in response to identified local demand for direct connectivity and faster door-to-door journeys.

Table 2-1: Kyiv transport modes and function

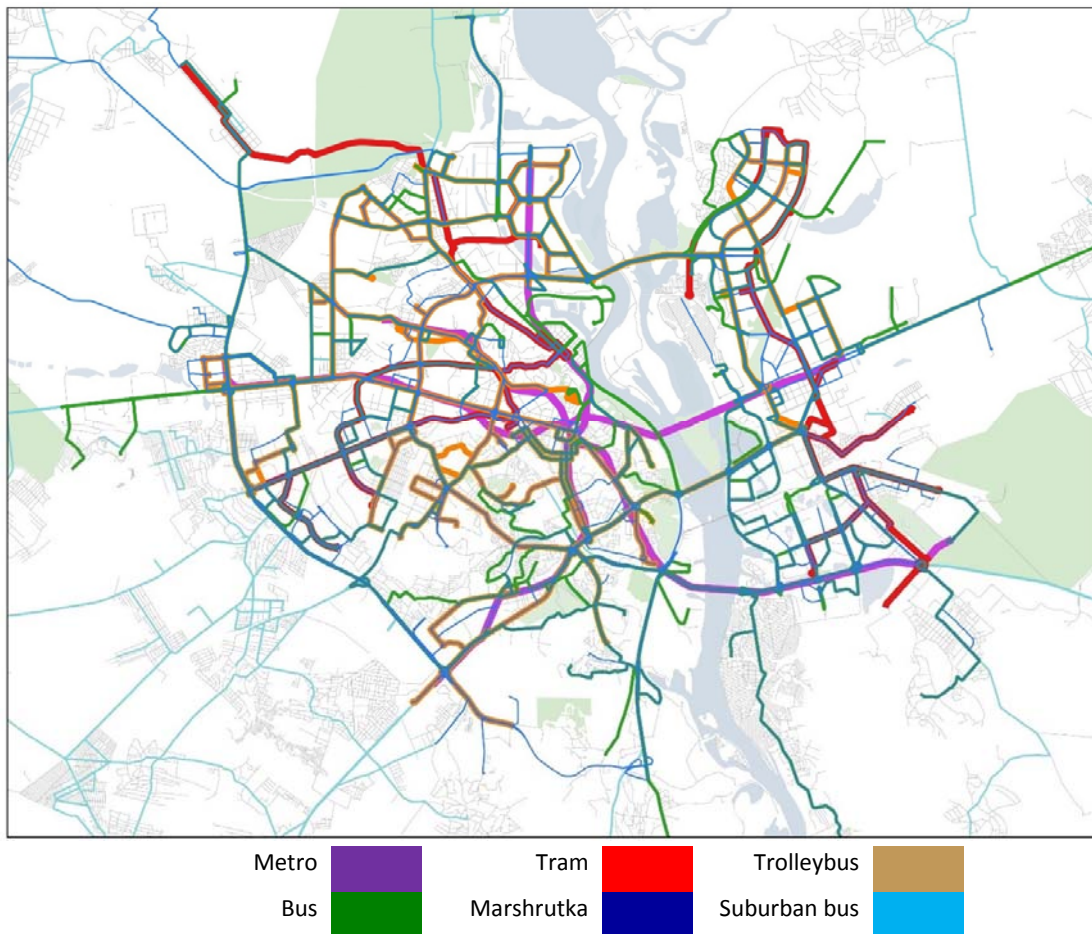
Mode	No. Routes	Operating vehicles	Daily Passengers	Key function
Metro	3	-	1,714,000	<ul style="list-style-type: none"> • Rapid cross-river connectivity • Mass movement of people • Access to and across city center
Private Marshrutka	141	1,525	937,300	<ul style="list-style-type: none"> • Some offer direct, end-to-end trip connectivity • Some feed metro lines
Public Marshrutka	30	279	174,000	<ul style="list-style-type: none"> • Run mainly by private operators • Smaller, nimble vehicles that are cheap to run and agile in traffic
Bus	72	370	548,000	

Trolleybus	41	369	800,000	<ul style="list-style-type: none"> Scheduled public services
Tram	21	289	416,000	<ul style="list-style-type: none"> Feed metro lines & interchanges Connect peripheral locations
Suburban Bus	161	-	-	<ul style="list-style-type: none"> Connectivity to outlying towns Interchange with city services

Source: ITP & A+S Boarding and Alighting Survey 2015

The metro provides the fastest connections across the Dnieper River, and is heavily used as a result – attracting 1.5 million passengers per day on average, and 1.7 million per day in winter months. The tram network is relatively sparse, serving limited areas of the city. Most of the network is served by single tram units which operate in mixed traffic that restricts their usage. These tram units are largely old and in need of refurbishment, as is the infrastructure over which they run and the catenary that distributes power. The exceptions are the two Rapid Tram lines, Pravoberezhna and Livoberezhna which provide modern, fast and high capacity services.

Figure 2-10: Kyiv’s public transport network



Buses and trolleybuses are mainly used to move around areas on the periphery of the city, as opposed to travelling into the city. The metro is considered the primary mode for accessing the city center. Other modes of surface transport available in Kyiv include the City Train, a heavy railway that runs on a loop around the

city, and a funicular railway that connects the historic upper town, and the lower commercial neighborhood of Podil through the steep Volodymyrska Hill overseeing the Dnieper River. Both are lightly-used in terms of daily passenger numbers, when compared with the other transport modes described above.

Figure 2-11: Typical examples of public transport vehicles operating in Kyiv

Marshrutka



Tram



Trolleybus



Bus



Figure 2-12 emphasizes the density of surface public transport routes on the Kyiv road network. It illustrates how heavily-plied the road-based river crossings are. The greatest volume of overlapping routes occur at Lisova and Sviatoshyn where many suburban routes from Oblast towns terminate.

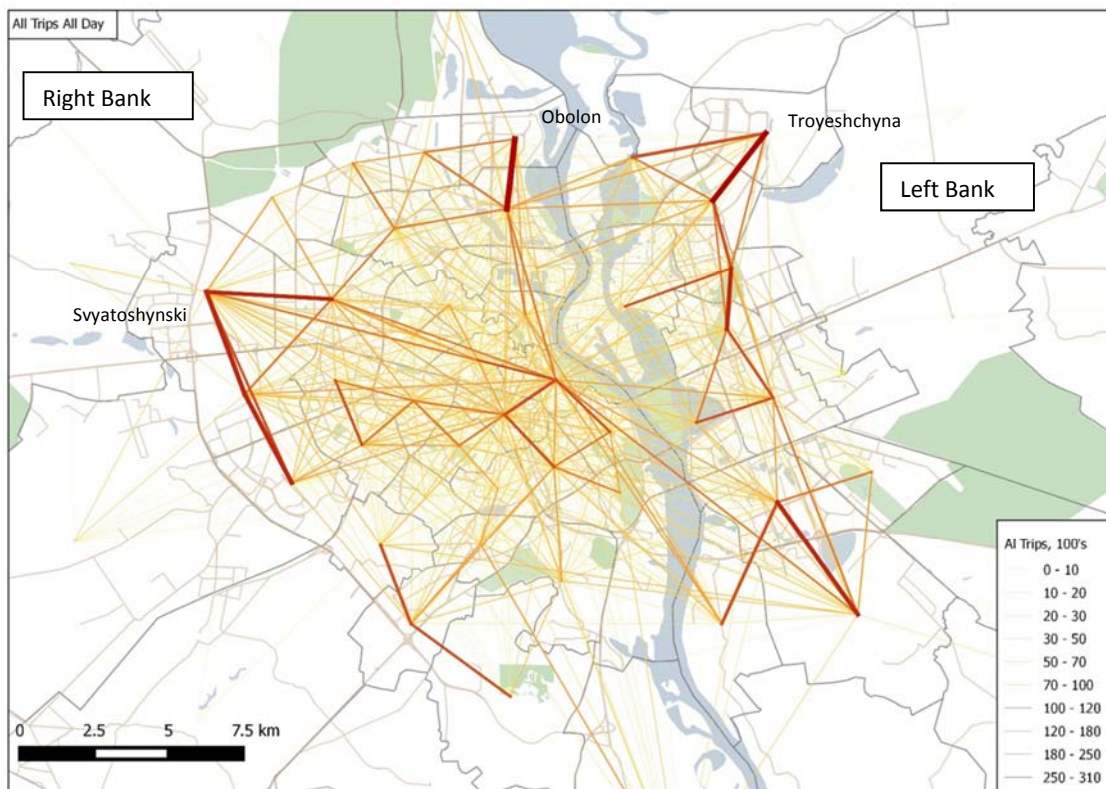
Figure 2-12: Count of all PT routes on each road segment



Up to 20 bus and marshrutka services operate across the Dnieper bridges. Tram routes no longer run across the Dnieper, while trolleybus routes use the Moskovskiyi and Darnytskyi bridges. Figure 2-12 shows a lack of arterial routes serving the city center. Instead the focus of the network is on circular movements around the edge of the city center. As mentioned previously, the metro is considered the primary mode for serving the city center.

The trip origins and destination data from the household survey, factored-up to match the sample in the transport model, reveal the complexity of travel demand in Kyiv. While the trip patterns in Figure 2-13 are, in part, constrained by the existing public transport supply, they illustrate a high volume of short trips occurring between zones in the city’s periphery. These short trips are notable in high density residential areas of Obolon to the north of the city center and in Troyeshchyna in the north-east. Other significant trip flows are observed between zones in the Svyatoshyn's'kiy district to the west. The map also shows many flow lines converging on Podil and the Khreschatyk/Maidan area. These reflect demand for connectivity to the city center from many areas of Kyiv. The trip patterns highlight disconnect between the east and west sides of the Dnieper River, with few strong flows of trips occurring across the river. This suggests people living on the Left Bank access many services and amenities they need without crossing the river. Few movements are observed in the south west area of the city which has the lowest population density.

Figure 2-13: O-D pattern of all trips in Kyiv over the course of a day



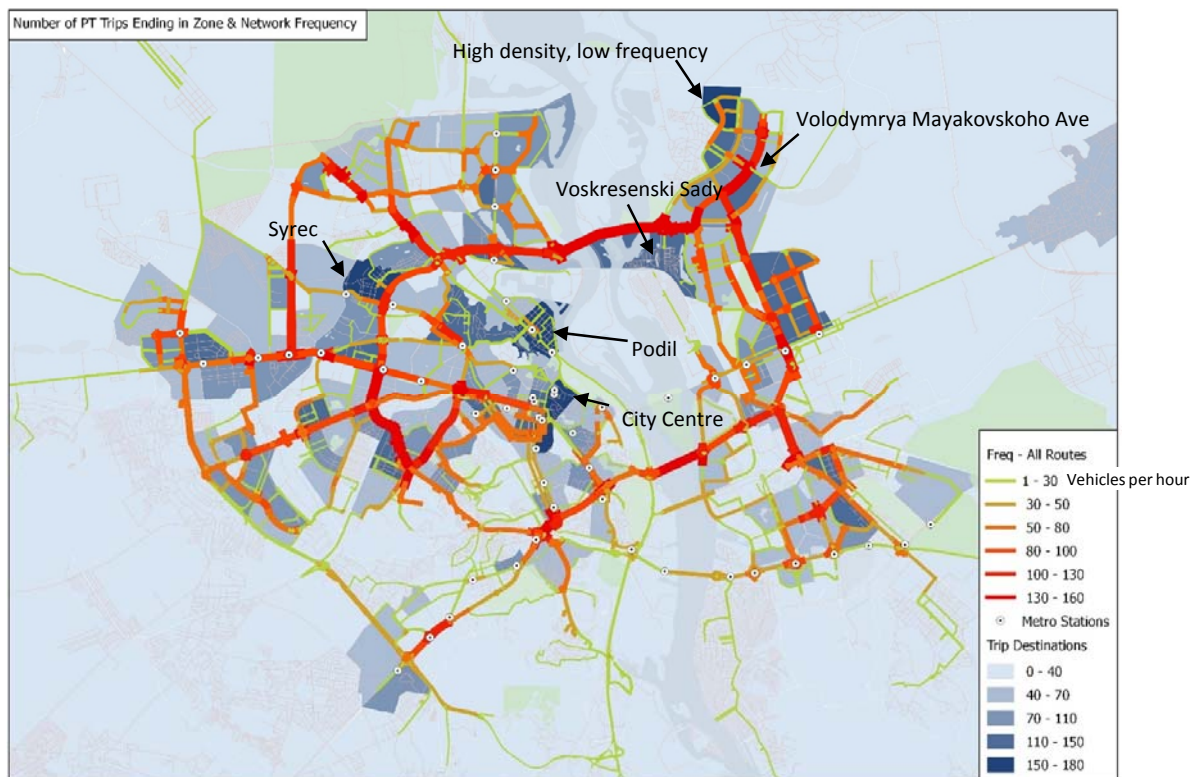
The public transport network was assessed, with regard to whether it serves popular destinations and attractions by providing good quality services at appropriate frequencies from multiple areas of the city. Figure 2-14 presents the number of trips which end in each zone from the data collected in the household survey. This data is compared to the frequency of the ground-based transit network, and metro stop locations, to see how well the network and frequency changes meet the demand for certain destinations. By

analyzing these trip patterns in relation to public transport supply, the project team was able to identify the overlaps and gaps in existing services to inform possible optimization activities, as summarized below.

This analysis highlights some of the gaps between transit provision/frequency and demand to certain locations. In general, most of the areas of high trip attraction are served by a high frequency of transit services. However, some areas of high trip attraction are poorly served by public transit, these include the city center, Podil, Syrec, Voskresenski Sady and north-west Troieschyna. Firstly the city center and Podil areas both attract a high number of trips yet these have low frequency of ground transit. While these areas have metro stations, which make them accessible by metro, this does not make the city center accessible from areas like Troyeshchyna that are not connected to a metro line. The metro stations in the center are also very spread out, which acts to increase the walking distance to access the city center.

Within Troyeshchyna residential areas are primarily served by Volodymyra Mayakovs'koho Avenue which runs along its east side. However, this road does not serve the north-west area of Troyeshchyna which sees the highest number of trips terminating there based on the O-D household survey data. The residential area of Syrec to the north west of the city is also a location at which a large number of trips begin or end. Although there is a high frequency of surface public transport service along the eastern ring-road, and a metro station to the south west, most of the area has no public transport connectivity.

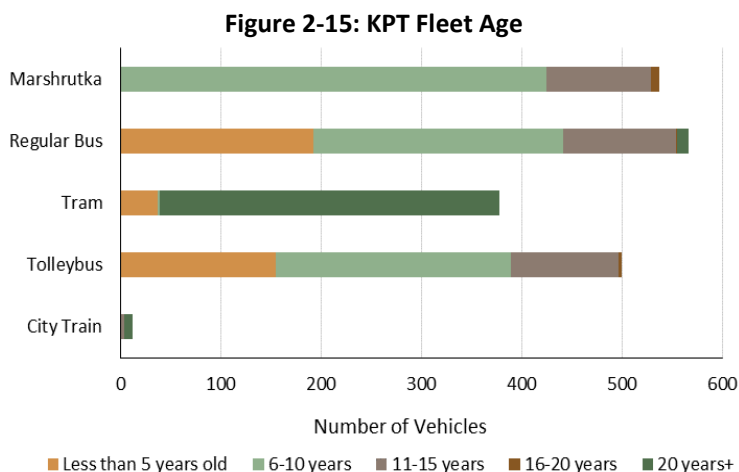
Figure 2-14: Number of trips ending per zone and network frequency



Source: A+S Socio Economic Profile V2 2015 & Easyway GTFS Feed 2015

2.2 PERFORMANCE BENCHMARKING OF URBAN TRANSPORT SYSTEMS

2.2.1 Fleet Quality and Size



Source: Kyivpastrans transport Data request form

The public transport fleet in Kyiv has evolved over a period of time. In recent years new trolleybus and bus vehicles have been added to the fleet, resulting in fewer vehicles that are over 20 years old. These investments also have helped reduce maintenance costs, and ensure the new vehicles are fit for purpose and able to cope with existing demand.

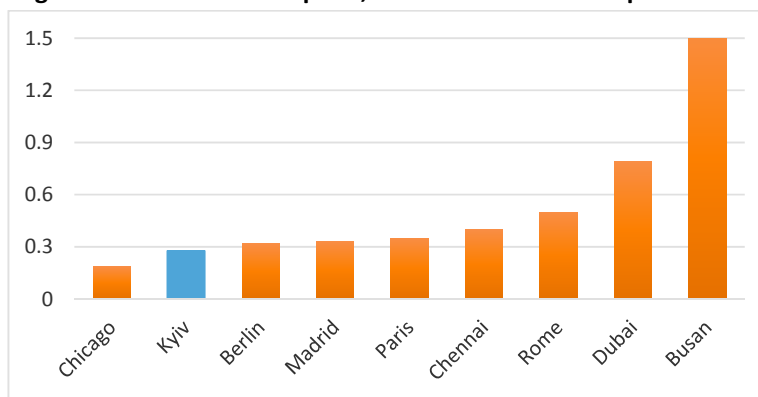
The majority of marshrutka vehicles are between 6-10 years old. The maintenance costs are likely to be lower than for regular bus and trolleybus vehicles given their similarity to minibuses. Consequently

the pressure to invest in new vehicles of this nature has been less demanding. Marshrutka's are also operated by private operators who are less likely to invest in new vehicles and more likely to favor ongoing maintenance and use their existing vehicles for as long as possible to maximize their profits.

The tram fleet is made up of mostly very old rolling stock that is 20 or more years old. This is problematic as old trams require a high level of maintenance and, more significantly, the design capacity of these older vehicles is not suitable for today's demand. The newer trams in the fleet operate on the light rail routes that offer increased capacity and faster services along the Pravoberezhna and Livoberezhna line. Updating tram units is expensive compared to rubber-tired vehicles. The City Train (electric train) utilizes existing rail stock from Ukraine Railways.

As shown in **Error! Reference source not found.**, when averaged by population, Kyiv city's bus fleet size (public buses and 'route taxi') is relatively small compared with cities of similar size of population. There could be more buses running on the roads to meet people's travel demand.

Figure 2-16: Bus vehicles per 1,000 residents in metropolitan area



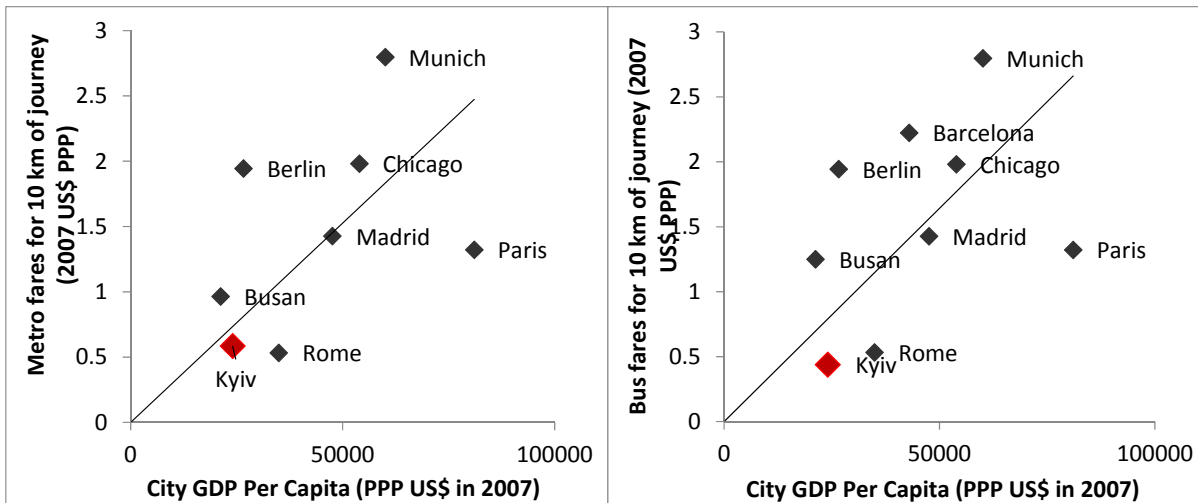
Data Source:

<http://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1>

2.2.2 Affordability and Safety of the Services

Public transport services in Kyiv are highly affordable by European standards, even taking account of relative income levels. All modes of public transport use a flat-fare, irrespective of journey distance and without transfer discount for trips requiring different stages. As of March 2015, the fare on Kyivpasstrans bus, trolleybus and tram is 3 UAH per trip and Kyiv Metro trips cost 2 UAH, after doubling of the fares in February 2015.¹ Figure 2-17 suggests that Kyiv's public transport tariffs, both for metro and buses, is lower than many cities with similar population size, as share of per capita GDP. It is noted that this comparison is on the basis of nominal fare, and given the high share of passengers who are eligible for fare discount or exemption, the actual affordability of public transport in Kyiv is actually greater than illustrated in the charts.

Figure 2-17: Affordability comparison



Data source: <http://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1>,
Kyiv fare data in 2013 before change

With respect to road safety, public transport of Kyiv ranks in the middle range compared to cities with comparable population size, but three times more fatality-prone than some of its European peers, of road accident deaths rates compared with peer cities. The situation has nevertheless been improving in the past few years. Of the reported accidents of public transport, driver mistakes accounts for a large share of buses and marshrutkas.

Figure 2-18: Road fatalities per million population

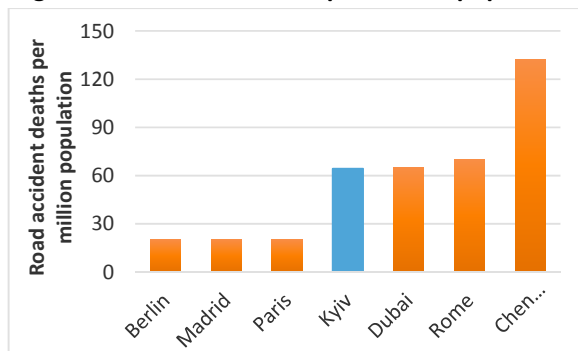


Figure 2-19: Reported causes of crashes by mode



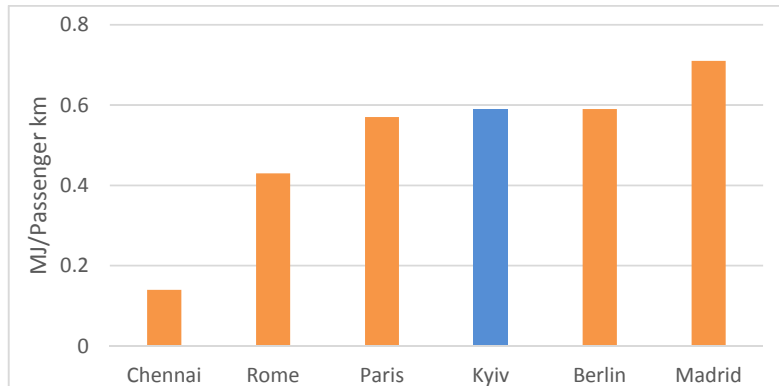
¹ While a doubling in fares appears steep, the adjustment does not fares to their real values a year ago, given the high nominal price inflation and devaluation of the Ukrainian Hryvnia during 2014.

Data Source: <http://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1>

2.2.3 Energy Efficiency and Emissions

Kyiv’s public transport system consumes similar level of energy per passenger-km compared to its European peers. Combining energy consumption data from all modes, both diesel and electricity, and ridership data from 2012 for fair comparison with peer cities, the energy consumption per public transport passenger kilometers compares well with other cities that have more modern, fuel efficient bus fleet. This is likely to be attributed to the high reliance on electrical modes and high passenger numbers.

Figure 2-20: Public transport energy consumption per passenger-kilometer



Data Source: <http://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1>

However, there is much room for improvement concerning the emissions of public transport systems of Kyiv. Comparing to some other European cities, the data from Kyivpasstrans suggest a greater share of fleet with lower emission classes (Table 2-2). Kyiv’s fleet currently consists of mainly Euro standard vehicles with just 8% below Euro II standard emission vehicles. These are older Marshrutka vehicles as newer vehicles purchased will be meeting the requirements of Euro II and Euro III. Not only Copenhagen but also Warsaw has significantly shifted towards cleaner fleets that include the latest standards and electric vehicles.

Table 2-2: Euro Emissions Standard Fleet Benchmarked (KPT Bus and Marshrutkas)

Emissions Standards	Kyiv (KPT Bus & Marshrutkas)	Copenhagen	Warsaw
<Euro II	8% (87 regular bus)	-	4%
Euro II	62% (350 Regular bus, 332 marshrutka)	7%	26%
Euro III	30% (335 regular Bus)	37%	15%
Euro IV	-	8%	27%
Euro V	-	12%	6%
EEV	-	34%	18%
LPG	-	2%	-

Source: *The capital city of Warsaw, The Transport System of Warsaw: Sustainable Development Strategy*

Table 2-3 present a set of calculations that estimate energy use and greenhouse gas emissions for the different types of vehicles which make up Kyiv’s ground public transport fleet. The energy efficiency and CO₂ emissions per passenger kilometer values provided in this table show there are potential energy efficiency savings of up to 33% when passengers are carried on a full tram or trolleybus, when compared with a KPT marshrutka vehicle; and around 30% when passengers are carried on a full regular bus compared with a privately operated marshrutka vehicle.

Table 2-3: Annual energy use, efficiency & GHG emissions of Kyiv

Mode	Energy use			Operational Statistics		Energy Efficiency		Total CO ₂ e emissions (tCO ₂ e/year)			CO ₂ e emissions / unit	
	Diesel litres/yr (000's)	Electricity KWh/r	Equivalent Energy TJ/year	Veh Km /year (000's)	Pax Km /year (000's)	MJ / vKm	MJ / pKm	Direct	Indirect	Total	CO ₂ e g/vKm	CO ₂ e g/pKm
Tram	-	42,234	152	11,265	419,997	13.5	0.36		16,856	16,856	1,496	40
Trolleybus	-	75,471	272	19,952	665,783	13.6	0.41		30,121	30,121	1,510	45
General Bus	9,381	-	337	23,537	606,366	14.3	0.56	23,800	5,174	28,974	1,231	48
KPT Marshrutka	4,812	-	173	15,995	304,858	10.8	0.57	12,207	2,654	14,861	929	49
Private Marshrutka	30,236*	-	1,087	100,512	1,460,272	10.8	0.74	76,708	16,676	93,384	929	64
Total	44,429	124,808	2,046	171,261	3,457,277	11.9	0.59	112,715	71,481	184,196	1,076	53

Source: KyivPasTrans, EasyWay GTFS feed, ITP public transport frequency and boarding/alighting surveys, Emissions factors from AEA 2012, EU Transport GHG: Routes to 2050, <http://www.eutransportghg2050.eu/cms/reports/>

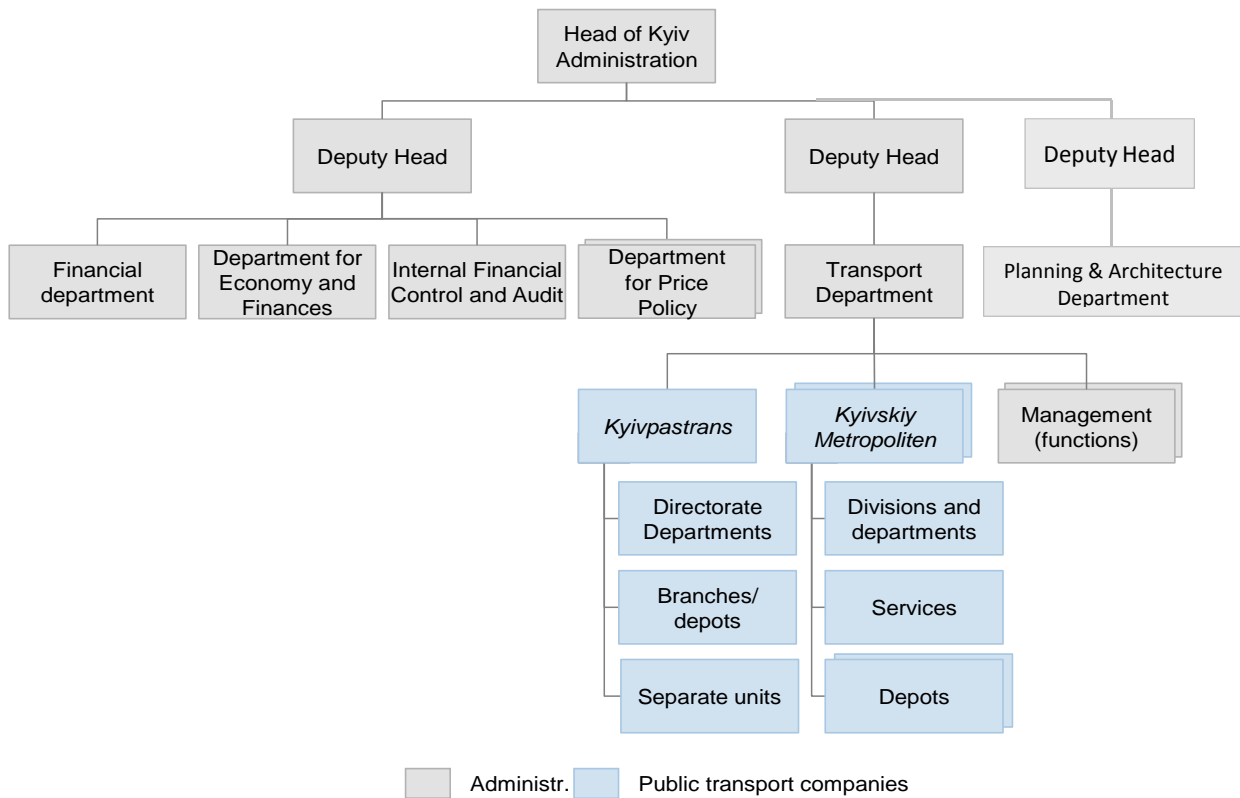
*Estimate based on distance plied

2.3 INSTITUTIONAL FOUNDATION

2.3.1 Urban Transport Planning

Several entities are involved in planning and managing transportation in the city (Figure 2-21). The Department of City Planning and Architecture (DCPA) is responsible for developing city development plans and transport master plans, including planning of transport network of fixed infrastructure, i.e., road network and rail-based transport network.² The DCPA engages the Institute of General Plan for Kyiv (KyivGenPlan), a municipal unitary enterprise, in developing and monitoring the General Plan of Kyiv. The Transport Master Plan for 2015-2025 has been prepared and is pending the City Council’s approval, which is unlikely to happen prior to the upcoming election in October, 2015.

Figure 2-21: Organization chart of the subgroup within the KCSA concerned with transport



Source: Kyiv City State Administration

There is lack of coordination between departments and subsidiaries of the City Administration. Entities that have powers to shape the city development in their own sectors (housing, roads, etc.) do not necessary coordinate under a coherent plan. For instance, Kyiv Road Agency, Kyivavtodor, has developed and implemented some road projects that have not been reflected in the planning work of the DCPA; the Department of City Housing and Construction has been allowed to develop its investment projects without proper cross-checking with the master plan.³ Under the current institutional arrangement, these activities are perfectly legitimate as they are within the legal powers and responsibilities of the respective entities.

² Planning of service routes of road-based public transport modes (trams, buses, trolleybuses, and route taxis) is the responsibility of the Department of Transport Infrastructure.

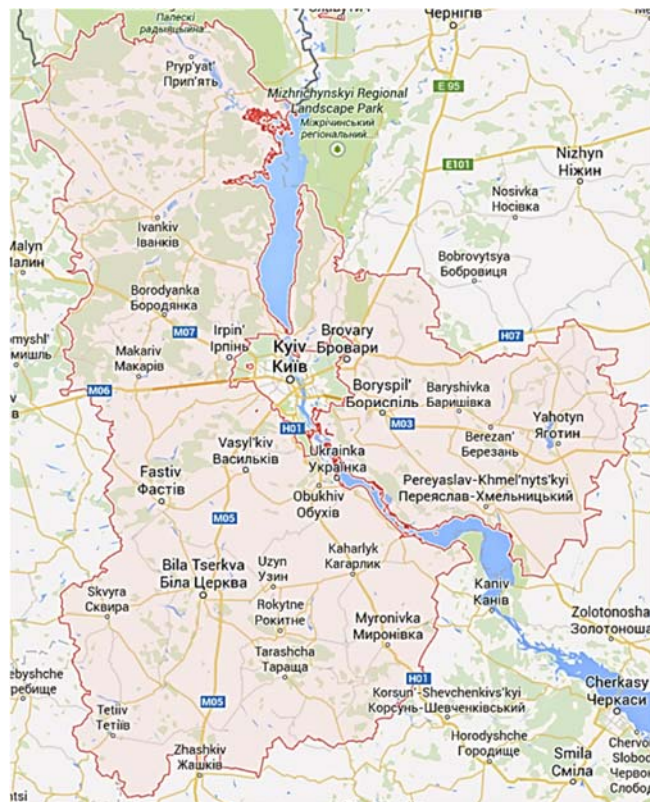
³ This is from the discussion with the DCPA, and not validated with the entities concerned.

There is neither a strong requirement/mandate to coordinate with other departments/entities, nor a clear instruction how such coordination might be achieved.

Coordination with neighboring municipalities in Kyiv Oblast is similarly weak. Many of those municipalities belong to the agglomeration of Kyiv City: their residents make frequent trips to destinations within the city proper, for their jobs and to access services. Therefore, land-use plans, housing development, and other initiatives in these municipalities have great implications on the city development plan of Kyiv.⁴ Despite this close link, the municipalities in Kyiv Oblast are allowed to develop their own master plans without having to coordinate that of Kyiv City; assumptions used in respective master plans are often inconsistent with regard to the future population growth, motorization rate, and their mobility needs and travel patterns. And this is the inherent weakness of the current planning practice.

The Transport Master Plan is not fiscally constrained, and thus highly unlikely to be fully funded by the city budget. The current master plan amounts to 150 billion UAH of investment in transport for 15 years, which is approximately six times the average annual budget of the city. This is unrealistic given that historically only about five percent of annual budget has been allocated for development of transport infrastructure. Mobilizing non-budgetary sources in such a large scale would not be an easy path although not impossible.

Figure 2-22: Kyiv City and Kyiv Oblast



2.3.2 Licensing and Regulation of Public Transport Services

Much of public transport in Kyiv, comprising metro, trolleybus, tram, diesel bus and marshrutka is provided directly by city-owned operators or under license from the City. A municipal company, “Kyiv Metropolitan” operates metro services and another municipal company “Kyivpasstrans” operates all tram and trolleybus services as well as some diesel bus and minibus services. The supply of electric transport services is fixed by the location of fixed infrastructure while bus services operated by Kyivpasstrans and by private operators are based on licenses issued by the City, following public tenders. Kyiv now has around 33 privately operators of bus or marshrutka services. This includes five to seven operators that have fleets of hundreds of vehicles and their own maintenance depots. Three of these operators dominate the market. Most of the other operators are very small, however, operating a few vehicles that are serviced by third parties. Some operators do not even own vehicles but rent from others.

The right to operate bus services in Kyiv is controlled by a municipal enterprise, owned by Kyiv City State Administration. The formal structure is that the City Administration identifies a route that requires bus services and advertises for operators to tender for the right to operate that service. The City announces

⁴ According to the DCPA, 38 percent of the housing plan of the previous master plan, developed in 2002, was outside the Kyiv City.

award criteria, focused on frequency of service and minimum technical requirements for vehicles, sets a reasonable period for tenders and establishes an internal tender committee to evaluate tenders. The City enters into formal agreements with the successful tenderer, specifying its requirements in terms of route, vehicle and frequency of service. The City carries out regular inspections and can impose sanctions for non-compliance, even to withdrawing the right to operate the service if poor performance is not remedied. The City also carries out ad hoc inspections in response to complaints from members of the public.

While the formal processes incorporate most of the key components of an appropriate procurement and regulatory regime, the reality falls short of effective regulation. For existing routes, more than 90% of tender invitations receive a response only from the incumbent provider. Some competition was generated by the arrival of marshrutka operators from Donetsk and Luhansk in Eastern Ukraine but in general, Kyiv operators do not compete for one another's routes. The tenders frequently do not meet the City's minimum standards for quality of vehicle and the City responds by entering into an agreement for a short period such as for one year rather than for the permitted five years.

The supervision and enforcement of performance standards in the agreements with marshrutka operators is minimal. The inspection team comprises four staff, which is charged with conducting an annual scheduled inspection of each route and occasional inspections in response to public complaints. If the operator is found to be in breach of the contractual standards, it is called for a meeting with the City Transport Department, which may issue a warning. After three such warnings, the City has the right to terminate the agreement but in practice, it never reaches this level.

The most serious deficiency in the regulatory regime is that marshrutka operators continue to provide passenger services even when they do not have formal permission to do so and this is tolerated by the City Administration and by police. Further evidence of poor regulation is that licensed bus operators, whose routes originate outside the city, pick up passengers within the city boundaries and offer discount fares. A national inspectorate of public transport has responsibility for regulating these operators but it tolerates irregular practices and the City does not have powers to intervene. The deficiencies in the current supervisory regime for private provision of bus services in Kyiv relate more to the enforcement of contractual and regulatory rules than to problems with the formal arrangements. If the City Administration is to consider alternative contractual arrangements, including options where the City would make payments to operators, the absence of effective enforcement of contractual and market regulatory rules would need to be addressed in tandem with other institutional changes.

Public transport fares for both public operators and privately owned marshrutkas are regulated by the City. Currently, fares of metro are UAH 4, Kyivpastrans buses are UAH 3 and Marshrutka private operators range from UAH4 to UAH6. Although not quantified, the price elasticity of demand could be observed when marshrutka private operators implemented fare increases during 2014 of about UAH 2 per trip. The public acceptance of this fare increase should make the fare increase for City-owned modes more acceptable. Kyivpasstrans observed an increase in patronage on its services, however passengers returned to marshrutkas when in January 2015 Kyivpastrans raised the fares with most doubling in price from UAH 1.5 to 3.

Currently, about 50 percent of public transport passengers do not pay the nominal fares or do not pay at all. This is a much higher share than what is typically observed in Western European cities, where the share of senior citizens is even higher than in Kyiv (for example, about 15 percent of public transport users in the UK get benefit from concessionary fares). It appears that national and city authorities in Kyiv do not reimburse transport operators for concessional travel in accordance with the terms of the statutory schemes and some private operators claim that they have not been reimbursed at all. Public transport operators should be compensated for the forgone fare revenues from the respective regulatory bodies: the State budget compensates for the exemption category stipulated in the State legislation, the City budget does for those categories in the local legislation. Kyiv Metro, which has the most reliable information on the numbers

of concessional-fare passengers, received only 30% of the requested compensation for these passengers in 2014 and expected to receive only 10% in 2015.

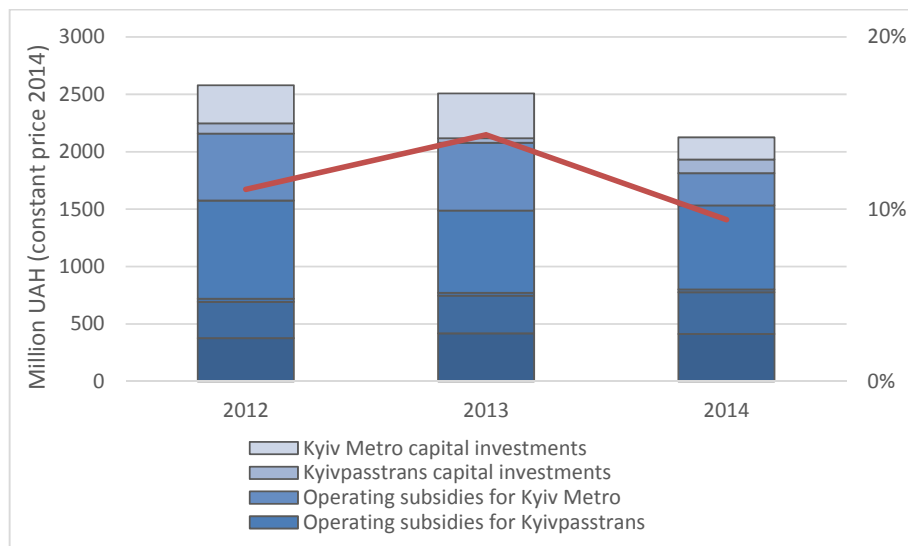
Fare-setting by urban transport authorities internationally varies depending on policies to favor public transport over private cars; availability of alternative sources of funds; and operators’ cost effectiveness.

The practice of fare setting in Central and Eastern Europe has generally been to maintain low fares and to fund investment and operations substantially from municipal budgets. It is quite common for expenditure on transport to be the largest single item in municipal budgets. However, this model has become more challenging for East European cities due to tighter municipal budgets and increasing costs of investment and operations.

2.3.3 Funding for the Urban Transport Systems

On average, the city spends between 9 and 14 percent of its budget on various sub-sectors concerning transport infrastructure and services—roads, traffic management and public transport—including capital investments, repairs of infrastructure and vehicles, wages, fuels, electricity, and other operating expenses. The allocation for transport has decreased over the past 3 budget cycles, primarily due to a decrease in operating subsidies to public transport operators (see Figure 2-23). Investments in road network—for new construction, capital repairs and maintenance—comprises about 30 percent of the total transport sector spending, while very small amount—about 1 percent—goes to traffic management. The remainder—about 70 percent of the total transport sector spending—is allocated to the two municipal enterprises, Kyiv Passenger Transport (Kyivpasstrans) and Kyiv Metropolitan (Kyiv Metro). Over 50 percent of the total transport spending, or three quarters of total allocation for the two public transport operators, is used to fill up the operating deficits, while less than a third of that amount goes to some type of investment, such as capital repairs and infrastructure construction.

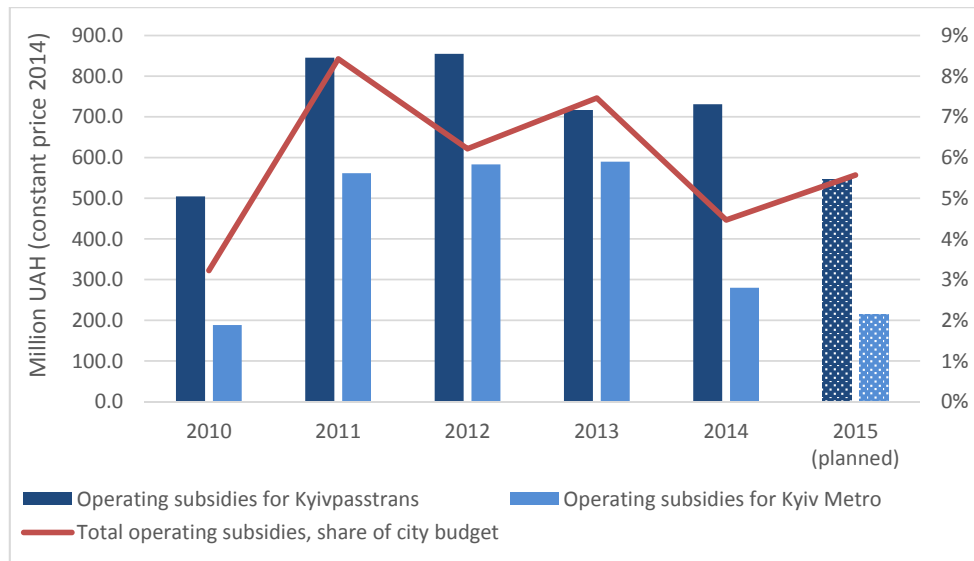
Figure 2-23: Transport Sector Spending by category



The operating subsidies to the public transport operators is a significant spending item for the city, at about 6 percent of its total budget, on average over the past 5 years. In 2011, the subsidies doubled in terms of amount and reached at 8.4 percent of the city budget, and have since been in decreasing trends both in terms of the amount and the share of the city budget (Figure 2-24). Nevertheless, they were still large at about 5 percent of the total city budget, putting a pressure on its tight fiscal space. The largest budget item was ticket price compensation for Kyivpasstrans, followed by recapitalization of Kyivpasstrans, which

was a *de facto* operating subsidy that compensates the losses. Subsidies to Kyiv Metro was smaller and decreased substantially since 2014; the difference from Kyivpasstrans was attributed to the fact that the tariffs are higher and fare evasion is harder for metro users due to the gated entry/exit of the system.

Figure 2-24: Trends in operating subsidies for Kyiv Passenger Transport and Kyiv Metropolitan



In fact, it is possible that the large operating subsidies are crowding out other more productive use of the budgetary resources, including timely maintenance and upgrading of the infrastructure and rolling stocks. Municipal public transport operators claim that their systems are chronically underfunded; they only receive money to meet less than 10 percent of the investment needs—capital repairs and asset replacement—from the city administration.⁵ The result of that is a huge and growing maintenance backlog and the system that does not adequately respond to the growing and evolving mobility needs of the citizens. The current practice undermines the long-term sustainability of the legacy system, posing a great risk that the system will become obsolete and the city will have to replace it with a new system, which would cost a lot greater than upgrading the existing one.

Underlying this funding problem is insufficient revenues, attributed to the tariff policy and inefficiency of the fare collection system.

First, the current tariff policy, which aims to provide socially affordable tariffs, is not sustainable from the fiscal point of view. Not only are the tariffs low proportionate to the income level (see Figure 2-17), but also a large number of users are entitled to fare discount or exemption under various socio-economic categories, according to the State and local legislation. Kyivpasstrans estimates that over 60 percent of its passengers benefit from free or discounted fares⁶; Kyiv Metro estimates that about 25 percent of metro users do. According to the recent household survey, however, concessionary fares are offered to a wide variety of users, including those who can afford regular fares, suggesting the current tariff policy is not very effective

⁵ From the discussion at the technical meeting with Kyivpasstrans and Kyiv Metro on January 28, 2015, in Kyiv.

⁶ Knowing the exact number of beneficiaries is critical as it is the basis for calculating compensation by the State and local authorities. However, as fares are collected manually on all modes except metro, it is difficult and costly to get the exact number of the “beneficiaries”. Operators claim that they are not fully compensated for their forgone revenues, especially the portion to be received from the State budget; but this analytical work has not been able to prove such claims. Estimation is more accurate for Kyiv Metro, as it is a gated system and many of its users eligible for free ride use an electronic identification card, “Kyiv City Card”, entering the metro station.

in targeting the assistance. As part of broader reforms on the fiscal/social policies, the City Administration is considering simplifying the beneficiary categories or replacing concessionary fares with targeted financial support for those who truly need such assistance.

Second, the ticketing and fare collection is manually handled except for the metro, resulting in user inconvenience, the lack of accurate data on usage, and the lack of revenue protection. The public transport operators have their own ticketing and fare collection arrangements (Box 1). Without integration across modes or operators, this makes trips that involve multiple transfers particularly costly and cumbersome. The current arrangement is also unable to record the numbers of passengers on each route and boarding/alighting at each stop. Most critically, the revenue protection scheme is rudimentary and cannot ensure either that all passengers pay or that all revenues are remitted to the operator. Given the high occupancy during peak hours, it would be difficult for Kyivpasstrans conductors to reach all passengers in a systematic way, giving ample opportunities to passengers to make short trips without payment. Kyivpasstrans employs 80 inspectors who are authorized to remove fare evaders from vehicles but the coverage of this control is naturally limited. Full accounting is even more difficult on route taxis due to its cash-based transactions and absence of any control schemes. Operators seek to enforce full revenue remittance by drivers through direct supervision of drivers at stops and by employing anonymous passengers to check for compliance. However, it is likely that there is an implicit revenue target for drivers to achieve and remit to the employer and certain discretion may be allowed if the driver collects fares in excess of the target.

The very low fares on all transport modes for fare-paying passengers and the high proportion of passengers who are entitled to free or reduced fares may explain why effective revenue protection has not been the focus of transport operators' attention in Kyiv, to the extent common in other major cities.

However, other changes in public transport funding may encourage an increased focus on revenue protection. The decision to double fares on transport provided by public operators in February 2015, following a similar fare increase by private operators in 2014, should

Box 1 Ticketing and fare collection arrangement

Kyiv Metro is a gated system, and passengers access through payment of plastic tokens, smart-cards with stored value or cards issued to passengers eligible for concessional fares. Tokens can be purchased from vending machines at stations or from cashiers and cards can be topped up for multiple trips. Smart-cards offer convenience to passengers and lower costs to Kyiv Metro but do not discount fares. Some 570,000 passengers who are resident in Kyiv and who are eligible for concessional fares have been issued with Kyiv City Cards, which are smart cards incorporating photographic identification and are used for a range of benefits in addition to free public transport. Some concessionary fare passengers continue to use paper-based identification, as a flash pass. These passengers may be Ukrainian citizens who live outside of Kyiv but who are eligible for free travel under national legislation or in some cases, passengers who have not yet embraced smart-card technology. All of these passengers are required to enter Metro through a designated channel where a staff member controls access.

Travel on **trams, trolleybuses and diesel buses operated by Kyivpasstrans** is paid for by purchasing a ticket from an on-board conductor, which the passenger is required to validate with a punch validator. The paper tickets are security printed. Passengers entitled to concessionary fares present their documentation to the inspector to confirm their entitlement to free travel, or reduced fares for school children.

Passengers on **route taxis operated either by Kyivpasstrans or private operators** pay the driver in cash and no ticket is issued. Passengers can enter and exit by either of two doors and fares are paid by passing cash along from passenger to passenger to the driver, during the journey. Change is passed back to the passenger by the same means. Regulations require route taxi operators to accept up to three concessionary fare passengers on each vehicle for which they can claim compensation from the City. Private operators report that they often provide free travel to more than three passengers, when space permits, and that they are not reimbursed for any free trips. There are other reports that private operators do not accept free travel recipients at all. In the absence of effective supervision of the sector, it is difficult to confirm which of these scenarios is most representative of the reality.

result in greater focus on revenue protection. Increased fares, even if to a still modest level, improve the return for the operator in protecting revenue but could also encourage more passengers to evade payment. Secondly, the Government of Ukraine is considering reforming welfare payments that would give welfare recipients greater discretion over how they spend their allowances. These reforms could result in passengers paying their fares directly to the operator rather than funds being transferred directly from the State to the operator based on estimated usage. Such changes may result in fewer trips by benefit recipients on transport provided by public operators and more trips on private marshrutkas. Thirdly, if Kyiv is to consider reconfiguring its public transport network to have more trunk and branch services and greater integration between marshrutkas and higher-capacity modes, it will need to offer transfer discounts so that the combined fare of two stages of a journey will be less than the sum of fares for the component trips.

2.4 BENCHMARKING SUMMARY – STRENGTHS AND WEAKNESSES

Strengths

- Kyiv's public transport network is dense relative to many other European cities, offering high levels of connectivity for many of the city's residents.
- In recent years new trolleybus and bus vehicles have been added to the fleet, resulting in fewer vehicles over 20 years old. These investments also have helped reduce maintenance costs, and ensure the new vehicles are fit for purpose and able to cope with existing demand.
- The energy consumption per public transport passenger kilometers is relatively low assuming either the average trip length by public transport as 10 km or 5 km, which is probably due to the high usage of electricity instead of diesel.
- Public transport services in Kyiv are highly affordable by European standards, even taking account of relative income levels.
- Kyiv city is in the middle range of road accident deaths rates compared with peer cities. The situation has also been improving in the past few years.

Weaknesses

- Destinations that attract a high number of have low frequency of ground transit. The metro stations in the center are very spread-out, which acts to increase the walking distance to access the city center.
- Despite recent improvement in other public transport fleet, the tram fleet is made up of mostly very old rolling stock that is 20 or more years old, which is problematic as old trams require a high level of maintenance and, more significantly, the design capacity of these older vehicles is not suitable for today's demand.
- The deficiencies in the current supervisory regime for private provision of bus services in Kyiv relate more to the enforcement of contractual and regulatory rules than to problems with the formal arrangements.
- Currently, about 50 percent of public transport passengers do not pay the nominal fares or do not pay at all.
- Funding is an issue for public transport operators. It appears that national and city authorities in Kyiv do not reimburse transport operators for concessional travel in accordance with the terms of the statutory schemes and some private operators claim that they have not been reimbursed at all.
- Underlying this funding problem is insufficient revenues, attributed to the tariff policy and inefficiency of the fare collection system. Ticketing and fare collection is manually handled except for the metro, resulting in user inconvenience, the lack of accurate data on usage, and the lack of revenue protection.

3 OPTIMIZATION OF THE PUBLIC TRANSPORT ROUTES

3.1 PRINCIPLES AND CRITERIA FOR OPTIMIZATION

The key aim for optimizing Kyiv’s public transport network is based on improving livability of the city. This translates into higher quality of life for each citizen, which is delivered through fast and convenient public transport, reliable utilities, high quality and affordable health care and education, clean air. Set against this context the four key objectives for Kyiv’s public transport network, defined through this study in partnership with colleagues at the City Administration, are:

- ✓ Ensuring the network meets user needs.
- ✓ Make the network more cost efficient to provide.
- ✓ Ensure the network serves the city in the best possible way.
- ✓ Consider contribution to wider policy objectives such as, economic development, environmental protection and social well-being.

A number of priority issues need to be tackled to improve the public transport system. The assessment of the current mobility conditions in Kyiv identified several issues related to the urban transport in Kyiv, associated in particular with the need for a bus network organization. The key priority issues and possible actions are summarized in the table below.

Table 3-1: Kyiv PT network optimization issues and opportunities

Priority issue	Possible action
1. Some mis-matched PT supply relative to demand	Simplify overly-complex network to better serve current & future land-uses
2. Some locations poorly connected to key trip attractors	Improve accessibility through more direct routes and less interchange
3. Scope for new mass transit services to reduce congestion	Directly connect most popular O-D flows without need for interchange
4. Poor access into (and within) city centre by surface PT	Reduce reliance on walking & interchange More directly connected locations
5. Operational inefficiencies which increase PT system costs	Smaller fleets of larger vehicles, operating fewer routes at higher capacities
6. Poor passenger experience making car travel more attractive	Establish faster journey times, and invest in newer PT vehicles
7. Poor integration from Metro & Rail with surface PT network	Establish appropriate feeder routes, and limit duplication of metro & rail services

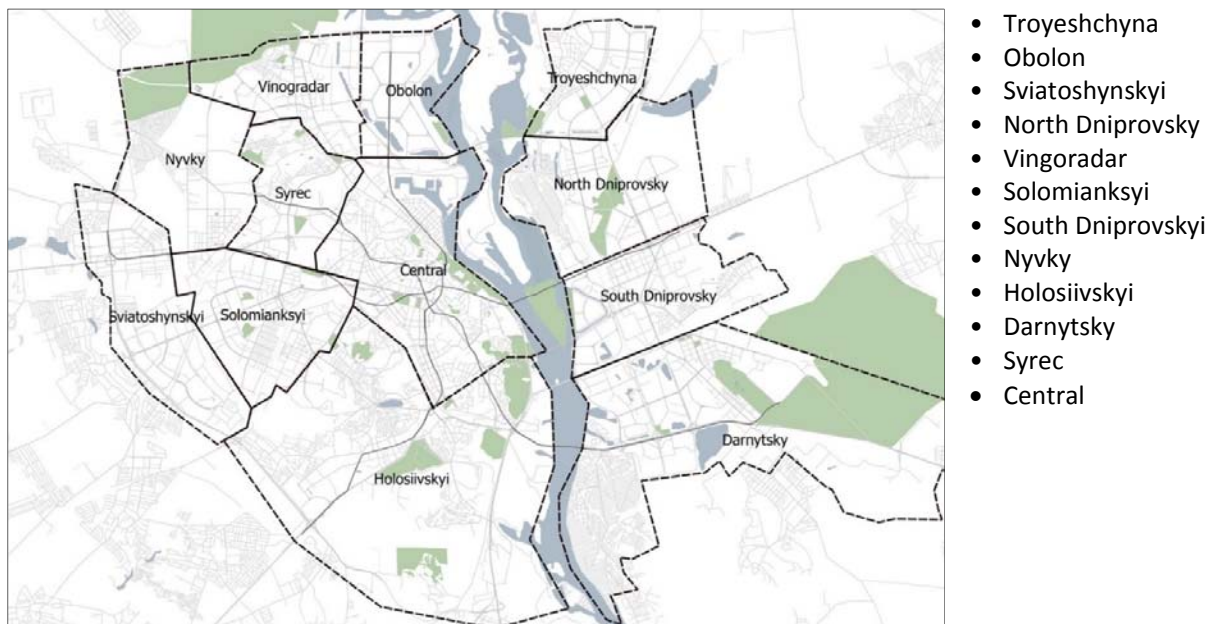
Optimization principles were identified sequentially applied in order to address these priority issues. A set of optimization criteria, including listed below were identified through the analysis of aggregated origin-destination passenger flows in the city and iteratively applied to all the routes through a corridor-by-corridor approach. And the city was split into 12 broad areas, to which the optimization process was applied sequentially (Figure 3-1).

Table 3-2: Kyiv public transport network optimization principles

Criteria	Indicators and Principles
Patronage	<ul style="list-style-type: none"> • <5,000 pax/day consider removing or merging • >8,000 pax/day consider bus/trolleybus • >50,000-80,000 pax/day consider mass transit
Duplication	<ul style="list-style-type: none"> • Is O-D patronage shared between similar routes?

	<ul style="list-style-type: none"> • If yes, consider merging to maximize load factor
Extension	<ul style="list-style-type: none"> • Do logs of people regularly alight in same place? • Does route fall short of desired destinations? • If so, consider extending to better meet demand
Route Length	<ul style="list-style-type: none"> • Does service run empty for a portion of its route? • Would two separate services be more efficient? • If so, consider splitting into two separate routes.
Directness	<ul style="list-style-type: none"> • Is journey time relative to O-D distance acceptable? • Can routes be altered to reduce travel time? • If so, consider re-routing to optimize journey times.
New route	<ul style="list-style-type: none"> • Are there O-Ds that are not being met? • If so, consider introducing a new route.

Figure 3-1: City areas used in the optimizing process



Changes were proposed primary to trolleybus, tram, and bus routes operated by Kyivpastrans; followed by secondary routes operated by marshrutkas and smaller buses. Having rationalized each corridor to maximize estimated passenger loads on as few vehicles and services as possible during peak hours, the next step in the optimization process was to sense-check the proposed changes and ensure there were no significant passenger flows that were detrimentally affected by the proposals. This involved checking direct connectivity between most popular O-D pairs (using accessibility maps) and interchange options that allow for connectivity between less popular origins and destinations with minimal transfers between different public transport services. Finally, it was ensured that the proposed revisions to the public transport network were also consistent with future land use plans for the Kyiv metro area. These indicate considerable population growth will happen in the towns and villages within the hinterlands around the city, suggesting a need for interchange facilities and good connecting public transport services at locations on the edge of the city where bus/rail/metro services converge.

The following workflow was applied to each area of the city:

- ✓ **Identification of new strategic routes** to serve long distance Origin-Destination (O-D) demand that are not currently served by existing routes. These were based on an analysis of the O-D movements and accessibility plots from each area.
- ✓ **Assessment of existing routes** following the principles presented in Table 3 1.
- ✓ **Realignment of routes** to relate to strategic city interchanges, where appropriate.
- ✓ **Realignment or consolidation of routes**, and development of new local routes to serve areas with poor local accessibility (including locations with concentrations of low income households).

The types of vehicle that would be suitable to ply each route were considered. For such, the vehicle size capacities and estimated route carrying capacity thresholds (expressed in Passengers, Per Hour, Per Direction; or PPHPD) defined in Table 5 2 were used as the basis for allocating vehicles to optimized routes.

Table 3-3: Vehicle size capacity and route passenger capacity thresholds (PPHPD)

Vehicle type	Comfortable capacity	PPHPD	Associated Headway (mins)
Marshrutka	30	<750	2.5 - 30
Bus 12m	80	750-1200	4 - 6.5
Bus Articulated	120	>1200	1- 6.0
Trolleybus 12m	80	750-1200	4 - 6.5
Trolleybus Articulated	120	>1200	1 – 6.0
Tram (single carriage)	80	750-1200	4 - 6.5
Tram (multiple carriage)	240	>2,000	1 - 7.0

A hierarchy for urban transport modes in Kyiv was also considered and defined, as follows:

Trams should provide fast services on strategic routes with few stops – a stop spacing of around 600m to 1km would be suitable, while also ensuring major attractors and interchanges are served. At present a number of tram lines operate like hop-on / hop-off bus services.

Trolleybus and general bus services are both suited to longer distance routes, as well as hop-on / hop-off operations. A stop spacing of around 400m would be suitable, while also ensuring major attractors and interchanges are served.

Marshrutka, due to their low capacity are not suitable for long-distance routes. They are instead suitable as feeder services, and hop-on / hop-off services. We recognize this requires a redefinition of marshrutka operations as they are technically meant to serve point-to-point movements at the moment.

Once this process had been completed across all routes, the updated Scenario’s routes and headway proposals were tested in the evolving Kyiv Transport Model. This process was repeated several times in order to sense-check the combined impact of the proposals which had been developed on an area-by-area basis. Further changes were made to both routes and headways, with the Scenarios being refined and re-tested over four iterations.

The next step in the optimization process was to sense-check the proposed changes and ensure no significant passenger flows were detrimentally affected by the proposals. This involved sense-checking to ensure direct connectivity between the most popular O-D pairs, using accessibility maps as well as interchange options exist that allow for connectivity between less popular origins and destinations with minimal transfers between different public transport services. Finally, it was double-checked that proposed revisions to the public transport network were also consistent with future land use plans for the Kyiv metro area. New routes were developed, or existing routes modified, to better serve areas of high population growth, like Osokorky. Additionally routes were altered to ensure the six suburban interchange sites provided links to a broad range of onward destinations.

3.2 OPTIMIZATION SCENARIOS

Applying the analytical approaches and principles defined earlier in the report, three sets of network proposals have been developed. They represent different levels of investment and alterations to Kyiv's transit network:

- ❑ **Scenario A, Short term** – Transit route changes that require minimal infrastructure works, such as simple changes to existing road intersections.
- ❑ **Scenario B, Medium term** - Route changes that require significant infrastructure works, such as catenary extensions and bus priority measures to segregate traffic.
- ❑ **Scenario C, Long term mass transit options** – identification of potential mass transit schemes that could be developed in the longer term, including a possible 'Reverse L' City Train route linking Left Bank and Right Bank, and reintroducing tram services across the Dnieper River.

Scenarios A & B represent the core focus of this analytical work. Each set of proposals was developed iteratively, by testing the suggested network changes in the Kyiv transport model and making changes based on the passenger forecasts and boarding/alighting profiles it projected. Comments received from the City Administration working group, in relation to an initial set of network optimization proposals, were also worked into the proposals where appropriate.

Scenarios A and B: Short and medium term route modifications

Short and medium term route changes can take one of four forms: retention, creation, deletion, modification (either shorten, extension or realignment). Table 3-4 presents an overview of the route changes proposed in this scenario. Today there are 313 operational routes, this reduces down to 222 in Scenario A and 215 in Scenario B. At this stage, this review of routes is strictly limited to the configuration of routes rather than who operates them. Any route on the new network could be run by either a private company or Kyivpastrans regardless of who operates that route at the moment.

Figure 3-2, **Figure 3-3** and **Figure 3-4** map the new, modified and deleted routes if both Scenario's A and B were implemented. The figures show these changes are considerable and affect the whole network.

Table 3-4: Overview of route changes proposed in Scenario A and B

Scenario A, short term	Scenario B, medium term
16 new routes	3 additional new routes
38 existing routes modified	6 Scenario A routes become Trolleybus 8 further route modifications
107 routes deleted from existing	11 additional routes deleted
168 routes retained with new headway	198 routes retained from scenario A
Total of 222 routes	Total of 215 routes

Figure 3-2: 19 new routes proposed across Scenarios A & B

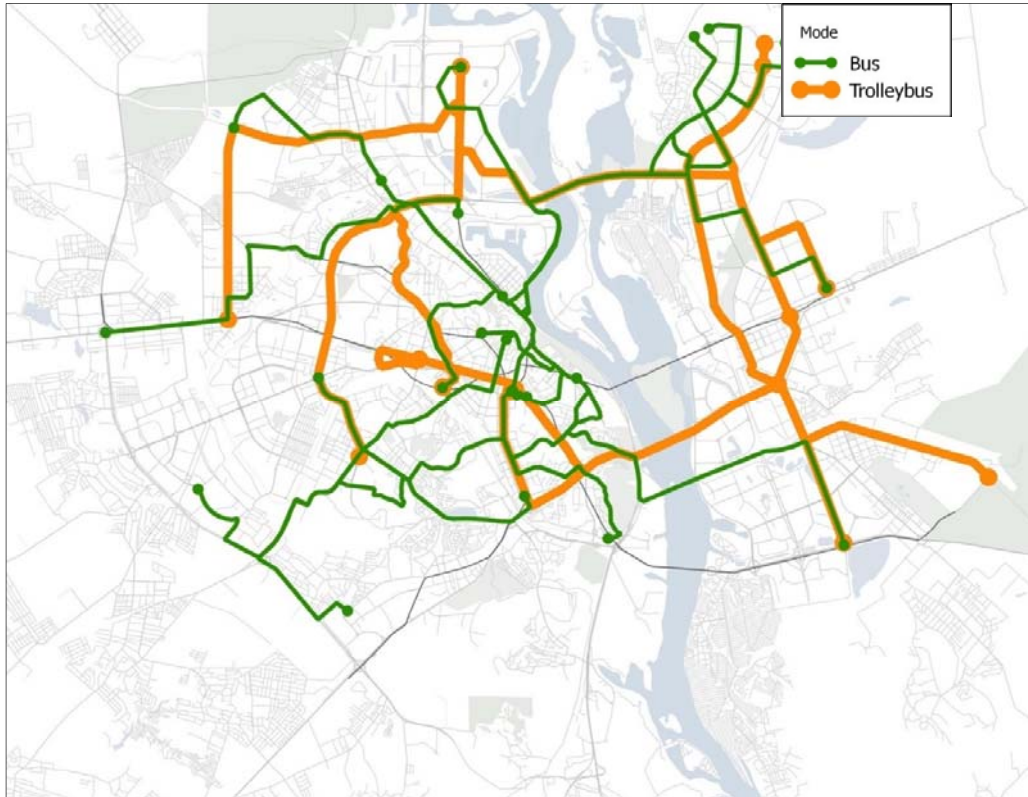


Figure 3-3: 46 route modifications across Scenarios A & B

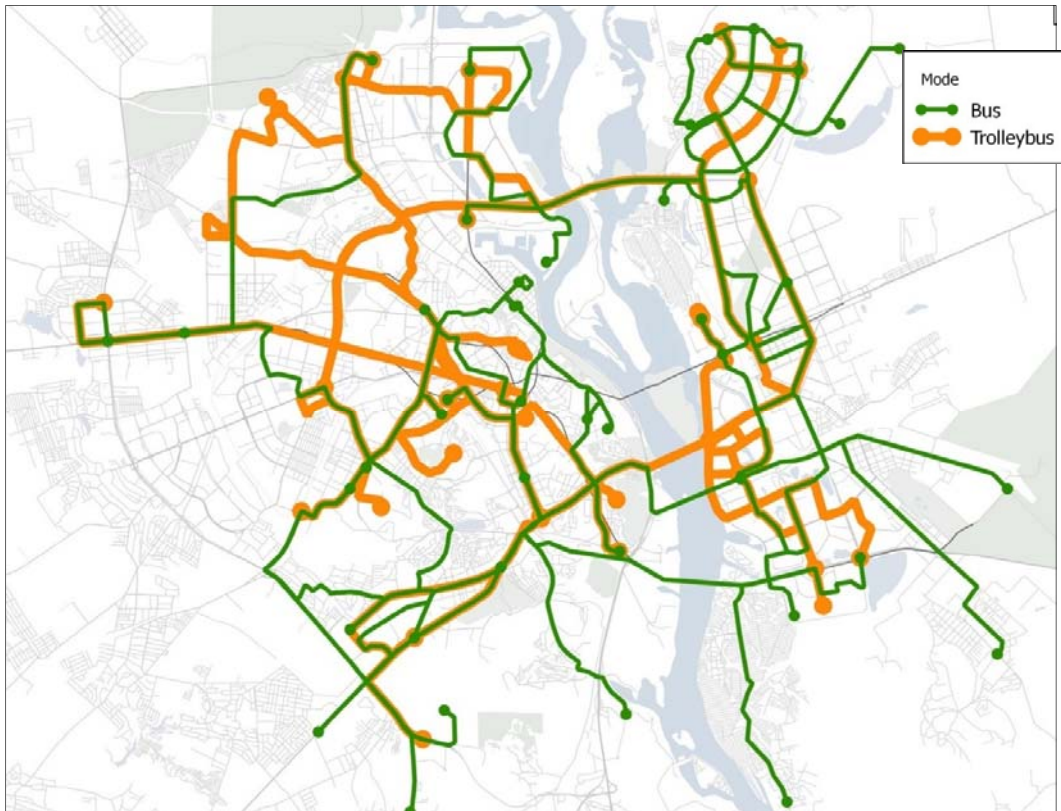
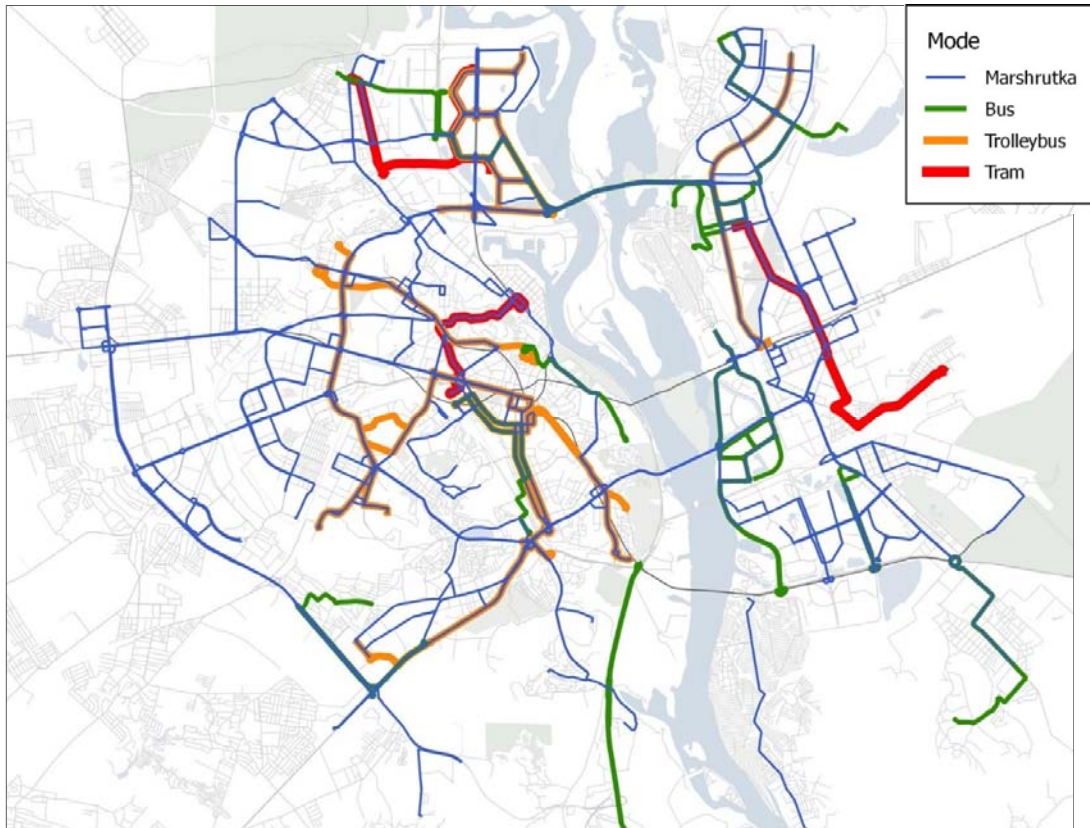


Figure 3-4: 118 routes removed across Scenarios A & B



Scenario B: Medium Term infrastructure changes

The Scenario B route additions and modifications set out in the section above, reflect suggested changes that can be made with moderate infrastructure works. The maps below list all of the locations identified for these works, which were built into the Kyiv strategic transport model to allow for testing of Scenario B's performance and benchmarking against the existing public transport network. The types of facilitating infrastructure investments required include:

- ❑ Extending trolleybus catenary to link new routes into the existing trolleybus network (e.g. along Oblonskyi Avenue in the north of the city).
- ❑ Bus priority measures, such as bus lanes (e.g. Moscovskiy Bridge) and fully segregated 'bus-only' roads (e.g. Velrka Vaskisvska Street).
- ❑ Junction changes, identified in Figure 3-6.
- ❑ Improvements to public transport interchanges.

The stretches of road that require bus priority measures were identified by comparing passenger loads with traffic speeds. The locations where high forecast passenger loads correspond with slow congested speeds were identified as requiring bus priority. Typically roads with passenger loads of >2,000 PPHPD were considered as suitable candidates. Traffic speed was taken from the Google Traffic database (<https://googleblog.blogspot.co.uk/2009/08/bright-side-of-sitting-in-traffic.html>).

Figure 3-5: Catenary & PT priority Improvements

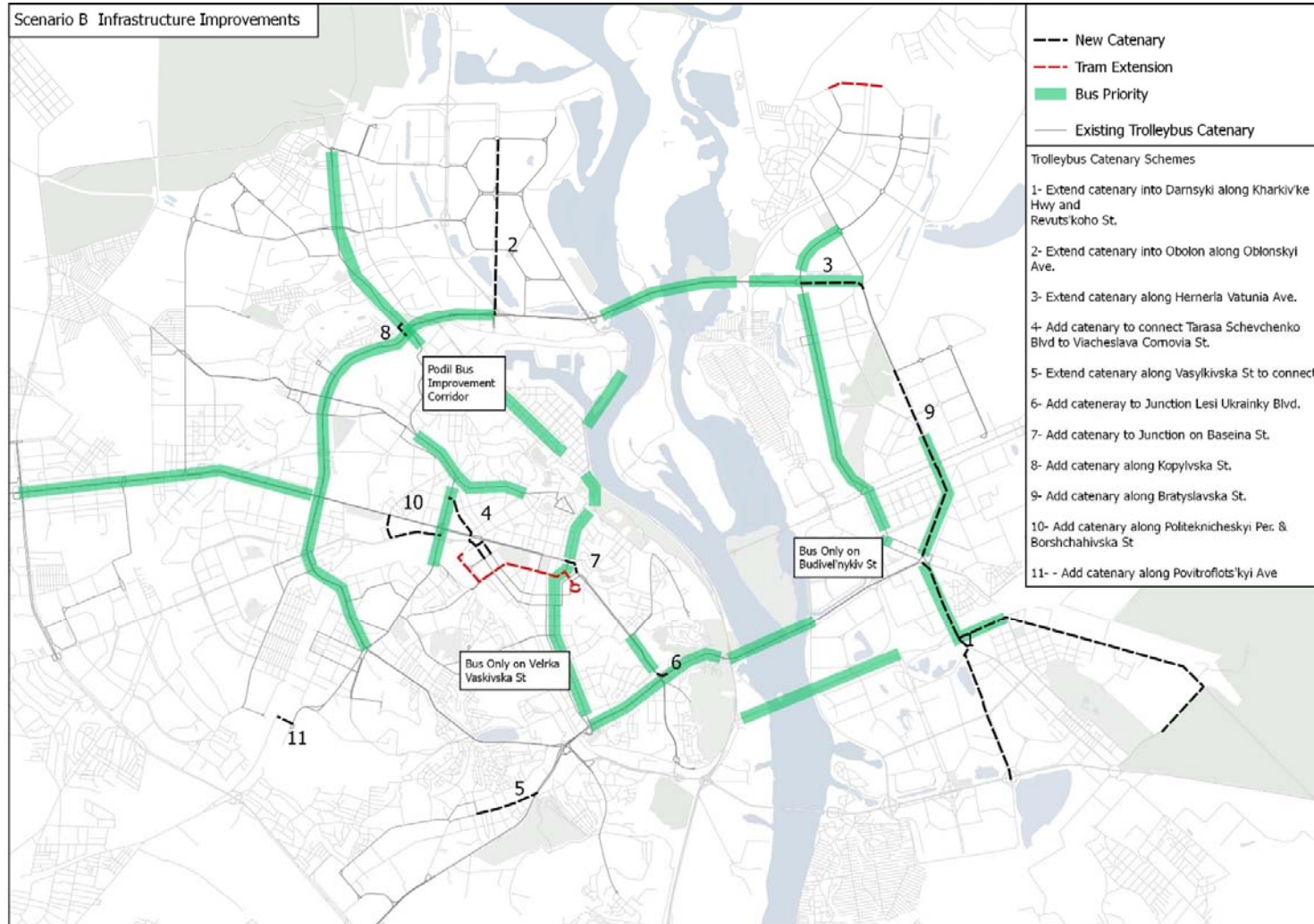
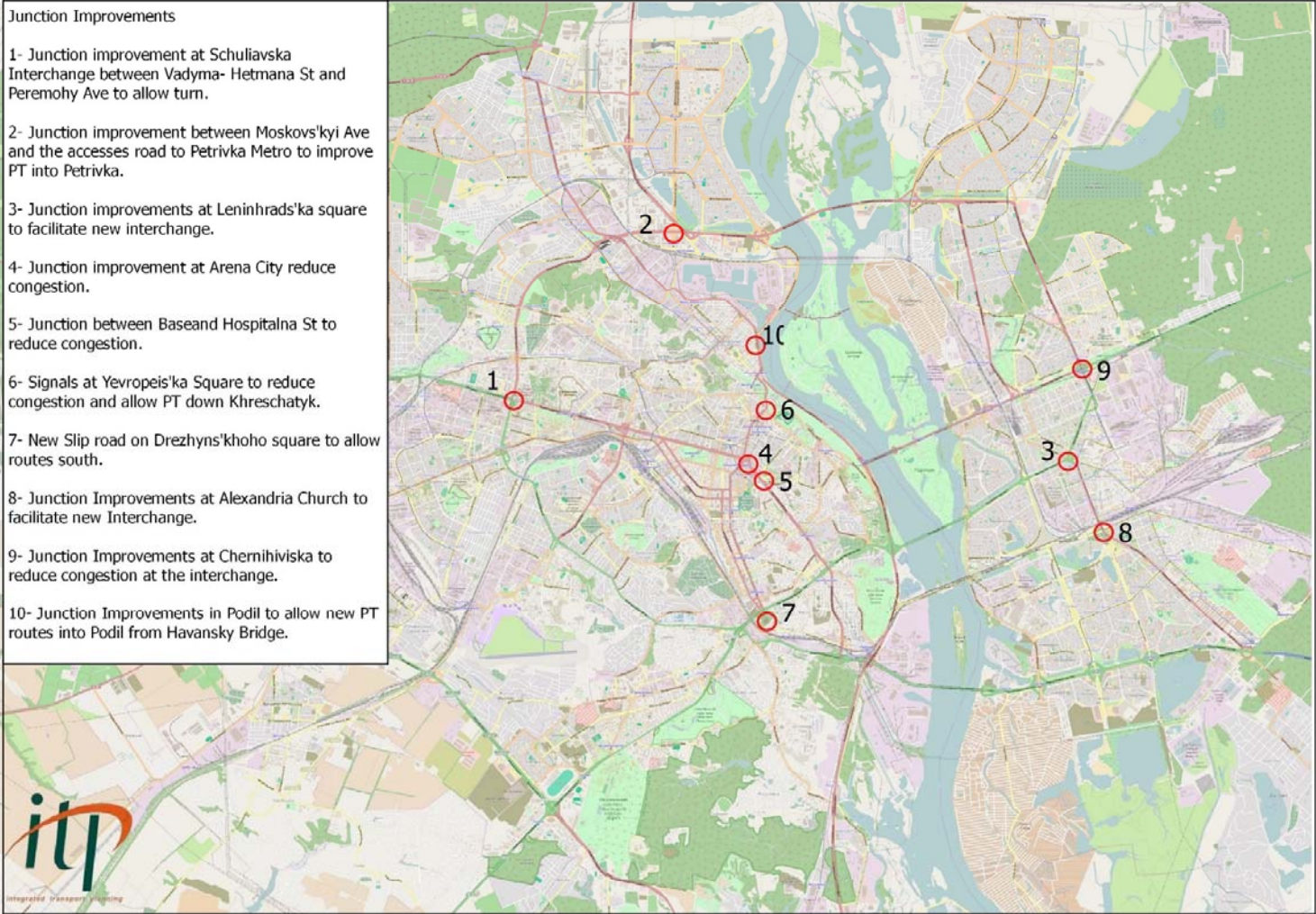


Figure 3-6: Junction improvements

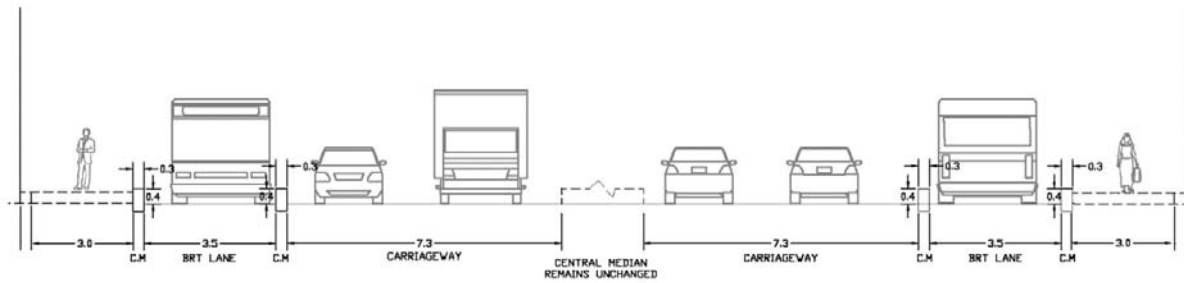


Priority for public transport vehicles should be achieved through the installation of a bus-only lanes as well as priority to PT vehicles at junctions. The bus lane should be a designated right-of-way only used by public transport vehicles and emergency vehicles. Such infrastructure requires effective enforcement to keep out other vehicles. In Kyiv this will also depend on the successful implementation of on-street parking restrictions. Figure 6 6 presents examples of bus lanes separated from general traffic by using a physical barrier (curb) or by using paint, both cases are used by trolleybus.

Figure 3-7: Demarked bus-only lanes in Rome (curb) and San Francisco (paint)



Figure 3-8: Typical cross section of bilateral bus lanes installed on a 3 lane road



Priority through junctions for public transport vehicles are a key part of these recommendations. Junctions should be adapted to include a separate bus-only lane with their own vehicle-activated signals, as presented in Figure 3-9. Such priority would also be suitable to implement at other congested junctions of the network that are not served by bus lanes.

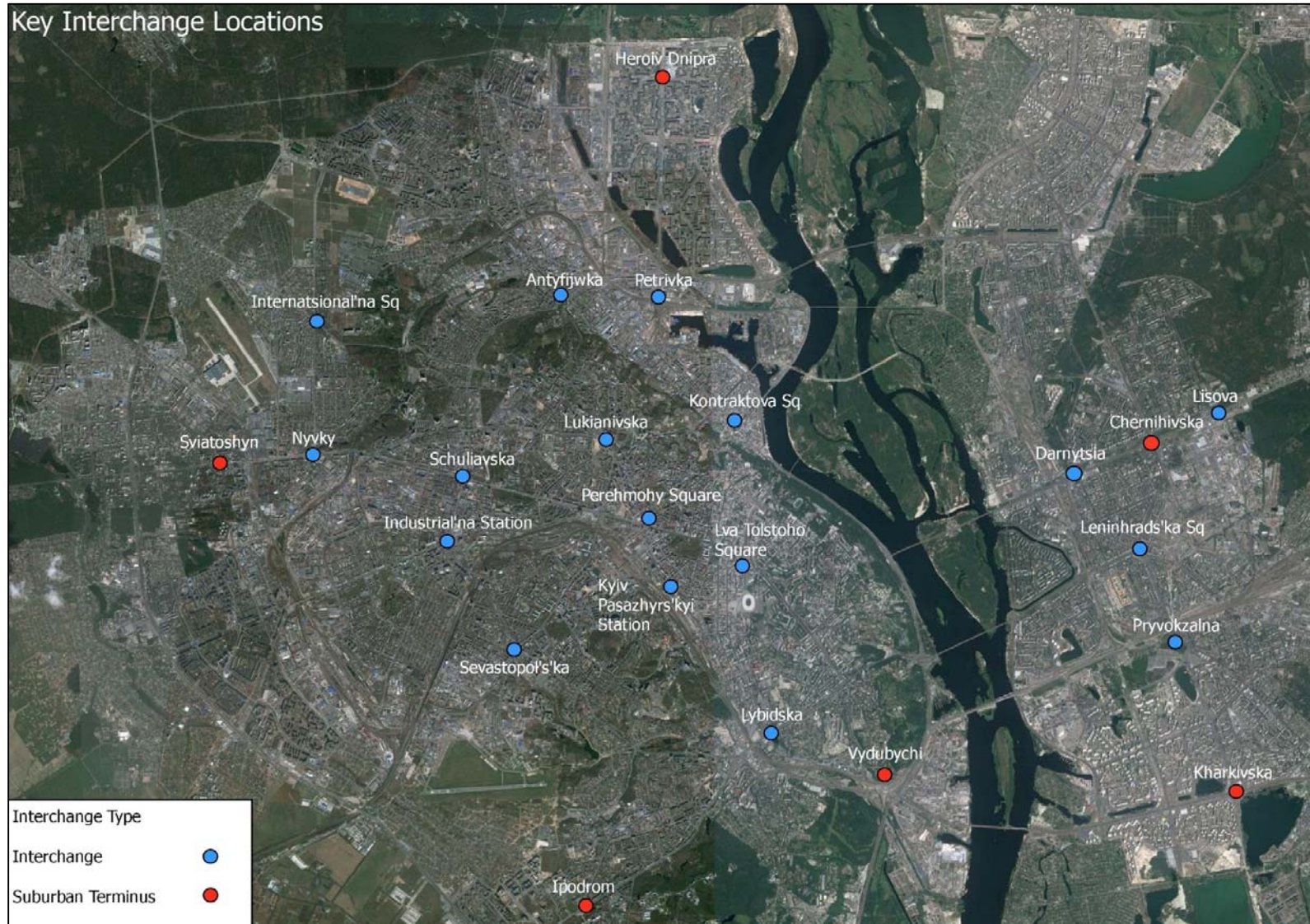
Figure 3-9: Signals providing bus priority at junctions



Underpinning the optimization proposals set out in this report, a total of 23 key interchange locations were identified through the passenger flow analyses that. These locations are shown in Figure 3-10. The identified interchanges represent transit stops which currently experience high daily boarding and alighting movements, or are stations that are anticipated to experience such levels if Scenario A and B optimization proposals are implemented. These locations warrant improvements in order to increase operational capacity and efficiency. They will also enhance passenger experience by providing smooth transfers between different routes and modes of travel.

The range of transport modes operating in Kyiv imply that many transit stops are multi-modal interchanges. There is scope to improve the design of some of the major interchange locations to make them more operationally efficient, and reduce time wasted by passengers (waiting, and transferring between services) and public transport vehicles (queuing and dwelling).

Figure 3-10: Key public transport interchanges in Kyiv



An effective multi-modal public transport interchange include key design features such as the single direction of movement for bus vehicles into passenger waiting area and absolute priority given to tram lines running into the interchange. Covered passenger waiting areas offer protection from the elements and creating scope for convenience retail at the point of interchange. The heavily pedestrianized public realm facilitates passenger transfer between modes, while also contributing to a pleasant environment around the interchange. The size of an interchange is primarily determined by the number of routes that it serves and the frequency of these services. It is recommended that high frequency routes should each have their own docking point, whilst infrequent services may share a docking point. Guidance on good interchange design has been produced by Auckland Transport⁷.

Interchanges in Kyiv need considerable improvements. Site visits conducted by the project team highlighted three key issues associated with the current design and management of many of the key interchanges in Kyiv. These are illustrated in Table 6.8, and include:

- ✓ Unconstrained parking on-street and on pavements immediately around interchanges.
- ✓ Lack of public transport priority in the vicinity of stops and stations.
- ✓ Inefficient interchange layouts, reducing passenger and vehicle throughput.

General improvements to address these issues could include:

- ✓ Improved layout, organization and communication of transit service stopping locations.
- ✓ Relocated bus, tram, and trolleybus stops closer to metro station entrances.
- ✓ Providing designated areas for vehicle layover and facilities for drivers (e.g. toilets).
- ✓ Improving signage, route maps, and timetable/real time information for passengers.
- ✓ Bus lanes into and out of interchange locations to maintain journey times.
- ✓ Improve paths and walkways at interchanges through decluttering of street furniture and improved/additional footbridges, underpasses and pedestrian crossings.
- ✓ Pedestrian safety improvements including clear crossing points with good sight lines, wide pavements for safe flow (at least 3m) that are well lit at night and uncluttered
- ✓ Passenger safety improvements including open plan waiting areas that are constructed of using see-through materials.
- ✓ Removal of on-street parking and pavement parking around transit stops.

⁷ https://at.govt.nz/media/imported/4394/Public_Transport_Interchange_Design_Guidelines.pdf

Table 3-5: Identified issues with public transport interchanges in Kyiv

Example locations	Identified issues
<p style="text-align: center;">Petrivka interchange</p>  <p style="display: flex; justify-content: space-around;"> Nyvky Shcherbakova St Lukianivska interchange </p>	<p>Parking control</p> <ul style="list-style-type: none"> • Marshrutkas, trolleybuses and buses have to navigate around closely parked vehicles and pedestrians walking in the road. • Buses and trolleybuses are unable to pass due to parked cars, and therefore must queue at stops. • Cars parked on the roads and pavement areas, mean passengers must step into the road to board.
<p style="display: flex; justify-content: space-around;"> Lukianivska, Mlnyкова St Beresteiska, Peremohy Ave </p> 	<p>Lack of PT priority</p> <ul style="list-style-type: none"> • Vehicles get stuck in traffic approaching busy stops. • Public transport vehicles competing with private vehicles for road space on approach to transit stops. • Queued public transport vehicles delay each other
<p style="display: flex; justify-content: space-around;"> Chernihiviska Interchange Lukianivska Interchange </p> 	<p>Inefficient interchange layout</p> <ul style="list-style-type: none"> • Lack of clear walkways and pedestrian crossings. • Narrow footpaths that don't allow for circulation and waiting for surface public transport services. • Crowding of interchanges through poorly situated convenience shops and cabins – very close to the edge of the pavement. These block passengers from spotting approaching vehicles • Cluttering of pedestrian desire-lines through street furniture.

Additional infrastructure improvements, which could aid operational efficiency. In addition to the interchange improvements set out above, discussions with local public transport operators also revealed the following potential infrastructure improvements. The costs and benefits of these activities, and the interchange improvements defined above, require more detailed cost-benefit appraisal. However, there is considerable potential for them to be delivered as part of a series of strategically planned, corridor-by-corridor public transport optimization projects. These include:

- ✓ Requiring suburban bus service operations to terminate at designated interchange locations on the edge of the city – ideally co-located with the major metro and bus stops. Kyiv’s private city operators felt this might help to prevent a growing trend for suburban services operating from the surrounding Oblast towns directly into the city center and picking up passengers within the city limits.
- ✓ Providing rapid onward connections into the city from these peripheral suburban interchanges. This would help to efficiently move the large volumes of passengers arriving into the city, and travelling in opposite directions, from dispersed Oblast towns and villages.
- ✓ Investigate the use of trolleybuses with batteries, similar to those used in Rome. This allows trolleybuses to ply unwired sections, creating more turn-around locations, and enabling them to switch more readily between lines.
- ✓ Renewal of the tired trolleybus catenary. Kyivpastrans state that 30% of trolleybus catenary needs to be replaced.
- ✓ Renewing dilapidated tram tracks to provide smoother ride quality, faster speeds, and improved stations and boarding access.

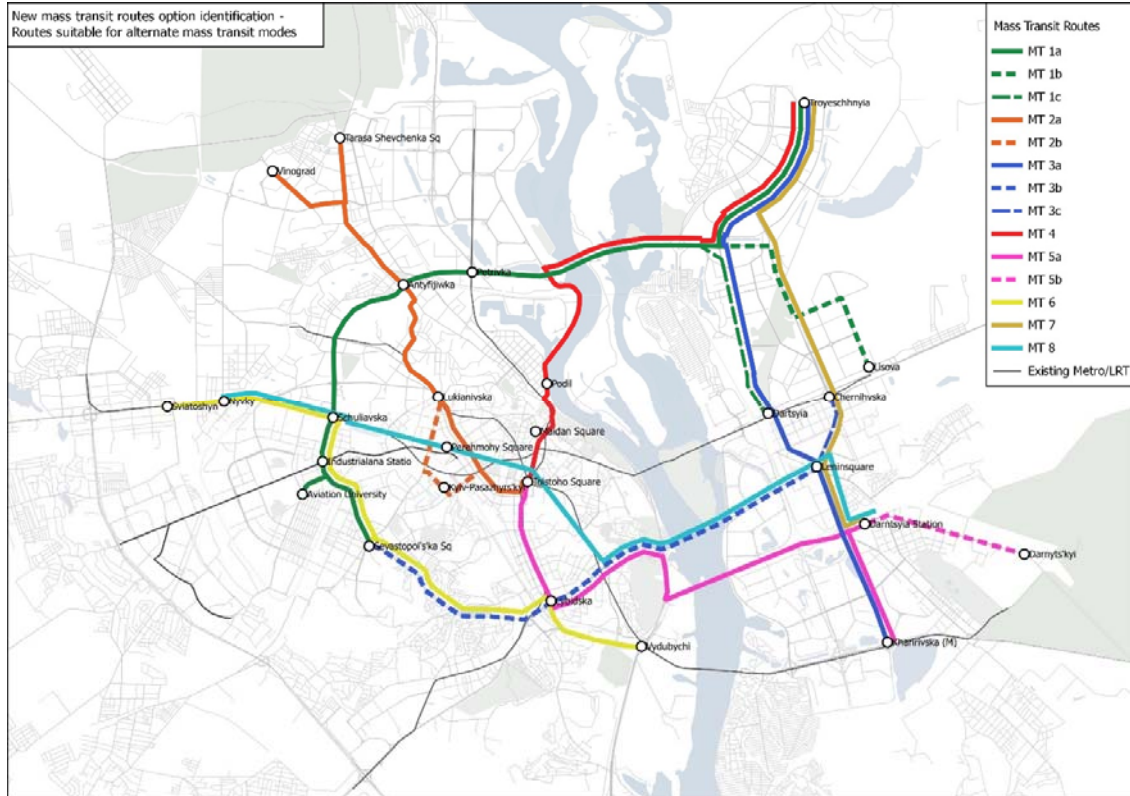
Scenario C: Longer-term mass transit options

Scenario C identifies a number of options for developing new mass transit routes in Kyiv. As such this scenario does not present a complete future network the way Scenarios A and B do but instead a list of possible schemes. The scenario is split into 2 sets of proposals:

- ✓ Mass transit routes that can be implemented using any alternate mass transit mode, such as Bus Rapid Transit (BRT) and Light Rail Transit (LRT).
- ✓ Mass transit routes that need to be implemented as rail – either light or heavy rail

A total of 8 potential mass transit corridors have been identified that would be suitable for either BRT or LRT. These are based on the project team’s analyses of Kyiv’s existing PT network and passenger O-D flows along key corridors. The routes represent outline concepts and would require detailed appraisal before being taken forward. Four of these routes include branches labelled (a), (b) and (c). An iterative modelling exercise was performed to test and improve route alignments. The passenger forecasts were prepared using the transport model and provided to KCA as indication of the potential level of demand for each route if all lines were implemented.

Figure 3-11: Mass transit schemes that could be implemented in the longer-term



The most popular scheme would Route 1 which has 3 branches. This scheme connects the north of the Left Bank to the South East of the Right Bank. It would increase accessibility to Troeshchyna and provide good orbital access around the north-east of the city through Petrivka, Syrec and Solomianskyi. Together these branches are forecast to carry 292,000 passengers day which is approximately half the load on a Metro line (the average Kyiv metro line carries ~550,000 passengers per day). Ridership levels on all proposed new routes are within the capacity of BRT or LRT systems. For comparison the forecast daily patronage on all 8 mass transit routes totals 1,141,000 people, which is less than the Bogota BRT system that currently carries 1,650,000 passengers per day. (Source: <http://www.worldbrt.net/en/cities/bogota.aspx>).

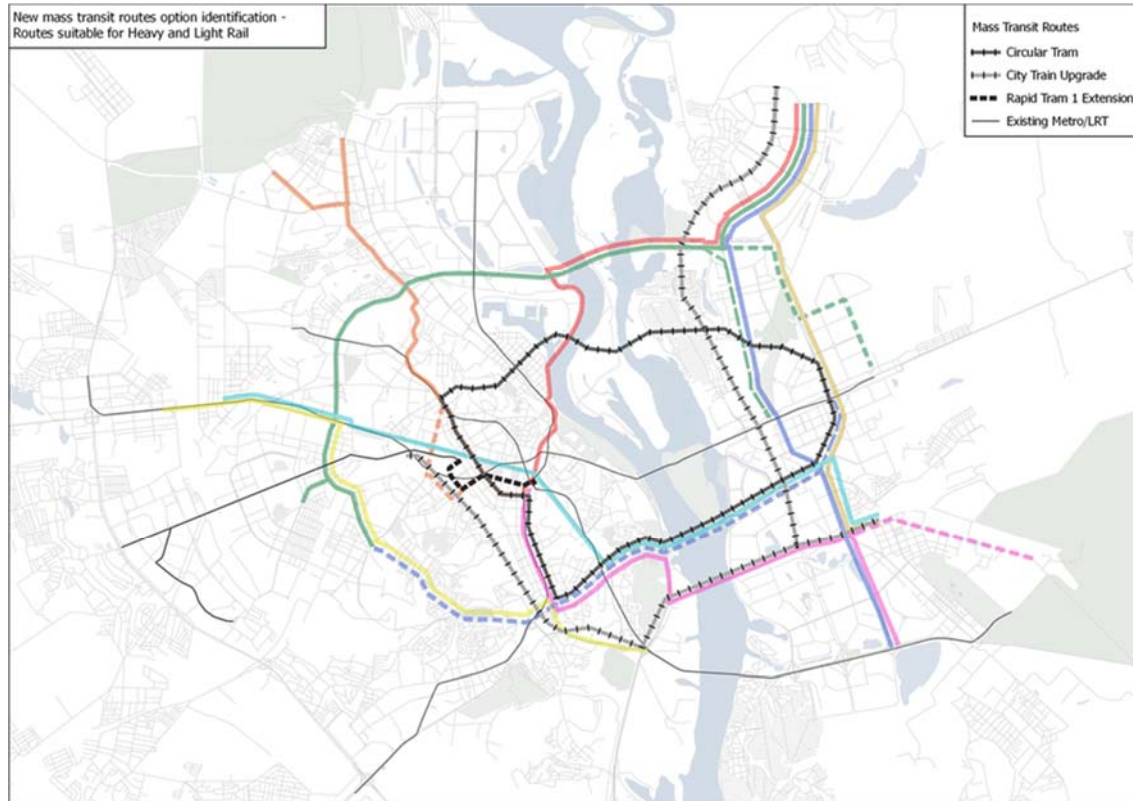
If any routes were to be implemented as BRT, consideration should be made to use trolleybuses to ply the system. Although uncommon, some BRT systems do utilize Trolleybuses - a relevant example is that of Quito in Ecuador. This system has a peak throughput of 6,000 PPHPD which is in-line with levels of capacity required in Kyiv - the Moskovs'kyi Bridge, which is the most loaded part of the network in Kyiv, currently moves 8,500 PPHPD in the AM Peak. The use of trolleybuses as vehicles allows for the possibility of upgrading existing trolleybus lines to BRT.

Three potential new rail schemes have also been identified, based on discussion with Kyiv City Administration's Urban Planning Department:

- ✓ Extension of Rapid Tram route 1 and 3 from Volkzalna to Lva Tolstoho Sq.
- ✓ Upgrading of the City Train on the Left Bank and Darnyts'kyi Bridge
- ✓ The reintroduction of tram services across the Dnieper River to link existing Left and Right Bank tram systems

These schemes are presented in Figure 3-12.

Figure 3-12: Potential new heavy and light rail mass transit routes



The rapid Tram 1 & 3 extension prolongs the very popular Tram route 1 and 3 from Starovokzalna Station to Lva Tolstoho Sq. passing directly in front of the central railway station. At present the rapid tram route is very popular however it does not access key areas in the city, forcing most passengers to interchange at the terminus or at Peremohy Sq for onward travel. This extension would allow the tram route to penetrate into the City Centre. This alignment would require construction of a raised track way between Starovokzalna Station and the central railway station over the Lybid River. A new multi-modal interchange should be constructed outside the central railway station.

The city Train upgrades the north-west rail line on the Left Bank, links to existing Rapid Tram route in Troyeshchyna and provides new chord in Darnytsky to allow for direct running between Troyeshchyna and the central railway station.

The circular tram route re-introduces tram routes crossing the Dnepr River to link up tram systems on the Left and Right Bank. This re-introduces trams on Patona Bridge as the southern crossing and utilizes the bridge currently under construction from the Rybalskyi Peninsula for the northern crossing. The alignment will require land to be purchased and cleared in north Dniprov's'kyi.

3.3 ESTIMATED IMPACTS

In order to measure the difference between the current transit network's performance and that of optimization scenarios developed through this study, objective and quantifiable benchmarks were defined. The impacts of the two public transport network optimization scenarios (Scenarios A and B) have been tested using the Kyiv transport model, and corroborated with the project team's analyses of modelled accessibility impacts, estimated operating cost implications, and energy efficiency calculations. Scenario C has been excluded from the impact analysis, because it doesn't present a

completed future network but a list of potential schemes for which each should be individually appraised. Table 3-6 provides a headline comparison of each Scenario's performance against the benchmark variables. It demonstrates the greater efficiency of the two optimization scenarios in relation to the baseline of the existing public transport network.

Table 3-6: High-level comparison of network performance under each Scenario

Benchmarks	Measures	Current baseline	Scenario	
			A	B
Physical and Operational Capacity	Number of passengers carried per vehicle Km travelled	5.7	7.8	8.2
	Daily average of passengers carried per vehicle	1,015	1,243	1,274
Energy Efficiency	Total estimated energy consumption (Energy TJ/year)	2,021	1,551	1,494
	Total average energy consumed per passenger km travelled (MJ / pKm)	0.58	0.45	0.43
	Total weighted-average energy consumed per veh km (MJ / vKm)	11.8	12.5	12.7
	Total diesel consumed (1,000,000 Litre/yr)	44.4	28.5	22.7
	Total electricity used (1,000,000 KWH)	124.8	146.3	189.3
	Accessibility by surface public transport modes	Percentage of population within 60 minute surface public transit trip of... Kyiv city centre	35%	75%
	Troyeshchyna	30%	67%	
	Obolon	68%	63%	
	Viradny Industrial Area	46%	74%	
	Ocean Plaza	41%	61%	
Affordability to the city	Generalised annual operational cost of network provision in relation to the number of passengers carried each year (UAH / passenger)	2.88	2.50	2.47
Number of transfers (interchanges)	Average number of transfers made across entire network (data from Kyiv Transport model)	1.6	1.49	1.47

Implementing the public transport network optimization recommendations set out in this report is projected to increase the efficiency of the whole system. They will drive-up the average number of passengers carried per vehicle kilometer travelled; thereby reducing operating costs and energy consumption – benefitting Kyiv City Administration and the local transport operators. These efficiency savings are achieved while improving surface public transport accessibility from key locations in Kyiv, and reducing the average number of transfers required per journey.

To achieve the network optimizations defined in Scenarios A and B, a modernization of the Kyiv public transit fleet is needed. This involves disposing of marshrutka vehicles and replacing them with high capacity, low floor modern vehicles. This will increase the operational efficiency and capacity of the transit network and improve customer comfort. It also accords with the strong desire of Kyivpastrans and Kyiv City Administration to:

- ✓ Improve energy security through increasing electric propulsion.
- ✓ Reduce transit network operating costs, through greater fuel efficiency.
- ✓ Reduce tailpipe emissions through improved environmental performance of vehicles.

For this to be achieved much of the existing trolleybus catenary needs to be renewed followed by extension and the acquisition of new vehicles. The potential to electrify the normal bus network could also be considered, taking advantage of recent advances in electric and plug in hybrid bus technologies.

Energy consumption and environmental impacts

The optimization can lead to total energy required to operate the city’s public transport networks by around 25%. A combination of cleaner vehicles, and the projected reductions in total vehicle kilometers Travelled resulting from Scenario A & B network optimization, are forecast to reduce the total energy required to operate the city’s public transport networks by around 25%. This has been calculated based on the net difference between a 50% reduction in diesel consumption, achieved primarily through the replacement of marshrutka vehicles with buses, net of an estimated 50% increase in electricity consumption related to greater trolleybus and tram use.

Significant emission reductions that could be achieved through optimization of the Kyiv public transport network. The analysis shows that successful implementation of Scenarios A and B will achieve an estimated daily reduction of 3 tons of nitrogen oxides and 70kg of particulates. When factored up to a full year⁸, this results in an estimated reduction of 883 tons of nitrogen oxides and 19 tons of particulates. These values were calculated using transit emission factors published by EMBARQ⁹ and applied on the basis that older (Euro II and Euro III emission standard) marshrutka vehicles are replaced with high capacity, low floor modern vehicles.

Table 3-7: Potential emissions reductions resulting from optimization (Tons/Day)

Scenario	Carbon Dioxide (CO ₂)	Total Hydrocarbons (HC)	Nitrogen Oxides (NOx)	Particulate Matter (PM)
Existing PT operations	3.02	0.84	5.47	0.12
Scenario B	1.34	0.38	2.45	0.05
Change (Tons/Day)	-1.68	-0.46	-3.02	-0.07
% change	-44%	-45%	-45%	-44%
Annualized reduction (Tons)	-491	-136	-883	-19

Source: Project calculations derived from total Vehicle Km Travelled by mode and emission factors⁴

Scenarios A and B both yield a reduction in GHG emissions from ground-based public transport of about 20%. This equates to a saving of 38,700 tons of CO₂ equivalent per year. These savings relates to a reduction in vehicle mileage coupled with a shift to electric modes. The estimates for GHG emissions are presented in

⁸ Annualized values assume 225 weekdays of full-fleet operation, and 135 weekend days of half-fleet operation.

⁹ EMBARQ (2012) Emissions of Transit Buses. Available online at: <http://www.wricities.org/sites/default/files/Exhaust-Emissions-Transit-Buses-EMBARQ.pdf>, last accessed on

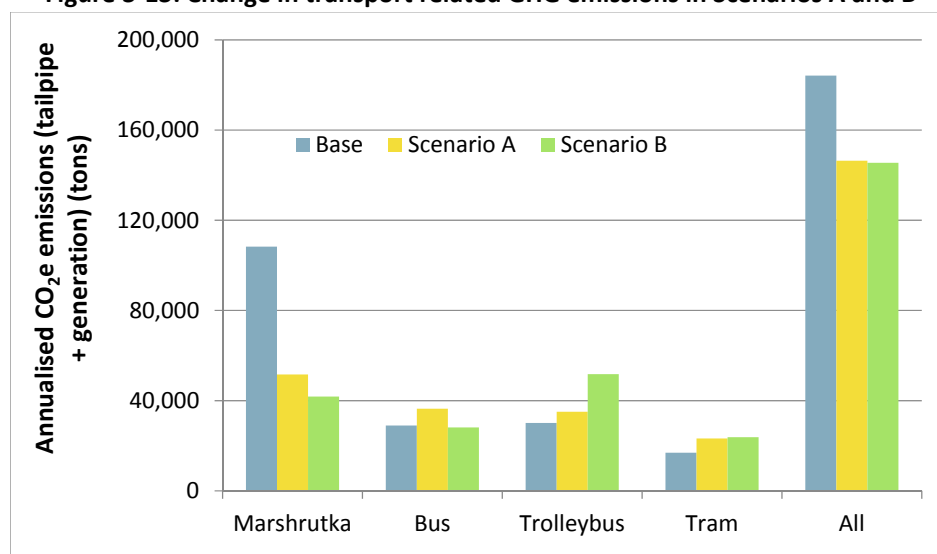
Table **3-8** and Figure 3-13, these include forecast changes in direct emissions (produced by the vehicle) as well as indirect emissions (produced when producing, storing and transporting the fuel). Indirect emissions are especially relevant when considering electricity use.

Table 3-8: Impact on Greenhouse Gas emissions (Annual CO₂ equivalent tCO₂e)

Mode	Direct			Indirect			Total		
	Base	A	B	Base	A	B	Base	A	B
Marshrutka	88,915	42,365	34,396	19,330	9,210	7,478	108,245	51,574	41,873
Bus	23,800	29,944	23,092	5,174	6,510	5,020	28,974	36,454	28,112
Trolleybus				30,121	35,133	51,729	30,121	35,133	51,729
Tram				16,856	23,254	23,828	16,856	23,254	23,828
Total	112,715	72,309	57,487	71,481	74,107	88,054	184,196	146,415	145,541

Emission factors from AEA 2012, EU Transport GHG Routes to 2050. Indirect emission factor for electricity production from IEA 2014, CO₂ Emissions from Fuel Combustion, 2014 Edition

Figure 3-13: Change in transport related GHG emissions in Scenarios A and B



Delivering the network optimization proposals set out in Scenarios A and B is expected to significantly reduce operational costs associated with public transport service provision. The shift to larger vehicles and operationally cheaper electric modes is estimated to deliver 20% annual operating cost savings. Table 3-9 shows this equates to a net annual saving of 348,000,000 UAH across all modes of travel, or \$14.67 million USD (\$3.47 million USD in Purchasing Power Parity – PPP – terms)¹⁰.

Table 3-9: Projected change in annual public transport operating costs

Public transport mode	Annual operating costs (Million UAH)		
	Baseline	Scenario A	Scenario B
Marshrutka	1,212	578	469
Bus	551	694	535
Trolleybus	429	501	738
Tram	245	337	345
Total	2,436	2,110	2,088
Net reduction	-	326	348

Source: Project team calculation from Vehicle Kilometres Travelled and Kyivpastrans per Km costs

¹⁰ Exchange rate derived from www.oanda.com on 28/11/15. PPP factor (for GDP) derived from <http://data.worldbank.org/indicator/PA.NUS.PPP> on 28/11/15.

Financial sustainability is considered a key objective for Kyiv's public transport. These considerable annualized operational cost saving may assist Kyiv City Administration and local public transport operators with their efforts to establish a financial surplus that can be used to place their operations on a more sustainable footing, and to reinvest in new transit vehicles. While significant, the quantum of these estimated savings is not expected to be sufficient to achieve the level of operational cost recovery typically associated with for-profit public transport systems.

Accessibility impacts for citizens of Kyiv

The optimization proposals aimed to provide accessibility improvements for public transport users.

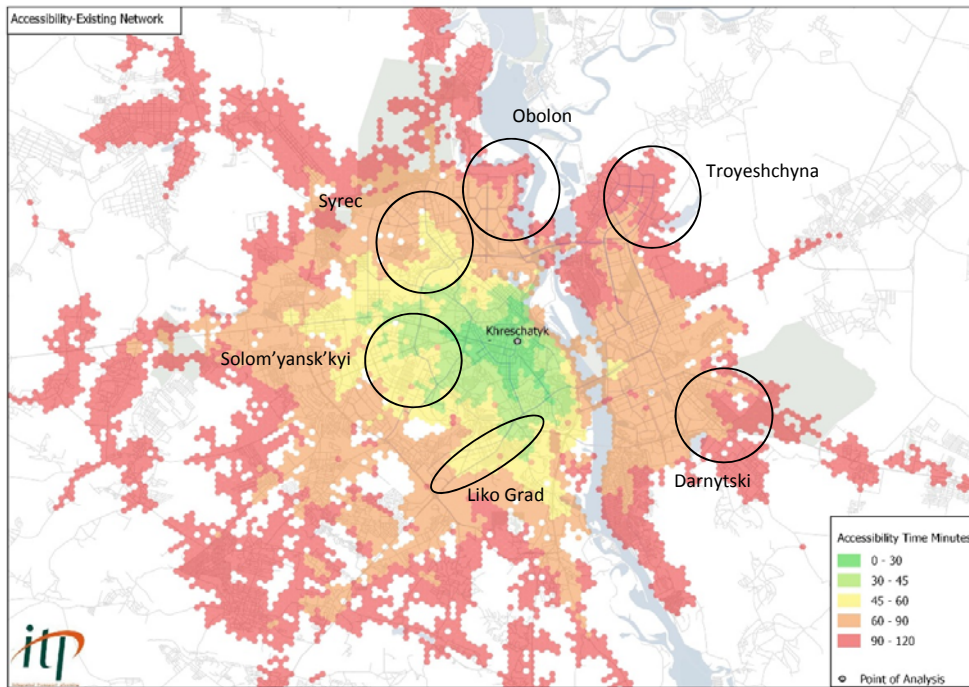
To measure the optimization proposals' impact on public transport connectivity across the city the open source GTFS Editor tool was used to alter the EasyWay GTFS feed for Kyiv and include the route and headway proposals defined in Scenario A & B. The updated GTFS feed (containing both Scenario's proposals) was then fed into the open source Transport Analyst tool deployed earlier in the project, with the outputs visualized using GIS software. As shown in Table 3-6 accessibility levels were tested from five locations around the city with the main objectives being to:

- ✓ Ensure the high degree of existing public transport accessibility would be maintained through the implementation of Scenarios A and B.
- ✓ Check the travel time isochrones to seek improvement on routes where public transport priority measures have been proposed.
- ✓ Observe whether connectivity has been improved to districts that are currently poorly served by public transport services.

To more clearly visualize the impact of the study's network optimization proposals, the before and after accessibility comparisons shown in

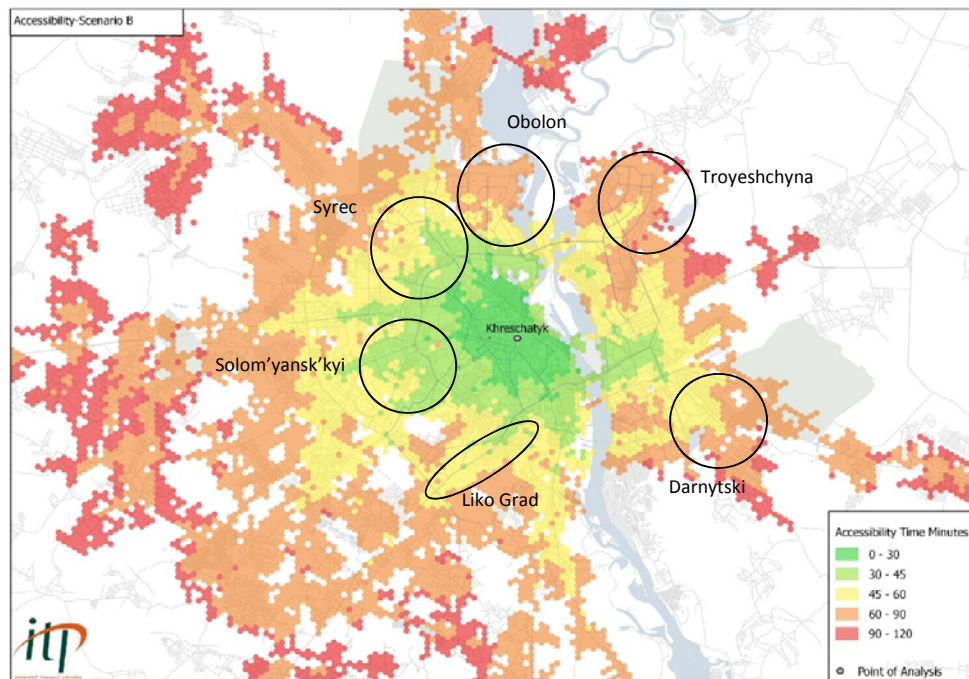
Figure **3-14** and Figure 3-15 deliberately exclude the city's three metro lines. Their service patterns and headways are unchanged in each Scenario, but their rapid operational speeds and comparatively fast journey times obscure the patterns of change in surface transport options. Before and after maps from all five areas are presented in Appendix D, the figures below illustrate the before and after accessibility maps for trips to the city center.

Figure 3-14: Public transport accessibility to Kyiv City Center (current)



Source: Project team accessibility analyses with baseline transport network GTFS data

Figure 3-15: Public transport accessibility to Kyiv City Centre (post-optimization)



Source: Project team accessibility analyses of Scenario A & B optimization proposal GTFS data

Significant accessibility improvements which, in combination with the existing metro lines, are projected to improve direct connectivity and reduce journey times for people travelling in Kyiv using public transport. When compared with the accessibility of the current surface public transport network (

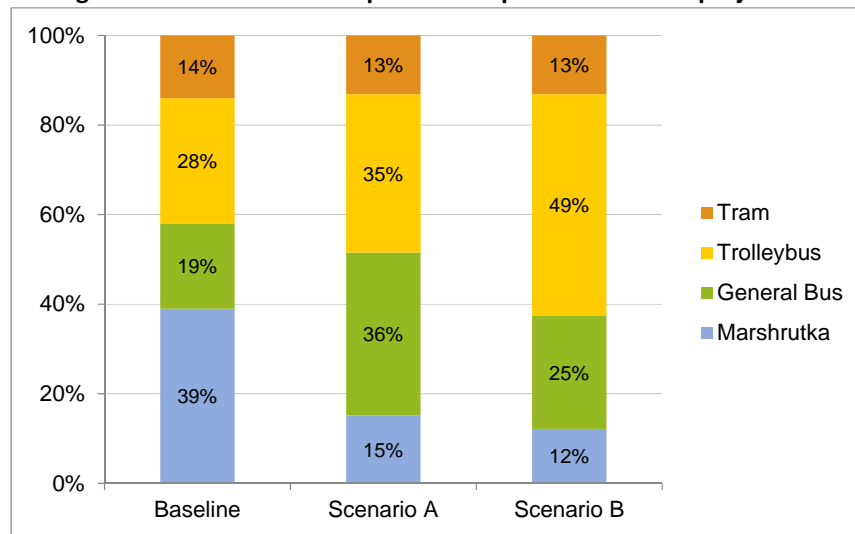
Figure 3-14), Figure 3-15 shows the project team’s optimization proposals will:

- ✓ Significantly increase the coverage of Kyiv’s public transport network, expanding the total area of the city and surrounding areas that are within 2 hour’s public transport travel from the city center (demarcated by ‘Khreshchatyk’).
- ✓ Enable the majority of the urban areas of Kyiv to be accessed from Kreschatyk, in the city center, within 45 minutes using surface public transport modes.
- ✓ Significantly improve connectivity to the densely populated areas of Liko Grad, Solom'yansk'kyi district, South-eastern Darnytski, and north Obolon that are currently poorly served by public transport.
- ✓ Significantly improve connectivity to areas with high levels of trip attraction, which includes north-west Troyeshychna, Podil and the city center, and Syrec.

Impact of proposals on mode shift, passenger transfers and interchanges

The network optimization will lead to significant modal shifts. Using outputs from the Kyiv transport model it is possible to estimate the mode-shift that will occur as a result of the implemented optimization proposals in Scenarios A and B. The projections shown in Figure 3-16 incorporate predicted changes in local travel behavior resulting from the proposed reductions in marshrutka routes in favor of revised and additional bus and trolleybus services. The data highlight the significant forecast reductions in the share of passengers carried by marshrutka services in both Scenarios A and B, and also highlights the net increase in the share of patronage carried by bus and trolleybus. In Scenario B the bus mode share declines from that forecast in Scenario A as a result of the proposed investments to upgrade busy bus routes to trolleybus by extending catenary.

Figure 3-16: Surface-based public transport mode share projections



The analysis indicates the proposals will reduce the number of transfers needed to complete a public transport trip from an average of 1.6 per trip to 1.47 per trip once all Scenarios A and B proposals have been implemented. This suggests the range of public transport services on offer becomes more direct and more efficient for passengers. They become able to complete trips by public transport without needing to transfer between services as frequently as under the network’s current configuration.

The key interchange locations illustrated in Figure 3-10 are identified for a range of improvements. While no assumptions about their impact have been built into the Kyiv transport model, the project team envisages the types of investments detailed for these interchanges and the surrounding public transport network infrastructure would serve to:

- ✓ **Reduce passenger transfer times** through reduced walking distances, thereby removing real or perceived interchange penalties and making multi-modal journeys more likely.
- ✓ **Reduce traffic congestion** in the vicinity of multi-modal interchange locations, improving the overall performance of the city's transport networks.
- ✓ **Provide priority for surface public transport** services to prevent them from queuing, so as to improve their journey time performance relative to private car travel.

Future surveys and monitoring are needed to quantify the benefits. The impact of any interchange improvements implemented in the future could be measured using passenger surveys, monitoring of passenger transfer times between modes, monitoring of public transport service dwell times (and interchange-affected delays), and traffic speed and flow monitoring in the vicinity of the interchanges. Once collected, such data could be used in future iterations of the Kyiv transport model to predict the likely impact of similar interchange improvements on the surface transport routes that serve them.

4 THE ROADMAP TOWARDS SUSTAINABLE URBAN TRANSPORT IN KYIV

4.1 IMPLEMENTATION OF THE PUBLIC TRANSPORT OPTIMIZATION

The public transport reform being considered by Kyiv encompasses three distinct initiatives that would each be considered a major project in other cities and would be likely to be implemented on a phased basis. This is true, even for the most limited scope of Scenario A. The three distinct components that require separate policy decisions and management resources could be considered as: (i) optimization of the bus network; (ii) change in the contractual relationship between the City and private transport operators; and (iii) transition from very light regulation to a model of active supervision and contract management for both municipal and private operators. The effectiveness of any of these components will depend on the support of the other two so a phased implementation should involve optimization of a small number of routes, on the basis of a number of contracts with separate operators that can be varied as all parties learn from experience. The City will need to retain supervisory and contract management resources from the outset, appropriate to the scale of network reconfiguration and contracts being managed.

Implementing such changes require simultaneous action within the following four work streams. These work streams support each other and are each essential for improving the provision of public transport.

- ✓ Network changes, infrastructure and vehicle investment
- ✓ Fare level, fare structure and concessions
- ✓ Route tendering and contract management, including enforcement
- ✓ Communication plan

4.1.1 Network changes, infrastructure and vehicle investment

There are a number of ways the changes presented in the network optimization proposals could be carried out:

- ✓ **Introduce all route changes on the same day** – quickest method of implementation, but hard to organize, communicate and often meets passenger resistance.
- ✓ **Carry out quick wins first** - to show action is being taken and gain early public support, however passengers may resist the deletion of routes that comes later in the process
- ✓ **Conduct all route changes that relate to a particular corridor or area** - allows communication resources to be focused on a particular area to better inform passengers.
- ✓ **Split up the network changes into a number of implementation packages that are enacted sequentially** - this can allow for a balance of route creation/modification/deletion in each package. However it can be hard to fit all route changes into such balanced packages

The sequential implementation of packages was the preferred option. Following discussion with the City, KPT and the municipal licensing enterprise it was considered that the best method of implementation in Kyiv was to enact route changes in a number of balanced packages. Each package would ideally be beneficial to the passenger, KPT and the private operators. Each package should also include route deletion as well as the implementation of new or modified routes, in order to balance negative impacts passengers may feel regarding route deletion against the development of new routes.

The use of implementation packages enables the network changes to be implemented in a slower and controlled manner. Such approach allows implementation methods to be tested and lessons learned. Chapter 3 describes the three pilot packages for the City to test the implementation method. These packages were prepared and discussed with KCA, KievPassTrans and private operators in great level of details. The use of packages also allows the timeframe for implementation to respond to the speed that private operators will be able to scale up their operations and begin to ply larger buses.

The use of balanced packages also ensures that neither KPT nor private sector operators gain an unfair advantage as the network changes are carried out. The use of quick wins was initially proposed by the City to show to the public that action was being undertaken; however the consultant identified that these quick wins would overtly benefit KPT because they were more ready to operate the new routes.

Three pilot packages have been developed through discussion with the City Transport Department, KPT and the municipal licensing enterprise. These packages, described below, have been designed to test a full range of implementation challenges.

The **Troyeshchyna - Patona Bridge Package** changes affect routes that cross the Patona Bridge from the Troyeshchyna area. The package reduces 7 routes to 5 and increases the number of high capacity routes crossing the river. The package includes discontinuing 3 marshrutka routes and one trolleybus route. The package also involves the creation of one new bus route to be tendered out to private operators and the extension of one existing KPT trolleybus route.

The **Vinograd - Nyvky Package** considers routes between Vinograd and Nyvky that use Daryla Shcherbakivskoho St. This street has been identified as a major transit corridor that has significant duplication of routes. This package reduces the number of low capacity Marshrutka routes and increases the number of higher capacity bus and trolleybus routes. The package includes discontinuing four marshrutka routes, merging one marshrutka with a bus route and the creation of a new trolleybus route.

The **Lukianivska Package** impacts routes that pass through or terminate at the Lukianivska interchange. This interchange has been identified as a major transit hub, but it suffers from severe congestion due to the quantity of transit and private vehicles passing through. The implementation of this package aims to help decongest the area and simplify the PT movements around the interchange, thus helping traffic flow. This involves discontinuing 6 marshrutka routes and one trolleybus route, merging a marshrutka and bus route together and introducing a new strategic bus route from the Obolon to the central railway station.

The identification of balanced packages is a complicated process because of twin needs of ensuring both private and public operators see opportunities for themselves and also ensuring that no large groups of passengers are unduly affected by changing a limited number of routes. The network optimization proposals increase the coverage of the network while reducing the total number of routes, this means that the deletion of one route might be covered by changes made to two or more other routes. As a result, the implication of changing a single route can have knock-on effects on many other routes. It can therefore be hard, but not impossible, to identify a group of route changes that can be implemented in isolation.

The use of balanced packages also allows the opportunity to use targeted infrastructure improvements to support route changes. For example, the installation of a particular bus lane could accompany route changes on that road. Twining infrastructure improvements with route changes should help to gain passenger support.

It will be necessary to change regulation that limits the installation of bus lanes to roads with three lanes or more in one direction. There are a number of two lane roads in Kyiv on which public transport would greatly benefit from bus lane such as Sichovykh Sritsiv St around Lukianivska and Bratyslavska St near Chernihiviska.

Correct enforcement powers will need to be gained by the City to ensure that bus lanes are clear for public transport vehicles to use. This includes the power to remove and penalize vehicles parked in a bus lane as well as penalize private vehicles that travel in a bus lane.

Feedback from the operators on the proposed network changes identified two railway crossings in Darnyts'kyi whose current condition prevents new routes from using them. The crossings, which are identified are lightly used for industrial purposes only. The presence of these crossings, which are deemed unsafe at the moment, should not result in changing the network optimization proposals. This is because the realignment of these routes provides new strategic links, and local accessibility improvements, which would greatly benefit residents in the area. Rather than watering down the network optimization proposals to the detriment of the travelling public, work should instead be undertaken to make these crossing safe.

Marshrutkas are operationally inefficient for moving large passenger movements. Therefore private operators will need to begin operating 12m buses on a number of new and existing routes, these routes are identified in the excel workbook 'Route Table for Scenarios A & B v2.xlsx'. The purchase of new buses will require financing and expertise will need to be developed regarding their use and maintenance. Promisingly, it has been reported that a local manufacturer is due to start producing larger vehicles this year. These should be more affordable and have familiarity of use and maintenance.

4.1.2 Fare level, fare structure and concessions

Today KPT and the private operators use different fare levels and follow separate rules for carrying concessionary passengers:

- ✓ KPT charge a flat fare of 3 UAH, they carry all concessionary passengers including public sector workers. They also offer a monthly travel ticket.
- ✓ Private operators generally charge higher fares, sometimes as high as 6UAH. They carry fewer concessionary passengers, and do not allow public sector workers to travel free. They do not offer a monthly travel ticket

The network optimization proposals require the fare level, structure and concessionary discounts to come into alignment for both public and private operators. This is because the removal of duplicative services, and a general simplification of the network, will remove the choice of travelling on KPT services for a number of passengers. Concessionary users who currently travel on a KPT service may see their service removed, forcing them to use a private service. This will be a particular problem for the 37 duplicative routes that should be merged into 17. The alignment of fares is also necessary to allow KPT and private operators to compete on a level playing field.

It is necessary for KPT and private operators to use the same fare level and same rules for accepting concessionary passengers in the future. As the private sector will be given exclusive rights to operate some, or all, merged routes they will need to be obliged to collect all passengers who wish to use that service, whether they are a concessionary passenger or not. This will require contract enforcement to ensure that the private operator is collecting all passengers, but it also requires private operators to be correctly reimbursed for carrying concessionary passengers. This area requires considerable work

as the City and State already struggles to correctly reimburse private operators for the concessionary passengers they carry.

The new fare level and structure should cover the operational costs as well as investment in new vehicles once concessions are factored in. We anticipate this would result in fares on KPT services rising, while some of the high private-sector fares could fall. The fare level, as well as the reimbursement settlement, should be set by KCA working with the private and public operators. As the fare levels on private and public operators should be the same in the future, it makes sense to increase the fares on KPT routes, rather than decrease the fares on private routes. Otherwise private operators will not be able to afford to run. It might be possible to use some of savings received from increasing the KPT fare to help reimburse private operators.

The network optimization proposals would be better supported through the use of distance based fares, such as a zonal system. This is because the proposals increase the average route distance from 10.7 to 11.9km. The use of longer routes, and also the overall reduction in interchanges will require fares to better match the costs of operating routes. An e-ticketing system is recommended because it provides much greater flexibility in the ticket types available, including cross-operator tickets that might be desirable in the future. E-ticketing can also help to reduce fare leakage, and provide useful passenger demand information to help plan and operate the network.

4.1.3 Route tendering and enforcement

A number of changes to way routes are contracted out would support the network optimization. The different contracting options are analyzed in detail in section 4.3. Longer contracts should help private operators secure financing for new vehicles. Higher levels of service should also be stipulated, including vehicle standards, minimum frequency of service and levels of reliability. It should no longer be expected that the City stipulate the number of vehicles that are required to ply each route, this should instead be a concern of the operator. The contract should instead include measures to prevent the over-bussing of a route or the blocking of stops and termini with vehicles.

To ensure exclusivity to a route it makes sense that route variations are incorporated into a single contract so that they can be operated by the same operator. This is recommended since a number of routes in the optimized network appear as route variations.

The improvement of public transport in Kyiv will rely on improved measures for contract enforcement to ensure higher standards are maintained and to ensure that operators that with exclusive rights to routes are carrying concessionary passengers. The resources made available for enforcement will accordingly need to be increased and their independence from operators maintained. The policing of suburban routes is also required to stop them serving intra-city movements.

4.1.4 Communication plan

Successful implementation requires a comprehensive communications and public engagement plan. This should include:

- ✓ **A process of public consultation** regarding the plans. This should include opportunities for key stakeholders, such as transport activists, to study the proposals and suggest improvements.
- ✓ **Marketing, branding and a public information campaign** to inform Kyiv residents of the project objectives and how it will change the way they travel, including route restructuring and fare changes.

- ✓ **Communication with affected passengers** on specific routes as to how their journey will change and the new options they will have for travel during the implementation of route changes.

We would encourage the use of the following:

- ✓ **Focus groups** to develop a brand for the project.
- ✓ The development of a **website** that they explains the project, including maps and provide a process to receive feedback or concerns from the public.
- ✓ **Public exhibitions** around the city to present the project and highlight specific impacts in their area.
- ✓ **Leaflets developed for each package of route changes** to inform passengers of specific route changes are and to help them to make a new route if necessary.
- ✓ **A team of project ambassadors** to advise passengers during the run up to the day of change, and help passengers during the first few days of route changes being made.
- ✓ **Communication strategy** to work with the press and social media.

Box 2: Gradual roll-out or big-bang approach: Dublin and Houston

In 2010, the main bus operator in Dublin introduced a Network Direct initiative that resulted in around 80% of routes being changed in a number of phases, over a two- year period. The main objectives of the network reform were to (i) straighten routes that had been changed incrementally in response to requests from local representatives; (ii) improve timetable design, making it more understandable for customers; and (iii) increase the number of routes that traversed the city, rather than terminate in the city center. The network reconfiguration did result in passengers walking further to stops on but a comprehensive communications program explained the benefits of shorter overall journeys on routes with bus priority, and a more regular schedule. The network reconfiguration allowed the operator to reduce the size of its bus fleet while carrying the same number or more passengers. Extensive local communication initiatives in advance of route changes probably resulted in very few passengers abandoning the bus.

The City of Houston, Texas took a more radical approach to network reconfiguration when it changed its entire network of 80 routes, 1,200 buses and 250,000 daily passenger trips on August 17, 2015. Travel was provided free of charge for a week while residents became familiar with the new network. The changes were necessary to reflect commuters’ growing need to travel between suburban neighborhoods rather than have destinations in the city center or transfer there. The revised network also took account of a new light rail service that had been launched earlier in 2015. The Houston New Bus Network is intended to attract an increase in patronage over two years, while not increasing costs. By October 2015, total patronage on all public transport had increased. More passengers were using higher capacity rail services, as intended, and bus patronage at weekends had grown rapidly reflecting improved frequency. Bus patronage during the week had not increased but the transport authority remain confident that buses would attract more passengers as residents would be attracted to new routes.

4.1.5 Key implementation decisions

Kyiv will face many implementation challenges. An assessment of the deliverability of the proposed reforms is presented in Table 8. It ranks the City’s financial constraints and private operators’ limited access to debt or lease finance in Ukraine as the highest risks to implementation. Many of the other risks, relating to securing buy-in from the public, private operators and Kyivpasstrans, should be amenable to mitigation through active engagement with stakeholders and a measured approach to implementation.

Table 4-1: Deliverability Criteria and Mitigation

<i>Deliverability Criteria</i>	Barriers	Risk to Implementation	Possible mitigation
<i>Financial Sustainability for City</i>	Fleet improvement and payment for additional services will require increased expenditure in any scenario.	High: Financial commitment by City up-front with benefits over time. City cash constrained in short-term.	Improved service should attract more fare-box revenue. Consider higher fares and staged fares.
<i>Availability of finance for new vehicles.</i>	Capital cost of new fleet of buses large, irrespective of approach to implementation.	High: Finance markets in Ukraine restrict access to lease, debt and equity, at present.	Phased implementation. City could offer limited credit support, to lenders, for eligible borrowers.
<i>Acceptability to marshrutka operators</i>	Diverse group, whose interests may vary. Interests of owners and drivers may differ. Many operators may not survive network transition.	Medium: Existing model unprofitable. Large operators open to reform.	Consult with operators on structure of reform. Progressive roll-out, modifying structure if necessary.
<i>Enforcement of new regulatory structure.</i>	City will need team of supervisors with appropriate skills. Needs support of police and national agencies.	Medium: Takes time to develop regulatory skills and culture.	Progressive roll-out with small regulatory staff. Seek Govt of Ukraine support for reforms.
<i>City's formal authority to implement reform</i>	Marshrutkas have 3-yr contracts and have expectations of renewal.	Low: Existing problems relate to enforcement.	Award new contracts when current licenses expire. Offer opportunities in new network.
<i>Acceptability to public</i>	Marshrutka passengers may oppose loss of direct services.	Low: Deficiencies of current structure acknowledged.	Communicate benefits of improved PT, including traffic calming in CBD.
<i>Acceptability to KPT</i>	KPT may see other operators of large buses eroding its role.	Low: Removal of duplicate routes benefits KPT.	Clarify long-term role of KPT.

Kyiv City Administration needs to make a series of policy and resource decisions on how reform will be implemented. A list of policy questions is set out below.

- ✓ Does the network optimization proposed in ITP's Scenario A meet the City's objectives for the first phase of reform?
- ✓ If some routes now served by marshrutkas are to be replaced by services on consolidated routes using standard-size buses, is it intended to enter into commercial arrangements with private bus operators to provide services to a higher standard? It is very unlikely that the modal shift from marshrutka to standard-size bus can be achieved without some form of payment or guarantee from the City Administration to operators of the new services.
- ✓ What is the City's preference for selecting operators and contracting for services? The City could consider negotiating Direct Award contracts to existing operators on a pilot basis that would allow both the authority and contractors to establish benchmark cost and revenue standards.
- ✓ If a transition to higher standard services is to be extended across the network, it is likely that the authority will seek competitive tenders for longer-term contracts. Is the City's preference for form of contract closer to the Gross Cost or the Net Cost end of the contracting continuum?
- ✓ Is the City confident that it can achieve genuine competition among Ukrainian bidders for award of contracts? The absence of genuine competition among bidders would undermine the objective of securing value for money and the City should be willing to terminate any contracting process if it believes that there is only one bidder or that competitors are colluding.
- ✓ What is the proposed term of the contracts, the minimum service requirements for which operators would be paid, the minimum vehicle standard, the sharing of revenue risk, and the basis for any payment to contractors?
- ✓ How are routes to be packaged to implement reform and for allocation to individual operators?
- ✓ Does the City have the corporate powers and resources to support private operators in securing loan or lease finance for new vehicles and would it consider such an option? The City's debt ceiling may make this unrealistic in the short-term.
- ✓ If the City invites tenders to operate large buses on consolidated routes, will Kyivpasstrans be eligible to tender and how will the City ensure that there is a level playing field between public and private operators? Private operators argue that they are at a disadvantage relative to Kyivpasstrans in relation to operating subsidies, access to EBRD loans guaranteed by the City and different rules for paying value added tax.
- ✓ What is the status of the City's electronic ticketing project and how is public transport to be incorporated in the scheme, for municipal and private operators?
- ✓ Is Kyiv City Administration committed to providing supervisory and contract management resources to implementing institutional reform and is that commitment shared by other relevant parties such as Police and the National Inspectorate responsible for supervising transport services originating outside the city?
- ✓ Are the indicated cost estimates for implementation and for annual payments to operators sustainable within Kyiv's budgetary forecasts?

4.2 PRIORITY INVESTMENTS

4.2.1 Bus network reorganization

Implementing the proposed bus reorganization would represent a considerable improvement of the mobility conditions with very limited investments. This section assesses the cost of operating the bus, minibus, trolleybus and tram network as reconfigured under Scenarios A and B. It also estimates the cost of implementing the project. The cost estimates are based primarily on information provided by KyivPasTrans (KPT), supplemented by information provided during visits to VinnytsiaPasTrans (VPT) and a private operator of minibuses in Kyiv. Values provided by transport professionals in Ukraine have been assessed against costs for similar works in Poland and Russia, taking account of lower costs in Ukraine.

The network optimization envisaged in the proposed scenarios will require replacement of capacity on minibuses with capacity on standard-size buses, trolleybuses and trams. The pace of this replacement and investment in new capacity will be determined by policy decisions on institutional change and resource availability. The allocation of responsibility for investment and service operation between the public and private sectors will also need to be decided. For these reasons, the cost of implementation is estimated on a network basis, consistent with the network reforms proposed.

The capital cost estimated for implementing reform is UAH 3,951 billion for vehicles to be purchased to meet Scenario A requirements. An additional UAH 4,247 billion would be required for the additional fleet and investment in fixed infrastructure for Scenario B. Table 4-2 provides detail of this expenditure for new buses, trolleybuses and trams; installation of new catenary and sub-stations in areas where new electric transport is proposed; renewal of fixed infrastructure for electric transport; and provision of other fixed infrastructure. It also includes necessary investment in upgrading facilities at a depot and control room for the expanded fleet of large vehicles. The cost estimate is based on values provided by KPT, which has the most recent experience of purchasing fleet and renewing infrastructure in Kyiv. As noted above, the unit values for the vehicles are substantially higher than those quoted by the leading vehicle supplier in Ukraine and the cost per kilometer of renewing tramway catenary also seems high. Public transport operators are often more reliable than vehicle suppliers as a source of information on the actual cost of new vehicles entering service. There may also differences in the specifications of vehicles being referred to by the different parties providing estimates.

Table 4-2: Estimated Cost of Implementing Network Optimization

	Scenario A Units	Scenario B Units	Scenario A UAH 000	Scenario B UAH 000
<i>12 meter buses</i>	231	0	873,180	0
<i>17 meter trolleybuses</i>	171	246	1,292,760	1,859,760
<i>26-30 meter trams</i>	62	10	1,785,600	288,000
<i>Catenary Extension Trolleybus</i>	0	27	0	68,500
<i>Catenary Renewal Trolleybus</i>	0	300	0	450,000
<i>Catenary Renewal Tramway</i>	0	30	0	450,000
<i>New substations</i>	0	8	0	173,442
<i>Substation renewal</i>	0	67	0	737,000
<i>Depot & Control Room Upgrade</i>	0	1	0	197,750
<i>Bus priority lanes</i>	0	62	0	15,700
<i>New Junction layout</i>	0	10	0	7,500
Total Capital Cost			3,951,540	4,247,712

There is a risk that KPT has estimated a high cost for works for which it may expect to have exclusive responsibility, resulting in a higher overall cost estimate than may be required to implement the proposed network changes. The cost estimates provided by KPT for minibuses are lower than the supplier's estimate. In deciding on the appropriate mix of large-scale vehicles (bus, trolleybus or tram) and in finalizing budgets for implementation, the differences in cost estimates should be examined more rigorously. It is likely that the total cost of vehicles may be less than the KPT estimate but some of that potential saving may be offset by the need to invest more in track renewal and other fixed infrastructure.

In addition to capital costs, the City will need to provide funds for design and project management for implementing the network and depot changes. If the network reform is to involve new contractual relationships between the City as transport authority and transport operators, the City will need to retain specialist procurement and contracting advice to negotiate these changes. The funding required for these activities will depend on policy decisions by the City but it would be reasonable to provide for UAH10-15 million for the design and early implementation phases.

The estimated cost of implementing the network reform presented in Table 4 should be considered as a tool for decision-making on network optimization. When there is greater certainty on the scope, timing and institutional arrangements for implementing the proposed changes, a revised cost estimate should be prepared. Greater definition on the scope of work for implementing network reform will assist in developing more reliable cost estimates.

4.2.2 Additional Investments

In addition to the investment needed to implement scenarios A and B discussed above, which consist mainly in rolling stock, there are key investments needed in urban transport which were identified during this analytical work, but not quantified. These key investments are summarized below, the order of presentation does not correspond to any prioritization and do not include road investments.

Scenario C identifies a total of 8 potential mass transit corridors that would be suitable for either BRT or LRT. The routes represent outline concepts and would require detailed appraisal before being taken forward but could represent a significant improvement of the mobility conditions in the city. In particular, the Kyiv City Administration envisages that Kyiv could pioneer the first BRT line in Ukraine.

The need for investments in key interchange locations was identified to underpin the optimization proposals set out in this report. The identified interchanges represent improvements in order to increase operational capacity and efficiency and comprise transit stops which currently experience high daily boarding and alighting movements, or are stations that are anticipated to experience such levels if the optimization proposals are implemented.

The range of transport modes operating in Kyiv imply that many transit stops are multi-modal interchanges. There is scope to improve the design of some of the major interchange locations identified in this analysis to make them more operationally efficient, and reduce time wasted by passengers (waiting, and transferring between services) and public transport vehicles (queuing and dwelling).

There is a need for a decision regarding the future of the city train (a heavy railway that runs on a loop around the city), which is now in poor condition. Rehabilitation of the line would require significant investments and the city must prioritize its investments taking into account the overall impact on mobility.

The metro extension, in particular to Troyeshchyna, has been discussed for a number of years. The analysis presented in this report supports postponing the heavy investments in the metro system in favor of more affordable means of transport that would satisfy the mobility needs in the short and medium term.

Kyiv must improve its cycling conditions. While the first in Ukraine network of municipal bicycle rent opened in Lviv on the 31st of March, Kyiv lags behind on cycling infrastructure and services. With increasing public advocacy in favor of improved cycling infrastructure, in particular from the Kyiv Cyclists Association, the city has recently approved a cycling master plan and is starting to expand its infrastructure.

There is an urgent need for improving the traffic management system and the parking conditions in Kyiv, as discussed further in this chapter. Such measures would bring enormous benefits in terms of congestion reduction, pollution, noise and safety.

4.3 CONTRACTING OPTIONS

Cities have an interest in regulating public transport to guarantee minimum levels of safety and environmental compliance. However, in addition to regulation, most large cities commit substantial financial and management resources to ensuring an adequate supply of public transport at a standard that offers a credible alternative to private cars. This commitment is required to ensure reasonable access for residents to employment, education and leisure and to avoid traffic congestion. The need to offer affordable fares makes it difficult to earn attractive financial returns from fare-box and ancillary revenues. There are some exceptional examples of city transport networks covering their operating costs from fare-box revenues or of particular routes in cities covering their full capital and operating costs but these are the exceptions. Generally, cities need to commit substantial financial resources on a continuing basis to guarantee a reasonable service standard for the full community. This commitment can be made by cities owning and operating public transport or by contracting with third parties, or by a combination of both. Even when a city owns the transport operator, it is good practice for the city government to specify its service requirements and link those requirements to budgetary support.

The main models used by cities to contract for public transport services are by means of Direct Award, Gross Cost Contract and Net Cost Contract. Under a Direct Award Contract, the City negotiates with a single operator that it has selected to provide transport services to defined standards and specifies the payment mechanism to be used, including any bonuses and penalties. This approach may be used to introduce better transparency in a city's relationship with an incumbent operator or to introduce new services on a route on a trial basis.

The choice of contractual model considered by public transport authorities for urban bus services depends on the degree to which revenue risk is to be transferred to the operator or retained by the authority. A Gross Cost Contract is where an operator is paid to operate a specified service and the transport authority retains all the fare revenue collected. In a Net Cost Contract, the operator is granted an exclusive right to provide services on a route and is allowed to retain the revenue. This operator also retains the risk associated with the revenue not covering the full cost of operations and maintenance.

These contractual models should be seen as ends of a continuum and most cities that contract for public transport services adopt a hybrid model, with at least some of the operators' returns depending on their success in attracting passengers and collecting fares. Gross cost contracts typically provide for bonuses and penalties related to contractual performance and to customer

satisfaction and more recently, bonuses related to passenger numbers. For example, gross cost contracts for bundles of bus routes in Stockholm allow operators to earn bonuses of up to 23% of the contract value if certain quality standards are met and if customer feedback is very positive. Gross cost contracts used in Elmsshorn in Germany and Halmstad in Sweden share fare-box revenue between the operators and the authority, if certain targets are exceeded. In these circumstances, the operator usually has greater input to route planning or changes to services patterns to respond to market trends. Toward the other end of the spectrum of contractual structures, transport authorities sometimes modify net cost contracts to supplement fare-box revenue that operators are allowed to retain. For routes that the authority considers socially beneficial but where forecast fare-box revenues are not sufficient to guarantee the desired level of service, the authority may award contracts that guarantee some payments for a defined level of service. These service requirements and quality standards are usually much more limited than for gross cost contracts.

Most cities that contract for transport services have modified standard gross cost or net cost models of contract to take account of policy priorities and their experience with early stage contracting.

These Hybrid Contracts combine aspects of Production and Revenue Risk sharing between authorities and operators. For example, German cities have traditionally favored gross cost contracts but some have modified terms to incentivize operators to attract more passengers through improved customer service. In Elmsshorn, operators receive a bonus for increased passenger numbers beyond the numbers carried in the first year of the contract. Transport for London incentivizes Gross Cost operators by committing to extend the contract period by two years if certain performance standards are achieved during the five years of the original contract.

The revenue risk in Net Cost Contracts is reduced for the operator in some cities by the authority guaranteeing minimum payments for concessional-fare passengers such as pensioners and students.

Authorities can also mitigate the regulatory risk associated with timely fare adjustment by committing to supplementary payments if regulated fares are not increased in line with general inflation. In this way, the operator continues to carry the risk associated with numbers of passengers but not with fare adjustment, where it has little influence.

Cities often consider which form of contract offers the best value for money but this cannot be assessed independently of local circumstances.

Some advantages and disadvantages of the main structures are outlined in Table 1. Most cities that have begun contracting for transport services in any form have achieved savings relative to direct provision, if they have achieved a genuinely competitive process. The potential for savings may diminish over time if the incumbent is regarded as having a strong advantage in subsequent competitions. For transport authorities with little expertise in fare collection and revenue protection, the Net Cost approach to contracting may be the lower risk approach to contracting, at least until strong fare collection systems have been developed.

Table 4-3: Advantages and Disadvantages of Contract Structures

	Advantages	Disadvantages
<i>Gross Cost Contract</i>	<ul style="list-style-type: none"> • Generally, larger pool of bidders for contracts when Authority retains revenue risk. • Authority has full control over routes and schedules. • Authority has control over fares, access for concession-fare passengers and network integration. 	<ul style="list-style-type: none"> • Revenue risk remains with Authority. • Operator has little incentive to ensure that fares are collected, requiring Authority investment in fare collection and inspection regime to control fare evasion.

	<ul style="list-style-type: none"> • No on-street competition. 	<ul style="list-style-type: none"> • Little incentive for Operator to innovate to improve service or respond to market changes.
<i>Net Cost Contract</i>	<ul style="list-style-type: none"> • Authority does not carry full revenue risk. • Incentive for Operator to respond to market trends and to improve service to attract more passengers. • Responsibility for revenue protection remains with Operator, which is better equipped to manage its own staff. 	<ul style="list-style-type: none"> • Operators seek a premium for accepting fare-box revenue risk. • Benefits of economic growth, new development and other growth in passenger numbers, during period of contract, accrue only to Operator. • If fare-box revenue is much lower than Operator has forecast, the contract may become unviable and the risk could return to the Authority.
<i>Hybrid Contract</i>	<ul style="list-style-type: none"> • Mechanisms to limit the potential losses to Operator due to low revenue can attract more bidders. • Commitments by Authority to underwrite minimum returns, such as for concessional-fare passengers, can be used by Operator to secure lease/loan facilities at reasonable rates. 	<ul style="list-style-type: none"> • Complex payment mechanisms require higher Authority cost of negotiation and supervision.

Box 3: Transition to Contracting for Transport Services in Poland

Polish cities have substantially renewed public transport infrastructure and services through a mix of investment in upgrading the municipal tram, trolleybus and bus network and contracting with private operators to extend the network. The main urban transport challenges in Poland have arisen due to fixed-line infrastructure that had served industrial complexes no longer meeting current trip-making, increased residential suburbanization and increased costs of operating municipal transport.

Much of the urban network extensions have been carried out by means of gross cost contracts, awarded through competitive tenders for periods of between five and ten years. The contracts require operators to provide service to a schedule specified by the municipal transport authority and paid for on a per-kilometer travelled basis. Polish practice is to prequalify bidders and to award contracts exclusively on the basis of lowest tendered cost per vehicle kilometer. Contractors provide buses that must meet size, age, accessibility, emissions and quality standards that are closely defined by the authority. The authority retains revenue risk, using its own ticketing equipment and staff to collect and protect revenue.

Polish cities are generally satisfied with their experience of gross cost contracting. There are sufficient bidders with adequate skills and resources to tender for contracts, resulting in very competitive tendering and value for money. Cities are also satisfied that the contracts' reward and penalty regime allows sufficient control to achieve the desired service level.

Most Polish cities are in the first or second cycle of contracting for transport services but the transport authorities now have benchmark information on the cost of operating and maintaining vehicles, which can be used to evaluate the cost performance of municipal operators, even allowing for higher overhead and legacy costs. This benchmarking will be used for future contractual cycles when cities are deciding on the scope of services to be provided by municipal operators or by private operators.

The gross cost approach to contracting has given Polish cities a high level of control over schedules, service standards, ticketing and other aspects of service. The approach also achieves excellent integration between all urban transport services. However, the cost to municipal authorities of achieving these objectives is high. The high financial commitment for urban authorities has been affordable, as many cities have benefited from EU and national government support to upgrade infrastructure. Over

the longer term, it may be necessary to modify the contractual structure to have greater sharing of fare-box risk with private operators. Operators are not now directly incentivized to attract more passengers or to respond to market developments.

Intercity and some regional bus services in Poland are organized on a model closer to net cost contracting but with very little financial support from transport authorities and very light regulation. Private operators are eligible to apply for reimbursement of fares for some concessional fare passengers and some regional operators benefit from having taken over depot and terminus facilities from the former state-owned bus intercity bus company. However, many routes that provide an important social service are not viable based on fares collected from passengers and the vehicle fleet is in poor condition. Polish regional governments could invite these operators to tender for Public Service Obligation payments to maintain socially important services but they have not done so. In the absence of adequate support, the capacity and quality of these services is diminishing, at a time when urban bus services are expanding and improving in quality.

4.3.1 Role of private operators

In considering the most appropriate model for reform in Kyiv, it is worth identifying deficiencies in the current structure that need to be addressed. It is also relevant to recognize the constraints that would face the transport authority in bringing about change in Kyiv in 2015/2016.

Table 1 proposes an evaluation of the state of public transport in Kyiv in 2015, focused on bus and minibus services, and the potential benefits from reform. In addition to considering optimization on its own, the benefits of network changes coupled with greater integration of privately operated services with municipal services are considered. The benefits of each of the scenarios and the associated costs would depend on how the network changes are implemented and the nature of the contractual arrangements with private operators. The scale of network reconfiguration envisaged in the comparison is based on Scenario A. Integration with private operators is envisaged to include better interchange between private services and municipal operators, improved access to private transport services for concessional fare passengers, and progressive improvement in the quality of private operators' vehicles. These changes would require additional financial support from the City Administration as well as better regulation.

Table 4-4: Benefits of Network Optimization and Integration of Private Operators

	Current Situation (2015)	With Network Optimization	With Network Optimization and Integration of Private Operators
<i>Integrated network, serving all areas</i>	X X	✓	✓✓
<i>Frequent, reliable service</i>	✓	✓✓	✓✓
<i>Comfortable, safe on vehicles and at stops</i>	X X	✓	✓
<i>Accessible, including for concessional and mobility-impaired</i>	X X	✓	✓✓
<i>Affordable for passengers</i>	✓✓	✓✓	✓✓
<i>Financially sustainable for Kyiv City Administration</i>	✓✓	X	✓
<i>Reasonable emissions control</i>	X	✓	✓✓

The evaluation suggests that network optimization would bring considerable benefits to passengers by having a higher share of trips on standard-size buses rather than on marshrutkas, which are less comfortable, less accessible and, generally, do not honor concessional fares. Currently, around 24% of trips are on marshrutkas and 12% on buses. However, if Kyiv City Administration were to attempt to achieve a shift to larger vehicles by direct provision through Kyivpasstrans, which is now the only operator of standard-size buses, the capital and operating cost to the City would be very high. A network optimization, accompanied by institutional changes that would see private-operators being granted contracts to operate some routes that the ITP analysis shows would be best served by larger vehicles, should be more affordable for Kyiv.

The potential for financial benefits to the City from contracting with private operators are based on assumptions that these operators would purchase their own vehicles and operate them more in a more cost effective way than the municipal operator does. While these benefits have been observed in other European cities that contract for provision of public transport, the basis for expecting similar results in Kyiv, in 2015/2016, requires closer inspection. For example, the practicality of private Ukrainian companies securing finance to invest in a fleet of buses could be a significant constraint.

The Ukrainian city that has made most progress in reforming its public transport sector is Vinnytsia. Vinnytsia was successful in asserting regulatory control over the marshrutka sector and in reestablishing the municipal tram, trolleybus and bus operator as the dominant transport provider in the city center. The City Administration decided not to contract with third parties and implemented institutional reform at the same time as upgrading its municipal transport fleet. While Kyiv could also consider this approach, it should be noted that while the marshrutka fleet had grown rapidly in Vinnytsia, it had not come to dominate the bus sector to the extent that it has in Kyiv. A removal of marshrutkas in Kyiv, along the lines implemented in Vinnytsia, would require a very large capital investment program to provide replacement capacity, in a much larger city.

The success of contracting for transport services with private operators depends on the participation of operators with the necessary management and financial resources to provide services at the standards envisaged by the transport authority. When cities invite transport operators to tender or negotiate for such services, the most likely candidates are local transport providers from the commercial sector and international transport operators, entering the market for the first time. The transport authority's perception of the level of interest from different categories of operator and its preference for contractual partners may influence the structure and scope of institutional change.

The large private companies that operate marshrutka services recognize that the Kyiv's current market and regulatory model is not satisfactory for the city and they argue that it is not profitable for them. They are aware of the City Administration's preference for services to be provided on standard-size buses with tighter emissions standards. They also know that the City plans to introduce electronic ticketing, which should be accepted on all modes. Marshrutka operators say that they are not opposed to the principle of an optimized route network and understand the City's desire to have more direct routes with better interchange with other modes, including Metro.

The private operators expect that the City will consult with them before attempting to change the route network. They disagree with the view that larger vehicles would provide a better passenger service, as such buses would operate less frequently. They acknowledge the potential social benefits of larger vehicles but this is not a matter of concern to them, unless they are compensated. Notwithstanding this stated dislike of large buses, one operator has recently purchased twenty 12-meter buses, of nominal capacity 110 passengers but these are likely to be used for intercity services. The operators say that they are ready to participate in a smart-card electronic ticketing scheme but need to be reassured that revenues would be fully remitted to operators, in a timely way. Public and

private operators agree that fares need to be increased more often to take account of currency devaluation.

The private operators' openness to changes in the market and regulatory structure depends on them being satisfied with the financial model to be proposed by the City. They are dissatisfied with the City's approach of entering into agreements for one or two years, which they argue is too short for operators to invest in fleet upgrades. They also claim that they have had experience of contracts with the City being cancelled within six months of execution, resulting in losses to private contractors. The operators also claim that they have not been reimbursed for providing free travel to concessional fare passengers. Ukrainian private transport operators are familiar with developments in Poland where municipal transport authorities pay private operators solely on the basis of distance travelled (gross cost contracts). They would welcome similar arrangements in Kyiv. As an alternative, they would favor low-interest loans to purchase higher standard vehicles.

The limited availability of commercial finance in Ukraine, either as corporate debt or lease finance, to purchase new vehicles presents a significant obstacle to contracting with private operators for improved bus services. EBRD provided finance to upgrade the Kyivpasstrans fleet but the City guaranteed this debt. Private operators argue that the short term of licenses to provide services and the low fares make it almost impossible to borrow on commercial terms for new services. This is likely to be the case but even if the credit risk were acceptable to banks and lease companies, the current interest rates of 25-30% for debt or lease finance in Ukrainian Hryvnia would make this option impractical. Borrowing at lower interest rates in international currency, even if such facilities were available, would expose borrowers to devaluation risk as fares are set in local currency and adjustments do not keep pace with inflation and currency devaluation.

4.3.2 Revenue Collection and Management

The suggested focus on concessional fares is intended to address a significant gap in current public transport provision in Kyiv. While private marshrutka operators are expected to carry up to two concessional fare passengers free of charge, this obligation is not enforced. As a practical matter, concessional fare passengers tend to use Kyivpasstrans bus services and not use marshrutkas. As marshrutkas have increased their share of trips in the city, certain categories of passenger who depend most on public transport have less access or pay for their trips. The categories of Kyiv resident that have been granted free travel are extensive, which results in a high proportion of Kyivpasstrans passengers being free travel beneficiaries. This poor integration of fare-paying with concessional fare passengers is unsatisfactory from a social perspective and probably adds to the problem of route duplication. It would be appropriate to address this issue in the network reform but an integrated fare collection system would be required.

The fare collection systems on all public transport in Kyiv are rudimentary and do not facilitate integration across modes, graduated fares, transport planning or other benefits that are now commonplace in urban transport systems. It could be argued that the very low single fares and the informal payment arrangements for marshrutka drivers favor the current systems. A smart-card system would benefit operators by allowing distance-based fares, potentially better control of fare evasion, control of concessional fares, and better fleet management.

Kyiv City Administration is now planning a wider smart-card system, which presents an excellent opportunity to add automated fare collection (AFC) for public transport to its functionality. A smart-card reader on each bus, incorporating automated vehicle location technology (such as GPS), could be used for dispatch and regulation of buses as well as for AFC. Such a reader would cost €2,000 equivalent per vehicle for new buses. Additional expenditure would be required at the design phase

to ensure that the City's new smart-card system can accommodate this functionality. The cost of AFC has not been included in the cost estimates presented above.

Private operators expressed willingness to participate in a smart-card AFC, recognizing that such a system would give greater control to the City as transport authority. They expressed concern about the control and timely remittance of fares collected but were satisfied that if accounts could be settled on an overnight basis, as is common in other cities, they would participate in such a scheme.

4.4 INTEGRATED TRAFFIC MANAGEMENT

4.4.1 Traffic Management and Control

Managing traffic in urban areas is a complex, multi-layered and multi-functional process generally involving a range of diverse agencies. There is no universal tool of urban traffic management and a range of applications have been developed over many years. Traffic signals, parking controls, pedestrian zones, public transport provision, freight provision and access controls are just some of the typical management applications found in our towns and cities. How the road network is managed can vary greatly from area to area and there will be local, national and international legislation and policies that influence this. National and international standards do apply to some of the management tools used for traffic management, for example traffic signals operate in broadly similar fashion across Europe. However, it is local policy that is likely to have the greatest influence on how urban traffic is managed and effective ITS traffic management needs to fully take into account the needs and expectations of all local stakeholders including residents, businesses and visitors¹¹.

ITS have a clear role to play in helping to deliver sustainable transport policy goals at an urban level. Whilst each urban area will have its own transport policies, there is now a considerable degree of uniformity of policy goals to be found in many towns and cities across Europe. The policy goals outlined below are representative of those adopted by many urban areas across Europe:

- ✓ Reduce congestion
- ✓ Reduce energy consumption and traffic emissions
- ✓ Improve quality of life in city centers
- ✓ Increase market share of clean vehicles in private and public fleets
- ✓ Increase efficiency of the transport system
- ✓ Increase attractiveness of public transport / Encourage modal shift
- ✓ Facilitate freight delivery and servicing
- ✓ Enhance road safety
- ✓ Decrease parking pressure

All successful cities have strong traffic management units with broad responsibilities. Well-designed traffic engineering, control and management of freight traffic, control over the location and availability of both on-street and off-street parking, combined with good road marking and signing, linked traffic signal systems and other intelligent transportation systems such as motorist information signing all help traffic to flow more smoothly. The functions of the traffic management units are usually broad

¹¹ Guidelines for ITS Deployment in Urban Areas - Traffic Management. DG Mobility and Transport. European Commission.2013.

and strategic. Where it is the policy of the city to encourage use of public transport, the traffic management unit can give effective priority to public transport both in intersection design and in signal system settings. Moreover, long-term planning and design of the traffic management system—particularly ITS applications—in conjunction with land use and road network planning contributes to the efficiency of the system as a whole.

Safety is usually a central responsibility of the traffic management unit. This would include covering traffic engineering design, particularly at intersections, speed control, signaling and road marking and street lighting. While the police may collect accident statistics, it is usually the duty of the traffic management unit to analyze those statistics and to design measures to improve road safety. Again good practice treats this as a matter of priorities. Maintaining a safe and comfortable environment for pedestrians may require more frequent signal controls for crossing roads at grade, and lower priority on high speed (as opposed to regularity of flow) of vehicles in areas of high pedestrian density. While the police enforce the law, and are consulted on the practicability of designs, they are not the primary authority responsible for road safety.

In Kyiv, the existing Urban Traffic Control (UTC) system covers a very limited perimeter and has limited capabilities. In 2008, the EBRD proposed to finance the design and implementation of an Active Traffic Management System and Road Improvement Programme in the city of Kyiv. The Active Traffic Management System, coupled with specific junction and corridor improvements, would complement and expand upon the initial city-planned and financed UTC. For multiple reasons, in particular lack of political commitment, the project never took off.

With increasing traffic volumes the city would benefit from a system that would at the very least optimize the signalized intersections and give priority to public transport and emergency services. Recently, in 2015, the city prepared the terms of reference for the implementation of a traffic management system and the creation of a traffic management unit. These still remain at the planning stage.

4.4.2 Parking Supply and Management

One issue highlighted in relation to interchanges and on-street public transport priority through this project is the lack of parking enforcement across the city. Unconstrained parking on bus routes, and at major public transport interchanges (particularly those where bus and trolleybus routes intersect with metro lines) impacts significantly on public and private transit operator’s ability to deliver timely services. Key issues include:

- ✓ An apparent lack of off-street parking capacity in Kyiv, resulting in on-street parking at the margins of many roads. This reduces the effective capacity for all traffic and has the effect of slowing traffic speeds around the city. It also impinges on public transport services, preventing the drivers of buses and trolleybuses from being able to park kerbside in some locations. This makes it harder for people with limited mobility to use public transport in Kyiv.
- ✓ A lack of national legislation relating to parking charges, which inhibits the City Administration’s ability to use pricing as a mechanism for limiting parking demand.
- ✓ No mechanism for on-street parking enforcement, to preserve public transport routes and maintain faster journey times.

On-street parking remains a significant issue that will continue to limit the effective provision of public transport services post-optimization implementation. Workarounds such as bus lanes that are restricted for Bus/Trolley/Tram vehicles, and car parking restrictions in the vicinity of public

transport stops (particularly city center metro stations and bus stops), could potentially be delivered in support of the public transport optimization.

A recent parking strategy has been developed for Kyiv with support from USAID. The strategy recommended the seven (7) steps outlined below for improving the system now, including lobbying that can be done to pass the laws needed to enable enforcement:

1. Create a project unit

The first important step is to create a working group that would convene all relevant city stakeholders until the on-street parking situation is improved. The role of the group would be to review how the on-street parking situation is evolving.

2. Update the general parking policy

- ✓ Update the Zonal Map
- ✓ Unify working hours within each zone to simplify the system and make it more understandable to the public
- ✓ Stimulate car turnover at parking lots to improve access to the city for short term users and increase revenue from the Parking Fee
- ✓ Introduce a legal limit on the maximum period of use of day parking lots – for example 3 or 4 hours maximum in Zone I, 24h in Zone II and III;
- ✓ Differentiate monthly subscription tickets for residents and other potential subscribers (such as commuters);
- ✓ Cancel the discount offered by daily subscription tickets;
- ✓ Draft a long-term parking policy in coordination with the long-term land use and transport plans for the city.

3. Improve parking information and clarify rules

- ✓ Improve back-end information
- ✓ A full inventory of public parking supply should be carried out (by another body than KTPS to avoid underreporting)
- ✓ GIS maps would be needed for planning purposes
- ✓ Improve general information to the public about how parking works through a website, map, leaflets and other communication channels (e.g. social media interaction with public)
- ✓ Clarify on-site rules
- ✓ Improve signage by indicating working hours and the payment Zone, at the very least. Include signage about off-street parking facilities nearby
- ✓ Improve markings: clear demarcation of individual parking spaces
- ✓ Use physical obstacles such as bollards, barriers and planters more comprehensively to contain illegal parking, , starting with Zone I
- ✓ Make some unofficial parking places along the curb part of the official municipal parking supply as long as they do not impede traffic

4. Improve administration of KTPS

Parking attendants seem to be the only solution to encourage drivers to pay in a situation where the legal tools to enforce the laws are insufficient. Their mere presence assures payment is made by at least some drivers.

To improve the revenue collection and reporting process, it is advised to:

- ✓ Rotate attendants to different streets on a regular basis to prevent them from becoming too familiar with drivers, resulting in evasion of their duty to encourage parking payment

- ✓ Clarify system of payment
 - Payment should be allowed only at parking meters when they exist
 - Elsewhere, each attendant should have his/her own cash machine
- ✓ Train attendants :
 - To ask for payment systematically, by sensitizing them to the stakes of on-street parking payment (such as stimulating car turnover and improving access to the city center);
 - Not to take money and direct car users to use parking meters when they exist;
 - Manage potential situations of conflict with car users refusing to pay;
- ✓ Change agents that collect money from parking meters on a regular basis: this is meant to avoid potential misappropriation of the parking fees by a pair of collecting agents;
- ✓ Involve staff from the City Administration in revenue collection process: this could be done occasionally, a few days per year on a random basis, or systematically;
- ✓ Lease night parking assets systematically instead of operating some directly, since it is more profitable.

5. Improve transparency

To improve transparency and reduce potential areas of corruption, the Kyiv City State

Administration should also consider to:

- Conduct an annual audit
- Financial: check the books, the expenses, etc. It could be envisaged to replace a few parking attendants for a day to check fee collection
- Physical: random check of parking lots (e.g., number of parking places reported, occupancy rate, etc.)

During the first years, it may be preferable to resort to an external audit rather than the audit department of the KCSA.

- Investigate into lease agreements (financial and legal audit): estimation of the profitability of a few lease contracts, rate of renewal of those contracts, etc.
- Investigate further topics that could not be assessed in depth during the present assignment: organizational chart and revenue collection / reporting process in particular
- Ask/oblige KTPS to systematize tenders for new lease agreements
- Ask KTPS to provide more complete information in annual reports –concerning revenue in particular.

6. Improve communication to the general public

Beyond improving information to the public, the city may consider to:

- ✓ Launch a PR campaign:
 - “Why pay”, to sensitize the public to the Parking Fee and rules; and
 - “Ask for a receipt”, so that parking attendants may be incited to report the fees collected more systematically;
- ✓ Consider organizing volunteers.

7. Lobby in favor of legal changes

- ✓ Transition to performance-based parking service
- ✓ Ensuring effective sanctions
- ✓ Decentralization of parking regulatory framework and policy
- ✓ Parking Charge reform
- ✓ Straightening legal basis for private operators / role of KTPS

4.5 TOWARDS INTEGRATED PLANNING

4.5.1 Promoting better planning: the role of data, modelling and monitoring

Traditionally transport planning has been reactive or 'problem-oriented'. More recently pro-active, 'objectives-led' approaches have emerged. Both can help frame strategic transport planning, but successful plans are those which: have a clear vision of what the plan is trying to achieve; are capable of being both proactive and reactive; contain a mix of policy instruments; and make appropriate use of forecasting models and options appraisal.

Objectives-led planning based around a vision statement and a series of high level cross sectorial objectives. An example is the UK's New Approach to Appraisal (NATA) and it's so called EASIE objectives: (1) Economy, (2) Accessibility, (3) Safety, (4) Integration and (5) Environment. This approach is identified with top-down planning and high-level jurisdictions. It is often associated with an emphasis on accessibility, and more naturally lends itself to integration with other policy areas, with transport seen as facilitating sustainable access to, for example, healthcare, employment, and the countryside and tourist sites. This is consistent with the view of transport as a derived demand – in the main people travel in order to engage in various forms of socio-economic activity

Effective long-term transport planning is a circular process in which monitoring is undertaken to determine how the system is operating with respect to key success indicators relating to the economy, society and the environment. In combination with public consultation and changing budgetary constraints, the outcomes in terms of system performance are fed back to inform the vision and objectives and the appraisal process of the instruments used to deliver the plan. Albeit with slightly different terminology, this is the approach to long-term transportation planning adopted by the US Department of Transportation (Weiner & Rikin,2005). The World Bank offer guidelines on Monitoring and Evaluation of implemented transport interventions. (Monitoring & Evaluation Some Tools Methods and Approaches, 2004).

4.5.2 Keeping Modelling Tools up to date

Significant effort and expenditure was applied to the creation of the transport model for the city. The transport model was developed in parallel to this project on behalf of KCA to test the impacts of transport proposals based upon the understanding of demand and network definition as well as to make future forecasts. However, conditions are likely to change through time that alters that base situation, such as; the cost of transport can alter decision making (car ownership may increase, mode choice may change that has lasting impressions); new land uses can create new demand, and the general economic situation that creates context for movement within the city might change.

The transport model appears to have returned sensible passenger forecasts for the route optimization proposals developed through this study. The project team's independent review of the model, based on its status at the time of preparing this report, highlighted scope for the following improvement activities in order to ensure it can be used to inform more detailed analysis and transport option appraisal:

- ✓ Publish calibration statistics to allow for transparency in relation to the likely accuracy of future forecasts.
- ✓ Include costs within the model utilizing generalized costs for cars, trucks, and public transport services; as well as value of time and interchange penalty data.

- ✓ Validate each stage of the model to ensure it is calibrated to detect the impact of smaller changes to Kyiv's public transport network and road system. This should ideally involve checking the baseline scenario's trip generation forecasts, trip purpose and length distribution, mode choice, highway and public transport assignment.
- ✓ Alter the method for calibrating the model from weightings of perceived times for each route to flow-metered modelling, based on actual public transport schedules.
- ✓ Updating the 'building norm' traffic speeds underpinning the model's highway data with actual data collected using 'floating car' or secondary GPS data in Kyiv, including public transport vehicles.
- ✓ Update all data within the model to allow the model to be run for AM and PM peak hours, during which times the most congested road conditions and peak passenger flows per hour per direction (PPHPD) are anticipated.
- ✓ Study intersection capacity at major nodes, to allow the model to highlight where capacity exists on the highway network, and where additional capacity (or public transport network priority) may be required to improve traffic flow.
- ✓ Conduct boarding and alighting surveys on Suburban routes to inform detailed modelling of these routes, and their interactions with the City's public transport network (essentially)

It is important to remain aware that local conditions are likely to change over time. Such changes will imply that the base situation encoded in the transport model no longer represents the reality of local transport systems and travel behaviors. These changes might include:

- ✓ The cost of transport altering decision making (car ownership may increase, people's travel mode choices and preferences may change)
- ✓ New land uses can create new demands for travel in specific locations of the city
- ✓ The general economic situation that creates context for movement within and across the whole city might change (e.g. recession in the UK in 2010 attributed for a 10-20% reduction in long distance car travel at peak times).
- ✓ The implementation of new/optimized public transport routes (such as those proposed through this study) influencing the way people choose to travel for some trips.

To ensure that the model remains a useful tool, it will require periodic checking/validation and regular ongoing data collection. Data collection must therefore not end with the creation of the Kyiv transport model, but remain ongoing in order to:

- ✓ Support public transport scheme appraisal and relate to wider Governmental objectives.
- ✓ Monitor and evaluate the success of optimization initiatives.
- ✓ Identify potential for further improvements to local transport systems.
- ✓ Update and maintain the relevance of modelling tools