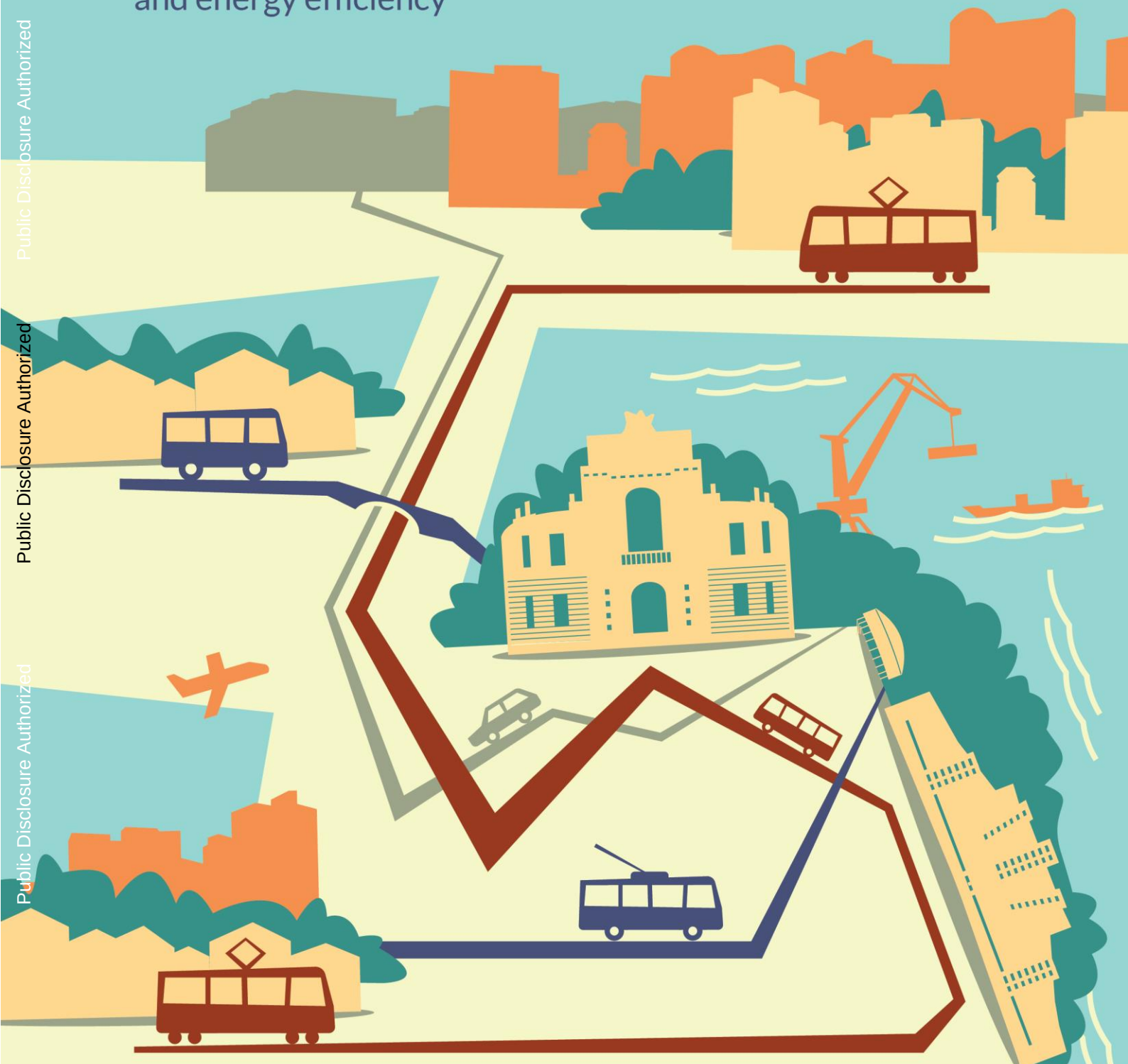
# Sustainable Mobility for Odessa

## A road map for improving accessibility and energy efficiency



WORLD BANK GROUP
Transport & Digital Development

ESMAP
Energy Sector Management Assistance Program

SUSTAINABLE mobility FOR ALL

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## A road map for improving accessibility and energy efficiency

Report No: AUS0000346

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# Acknowledgment

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The report was prepared by a World Bank team led by Antonio Nunez, Senior Transport Specialist. The team consisted of Galyna Beschastna, Dmitry Bespalov and a team of consultants from Integrated Transport Planning (ITP) led by Colin Brader and David Brenig-Jones. The report benefited from the comments of Peer Reviewers: Jen Oh (Sr. Transport Specialist), Winnie Wang (Sr. Transport Specialist), Dominic Patella (Sr. Transport Specialist) and Veronika Liskova (European Commission - DG MOVE). The team is grateful for the guidance provided by Juan Gaviria (Practice Manager), Fiona Colin (Lead Transport Specialist), Baher El-Hifnawi (Lead Transport Economist) and Ludmilla Butenko (Program Leader).

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| | |
|---|---|
| A | Bus route number prefix |
| $CO_2e$ | Carbon dioxide equivalent, measure of all GHG emissions |
| LOS | Level of service |
| MT | Marshrutka route number prefix |
| OGET | Odessagorelektrotrans, municipal operator |
| OD | Origin-Destination |
| PPHPD | Passengers Per Hour Per Direction (measure of passenger flow) |
| PPP | Purchasing power parity |
| PT | Public Transport |
| SB | Suburban route number prefix |
| T | Tram route number prefix |
| TB | Trolleybus route number prefix |
| UAH | Ukrainian Hryvnia currency |
| USD | United States Dollar currency |
| WB | World Bank |

# 1. Executive Summary

1.1 With a population of 1 million, Odessa is the fourth most populous city in Ukraine. It is a port city and major tourist destination. While Odessa retains its rich heritage of an outward looking, commercial city, much of the form and function of the city was defined through soviet-era expansion in the latter half of the 20th century; this includes high-rise residential developments on the city periphery and an infrastructure heavy public transport system comprising tram and trolleybus.

1.2 The benefits of this legacy include a high public transport mode share (46% of all trips), a large municipal operator, Odessagorelektrotrans (OGET), and dense residential areas that are well suited to public transport (PT). However strategic planning and investment has suffered under the transition from a centrally planned economy towards a market lead approach. As a consequence, tram and trolleybus networks have deteriorated and in their place a plethora of inefficient, uncomfortable and polluting marshrutka services have grown to fill the service gaps, and complete with, municipal services. Marshrutkas represent today about 50% of the total number of PT routes and 50% of the number of PT trips.

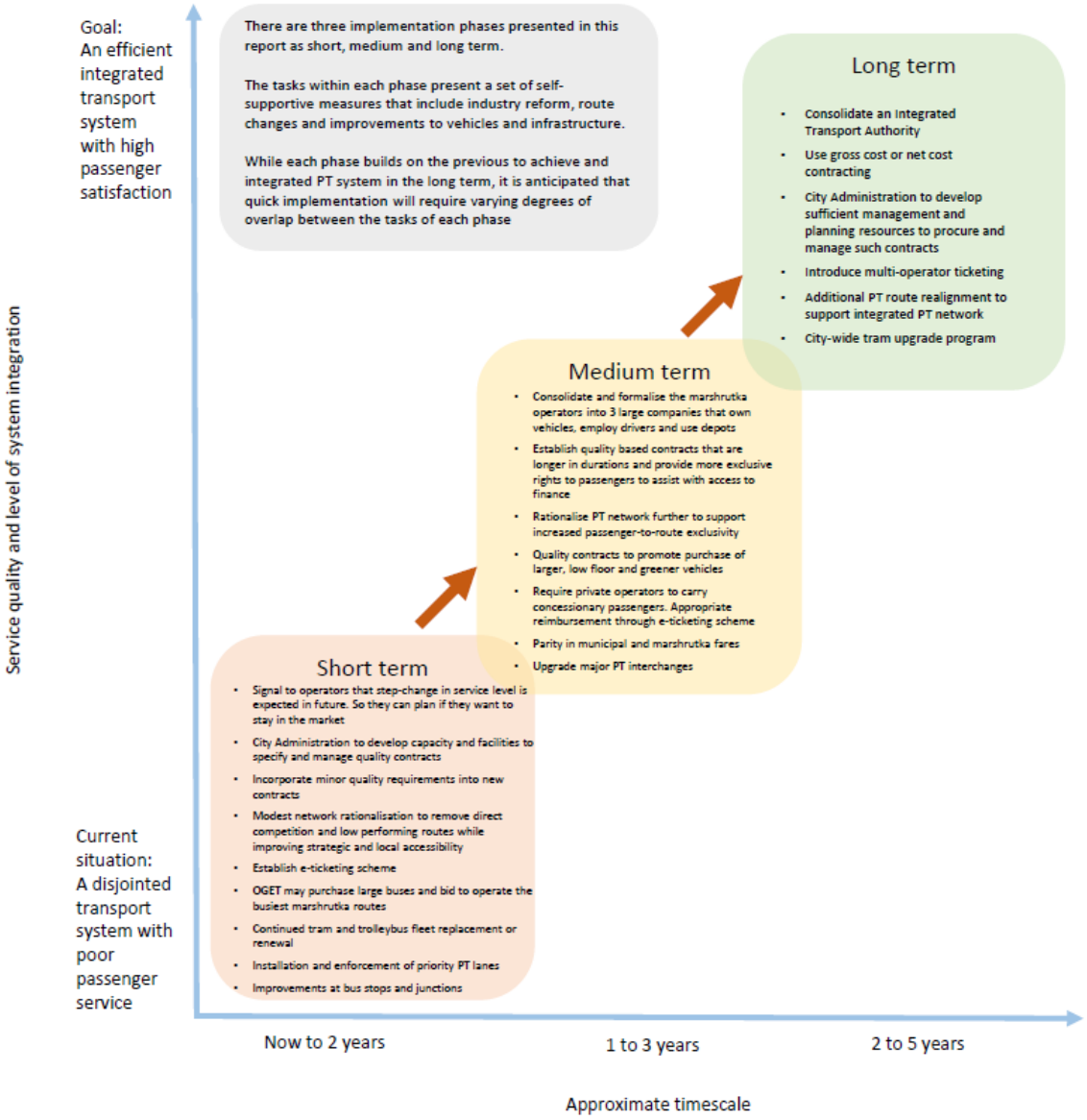
1.3 The City Administration is currently engaged in a project to improve the tram and trolleybus networks. This will the see the opening of the new north-south tram link in 2018 and the delivery of 10 new trams and 45 trolleybuses (with assistance from EIB/EBRD). Building on this success, the City has the ambition for wide-ranging improvements to achieve a step-change in provision of PT across the city.

1.4 There is an urgent need to reorganize and restructure the PT network to align with the actual needs of the population through enhancement of the routes and quality of service provided by OGET as well as revising the model of private operations from the current atomized low quality and inefficient operations to sustainable high quality operations through market consolidation, competition for the market and regulation. The reorganisation of the current network coupled with industry reform, and improvements to infrastructure and fleet will be necessary to improve the network efficiency both in terms energy consumption and services provided, supporting better financial stability and better mobility options and conditions for residents of Odessa.

1.5 This study has conducted a comprehensive assessment of the PT network in Odessa, involving the collection and analysis of PT demand and supply data, land-use and socio-economic data, focus groups, user needs surveys and stakeholder consultation. Special

attention has been paid to understand the particular challenges encountered by specific groups of users, including women, disabled and the elderly.

1.6 This information has been assessed to identify the root causes of underperformance, the desires of the travelling public, opportunities for improvement and the administrative capacity for delivery and supported the preparation of an integrated strategy to improve PT provision in Odessa in the short, medium and long term. The graph below summarizes the approach.



# Understanding the main issues

1.7 The assessment of the public transport network reveals the following as the problems faced by the passengers:

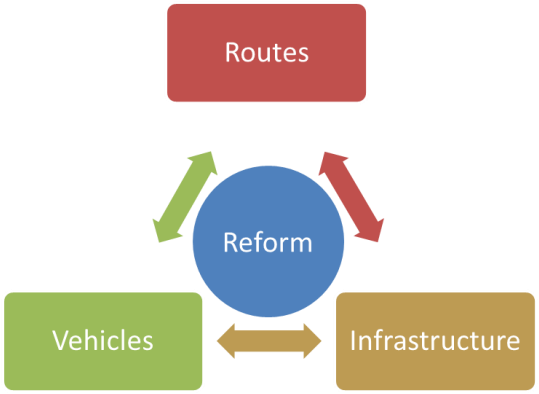
- **Despite the high level of network coverage, travel times across the city are slow**. This is caused by slow operating speeds as well as a lack of strategic connections to certain areas of the city. Travel times from the large residential area of Kotovskoho to get to the city centre is over one hour. The western industrial areas are also poorly connected. As well as costing time for the passenger, poor levels of accessibility reduce the opportunities to access employment and services. There are also local access issues where PT routes do not currently operate.
- **Reliability is poor, particularly for the municipal operator, and headways can be long**. Consequently, long wait times are incurred by the travelling public. This disproportionality affects the elderly and disabled passengers who rely on the municipal network. Poor reliability also affects women disproportionately because they tend to make more complicated trips that involve more interchanges. This is because the purpose and destination of trips undertaken by women tend to be more varied than for men. E.g. A women's family-care role makes them more likely to travel from their work location back home while collecting their child from school and undertaking shopping on-route.
- **Concessionary passengers are largely restricted to use the municipal services**. This network is not as extensive as the marshrutka network. As a consequence, the travel choices of concessionary passengers are limited, travel takes longer and involves more interchanges. This affects the elderly, disabled, young, and those travelling with them, which is often women. Approximately 40% of all PT passenger hold concessionary status, but they comprise 77% of OGET passengers. Public-sector employees also have concessionary status, but their earning enable them to use marshrutka if desired.
- **Poor vehicle comfort and poor ride quality have been raised as a major issue by all groups, but especially by women and disabled passengers**. Vehicles are often overloaded, seating poor and there is a lack of heating or air conditioning. The vehicles are hard to step on/off due to the high floor height. Furthermore, drivers seek to maximising revenue rather than passenger service. There is also a lack of a culture to look out for vulnerable users or prevent the harassment of women.
- **Infrastructure is lacking for waiting passengers and at interchanges**. This includes a lack of PT shelters.

1.8 The root causes of PT under performance in Odessa have been determined to be:

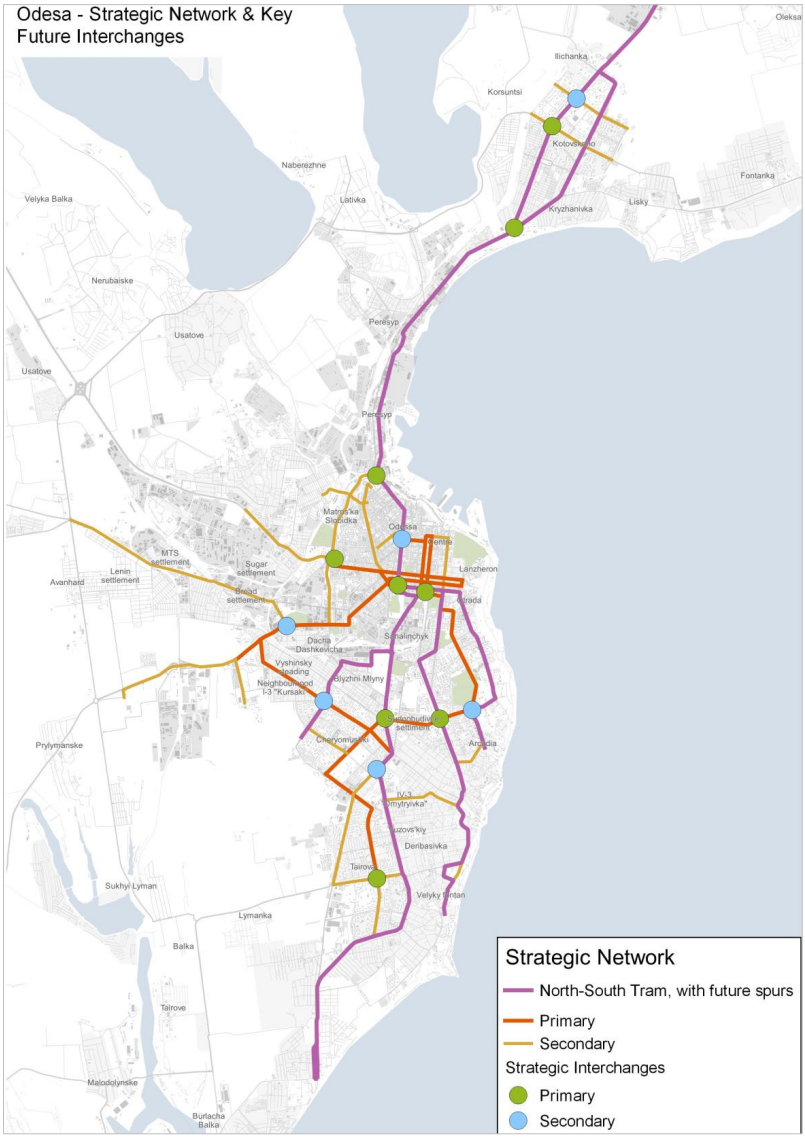
- **Market segmentation.** Effectively two separate PT networks operate side by side: the Marshrutka network, used more by fare paying passengers, and the municipal network, used more by concessionary passengers. This is operationally inefficient, increases the number of vehicles required and increases wait times for the passenger. Separating concessionary passengers from fare paying passengers reduces financial stability.
- **High network complexity.** Odessa has a large number of PT routes, most overlap considerably. There is a core set of routes that carry most passengers, alongside a large number of low passenger routes (43% of routes carry only 10% of passengers). This reduces operational efficiency and increases wait time for the passenger. Competition on the roads for the passenger is increased. This perversely leads to lower level of service (poor driver handling), pressure to keep fares low and underinvestment in vehicles or standards.
- **Light regulation of the marshrutka industry.** The loose regulatory and enforcement regimes create low barriers to entry where participants can operate on absolute margins. Expenditure on driver salaries, training, maintenance and spare parts can be cut to a minimum. Consequently unsafe, uncomfortable and overcrowded vehicles are driven by drivers seeking to maximise revenue whilst working long hours. This encourages poor driving that negatively impacts on traffic congestion, accidents and air pollution. Customer handling is also poor, as some drivers are rude and inconsiderate to passengers.
- **Constrained and inefficient use of road space.** The operational speed of PT services is reduced due to parking, insufficient junction control and congestion. Slow operating speeds require a larger fleet and increase operational costs and air pollution.
- **Tired infrastructure, old vehicles and lack of stop facilities.** Aged tram tracks are extremely worn which reduces operating speeds. Old vehicles are uncomfortable and their high floors make them hard to access. They are also less efficient and produce more air pollution.
- **Lack of capacity at the City Administration to improve PT.** The City Administration lacks the staff, knowledge and regulatory authority to develop and implement plans that improve PT, or to manage quality based contracting of services.
- **Low fares and lack of revenue protection.** The standard municipal fare is low compared to similar countries in terms of affordability. And due to the high numbers of concessionary passengers, the revenue per passenger collected by the municipal operator is extremely low. Consequently, the municipal operator cannot invest in new vehicles.

# Towards a more sustainable public transport

1.9 To achieve a step change improvement in the provision of public transport an integrated approach is presented. The four components are illustrated below. The improvement of routes, infrastructure and vehicles all support each other. But for improvements in these areas to have the desired impact, reform of the PT industry is necessary.




1.10 To focus the recommendations, a strategic network has been defined to that seeks to support the fast movement of the largest passenger flows. The recommended route changes and infrastructure improvements will support the development of this strategic network.




1.11 In accordance with the integrated approach to improvement, recommendations are presented that cover industry reform, route changes, vehicles and infrastructure.

## Industry reform

1.12 The City Administration has adopted a conceptual plan for improving public transport in Odessa (paragraph 3.6). This conception requires ambitious institutional development and complete reform of the public transport industry. The plan includes endowing the City with the powers to function as an Integrated Transport Authority. These reforms will be complex, challenging and cannot be made in a single step. Therefore, we have developed a series of actions that can be performed in the short, medium and long term to help achieve the goals.

1.13 ***In the short term:***

- **Marshrutka owners shall start improving the vehicle quality and performance**. The City Administration shall start preparing the contractual framework to support these changes.
- **New contracts should require improvements to vehicles interiors, bodywork, and seating.**
- **Develop a code of conduct for marshrutka drivers** accompanied by a driver training course and introduce a poor driver behaviour reporting system.
- **Review fares to reflect the real operating costs.** Odessa City Administration is already in the process of discussing fare increase to reflect the operating costs and ensure financial sustainability of the system.
- **Establish e-ticking system with GPS reporting** (Automatic Vehicle Location) to collect monitoring information and enable revenue reporting
- **Develop electronic database for monitoring and contracting routes**
- **City Administration to gain staff and technical ability** to:
  - Contract out, monitor and enforce route contracts that include quality criteria
  - Develop strong in-house transport planning capabilities
  - Deliver supporting infrastructure works such as priority lanes and junction improvements

1.14 ***In the medium term:***

- **Consolidate and formalise the marshrutka companies**. To improve their managerial, organisational and financial capacity. Consolidation could focus on the 3 major operators.
- **Encourage marshrutka companies to operate large buses,** and to become owners of the vehicles and employ drivers and mechanics.
- **Promote fair wages and employment opportunities for women** through operator permits.
- **Help private operators to access finance for new vehicles**: new contracts should provide exclusive, longer and more permanent rights to routes and their passenger base. This requires further rationalisation of the network.
- **Expand quality criteria for contracts** to include vehicle emissions, low floor access, CCTV.
- **City to help operators establish 3 new depots** from which to operate larger buses.

- **Require marshrutka's to carry any concessionary passengers**, monitoring e-ticking system.
- **Further increase the standard municipal (OGET) fare to match marshrutka**, as the marshrutka industry is formalised and routes rationalised.

1.15 ***In the long term:***

- **Implement an Integrated Transport Authority,** which will structure, plan and regulate an integrated network of public transport.
- **Consider the different options for contracting out routes** from gross cost to net cost and the hybrid options, making incremental improvements using models that are pragmatic given other constraints.
- **City to gain considerable management resources** to procure and supervise contracts.
- **Introduce multi-operator ticketing** such as travel cards

## Route changes

1.16 **Route changes seek to increase strategic and local connectivity and improve operational and energy efficiency.**

1.17 **Route changes are required at every stage of the reform process.** As some changes require industry reform or new infrastructure.

1.18 **In the short term we recommend 5 new routes, 16 routes are modified and 25 are deleted.** Resulting in a reduction in the total number of routes from 91 today to 73. We recommend:

- 5 new routes are introduced and 6 routes are modified to improve strategic and local access as well as to feed the new north-south tram route.
- 6 marshrutka routes are closed and 1 is shortened to reduce completion with municipal services.
- 7 pairs of marshrutka routes share very similar paths. The route with the lower number of passengers should be closed and the surviving route modified to help carry the displaced passengers.
- 7 marshrutka routes with very low passengers and no social need should be closed.
- OGET could take over the operation of the most intensively used marshrutka routes and being operating 12m buses on them. The eight most intensively used

marshrutka routes are expected to carry 45% of the total marshrutka market following rationalisation.

1.19 **In the medium term further route rationalisation is required** to support industry consolidation to provide more exclusive passenger base per route for operators.

1.20 **In the long term we recommend the upgrade of the tram network and a new 5.5km tram spur in Kotovskoho**. This will allow new long-distance tram routes from Kotovskoho in support of the new north-south tram line.

## Vehicles

1.21 ***In the short to medium term:***

- **Continue to refit trams that are over 30 years old** ($6.18M)
- **Continue to replace 128 trolleybuses that are over 15 years old**, with new ($19.2M)
- **Purchase an additional 7 trolleybuses** to carry the extra forecast passengers ($1M)
- **Purchase a fleet of large 12m buses**, that are either electric or diesel powered. These large buses can be operated by OGET or private operators following industry reform. Electric buses should be strongly considered ($26.8M for a new fleet of 223 diesel buses or $55.8M if they are electric)

1.22 **In the long term: replace the tram fleet** because the current high floor units are uncomfortable and hard to get on/off. Replace with low floor units that have a larger carrying capacity, improved operational efficiency and easier to get on/off ($100M). The use of low floor vehicles depends on the renewal of the tram tracks and catenary which is required in the long term.

## Infrastructure

1.23 ***In the short term:***

- **Public Transport (bus) stop upgrades**:
  - Upgrade 600 of the busiest stops by installing raised platforms, new shelters, maps, timetables and CCTV ($6M)
  - Install Real Time Passenger Information (RTPI) at the top 300 busiest stops ($3M)
- **Improve 15 major junctions**

  - Channelization to guide vehicles through the large squares
  - Removal of parking
  - Coordinated signals, including priority for PT, such as trams
- **Install 60km of PT priority lanes along the strategic network** ($5M)
  - A comprehensive traffic plan is required for the key city centre streets of Preobrazhensk'ka St and Panteleimonivs'ka St. These streets suffer severe congestion that hamper the core tram and trolleybus routes.

1.24 **In the medium-term upgrade 15 major interchanges sites** including improved layout, organisation, shelters, passenger amenities, walkways, crossing points and disabled access ($7.5M)

1.25 **In the long term renew 200km of tram tracks and catenary** that OGET have identified to be in a poor state ($400M) this will enable 3 more north-south tram routes to be developed. Also construct a 5.5km tram spur through Kotovskoho ($25M).

1.26

## Expected impacts

1.27 **The recommendations will improve mobility across Odessa**. They will allow residents to access more jobs and services while enabling tourists and other visitors to reach more destinations. The introduction of new strategic routes and PT priority lanes will help to connect peripheral areas such as Kotovskoho to the rest of the city. Improvements to the vehicles and stops will enable a more comfortable passenger experience which is so much desired by the travelling public.

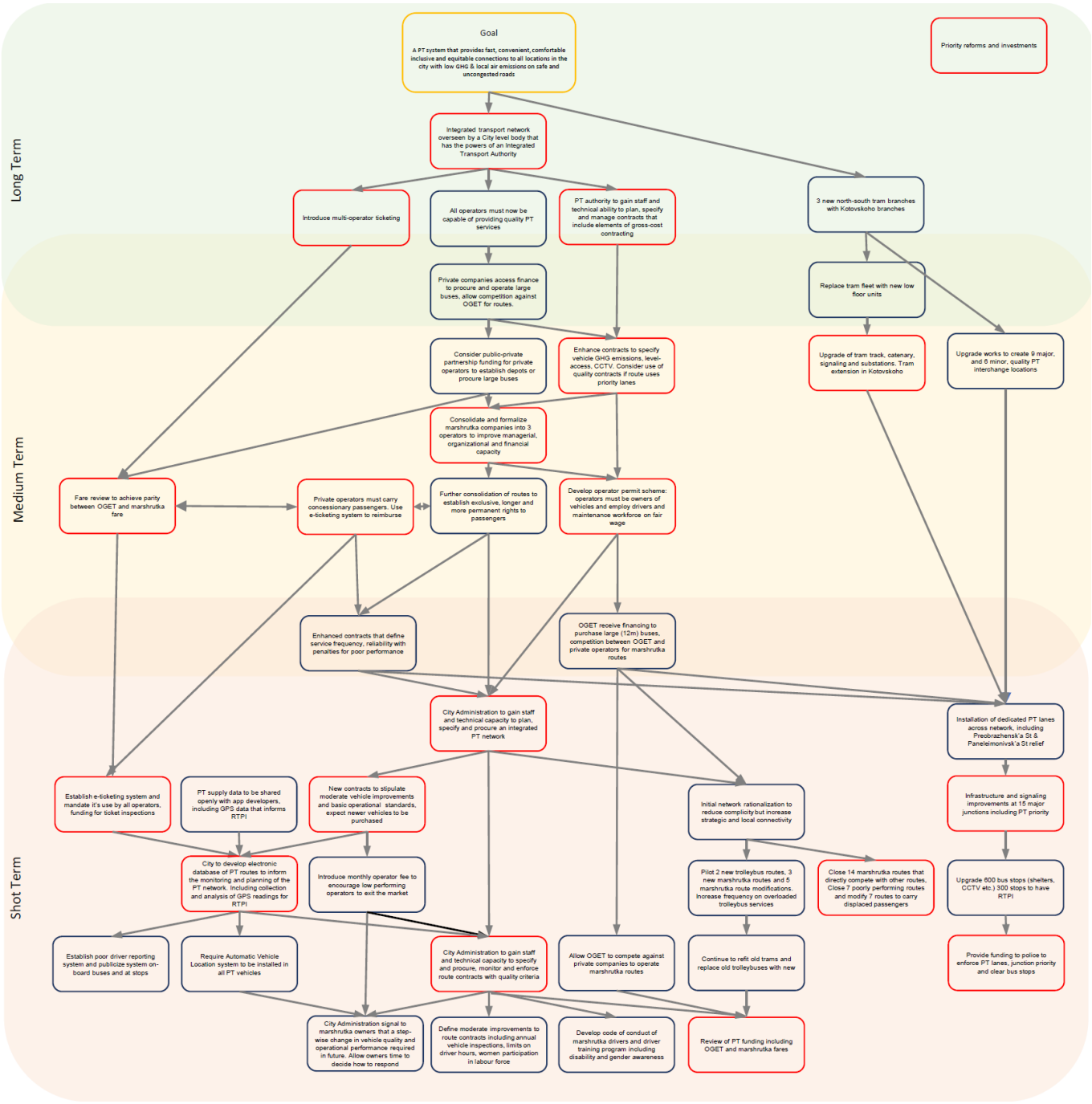
1.28 **Significant environmental gains are expected**. A shift to use greener PT modes in a more efficient way will enable GHG emissions, and local air pollutants to reduce by 18% if a new fleet of large buses are diesel, or by 29% if they are electric powered. But even more importantly, the plan seeks to develop a quality public transport system that will offer a better service than the car, thereby encouraging Odessa citizens to stick with PT for the long term.

1.29 **The travelling experience for women and participation in the transport labour market should be improved** through better service reliability, facilitating interchange and enabling children to travel on marshrutka, by the use of comfortable and larger vehicles, driver training, and the inclusion of more women in the PT workforce at all levels.

1.30 **Disabled users will benefit from a dramatic increase of the usable PT network** through the introduction of modern low floor buses, accessible stops and the acceptance of concessionary passengers on all services.

1.31 **Direct economic benefits such as operating costs savings and travel time savings will accompany the wider economic benefits that include agglomeration effects and the realisation of latent demand from poorly connected areas**. Operators will benefit from faster journey times and the use of larger, more energy efficient vehicles. Total operating costs will reduce by 18% in the short term. The operational cost per passenger should reduce from 2.7UAH today to 2.2UAH.

1.32 **The chart below shows the interrelation between the different proposed actions and expected results.**


Long Term
Medium Term
Shot Term
Goal
A PT system that provides fast, convenient, comfortable inclusive and equitable connections to all locations in the city with low GHG & local air emissions on safe and uncongested roads
Priority reforms and investments
Integrated transport network overseen by a City level body that has the powers of an Integrated Transport Authority
Introduce multi-operator ticketing
All operators must now be capable of providing quality PT services
PT authority to gain staff and technical ability to plan, specify and manage contracts that include elements of gross-cost contracting
3 new north-south tram branches with Kotovskoho branches
Private companies access finance to procure and operate large buses, allow competition against OGET for routes.
Replace tram fleet with new low floor units
Consider public-private partnership funding for private operators to establish depots or procure large buses
Enhance contracts to specify vehicle GHG emissions, level-access, CCTV. Consider use of quality contracts if route uses priority lanes
Upgrade of tram track, catenary, signaling and substations. Tram extension in Kotovskoho
Upgrade works to create 9 major, and 8 minor, quality PT interchange locations
Consolidate and formalize marshrutka companies into 3 operators to improve managerial, organizational and financial capacity
Fare review to achieve parity between OGET and marshrutka fare
Private operators must carry concessionary passengers. Use e-ticketing system to reimburse
Further consolidation of routes to establish exclusive, longer and more permanent rights to passengers
Develop operator permit scheme: operators must be owners of vehicles and employ drivers and maintenance workforce on fair wage
Enhanced contracts that define service frequency, reliability with penalties for poor performance
OGET receive financing to purchase large (12m) buses, competition between OGET and private operators for marshrutka routes
City Administration to gain staff and technical capacity to plan, specify and procure an integrated PT network
Installation of dedicated PT lanes across network, including Preobrazhensk'a St & Panelelmonivsk'a St relief
Establish e-ticketing system and mandate it's use by all operators, funding for ticket inspections
PT supply data to be shared openly with app developers, including GPS data that informs RTPI
New contracts to stipulate moderate vehicle improvements and basic operational standards, expect newer vehicles to be purchased
Initial network rationalization to reduce complicity but increase strategic and local connectivity
Infrastructure and signaling improvements at 15 major junctions including PT priority
City to develop electronic database of PT routes to inform the monitoring and planning of the PT network. Including collection and analysis of GPS readings for RTPI
Introduce monthly operator fee to encourage low performing operators to exit the market
Pilot 2 new trolleybus routes, 3 new marshrutka routes and 5 marshrutka route modifications. Increase frequency on overloaded trolleybus services
Close 14 marshrutka routes that directly compete with other routes. Close 7 poorly performing routes and modify 7 routes to carry displaced passengers
Upgrade 600 bus stops (shelters, CCTV etc.) 300 stops to have RTPI
Establish poor driver reporting system and publicize system on-board buses and at stops
Require Automatic Vehicle Location system to be installed in all PT vehicles
City Administration to gain staff and technical capacity to specify and procure, monitor and enforce route contracts with quality criteria
Allow OGET to compete against private companies to operate marshrutka routes
Continue to refit old trams and replace old trolleybuses with new
Provide funding to police to enforce PT lanes, junction priority and clear bus stops
City Administration signal to marshrutka owners that a step-wise change in vehicle quality and operational performance required in future. Allow owners time to decide how to respond
Define moderate improvements to route contracts including annual vehicle inspections, limits on driver hours, women participation in labour force
Develop code of conduct of marshrutka drivers and driver training program including disability and gender awareness
Review of PT funding including OGET and marshrutka fares

# 2. Public transport in Odessa

## Urban structure

2.1 In the absence of detailed population and employment data by area, Figure 2-1 presents a map of land use and building density which is expected to be indicative of population and employment density.

2.2 There are three high density residential areas, Kotovskoho, Tairova and Cheryomushki. Kotovshoko and Tairova are located at the extreme north and south of the city. Other residential areas include:

- Medium density residential areas:
  - Old Cheryomushki
  - City centre
- Low density residential areas:
  - The eastern half of Kievskji District, to the south of the city
  - Kryva Balka and Slobadka in the west
  - Usatove in the far west
  - Kursaky and Lenselyche in the south-west

Employment is largely focused around:

- the city centre,
- the Port and ancillary activities in Peresyp' district
- A western 'finger' of industrial processing units along Mykoly Borovskogo St and in Bukaivka.

Other important trip attractors include:

- 7-km market, which is an important trading/commerce site
- Tourist destinations on the east coast including Arcadia

2.3 The key challenges relating the structure of the city and transport include:

- The peripheral location of Kotovskoho which necessitates long trip distances to access services and employment in the rest of the city. These trips must also be made through the constrained Peresyp' district.
- Long trip distances are also a feature of journeys from Tariova in the south
- Generally poor PT services connecting with industrial area in the west
- Arcadia is only part of the tourist/beach area which has good PT connections

## Figure 2-1: Land use and building density


Source: www.openstreetmap.com

# Institutional arrangements

2.4 PT services are regulated by the Department of Transport which sits within the Administration of the City of Odessa. The Department of Transport is responsible for specifying and issuing route permits to operators. This means that the Department of Transport has control over where the routes go in the city, opening, closing and amending routes, their level of service, mode used and quality factors.

2.5 The route specifications are referred to as 'route passports'. These detail the path of the route as well as the expected frequency of service and travel time. Each route is let out to an operator for approximately 5 years following a bidding process. However, it is rare for routes to change operators. Operators sometimes propose new routes to the Department for Transport who then decide whether to allow the new route or not.

2.6 The powers of the Odessa Department for Transport are established by state law. The state retains control over some aspects the PT services, for example the state regulates the permitted fares and concessionary fare schemes.

2.7 The municipal operator, Odessagorelektrotrans (OGET), operates half of the routes in the city. As a municipal enterprise it also sits within the Administration of the City of Odessa and works closely with the Department of Transport. There are 11 private operators who operate the marshrutka routes in the city, these make up half of all routes.

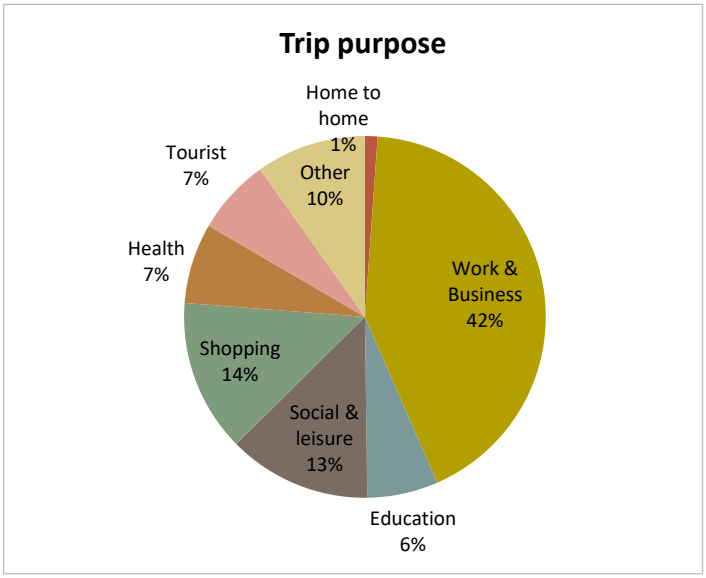
# Demand for public transport

## Trip purpose

2.8 Figure 2-2 presents the split of trip purpose for trips made using all modes throughout the day. The data is derived from the traveller interview survey which was undertaken in September – the number of tourist trips would not be at their maximum during this time.

2.9 7% of trips are made for health purposes. This is high by international standards (in Kyiv it is 2%), however Odessa is known as a healthcare destination providing a number of spa and therapeutic resorts.

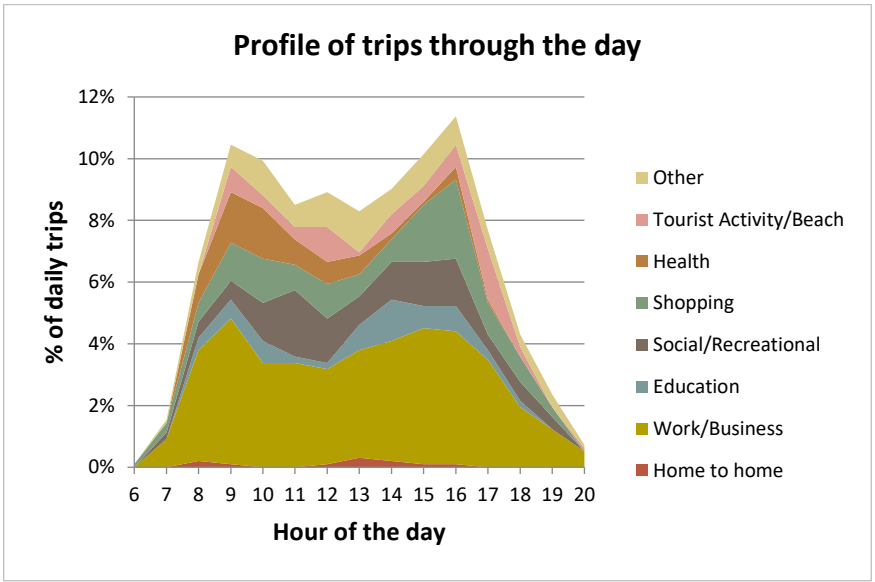
## Figure 2-2: Trip purpose share




Source: Traveller interview survey

2.10 The profile of the time of day these trips are made is shown in Figure 2-3.

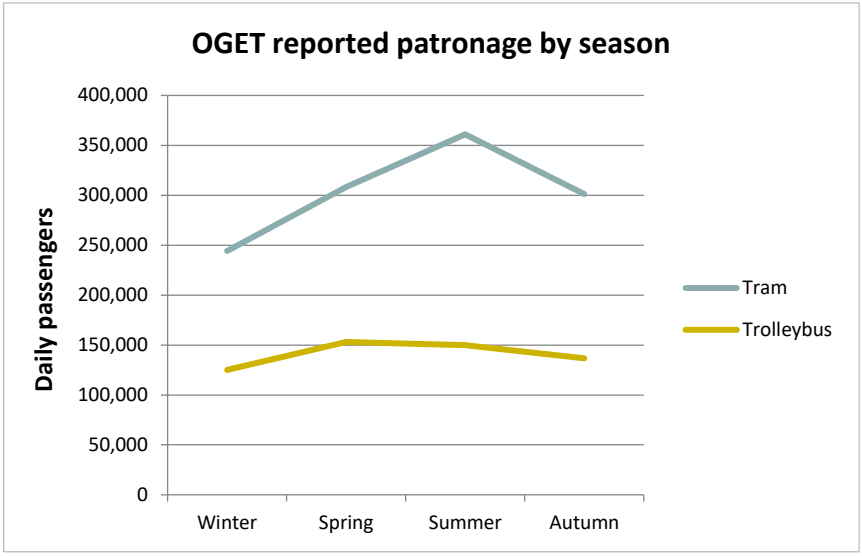
## Figure 2-3: Profile of all trips undertaken throughout the day




Source: Traveller interview survey

2.11 The demand for public transport changes through the year as the large number of tourists visiting Odessa push up passenger numbers in the summer. The peak tourist season runs June, July and August.

## Figure 2-4: Seasonal changes in patronage




Source: OGET passenger numbers

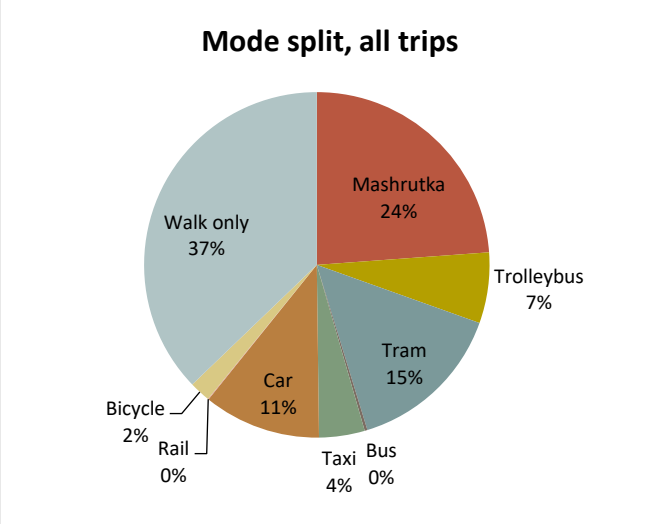
## Mode share

2.12 An initial estimation of the mode share in Odessa has been developed by combing the results of the traveller interview survey, boarding/alighting survey and an estimate of the total number of trips conducted in the city in a single day. This estimate is presented in Figure 2-5. To further develop mode share statistics, including the identification of variations by neighbourhood, a city-wide survey is required.

2.13 Public Transport (PT) is the dominant mode in Odessa. Nearly half of all trips (46%) are conducted on PT. This is very high by international standards and is slightly higher than Kyiv where 37% of trips are carried by PT. Walking is the second most popular mode, accounting for 37% of trips (compared to 35% in Kyiv). Trips conducted by car and taxi together only make up 15% of all trips, compared to 28% in Kyiv.

2.14 The low number of trips conducted by car can be explained by the low level of car ownership in the city. 63% of respondents, to the traveller interview survey, reported to live in a house without access to a car, while only 8% live in a house with two or more cars (Table 2-1).

### Figure 2-5: Mode split of all trips




Source: Composite of boarding/alighting and traveller interview surveys

### Table 2-1: Car ownership in Odessa

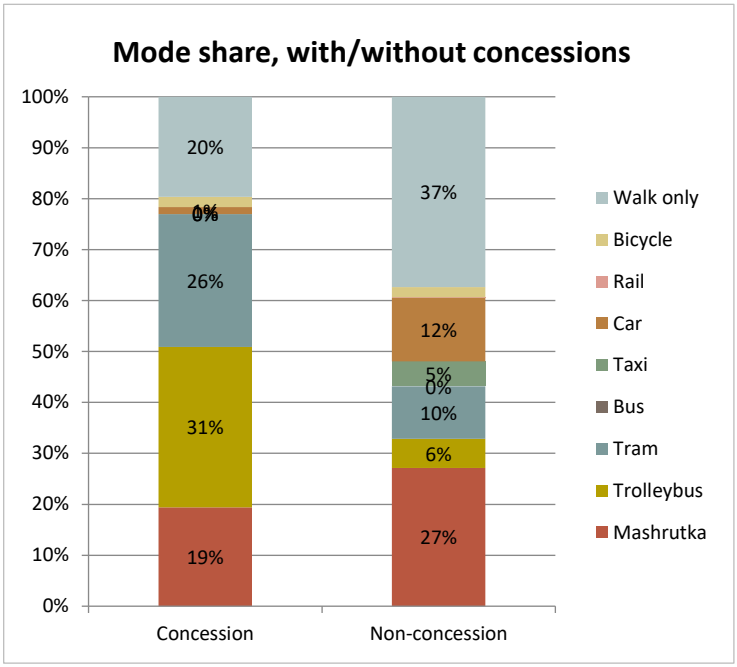
| Number of cars in household | % of travellers |
|---|---|
| **None** | 63% |
| **One** | 28% |
| **Two** | 7% |
| **Three** | 1% |

Source: Traveller interview survey

2.15 Differences in mode split are also related to a traveller's concessionary status. A number of social groups receive free and discounted PT travel, the largest of which are the elderly. These free trips can be performed on all tram and trolleybus services, however the privately operated marshrutka services are only expected to carry up to 2 concessionary passengers.

2.16 As expected Figure 2-6 shows that concessionary passengers perform many more trips on tram and trolleybus and fewer on marshrutka. Interestingly they make fewer walking trips; this could be because they can simply take a free ride on PT instead of walking.

### Figure 2-6: Mode split by concessionary status




Source: Traveller interview survey

## Pattern of travel demand

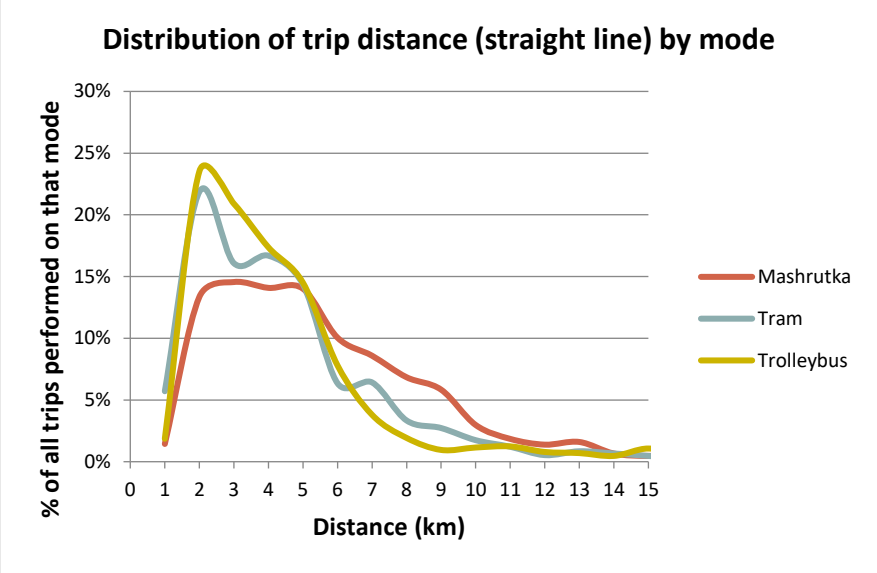
2.17 The demand for PT trips has been derived from the on-board origin-destination surveys. Table 2-2 shows that marshrutka services tend to serve longer distance trips, matching their longer route length (Table 2-3). In comparison trolleybus and tram routes serve a larger number of short movements (Figure 2-7).

### Table 2-2: Average trip distance by mode used

| Mode | Average straight line trip distance (km) |
|---|---|
| **Tram** | 5.2 |
| **Trolleybus** | 4.0 |
| **Marshrutka** | 4.0 |
| **PT average** | **4.7** |

Source: Origin-destination survey

## Figure 2-7: Distribution of trip distance performed on each PT mode




Source: Origin-destination survey

2.18 The trip pattern derived from the OD survey is plotted in Figure 2-8 for all PT modes and in Figure 2-9 by marshrutka/OGET modes for the AM peak hour.

2.19 The intensity of where trips begin and end are presented by the coloured hexagons. This tends to follow the pattern of building density presented in Figure 2-1. Significant trip production or attraction occurs around:

- Residential areas of Tairova, Cheryomushki and Kotovskoho, as well as Old Cheryomushki and Matros'ka Slobidka
- The city centre, especially the area around the central rail station and near to the Cathedral and Moldavanka, which is adjacent to the city centre to its west
- Arcadia, 7-km market, Peresyp' bridge

2.20 Large passenger movements occur between:

- Kotovskoho and: Peresyp', range of city centre locations (which would require interchange or a long walk to complete)
- Tairova and: city centre, Cheryomushki , 'City Center' shopping mall,
- Cheryomushki and: Moldavanka
- Old Cheryomushki and city centre
- Lenselyche and city centre
- Short trips with the city centre and between city centre and Moldavanka district

- Arcadia and: city centre, Moldavanka, old Cheryomushki, other resorts

2.21 Figure 2-9 shows a distinct difference in the trip movements served by the marshrutka services compared to tram and trolleybus services:

- The tram is very popular for trips between Kotovskoho and Peresyp, while marshrutka carry more passengers between Kotovskoho and the city centre - this is because of the presence of direct marshrutka services to the city centre.
- A large number of tram and trolleybus trips occur between the city centre and Moldavanka, but more specifically between the central railway station and the inter-city bus terminal.

## Figure 2-8: Origin-destination pattern for all PT trips

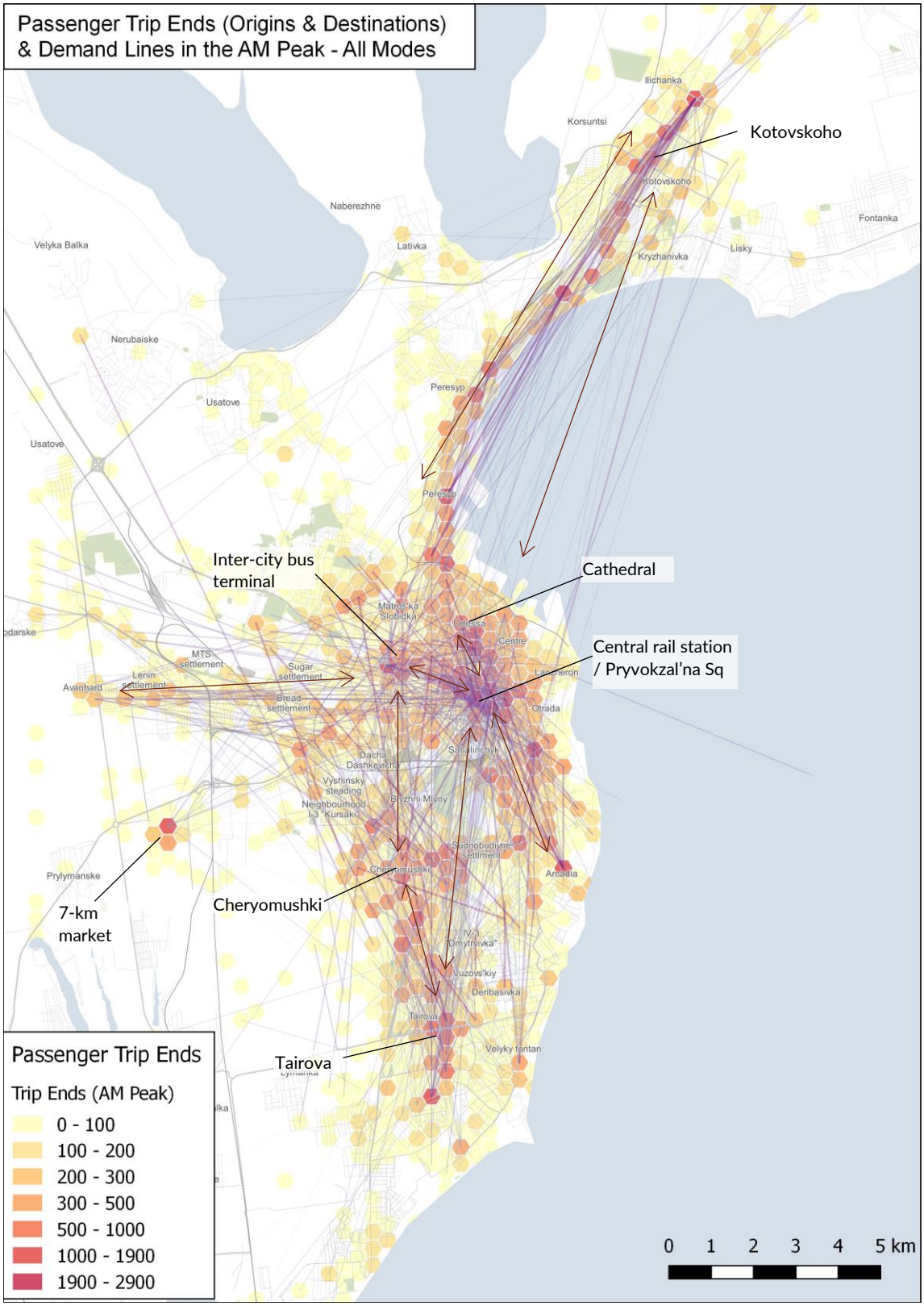
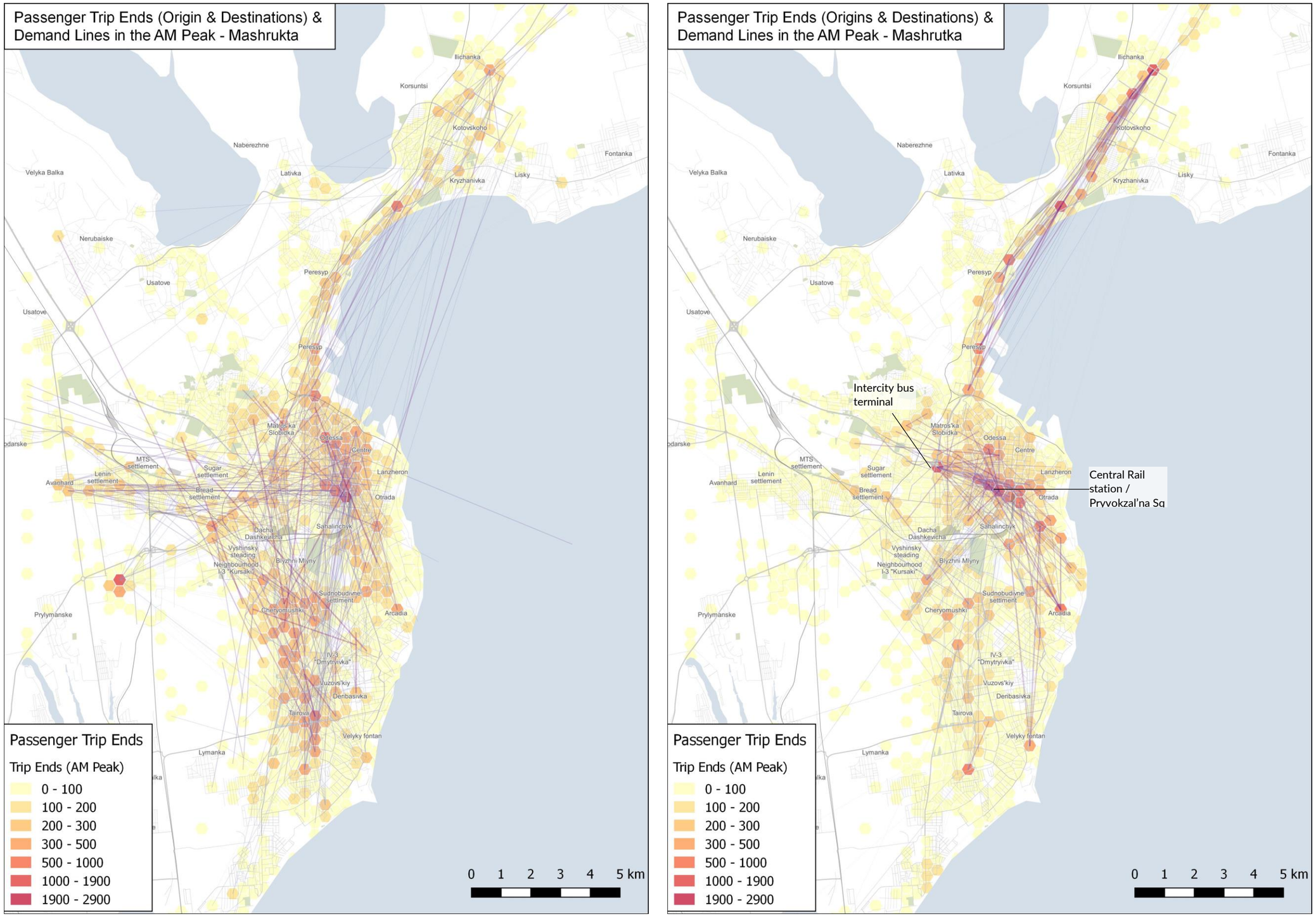


Figure 2-9: Origin-destination pattern for marshrutka (left) and trolleybus/tram (right)



# Supply of public transport

## Transport modes

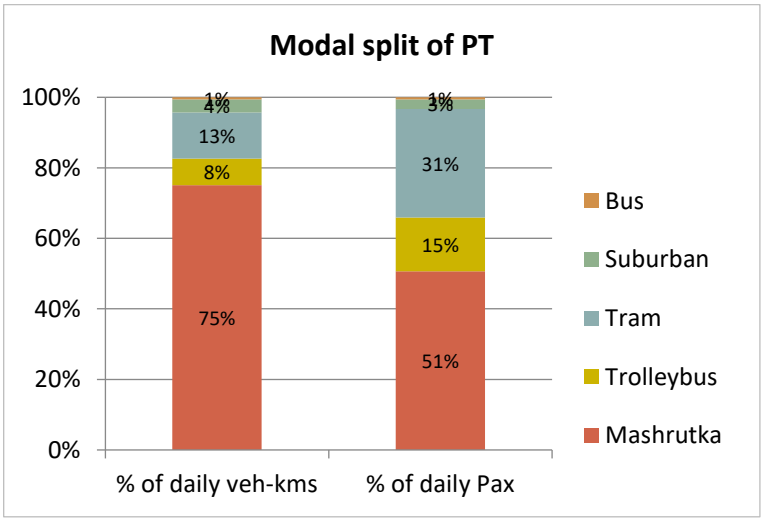
2.22 Odessa is served by six public transport modes; tram, trolleybus, marshrutka, bus and suburban bus. However, the marshrutka and bus routes are operated using the same type of vehicle.

2.23 The municipal operator is Odessagorelektrotrans (OGET) which operates the two electric modes; tram and trolleybus. There are 11 private operators, most of which operate a mix of marshrutka, bus and suburban bus routes.

2.24 The supply of PT in Odessa has undergone an evolution similar to many post-soviet cities. This story begins during soviet times when the municipal operator operated extensive tram, trolleybus and bus networks. Underinvestment in the 1990s and 2000s led to a curtailing of the municipal network and prevented investment in new vehicles. A plethora of privately operated marshrutka services established themselves to provide much needed extra capacity. Today there are a total of 100 PT routes which serve Odessa, this is high for a city with a population of 1,000,000.

2.25 Figure 2-10 and Table 2-3 show that marshrutka services overwhelmingly make up the majority of vehicle kilometres plied by PT vehicles in Odessa, at 75%. However, their small carrying capacity means that they carry only half of all PT passengers.

Figure 2-10: Modal split of PT services




Source: Composite of boarding/alighting and PT frequency & occupancy surveys

## Table 2-3: Public Transport modes in Odessa

| Mode | | Ownership | Typical capacity | No. of routes | No. of units | Ave. length 1-way (km) | Total daily veh-kms | Total daily pax | Ave. speed AM-pk (kph) | Single Fare (UAH) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tram |  | Municipal OGET | 110 | 19 | 228 | 9.1 | 31,000 | 299,000 | 14.5 | 3.0 |
| Trolleybus |  | Municipal OGET | 80 | 11 | 169 | 10.3 | 16,200 | 148,000 | 14.6 | 3.0 |
| Marshrutka |  | 11 private operators | 45 | 56 | 800 | 18.1 | 169,700 | 491,500 | 17.8 | 6.0 |
| Bus | | 4 private operators | 45 | 5 | | 11.8 | 1,300 | 5,000 | No data | 0.7 |
| Suburban bus |  | 2 private operators | 45 | 8 | | 12.0 | 8,800 | 26,500 | 12.2 | 6.0 to 26.0 |
| Total | | | | **99** | **1,197** | | **227,000** | **970,000** | | |

Source: Composite of boarding/alighting, PT frequency & occupancy and traveller interview surveys

2.26 Figure 2-11 shows that the PT network in Odessa is dense and extensive. All of the main roads in the city are plied by a PT route, with many roads served by multiple modes.

2.27 Table 2-4 specifies the extent of the services provided by each PT mode and their functional role. The flexibility of the marshrutka has allowed these services to take on a range of route types. While the fixed infrastructure of the tram and trolleybus networks have led these modes to be more focused on radial routes.

### Table 2-4: Functional role of each PT mode

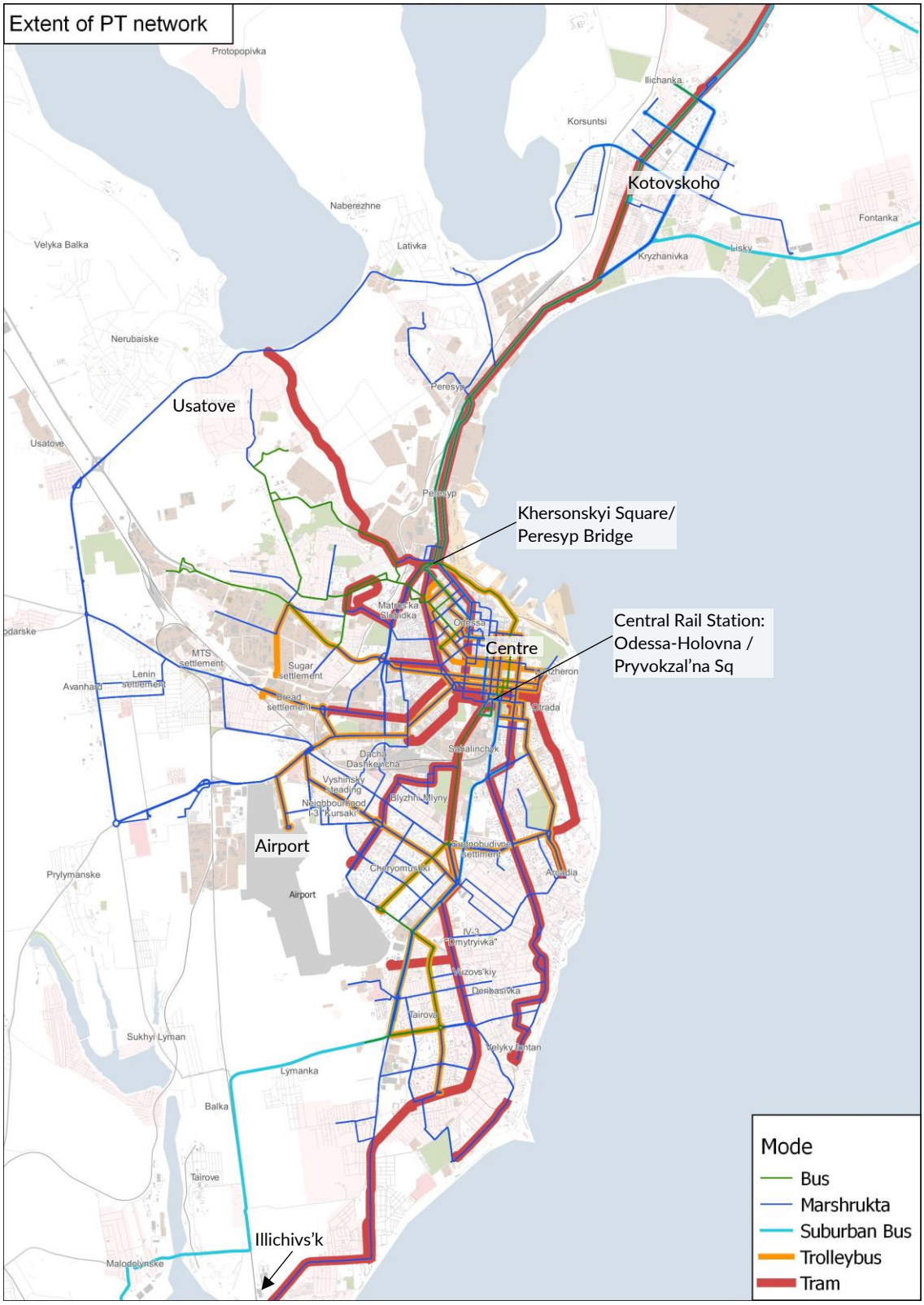
| Mode (route number prefix) | Locations served | Functional role |
|---|---|---|
| **Tram (T)** | • Radial routes emerge from the central rail station (Odessa-Holovna) and from Khersonskyi Square/Peresyp Bridge<br>• Routes do not penetrate CBD<br>• Connects large residential districts located on the edge of the city<br>• Provide long distance connections to Illichivs'k in the south and towards Usatove in the west | • 75% segregated<br>• Slower travel on the road because they stop at all stops and do not overtake vehicles<br>• Low fares<br>• Provide free travel for all concessionary passengers<br>• Connects peripheral locations |
| **Trolleybus (TB)** | • Connects the city centre, the south and west of the city through 9 radial routes and 2 orbital routes<br>• No trolleybus serves run north of the city centre<br>• Penetrates the CBD<br>• Serves airport | • Slower travel speeds because they stop at all stops and do not overtake vehicles<br>• Low fares<br>• Provide free travel for all concessionary passengers |

| Mode (route number prefix) | Locations served | Functional role |
|---|---|---|
| **Mashrutka (MT)** | • Marshrutka services operate on all main roads across the city in a mix of radial, orbital and cross-city routes<br>• Many routes penetrate CBD<br>• Orbital routes connects residential and industrial areas<br>• 9 cross-city north to south routes<br>• 9 routes directly link Kotovskoho and CBD (Trams from Kotovskoho do not penetrate CBD) | • Offer a range of services which provide direct links between trip producing (residential) and attracting areas (CBD/industrial)<br>• Only mode to provide cross-city (north to south) connectivity<br>• Cheap to run and agile in traffic<br>• Higher fares and they only carry up to 2 concessionary passengers |
| **Bus (A)** | Radial routes begin in city centre | Very infrequent services with low fare |
| **Suburban Bus (SB)** | • 2 long distance routes connect CBD to suburban areas<br>• 6 routes connect Kotovskoho to suburban areas in the north and east | • Connectivity to outlying towns<br>• Interchange with city services at Kotovskoho |

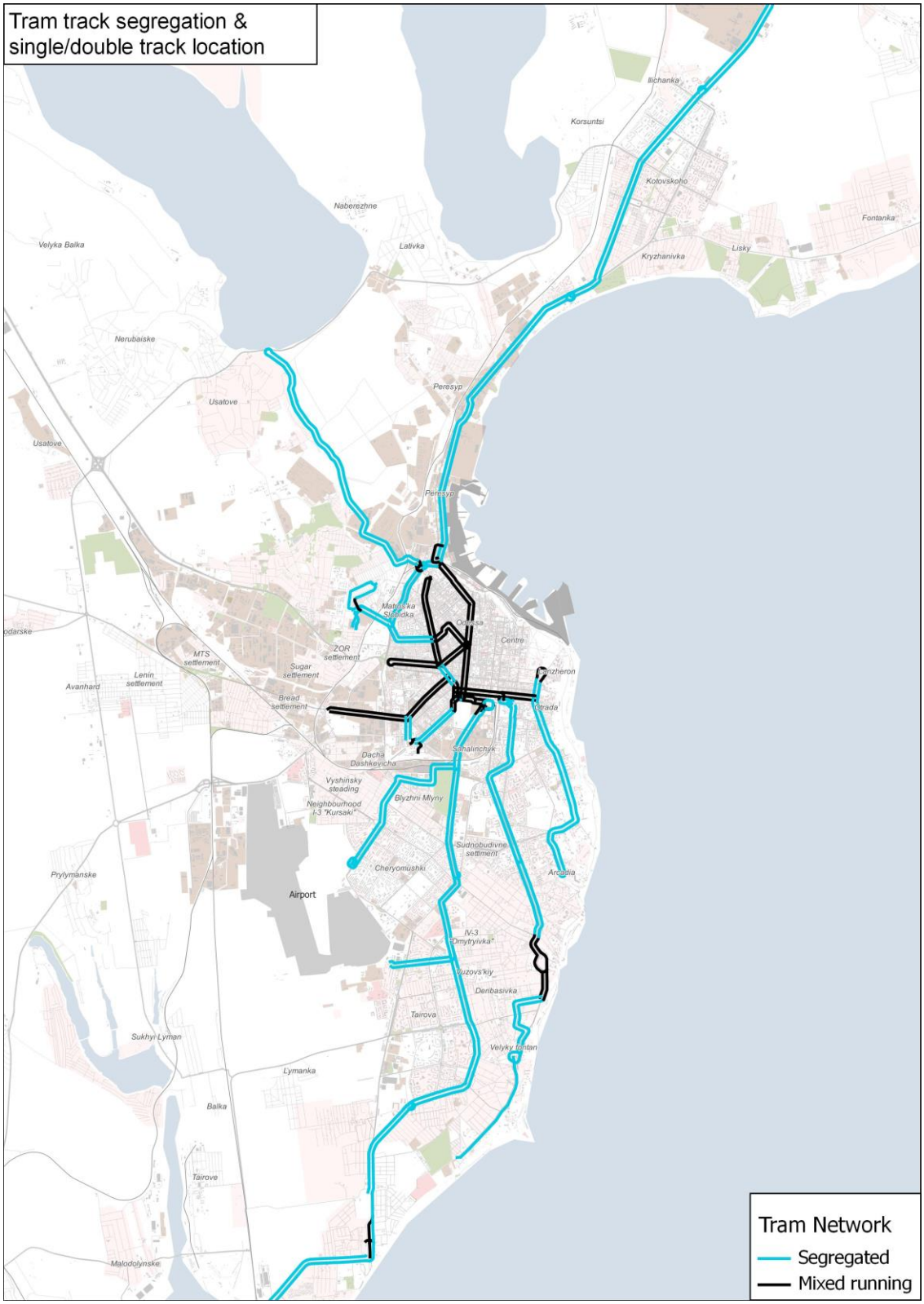
2.28 Figure 2-12 plots just the tram network in Odessa. 75% of which is segregated from general traffic. While poor track and catenary conditions limit operating speeds, the segregated nature of the network is of benefit to travel speed. The average speed for a tram in Odessa is 15kph when segregated and 10kph when in mixed traffic.

2.29 Additionally, most of the tram network is made up of double tracks enabling higher frequencies to be achieved.

## Figure 2-11: Extent of PT network



## Figure 2-12: Tram network



## Network complexity

2.30 While the network is extensive and dense, it is also complex. Figure 2-13 presents the count of PT routes operating on each road section. Many sections are served by a large number of routes which indicates significant route overlaps. The following locations have over 10 PT routes plying the same road:

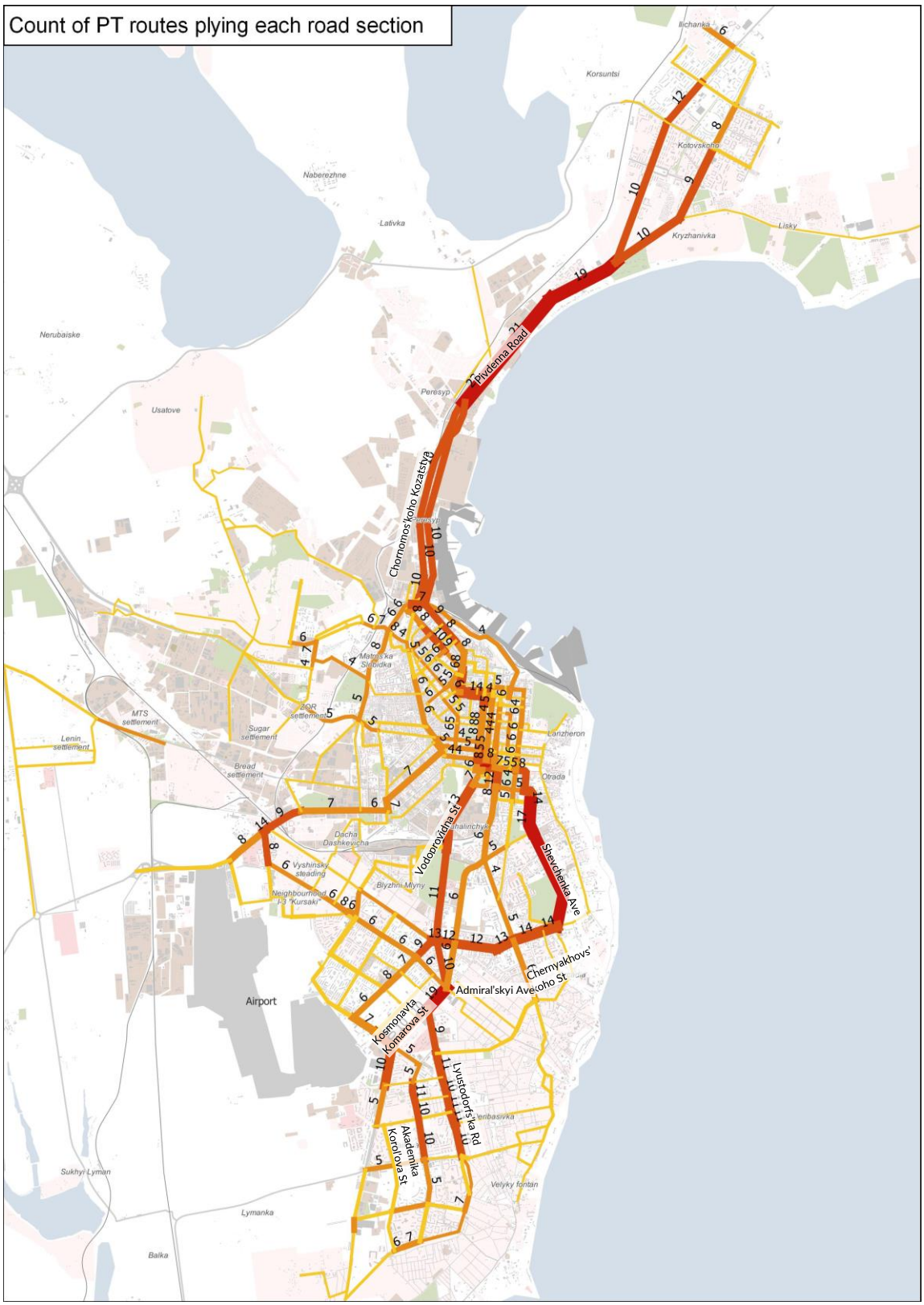
- Chornomos'koho Kozatstva St & Pivdenna Road
- Shevchenka Ave
- Chernyakhovs'koho St & Admiral'skyi Ave
- Vodoprovidna St
- Kosmonavta Komarova St
- Lyustodorfs'ka Rd
- Akademika Korol'ova St

2.31 Unlike Kyiv, where many marshrutka services directly duplicate trolleybus and tram services, there is only one duplicative marshrutka service in Odessa (M9 which duplicates TB9). However, a large number of routes are very similar to each other and share the same path for a significant portion of their route. This indicates an overly complex network. Table 2-5 presents these overlapping routes - the table excludes any overlapping tram routes, or marshrutka services which overlap with tram routes from Kotovskoho.

## Table 2-5: List of overlapping routes

| % of route overlap | | | |
|---|---|---|---|
| 70% - 79% | 80% - 89% | 90% - 99% | 100% |
| **Total: 19** | **29** | **3** | **4** |
| M130 - M131 | TB3 - M233 | TB11 - TB7 | S59 - M240 |
| M250 - M240 | S59 - M190 | TB10 - M210 | TB9 - M9 |
| M190 - M120 | T19 - M191 | M190 - A155 | S39 - S13 |
| TB9 - M210 | S59 - S13 | | S18t - S68 |
| TB9 - TB10 | S59 - S39 | | |
| M240 - A155 | S59 - T7 | | |
| S59 - M130 | TB13 - M210 | | |
| S59 - M165 | TB13 - M9 | | |
| TB14 - M171 | TB13 - TB10 | | |
| S59 - T1 | TB13 - TB9 | | |
| M148 - TB7 | M130 - M145 | | |
| M240 - M190 | M104 - M131 | | |
| M110 - M100Đ | S68 - M131 | | |
| M131 - M242 | S68 - M242 | | |
| M120 - A155 | M250 - M168 | | |
| M240 - M165 | M150 - M124 | | |
| S39 - A155 | S31 - M288 | | |
| S39 - M240 | M130 - A155 | | |
| S39 - T7 | M130 - M146 | | |
| | M130 - M165 | | |
| | M130 - M190 | | |
| | M130 - M240 | | |
| | TB7 - M175 | | |
| | M110 - A155 | | |
| | M110 - M120 | | |
| | M110 - M190 | | |
| | TB11 - M175 | | |
| | M100Đ - M120 | | |
| | M150 - M221 | | |

## Figure 2-13: Count of PT routes plying each road link



2.32 Table 2-6 compares the total number of ground based PT routes in a city to its population. It shows that for its size Odessa has a comparatively large number of routes at 91 per 1,000,000 capita.

Table 2-6: Benchmarking of the number of PT routes by city size

| City | Population | Total number of bus, tram and trolleybus routes | Number of routes per 1,000,000 cap. |
|---|---|---|---|
| **Kyiv*** | 3,375,000 | 368 | 109 |
| **Odessa*** | 1,000,000 | 100 | 91 |
| **Sofia*** | 1,547,000 | 133 | 86 |
| **Kraków, Poland*** | 762,000 | 59 | 77 |
| **Astana, Kazakhstan*** | 1,000,000 | 74 | 73 |
| **Warsaw, Poland** | 3,100,000 | 204 | 66 |
| **Santiago, Chili** | 7,300,000 | 307 | 42 |
| **London, UK** | 9,800,000 | 400 | 41 |

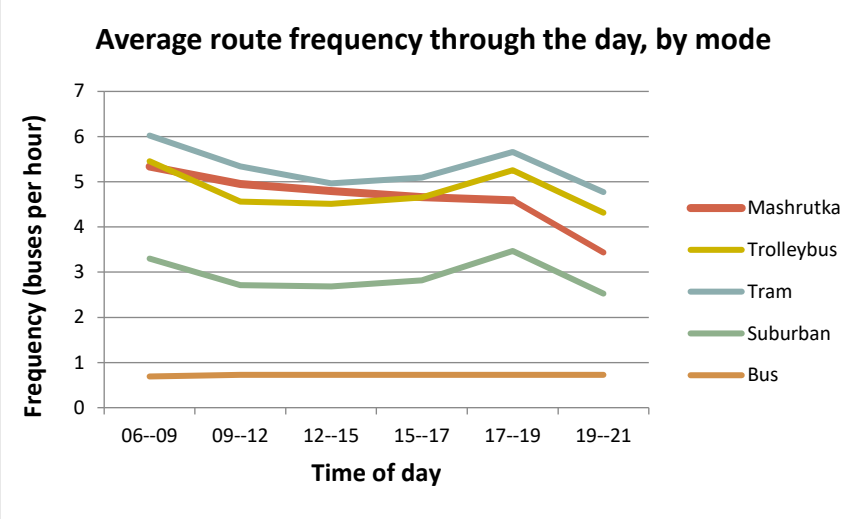
* Source: www.eway.in.ua

## Frequency of service

2.33 The frequency of the typical PT route for each mode is presented in Figure 2-14. This shows that the typical trolleybus, tram and marshrutka routes have a frequency of 5 vehicles per hour in the AM peak. While bus routes are less than 1 vehicle per hour on average.

2.34 The level of frequency is largely maintained throughout the day, without responding to a reduction in demand during the inter-peak (Figure 2-3). Services during the inter-peak are therefore be less loaded than the peak (Figure 2-27).

## Figure 2-14: Average route frequency through the day

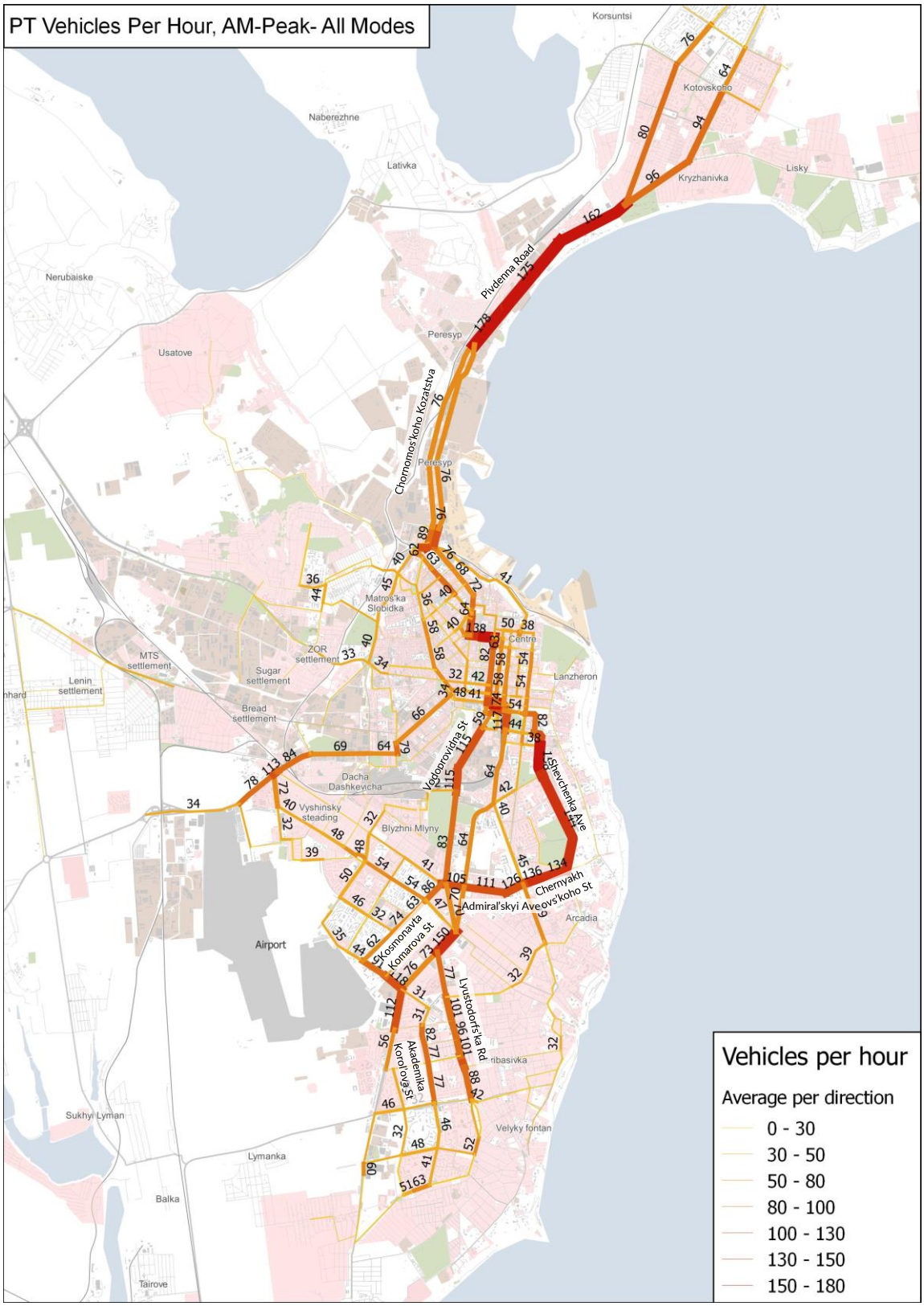



Source: PT frequency & occupancy survey

2.35 Combining the reasonably high frequencies with a high number of routes on many roads results in large number of PT vehicles plying the main roads in Odessa. Figure 2-15 maps the combined frequency of all PT services operating on each road link. It shows a number of roads which have over 60 vehicles per hour (or one per minute). This includes Chornomos'koho Kozatstva St, Pivdenna Road, Shevchenka Ave, Chernyakhovs'koho St, Admiral'skyi Ave, Vodoprovidna St, Prokhorovs'ka St, Lyustodorfs'ka Rd, Kosmonavta Komarova St and Akademika Korol'ova St.

2.36 Such high frequencies indicate a very high level of service; however, this doesn't translate into high effective frequencies for the waiting passengers. This is because many of the services passing will not be relevant to the waiting passenger. Concessionary passengers will wait longer to board a trolleybus or tram where they can travel for free. The average wait time at a stop to board a marshrutka service is 5 minutes, for a trolleybus 9 minutes, and 6 minutes for a tram (Figure 2-21).

## Figure 2-15: Combined frequency of PT services on each road link




Source: PT frequency & occupancy survey

## Public transport stops

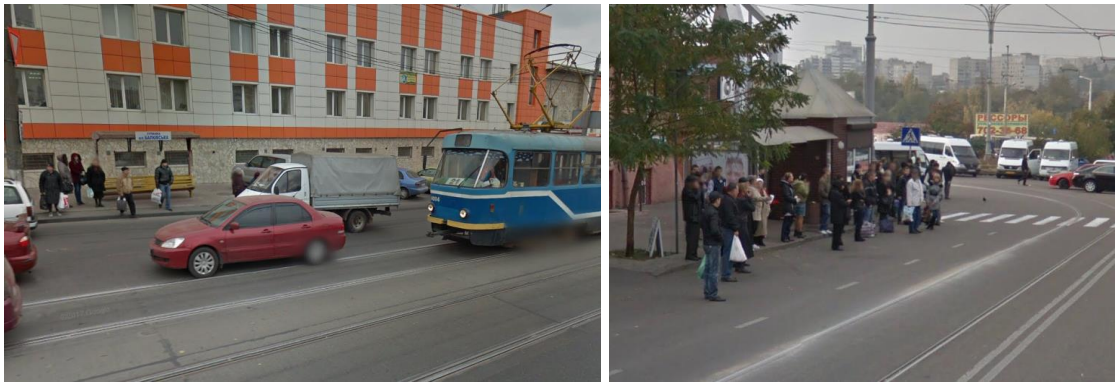
2.37 The majority of PT stops in Odessa lack a shelter, this includes large interchange sites such as Khersons'kyi Skver and parts of Pryvokzal'na Sq - see left image below of Figure 2-16 . Examples of stops shelters which are in place are also shown on the right the figure.

### Figure 2-16: PT stops without a shelter (left) and with (right)


Top left: Khersons'kyi Skver, top right: New Privoz Market,
Bottom left: Pryvokzal'na Sq, bottom right: Seredin'ofontans'ka St

2.38 Many tram lines are located in the middle of road with stations at the side. To board a tram, waiting passengers may stand in the roadway, or have to cross busy road, both of which put passengers in a dangerous location (Figure 2-17).

## Figure 2-17: Dislocated tram stops



Left: Balkivska St, right: Avtovkzal (Intercity bus terminal tram stop)

2.39 Trolleybuses, trams and marshrutka all feature high floors with steep steps to board. These can be challenging for elderly, disabled, those carrying shopping or travelling with children. No PT stops provide a raised platform to assist passengers to board, and many vehicles stop away from the curb, requiring passengers to climb the full height of the steps (Figure 2-18).

## Figure 2-18: High steps to board a trolleybus and lack of level boarding

## Public transport interchanges

2.40 The number of passengers boarding and alighting at each stop in the city is presented in Figure 2-19 for the AM peak hour. This information is presented as a total for all modes on the left-hand side, and on the right the individual the three colours separate out the passenger movements by mode, this allows us to compare the number of passengers using each stop by mode.

2.41 A number of important interchanges have been identified; these are listed in Table 2-7 as well as their function and condition.

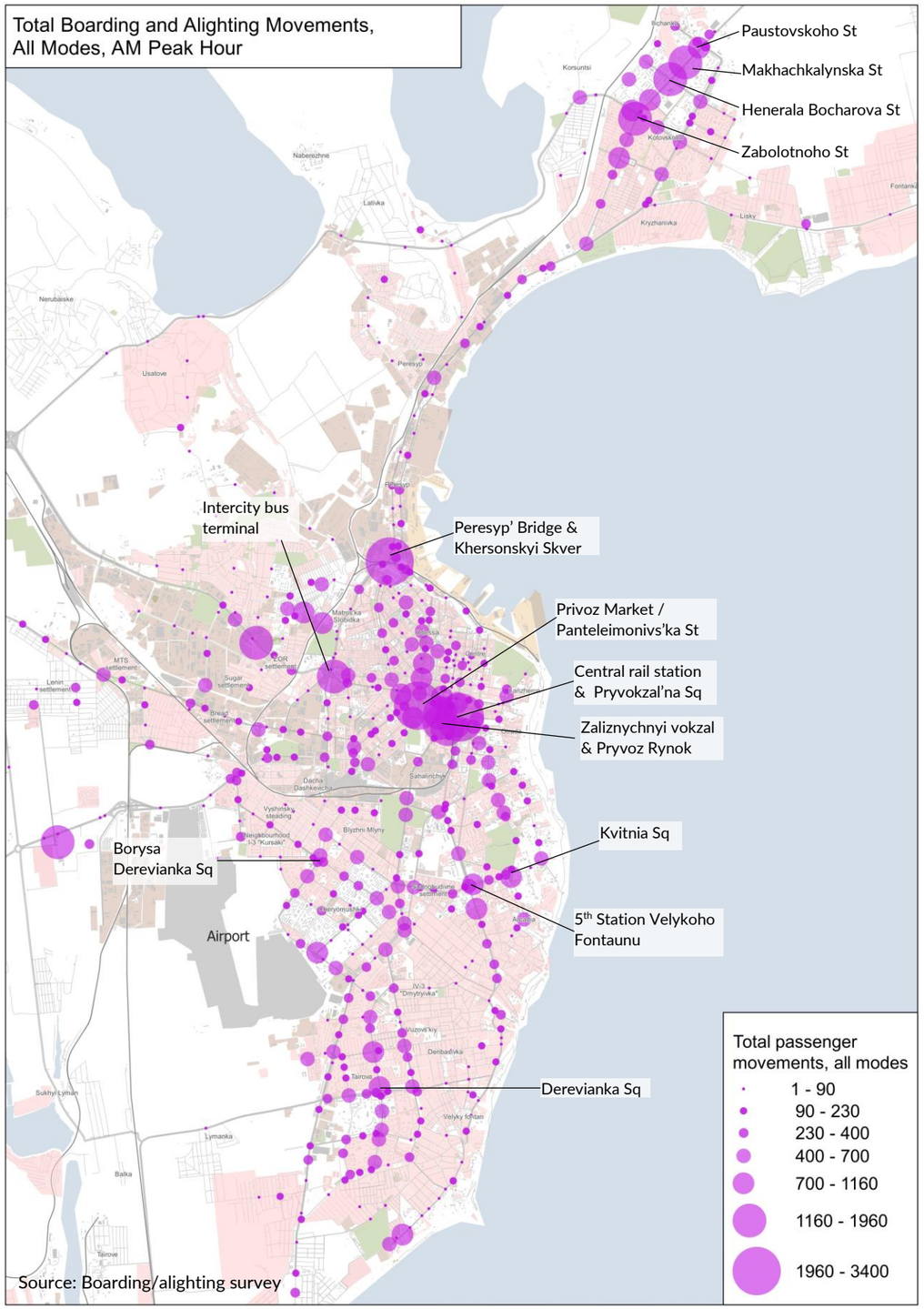
Table 2-7: Condition of the busiest PT interchanges/stops

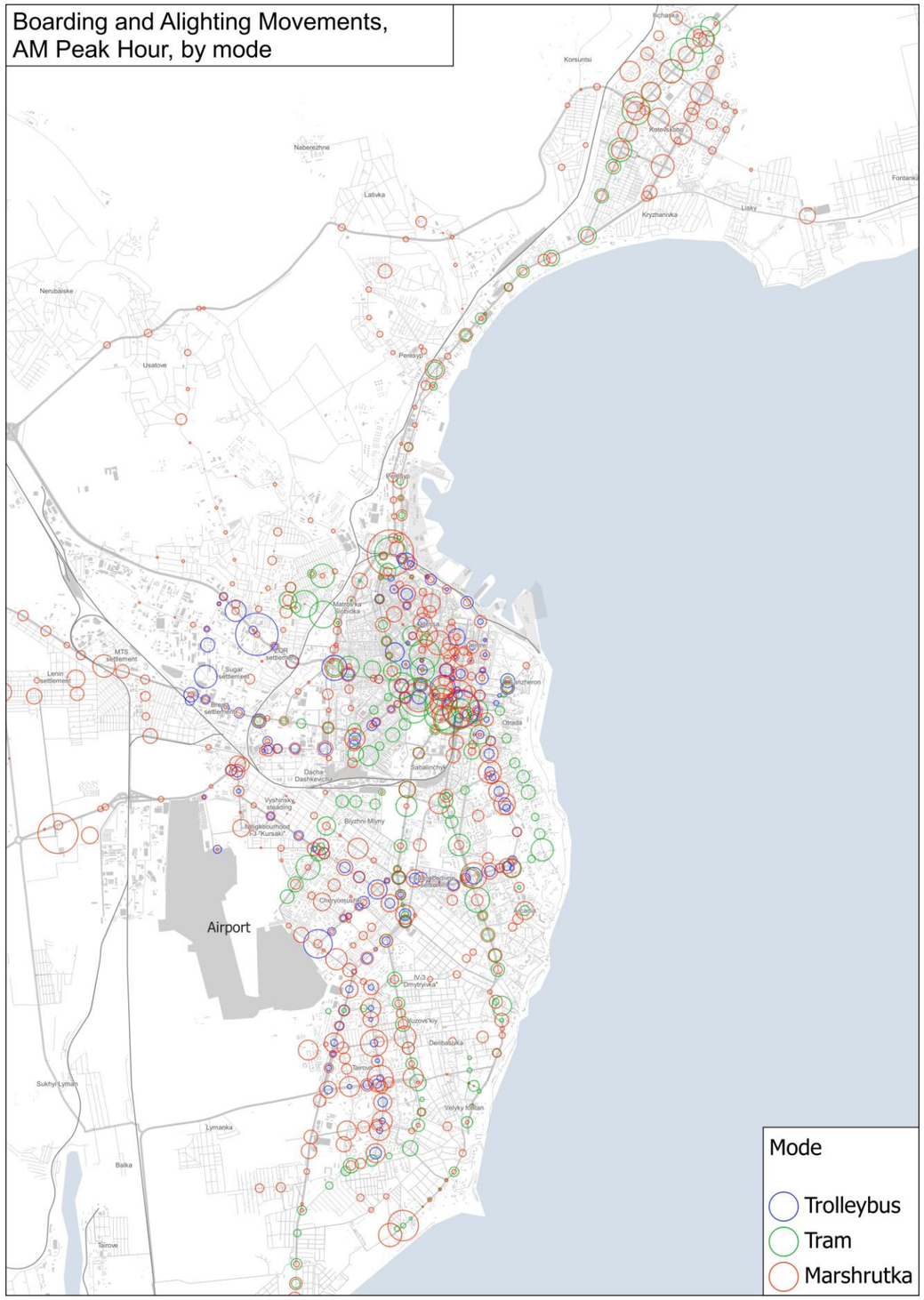
| Stop area<br>Total no. pax board/alight in AM-peak hour | Function | Condition |
|---|---|---|
| Central rail station (Odessa-Holovna)/ Pryvokzal'na Sq<br>5,200 | • Largest interchange in Odessa handling the railway and 26 PT routes<br>• Includes the terminus for 2 tram and 3 trolleybus routes<br>• Passengers of all modes passengers board/alight here<br>• Interchange here from rail and tram onto marshrutka or trolleybus to access city centre | • Interchange is spread over large area, little sign posting, few shelters<br>• Marshruktas layover here causing congestion at stops |
| Zaliznychnyi vokzal and Pryvoz Rynok<br>4,800 | • Adjacent to the rail station to the west<br>• Terminal for 5 tram routes (Zaliznychnyi vokzal)<br>• Suburban bus terminal (Pryvoz Rynok).<br>• 15 PT routes pass through this area<br>• Large number of tram and marshrutka passengers board/alight here | • Tram interchange is of high quality<br>• Suburban interchange is not large enough, so vehicles overflow onto adjacent streets |
| Privoz Market / Panteleimonivs'ka St<br>3,600 | • The market is an important destination in its own right<br>• Large number of tram and marshrutka passengers board/alight here | • Passengers must board trams in middle of road. Lack of shelters |

| | | |
|---|---|---|
| Peresyp' Bridge & Khersonskyi Skve<br>3,900 | • Terminus for 2 southbound tram routes and all northbound tram routes, of which there are 4.<br>• This terminus is not located in the city centre, or near many trip attractors, therefore most tram passengers either have to undertake a long walk or interchange onto marshrutka to complete their journey<br>• Mashrukta boarding/alightings actually surpass the tram at this interchange<br>• A total of 27 PT routes terminate or pass through this area | • Interchange is spread over large area with little sign posting.<br>• Lack of shelters |
| Intercity bus terminal<br>2,100 | • Interchange onto inter-city buses, including routes to Moldova<br>• Large number of boarding/alightings from all modes | • Congestion caused by uncontrolled parking of suburban buses and cars and cars dropping off |
| Borysa Derevianka Sq<br>1,300 | • Mashrutka and tram interchange serving Cheryomushki | • Large roundabout<br>• Parking around PT stops<br>• Pedestrians must cross large road |
| Kvitnia Sq<br>1,200 | • Interchange for all modes<br>• Gateway to tourist area of Arcadia | • Large roundabout<br>• Good pedestrian crossings<br>• No shelters |
| 5th Station Velykoho Fontaunu<br>1,800 | • Interchange for all modes<br>• Crossing point of key trolleybus and tram routes<br>• Adjacent to residential area<br>• Trip attractors include university, hospitals, administration | • Some shelters<br>• Pedestrians must cross large roads<br>• Parking around PT stops |
| Derevianka Sq<br>1,400 | • Trolleybus and Marshrutka interchange in centre of Tairova<br>• Residential area produces many trips<br>• Trip attractors include Shopping mall and Pivdennyi Market | • Interchange is spread over large roundabout<br>• Parking around PT stops<br>• No shelters |

| | | |
|---|---|---|
| Paustovskoho St, Kotovskoho<br>1,600 | • Collector in large residential area serving tram and marshrutka | • Lack of adequate pedestrian crossings over large road |
| Makhachkalynska St, Kotovskoho<br>1,500 | • Collector in large residential area serving tram and marshrutka | • Lack of adequate pedestrian crossings over large road<br>• Parking around PT stops |
| Henerala Bocharova St, Kotovskoho<br>1,300 | • Collector in large residential area tram and marshrutka<br>• Trip attractor includes Supermarket | • Lack of adequate pedestrian crossings over large road<br>• No shelters |
| Zabolotnoho St, Kotovskoho<br>2,400 | • Collector in large residential area<br>• Interchange in centre of Kotovskoho | • Interchange is spread over large area<br>• Parking at PT stops<br>• Lack of adequate pedestrian crossings |

Figure 2-19: Boarding and alighting at transit stops, all modes (left), by mode (right)



# System performance

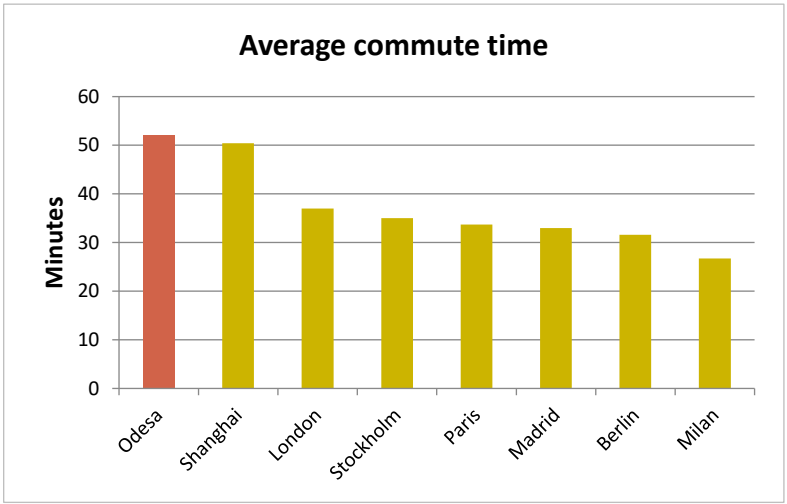
2.42 The following section presents and assessment of how well the PT system performs in terms of the level of mobility it provides to residents of Odessa, operational characteristics and the root causes of underperformance.

## Journey time

2.43 Average journey time results from the interplay of supply and demand. Demand acts to determine the length and origin/destination of trip, while supply determines how quickly that trip can be performed from end to end, including walk, wait time and interchanges.

2.44 The average journey time for a trip conducted on PT in Odessa is 52 minutes. It is also 52 minutes for commute trips. This is a long time considering the average trip length is 4.7km (straight line). And is long by international standards, see Figure 2-20. The long journey time indicates a PT network which poorly serves the trip demand, this may stem from slow vehicular speeds, long wait times, long access times or the need to interchange. These factors will be explored next.

### Figure 2-20: Benchmarking of average commute time



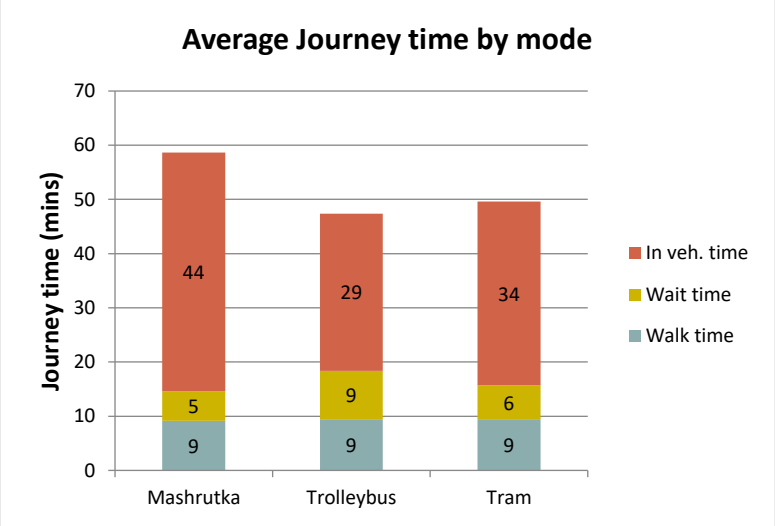

Source: Pereira, R. H. M. & Schwanen, T. 2013. *Tempo de deslocamento casa-trabalho no brasil (1992-2009)*

2.45 Figure 2-21 shows how much of the total journey time is spent walking to/from the transit stop and waiting at the stop. Walk time is typically 9 minutes for the whole trip,

which is high considering the density of the transit network, and a little high compared with best practice design standards which consider an average walk time of 5 minutes for the whole trip. This indicates that despite the large number of different service paths, passengers still have to walk reasonable distances to access the route of their choice.

2.46 The average wait time is also long considering the high combined frequencies observed on the main roads in Odessa (Figure 2-15). This is especially true for trolleybus passengers who wait on average 9 minutes for a service. This indicates long effective headways and unreliability in meeting scheduled times as passengers wouldn't normally seek to wait at the side of the road for a service with a headway of 20 minutes.

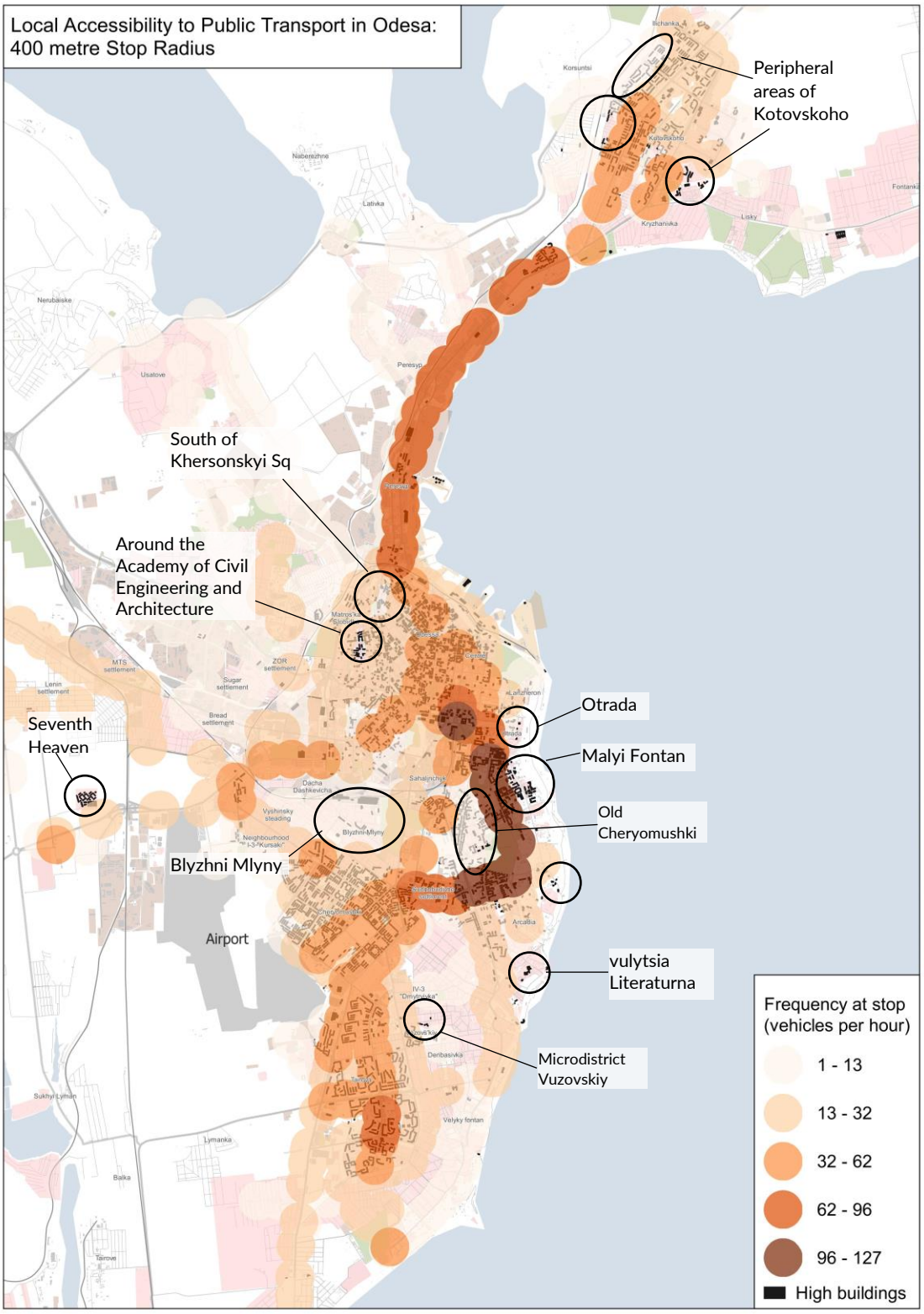
### Figure 2-21: Breakdown of journey time by mode




Source: Traveller interview survey

2.47 Walk time is related to how close an origin or destination is located to a well-served transit stop. Figure 2-22 maps the 400m radius (expected walk distance) around every PT stop in the city. While most of the city is well covered, owing to the dense and complex PT network, there are a number of tall (and hence densely populated) residential buildings which are isolated from the PT network, these are identified on the map. The locations include significant parts of Kotovskoho, Old Cheryomushki and the tourist areas along the coast.

## Figure 2-22: Local accessibility to transit stops




Source: PT frequency and occupancy survey

## Requirement to interchange

2.48 The requirement to make an interchange can add a significant time penalty to a trip. Table 2-8 shows how many stages it took to complete a PT trip in Odessa – for this analysis a walk of over 15 minutes is counted as an its own stage.

2.49 Across all PT trips, the average number of stages is 1.2, which is good by international standards. However, this number hides a PT network telling two stories:

- Trips undertaken using marshrutka are typically conducted in one stage (80%), this owes to large range of different and direct marshrutka routes.
- Trips on trolleybus and tram offer fewer route options, they therefore typically involve an interchange; this is especially true for trolleybus passengers.

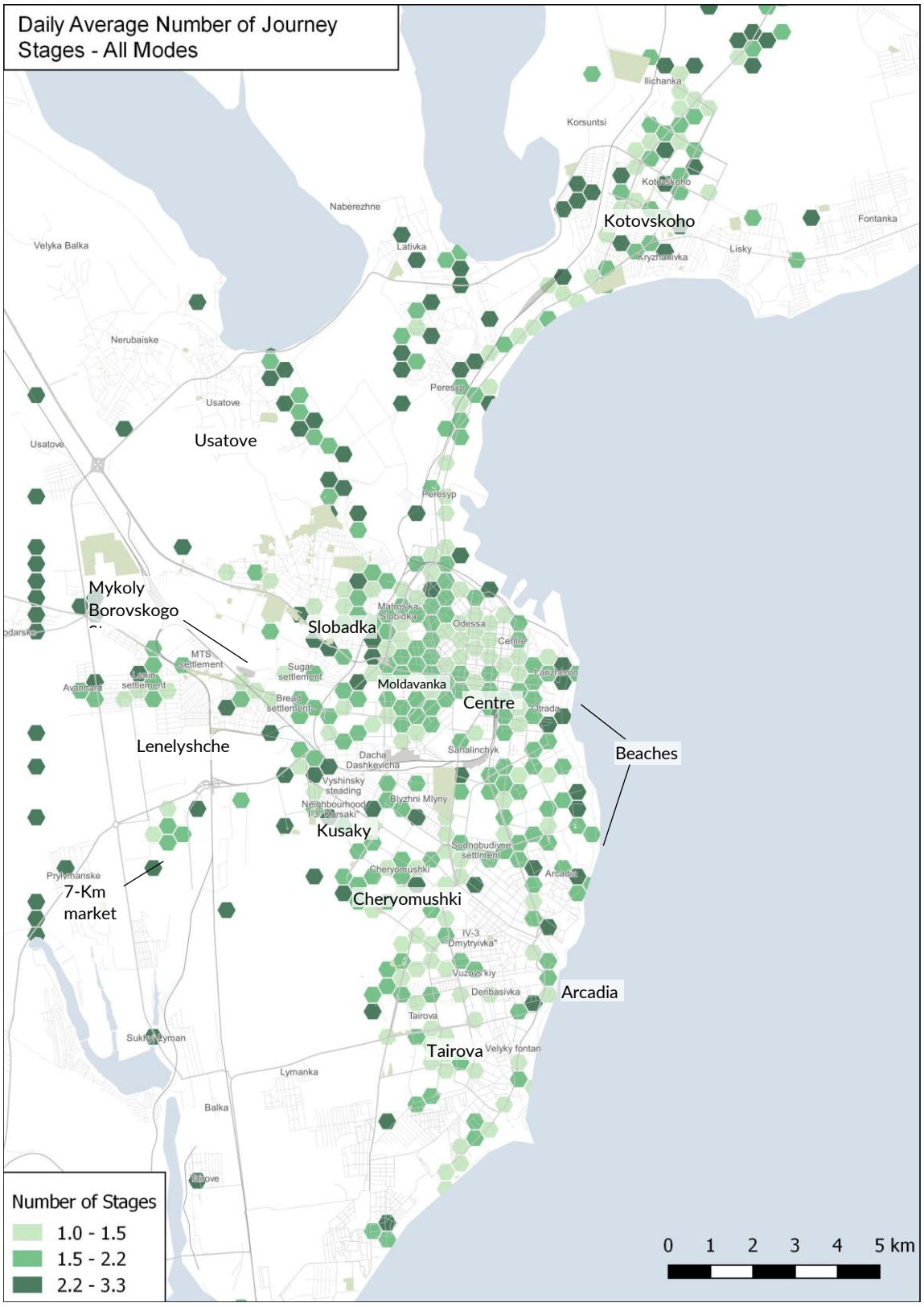
### Table 2-8: Number of stages taken to complete PT trip

| Number of stages | % of trips | | | |
|---|---|---|---|---|
| | Marshrutka | Trolleybus | Tram | All PT trips |
| 1 | 80% | 39% | 56% | 66% |
| 2 | 17% | 54% | 40% | 30% |
| 3+ | 3% | 7% | 4% | 4% |
| | | | | |
| Ave. number of stages | 1.1 | 1.5 | 1.3 | 1.2 |

Source: Origin-destination survey

2.51 Figure 2-23 presents the average number of stages required to complete a journey which starts in each of the hexagon areas. It shows that trips which tend to involve a high number of stages begin around the periphery of the city including Kotovskoho, along the tram route to Usatove, the east coast beach area, and low residential areas in the west including Lenelyshche, Kusaky and Slobadka. Strategically it is a concern that trips from Kotovskoho and from the tourist areas require a high number of interchanges to complete. These areas have also been identified as having poor access to transit stops.

## Figure 2-23: Average number of interchanges by trip origin




Source: Origin-destination survey

## Strategic accessibility

2.52 The following maps combine the elements of journey time discussed above (walk time, wait time, interchange requirement and travel speeds) to present access times to/from five key locations in the city. Overall levels of accessibility are poor considering the size of the city and the extensive nature of the PT network. Specific problems include:

- Kotovskoho is the most isolated part of the city, with long travel times to Peresp' bridge and beyond to the city centre. Large numbers of Kotovskoho residents make these trips despite long travel times (Figure 2-8).
  - The tram line which links Kotovskoho to Peresp' (plied by T1, T6 and T7) is segregated for its entire length. This provides an good running speed of 19kph. However the tram terminus at Peresyp' Bridge/Prymorska St is dislocated from the city centre, therefore passengers must interchange or take a long walk to access a city centre destination. The new north-south tram route is being constructed to provide better city centre connections for the tram
  - As an alternative there are many direct marshrutka routes which link Kotovskoho to the city centre, but they get stuck in heavy congestion on Mykolaivs'ka Rd/Otamana Holovatoho St/Choromors'koho Kozatstva St.
- Poor access time to/from the western industrial and suburban areas and most of the city
- Poor access times between Tairova and Moldavanka
- East-west movements are slow in the southern half of the city

## Figure 2-24: PT accessibility times to/from City Centre (left) and Arcadia (right)

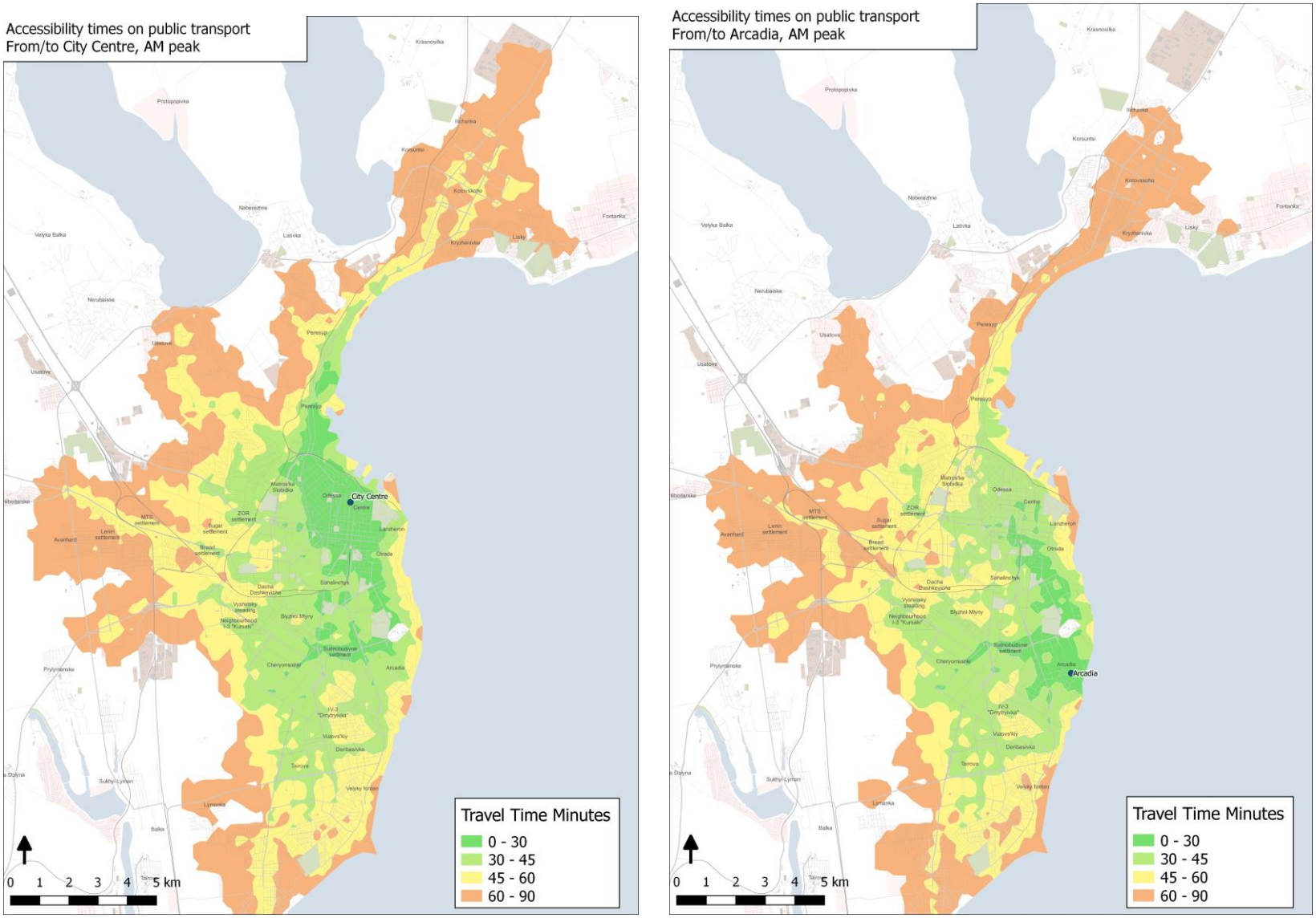
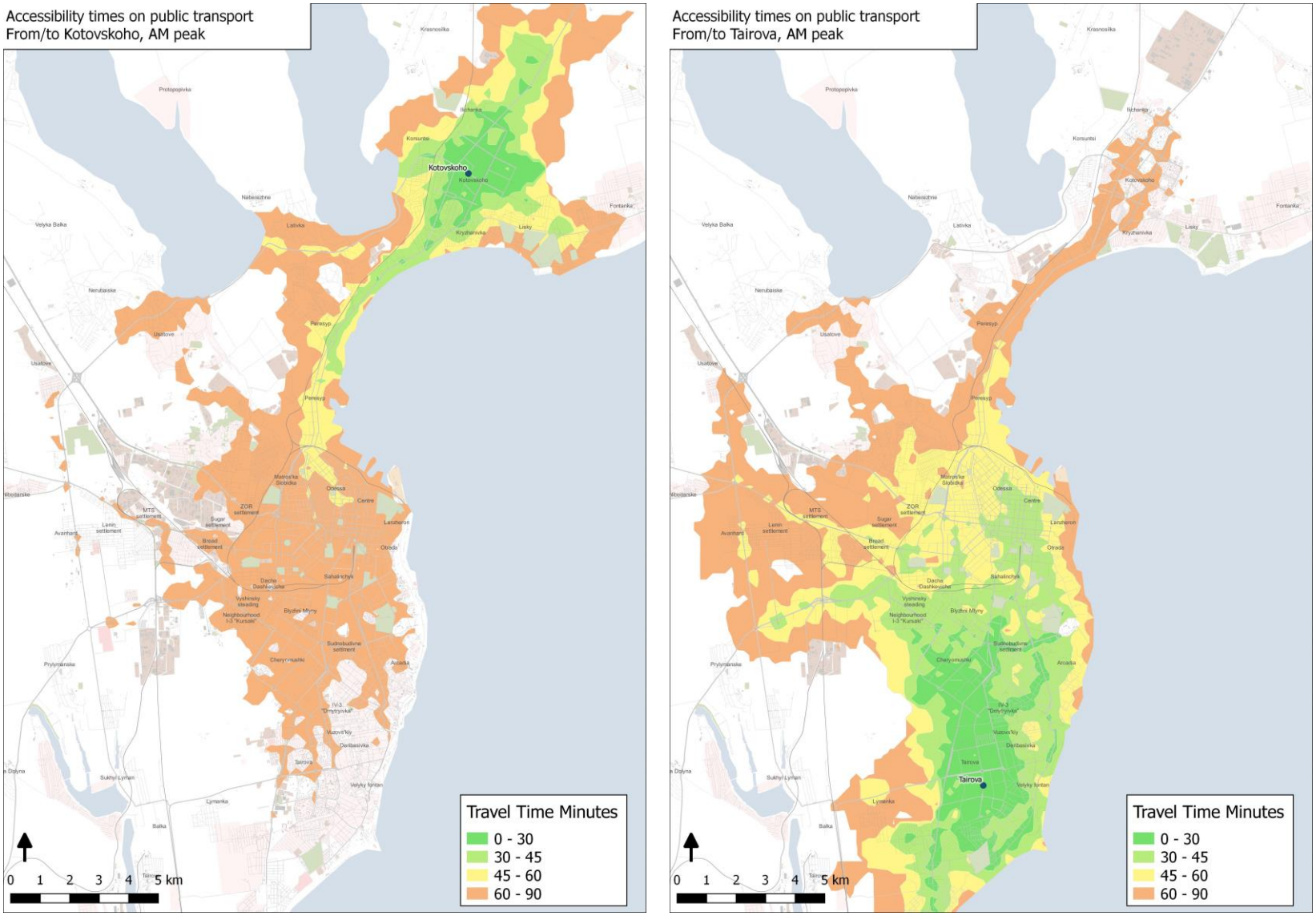
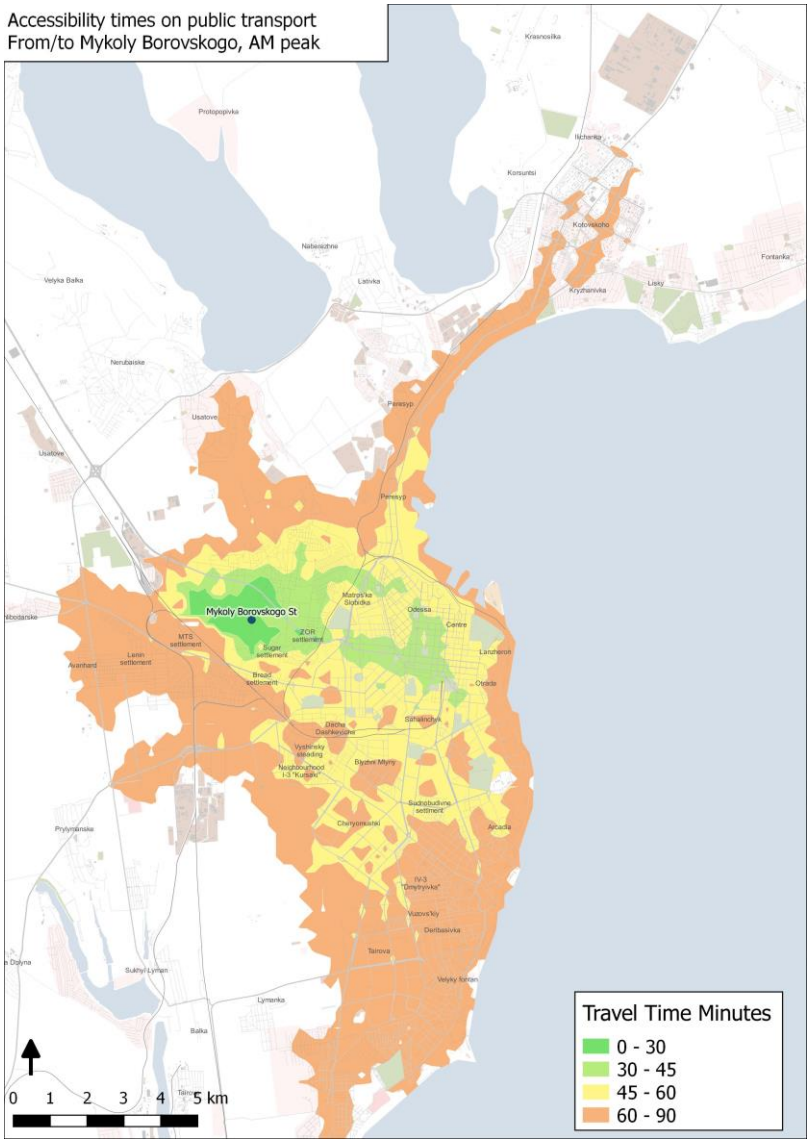


Figure 2-25: PT accessibility times to/from Kotovskoho (left) and Tairova (right)



## Figure 2-26: PT accessibility times to/from Mykoly Borovskogo St



## Use of public transport services

2.53 The interrelation between the supply of PT and trip demand determines how the PT service are used, this includes the loading on each route and where passengers board and alight the services. Table 2-9, Table 2-10 and Table 2-11 present the patronage data for a select number of marshrutka routes as well as for all of the trolleybus and tram routes.

2.54 There is a large disparity in the number of passengers carried by each PT route - the busiest routes in the city are T_5, T_7, MT_168 and MT232A, which all carry over 30,000 passengers per day. But these sit amongst many routes which carry less than 2,000 passengers per day. There is therefore a large number of underperforming routes which do not contribute much to the PT network.

### Table 2-9: Demand statistics for the top 10 and bottom 10 busiest marshrutka routes

| | Indices for Inbound service in the AM peak hour | | | | Pax all day | Ave. Speed (kph) |
|---|---|---|---|---|---|---|
| | Route Name | Freq | Boarders per veh | Pax per hour | | |
| Top 10 | MT_168 | 1.2 | 185 | 222 | 32,365 | 17.8 |
| | MT_232A | 14.4 | 125 | 1790 | 32,184 | 18.8 |
| | MT_185 | 20.0 | 71 | 1420 | 28,270 | 15.9 |
| | MT_220A | 15.0 | 62 | 933 | 24,726 | 17.7 |
| | MT_175 | 11.0 | 119 | 1306 | 23,824 | 15.4 |
| | MT_214 | 10.0 | 101 | 1006 | 22,759 | 12.1 |
| | MT_146 | 8.4 | 114 | 958 | 22,537 | 15.6 |
| | MT_145 | 6.3 | 102 | 644 | 18,694 | 12.7 |
| | MT_191 | 17.0 | 67 | 1138 | 17,806 | |
| | MT_9 | 12.0 | 60 | 722 | 17,806 | |
| Bottom 10 | MT_8 | 2.5 | 43 | 108 | 1,702 | 18.5 |
| | MT_165 | 1.0 | 90 | 90 | 1,477 | 21.7 |
| | MT_280 | 1.5 | 48 | 72 | 1,452 | 22.5 |
| | MT_7 | 2.0 | 27 | 54 | 1,362 | 23.3 |
| | MT_131 | 1.4 | 60 | 86 | 1,129 | |
| | MT_110 | 0.5 | 41 | 21 | 1,129 | 15.3 |
| | MT_105 | 3.5 | 40 | 139 | 764 | 25.1 |

| | Indices for Inbound service in the AM peak hour | | | | Pax all day | Ave. Speed (kph) |
|---|---|---|---|---|---|---|
| | Route Name | Freq | Boarders per veh | Pax per hour | | |
| | MT_288 | 0.4 | 61 | 23 | 620 | 25.5 |
| | MT_237 | 0.5 | 9 | 5 | 393 | 17.6 |
| | MT_215 | 1.5 | 24 | 36 | 381 | 15.4 |

Table 2-10: Demand statistics for the tram routes

| % of Segre-gation | Indices for Inbound service in the AM peak hour | | | | Pax all day | Ave. Speed (kph) |
|---|---|---|---|---|---|---|
| | Route Name | Freq | Boarders per veh | Pax per hour | | |
| 100% | T_7 | 12.3 | 121 | 1492 | 36,280 | 20.0 |
| 56% | T_5 | 15.0 | 110 | 1650 | 31,426 | 13.7 |
| 84% | T_18 | 7.0 | 158 | 1109 | 29,702 | 16.2 |
| 100% | T_1 | 8.4 | 146 | 1231 | 29,044 | 18.7 |
| 100% | T_10 | 11.0 | 130 | 1430 | 27,635 | 13.9 |
| 66% | T_15 | 5.0 | 97 | 487 | 24,834 | 11.6 |
| 80% | T_3 | 8.5 | 164 | 1397 | 23,271 | 13.0 |
| 16% | T_28 | 8.6 | 43 | 369 | 19,086 | 8.2 |
| 100% | T_31 | 4.5 | 95 | 430 | 12,315 | |
| 97% | T_12 | 6.3 | 95 | 601 | 10,150 | 12.6 |
| 100% | T_27 | 4.5 | 132 | 588 | 10,135 | |
| 100% | T_26 | 4.2 | 95 | 401 | 9,958 | |
| 100% | T_13 | 3.0 | 60 | 181 | 8,039 | 14.7 |
| 5% | T_21 | 4.6 | 66 | 301 | 7,791 | 12.2 |
| 58% | T_11 | 4.0 | 82 | 326 | 7,221 | 11.6 |
| 86% | T_17 | 1.7 | 95 | 162 | 5,072 | |
| 96% | T_6 | 1.3 | 95 | 124 | 3,697 | |
| 97% | T_20 | 2.1 | 29 | 62 | 2,079 | 18.6 |
| 100% | T_19 | 4.0 | 9 | 36 | 1,094 | 8.6 |

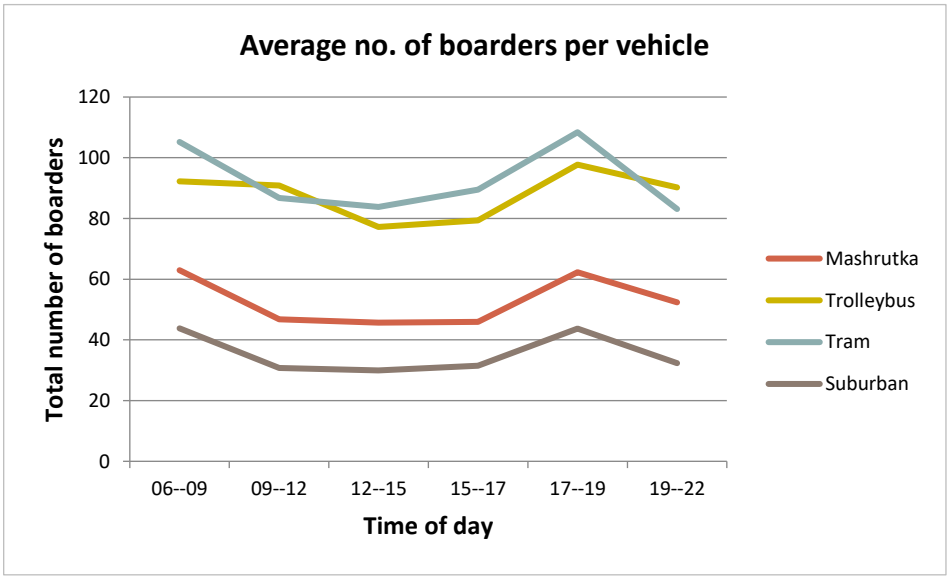
## Table 2-11: Demand statistics for the trolleybus routes

| | Indices for Inbound service in the AM peak hour | | | | Pax all day | Ave. Speed (kph) |
|---|---|---|---|---|---|---|
| | Route Name | Freq | Boarders per veh | Pax per hour | | |
| | TB_12 | 6.8 | 208 | 1404 | 26,354 | 13.5 |
| | TB_9 | 10.8 | 94 | 1013 | 20,537 | 10.3 |
| | TB_7 | 5.8 | 142 | 816 | 17,699 | 13.4 |
| | TB_8 | 6.3 | 114 | 711 | 17,330 | 13.2 |
| | TB_3 | 4.4 | 145 | 638 | 17,293 | 11.0 |
| | TB_10 | 6.6 | 83 | 544 | 15,802 | 6.9 |
| | TB_2 | 6.0 | 50 | 300 | 12,435 | 9.2 |
| | TB_11 | 2.1 | 145 | 308 | 8,523 | 11.2 |
| | TB_13 | 6.0 | 53 | 319 | 6,347 | |
| | TB_14 | 2.2 | 53 | 117 | 2,936 | 9.2 |
| | TB_5 | 4.0 | 30 | 120 | 2,839 | 12.3 |

Source: Composite of boarding/alighting and PT frequency & occupancy surveys

2.55 Figure 2-27 shows that the average number of boarders per vehicle through the day. The loading on the vehicles reduces during the inter-peak because service frequencies remain steady though the day (Figure 2-14).

## Figure 2-27: Average number of boarders per vehicle through the day



Source: Composite of boarding/alighting and PT frequency & occupancy surveys

## Operating speeds

2.56 Infrastructure constraints can cause slow operating speeds, service unreliability and poor levels of comfort for the passenger.

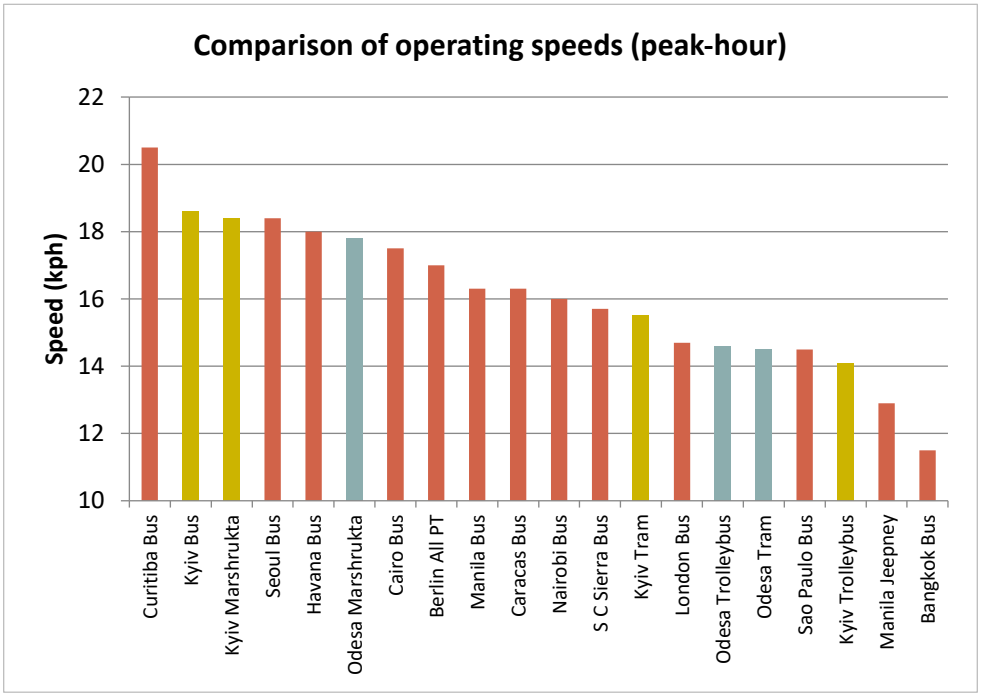
2.57 The average operating speeds for the main PT modes in Odessa and Kyiv are presented in Table 2-12 and compared internationally in Figure 2-28. Marshrutka speeds in Odessa are good at 17.8kph, but trolleybus and tram services are slow, despite the high levels of segregation tram services benefit from.

### Table 2-12: Average operating speeds by mode

| Mode | Average operating speed, peak hour (kph) | |
|---|---|---|
| | Odessa | Kyiv |
| **Tram (all)** | 14.5 | 15.5 |
| **Tram, when segregated** | 15.0 | |
| **Tram, when in mixed traffic** | 10.0 | |
| **Trolleybus** | 14.6 | 14.1 |
| **Marshrutka** | 17.8 | 18.4 |

Source: OGET GPS dataset and on-board surveys (boarding/alighting, origin-destination)

## Figure 2-28: International comparison of operating speeds




2.58 There are a number of causes of slow speeds in Odessa, which are discussed in Table 2-13. While many occur throughout the city, the locations of particular problems are plotted in (Figure 2-29). These locations have been identified by OGET and on-site observation.

2.59 The speed data collected from GPS loggers located on-board tram and trolleybuses is presented in Figure 2-30. This data corroborates the operational constraints map (Figure 2-29).

Table 2-13: Causes of slow operating speeds in Odessa

| | Cause of slow speed | Example |
|---|---|---|
| Infrastructure | **Pinch point** – The majority of roads in Odessa are wide however there are a handful of locations where roads narrow, or tram tracks reduce to one, which constrain flow | Khlibozavod Bridge   |
| | Poor **track condition,** found throughout Odessa – forces slow tram speed |  |
| | Old **signalling and junction equipment,** found throughout Odessa |  |

| | | |
|---|---|---|
| Use & control of highway | **Parked vehicles** at intersections and along the roadside can cause obstructions to PT vehicles. Frequent vehicle movements to use road side parking also imped PT vehicles – includes Panteleimonivs'ka St | Odessa zoo / Novoshchipnyi Ryad St  Korolyova/Hlushka  |
| | Lack of **intersection control.** Many intersections in Odessa cover a large area with little channelization to control flow. Some major intersections are also uncontrolled by either signals or a roundabout | Fontanska Rd/Admiralsky  |
| | High levels of **traffic** - a particular problem in the city centre | City centre  |

| | | |
|---|---|---|
| | **Road side activity** such as market stalls encroaching on tram tracks. And locations with high numbers of pedestrians but no formal crossings such e.g. market area along Panteleimonivs'ka St | Novoshchipnyi Ryad St  |
| PT vehicles and their use | **Long dwell time**s. Boarding/alighting times can be lengthened by overcrowding and steep steps inside the vehicle. Some marshrutka only have one door. Some trams and trolleybuses are operated without a conductor, requiring the driver to spend time handling fares | Congested trolleybus  |
| | Congested and uncoordinated **PT interchanges** | Panteleimonivs'ka St  |

Figure 2-29: Location of operational constraints

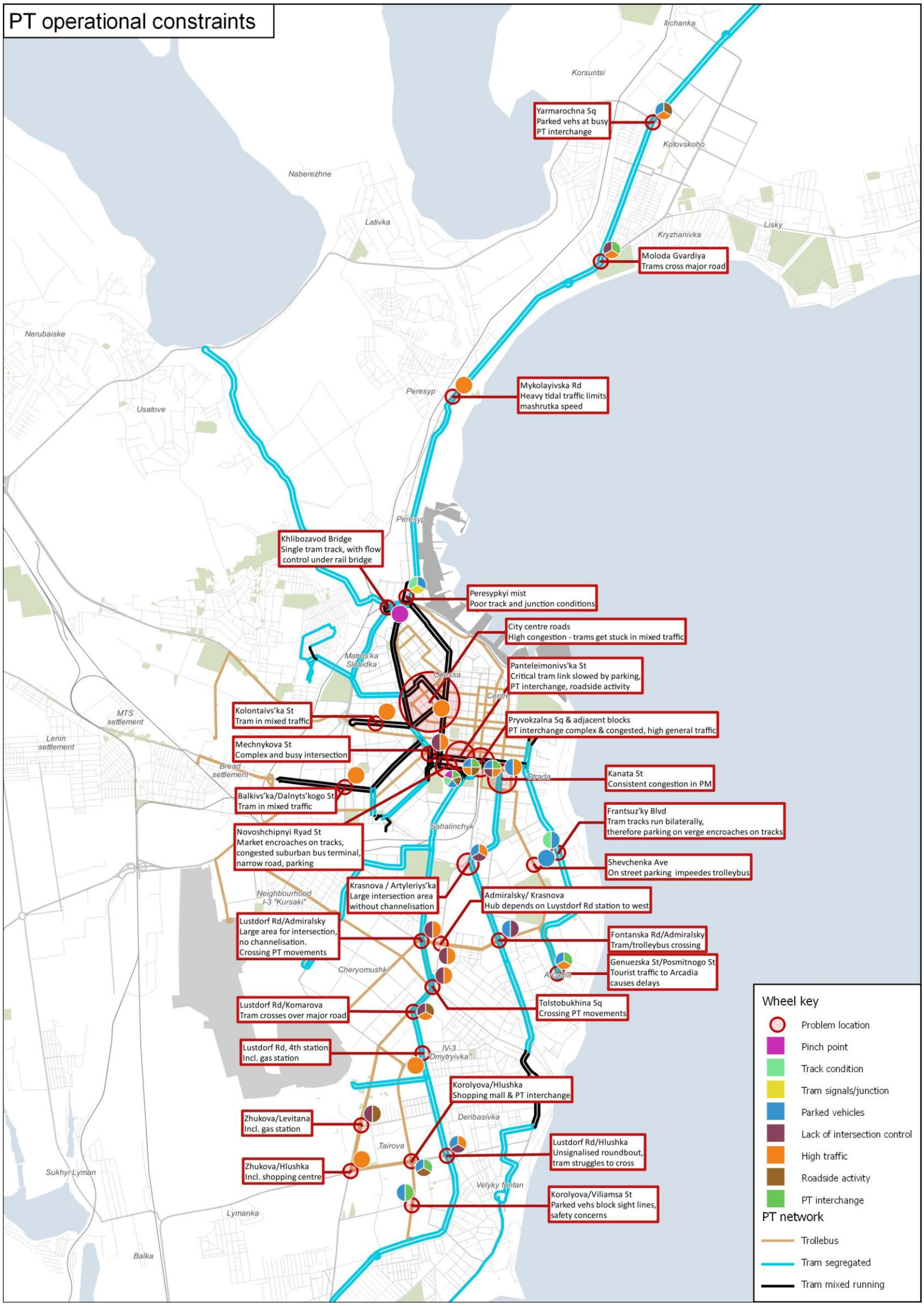
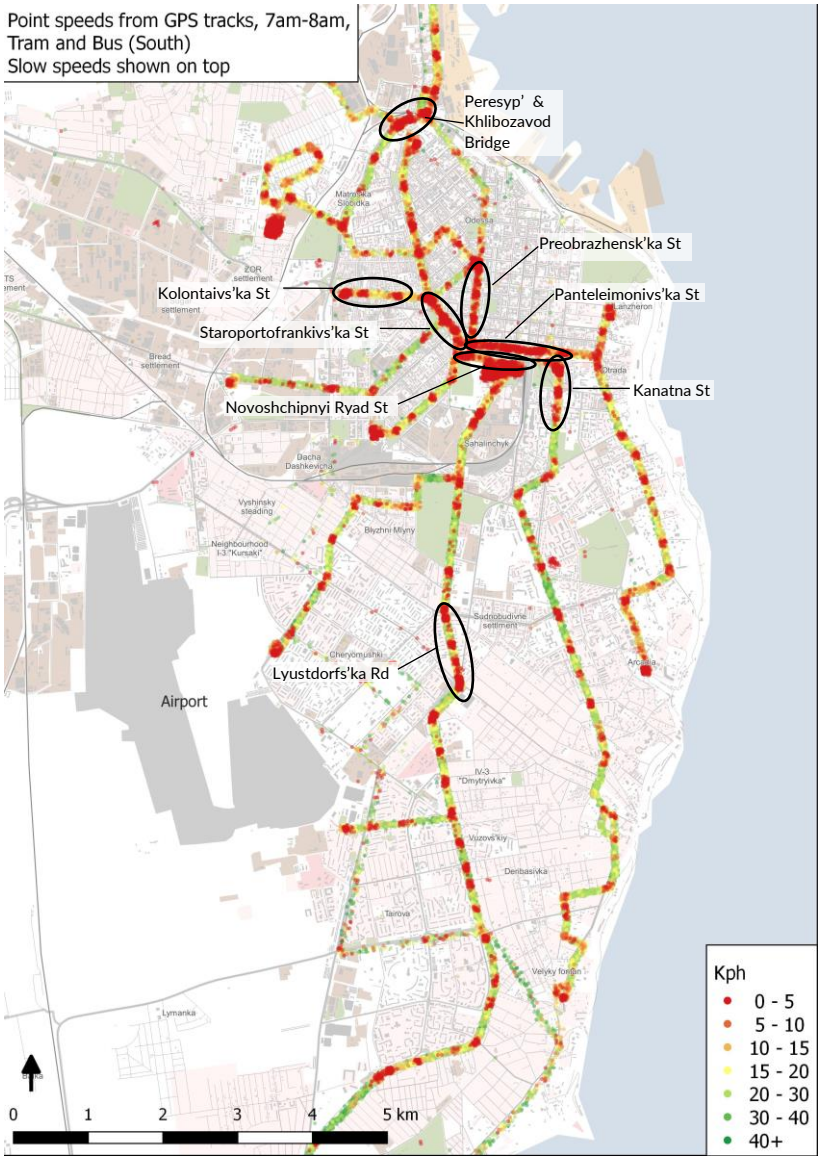
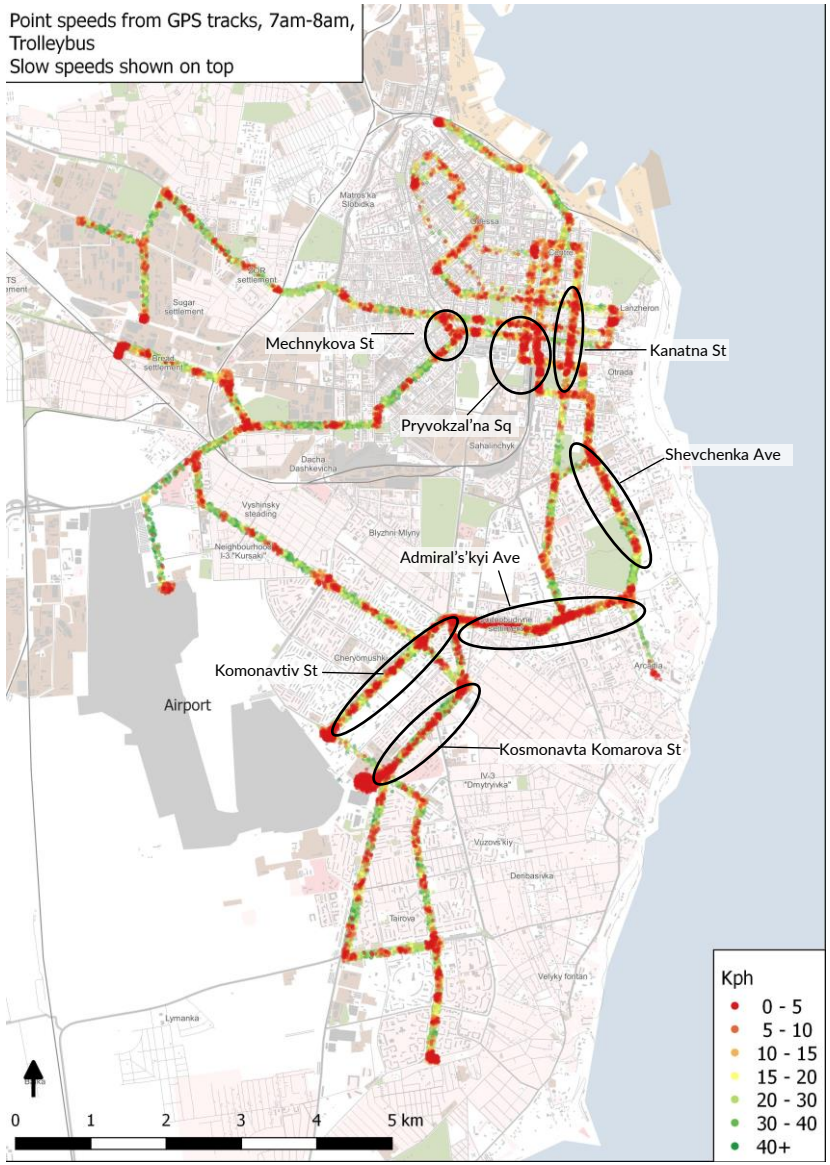


Figure 2-30: Speed blackspots for tram (left) and trolleybus (right)



## Service reliability

2.60 Service reliability has been identified as a problem from the user needs research (Table 2-17, Figure 2-32) where problems are indicated by the long passenger wait times at stops (Figure 2-21). Reliability issues may stem from the following:

- Overloaded vehicles can cause long dwell times as passengers struggle to alight and board each vehicle. This causes a feedback loop where the later a service gets, the larger the number of passengers there are waiting at the next stop. Consequently, these passengers take longer to board and bus is busier. This is one reason why buses tend to bunch together.
- Unexpected congestion - caused by traffic accidents, daily changes to traffic management, weather, and road works
- Driver behaviour
- Poor vehicle condition – leads to vehicle breakdown
- Poor catenary condition – catenary may fail, requiring repair
- Poor track condition – track may fail, requiring repair

## Operating costs

2.61 Table 2-14 presents the estimated operating costs by mode. Operational costs for tram and trolleybus services have been derived from OGET account summaries, while costs for marshrutka have been taken from examples in Kyiv. Patronage data was calculated from the boarding/alighting surveys and vehicle mileage from the PT frequency and route length data.

2.62 The average cost per veh-km across all PT modes is 12UAH (0.45USD) which is low by international standards and in part reflects the depressed local currency.

2.63 Tram and trolleybuses are the most cost-efficient PT mode in Odessa. They may have a higher operating cost per vehicle km compared to marshrutka, but because these vehicles carry more passengers they have a lower cost per passenger.

2.64 A trolleybus vehicle will carry twice as many passengers as a marshrutka over the course of the day (1,500 compared to 650), and a tram will carry 4 times as many passengers (2,000). While marshrutkas carry the majority of passengers in the city, they do so in a relatively inefficient way and considerable efficiencies could be gained if larger vehicles were used in their place. Small vehicles can provide flexibility to carry

small loads, but the high flows of passengers in Odessa would be better served by a smaller fleet of larger vehicles.

2.65 Compared to Kyiv, Odessa under performs in terms of the average number of passengers carried per veh-km (4.2 compared to 5.7), and cost per passenger (3.2UAH in Odessa, compared to 2.88UAH in Kyiv). This is caused by a greater use of marshutka's in Odessa (marshrutkas they 51% of PT trips in Odessa compared to 38% in Kyiv), and the use of articulated trolleybuses in Kyiv.

2.66 Total operating costs for the whole PT network in Odessa are estimated to be 850million UAH per annum compared to 2,436 million UAH for ground-based transport in Kyiv (35%).

## Table 2-14: Operating costs by mode

| Mode | Total daily Pax. | Annual Pax (million) | Ave. daily pax. per route | Pax. per veh-km | Ave. daily pax. carried per veh | Annual Veh-kms (million) | Annual Operating cost (million UAH) | Operating cost (UAH per veh-km) | Operating cost (UAH per pax) |
|---|---|---|---|---|---|---|---|---|---|
| **Tram** | 299,000 | 107.6 | 14,900 | 9.9 | 2,500 | 9.3 | 263* | 18.0 | 1.6 |
| **Trolleybus** | 148,000 | 49.9 | 13,500 | 8.5 | 1,500 | 5.3 | | | 1.9 |
| **Marshrutka** | 491,500 | 150.9 | 8,800 | 2.8 | 650 | 56.4 | 587** | 10.4 | 3.7 |
| **Bus** | 5,000 | 1.6 | 1,100 | 4.2 | | | | | |
| **Suburban bus** | 26,500 | 8.1 | 3,300 | 3.0 | | | | | |
| **Total (or average)** | **970,000** | **318.1** | | **(4.2)** | **(950)** | **71.0** | **850** | **(12.0)** | **(3.2)** |

*Derived from OGET 2016 financial figures
** Consultants estimate

## Energy and emissions

2.67 Table 2-15 presents the energy use and GHG emissions attributed to the PT network in Odessa. These values have been estimated by applying calculations of energy and emissions per km derived for the PT network in Kyiv.

2.68 Per passenger trolleybuses and trams use less energy than marshrutka. The added benefit of these modes using electricity means that they emit about half the amount of GHG emissions per passenger.

2.69 Total GHG emissions for the whole PT network in Odessa is estimated to be 74,300 tonnes of $CO_2e$ per annum, compared to 184,000 tonnes for ground-based transport in Kyiv (40%).

## Table 2-15: Energy efficiency and GHG emissions by mode

| Mode | Annual Veh-kms (million) | Ave. energy consumed per veh-km (MJ per vKm) | Ave. energy consumed per pax km (MJ/pax-Km) | Total energy consumed (TJ/year) | Total diesel consumed (1,000,000 Litre/yr) | Total Electricity used (1,000,000 KHW) | Annual GHG emissions (direct & indirect) ($tCO_2e$) | GHG emissions per passenger, (gCO2e) |
|---|---|---|---|---|---|---|---|---|
| **Tram** | 9.3 | 13.5 | 1.4 | 125 | | 34.8 | 13,900 | 152 |
| **Trolleybus** | 5.3 | 13.6 | 1.6 | 72 | | 20.1 | 8,000 | 177 |
| **Marshrutka** | 56.4 | 10.8 | 3.8 | 609 | 17.0 | | 52,400 | 326 |
| **Bus** | | | | | | | | |
| **Suburban bus** | | | | | | | | |
| **Total (or average)** | **14.6** | **(11.4)** | **(3.3)** | **807** | **17.0** | **54.9** | **74,300** | **(249)** |

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

## Financial & regulatory challenges

2.70 The current economics of providing public transport in Odessa results in an underinvestment in fleet and a poor level of service provided to the passenger. This occurs in spite of a high mode share for PT because the majority of the residents in Odessa do not have access to alternative modes such as the car (63%, see Table 2-1). Analysis presented here, as well as stakeholder consultation has identified that low revenue restricts investment in vehicles and adequate maintenance of those vehicles.

### *Municipal operator*

2.71 The municipal operator, OGET, typically make a loss each year, which prevents investment in vehicles. The current mechanism for OGET to receive new vehicles is through international donor bank investment.

2.72 The regular single fare charged by OGET of 3 UAH (0.10 USD) is very low when benchmarked internationally (Figure 2-36). This low fare, combined with a high number of concessionary passengers (77% of OGET passengers in 2015), and potentially high levels of fare leakage (many trolleybuses and tram services do not have a conductor) result in a very low revenue take for OGET. OGET's financial accounts show that they received 91.9 million UAH in ticket sales in 2016, which is an average taking of 1.7UAH per passenger.

2.73 In 2016 OGET made a loss of 146.9million UAH on the sale of these tickets, which was covered in-part by a government subsidy. This subsidy reimburses OGET for carrying concessionary passengers. Taking this subsidy into account OGET made a net loss of 1million UAH in 2016.

### *Private operators*

2.74 Marshrutka services do not tend to be coordinated by a company with rights to that route. Instead each individual driver is responsible for maximising the fare taken by their vehicle. They are therefore incentivised to maximise the number of passengers carried in their vehicle rather than incentivised to provide the best quality of service. This can lead to slow driving when empty or abrupt overtaking of competing buses.

2.75 Route contracts do not include quality standards, nor the associated need to monitor and enforce. Quality standards in contracts can be used to enforce driver hours, vehicle safety, vehicle quality and service reliability.

2.76 The complex and overlapping network is less efficient per passenger because it splits the PT demand up. Furthermore, the use of small marshrutka vehicles to carry large loads is also inefficient.

2.77 There are effectively two PT networks which run alongside each other and serve two separate markets:

- The municipal tram and trolleybus network provides cheap (or free) travel on slower modes with less route options
- Marshrutka network provides more expensive travel on a wide range of direct route options

2.78 This type of market segmentation is extremely inefficient with services effectively duplicated. The LOS is worse for all passengers as a result (longer headways) and there is no cross-subsidy.

## Root causes of underperformance

2.79 The root causes of underperformance are presented in Table 2-16 below.

### Table 2-16: Route causes of PT underperformance

| Root cause | Meaning | Impact |
|---|---|---|
| Market segmentation | Effectively two separate PT networks operate side by side: the Marshrutka network and the OGET network. They provide different levels of service and serve different market segments:<br>• Marshrutka services are more expensive, faster and more direct. They largely carry employed passengers.<br>• OGET services are cheaper, slower and require more interchanges. They carry the majority of concessionary passengers. | Market segmentation is operationally inefficient, it prevents economies of scale to be achieved in operation.<br>Splitting large passenger flows, many going to the same place, across different routes increases the numbers of vehicles required and increases waiting time for the passenger.<br>Separation of concessionary passengers and passengers willing to pay a higher fare removes the opportunity to cross-subsidise. Therefore, reduces financial stability. |
| High network complexity | Associated with the above point, Odessa has a high number of PT routes for a city of 1million people.<br>Many of these routes overlap significantly (55% of routes overlap with another route by 70% or more).<br>There is also a large number of routes that have low passenger volumes (43% of routes carry only 10% of passengers). | Splitting passengers up across many routes reduces operational efficiency and increases wait time for the passenger.<br>The lower the number of passengers on a route, the less scope there is to invest and encourage more formal management.<br>Competition on the roads for the passenger is increased. This perversely leads to lower level of service (poor driver handling), pressure to keep fares low and consequent underinvestment in vehicles or standards.<br>Some strategic connections are missing making it hard to access certain parts of the city from others. |

| Root cause | Meaning | Impact |
|---|---|---|
| Light regulation of the marshrutka industry and the resulting trend for these services to operate at absolute margins<br><br>(This section takes from Brendan Finn's 2008 paper[1]) | The marshrutka industry in many ex-soviet cities are structured to operate as much as possible outside of the tax framework.<br>As such, owners and drivers are loosely affiliated with companies that purchase route permits.<br>This structure, and resulting lack of information about the industry, combines with loose regulatory and enforcement regimes to create low barriers to entry where participants can operate on absolute margins.<br>Small private companies lack access to finance to invest in new fleet. Therefore, there is little to encourage formalisation into larger and more compliant bus companies. | Marshrutka's provide an essential service for many residents in Odessa. They are appreciated for their speed and reliability.<br>However, the light regulatory and organisation regime allows expenditure on driver salaries, training, maintenance and spare parts to be cut to a minimum.<br>Unsafe, uncomfortable and sometimes overcrowded vehicles are driven by drivers seeking to maximise revenue whilst working long hours. This encourages poor driving that negatively impacts on traffic congestion, accidents and air pollution. Customer handling is also poor, as some drivers are rude and inconsiderate to passengers. |
| Constrained and inefficient use of road space | The design and use of roadways and large junctions negatively impact on the speed of PT vehicles. There is also insufficient pedestrian infrastructure at large junctions.<br>South of the city centre a number of large junctions are located in close proximity, meaning a problem at one backs up to the others.<br>Parked cars at junctions, along key roads and adjacent to tram tracks impact on travel speed.<br>These constraints combine with high traffic flow to cause congestion in city centre and on major roads. | Slow operating speeds and poor reliability result in worse level of service for the passenger and reduced levels of accessibility across the city.<br>Slow operating speeds require larger fleet size to serve, and consequent higher operating costs, congestion and pollution. |

[1] Finn, B. 2008. *Market role and regulation of extensive urban minibus services as large bus service capacity is restored – Case studies from Ghana, Georgia and Kazakhstan*. Research in Transportation Economics, No.22 p118-125

| Root cause | Meaning | Impact |
|---|---|---|
| Tired infrastructure, old vehicles, and lack of stop facilities | Aged tram tracks and catenary are extremely worn. Trolleybus catenary also requires improving. Substations need replacing.<br>Most trams are over 30 years old, most trolleybuses over 20 years old, and most marshrutka over 10 years old.<br>Lack of appropriate waiting facilities (bus stops). Interchanges are spread out with little information or facilities. | Slow operating speeds and poor reliability for trams and trolleybuses as well as a bumpy tram ride. Impacts on accessibility across the city.<br>High floor, uncomfortable vehicles, that are often over-crowded results in poor ride quality for passenger and long dwell times for operators. Access problems for disabled/elderly. Old vehicles produce more air pollution.<br>Passengers cannot shelter from the rain/sun when waiting. |
| Lack of capacity at the City Administration to develop and implement plans to improve urban transport in Odessa | The City Administration lacks the staff, knowledge and regulatory authority to enable the City to develop strategic plans and policies to improve mobility in Odessa and provide an integrated public transport network that best services the City.<br>Capacity is also lacking to develop and implement detailed improvement plans.<br>The City also lacks on-going operational capacity to co-ordinate and regulate PT services. | The specification (routing and level of service) of most public transport services in the city has been driven by individual marshrutka owners/companies. These seek to maximise individual revenue rather than provide the best public transport network for Odessa. This results in the fragmented and complex network we see today which is operationally inefficient and sub-optimal for the passenger. |
| Low fares and lack of revenue protection | The fare of 3UAH on OGET tram and trolleybus services is low compared to similar countries and low in terms of affordability. Due to the high numbers of concessionary passengers, and high potential for fare leakage. The average revenue per passenger is 1.7UAH. | OGET consequently make a large operating loss each year, discouraging investment in new vehicles, infrastructure or capacity to co-ordinate PT services. |

## The passenger experience

2.80 To better understand the passenger experience, short interviews were held with nearly 1,000 travellers on the street in Odessa. These interviews asked travellers about the characteristics of their last journey, what decisions guided their transport choices and their opinions on travelling in Odessa. This is referred to as the 'traveller interview survey'.

2.81 This survey was followed by a number of focus groups used to identify transport issues that relate to gender, the elderly and uses with reduced mobility. The focus group attendees were chosen to cover a range of socio-economic statuses. The focus groups themselves were held in a variety of locations across the city to ensure they could be attended by disabled users. To capture a more strategic view of the barriers to travel for deaf, or hard of hearing users, an in-depth interview with Aleksandr Babin, chairman of the Odesa regional organisation of the Ukrainian Society of the Deaf was also conducted.

2.82 The findings of the traveller interviews and focus groups are discussed below.

2.83 As part of the traveller interviews, passengers were invited to rate different aspects of their journey conducted that day. Table 2-17 presents the results in relation to the mode used. The most concerning problems related to comfort and travel time. Marshrutka and trolleybus services offer particularly low levels of comfort.

2.84 Overall trolleybus services were rated the worst with problems concerning long wait times, overcrowding (cannot get a seat) and discomfort. This reflects a trolleybus service which is overloaded and suffers poor reliability, these issues partly stem from a lack of vehicles and low headways. Old vehicles also contribute to poor levels of comfort, see Figure 2-31. At present OGET is undergoing a process of trolleybus renewal which should help to ameliorate this situation. Trolleybuses are also generally the slowest of the modes because they operate in mixed traffic, stop at every stop and cannot overtake. It is concerning that trolleybuses score badly on personal and vehicle safety.

2.85 Marshrutka services in Odessa are also found to be uncomfortable and overcrowded. Most of these vehicles are also old and drivers aim to carry as many passengers as possible to maximise fare taking. Marshrutka typically carry up to 40 passengers with 20 seating and 20 standing, which can lead to uncomfortable levels of loading.

## Table 2-17: User rating of each transport mode (out of 5)

| | Mashrutka | Trolleybus | Tram | Taxi | Car | Rail | Walk only | All |
|---|---|---|---|---|---|---|---|---|
| Too long | 3.5 | 3.7 | 2.6 | 1.3 | 1.4 | 3.0 | 3.4 | **2.6** |
| Uncomfortable | 4.1 | 4.2 | 2.8 | 1.1 | 1.0 | 3.0 | 3.7 | **2.7** |
| Expensive | 1.6 | 1.6 | 1.2 | 2.2 | 1.8 | 2.0 | 1.3 | **1.7** |
| Wait time | 2.4 | 3.3 | 2.6 | 1.1 | 1.2 | 2.0 | 2.7 | **2.2** |
| Interchange | 2.5 | 2.8 | 2.6 | 1.1 | 1.3 | 4.0 | 2.1 | **2.4** |
| Cannot get a seat | 3.1 | 3.0 | 2.1 | 1.2 | 1.3 | 2.0 | 2.9 | **2.2** |
| Personal safety | 2.3 | 2.7 | 1.6 | 1.2 | 1.3 | | 1.8 | **1.8** |
| Driver or veh. unsafe | 2.2 | 2.7 | 1.8 | 1.2 | 1.3 | | 2.3 | **1.9** |
| **All** | **2.7** | **3.0** | **2.2** | **1.3** | **1.3** | **2.7** | **2.5** | **2.2** |

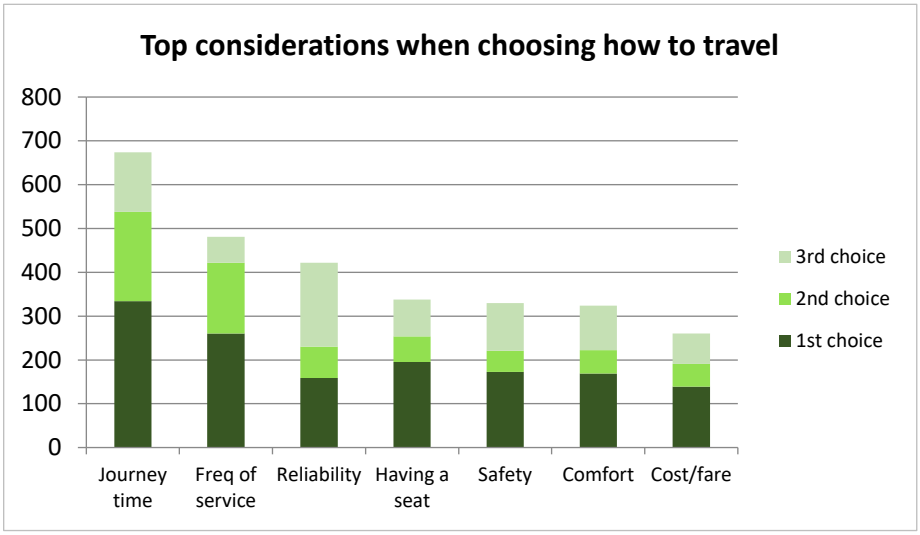
Rating out of 5: 5 = major problem, 1 = not a problem

Source: Traveller interview survey

## Figure 2-31: Old trolleybus interior

2.86 Figure 2-32 presents the most important considerations for travellers in Odessa. Journey time, frequency and reliability come top. While comfort is not so much of a concern, despite marshrutka and trolleybuses scoring poorly for comfort in Table 2-17.

## Figure 2-32: Top 3 considerations when choosing how to travel




Source: Traveller interview survey

## Common problems reported by focus groups

2.87 The main problems that this research has identified stems from the overall service provision or driver attitudes. All user groups, except representatives of the deaf or hard of hearing group, emphasised problems of rude or unwelcoming drivers, especially in marshrutkas. The following key points summarise the feedback from users:

- Drivers are rude to passengers and have a generally poor attitude;
- Unsafe or illegal driving;
- Using a mobile phone whilst driving;
- Drivers do not always stop to pick up users, including parents and children, from concession categories on the stop, where they are the only ones waiting;
- Vehicles start moving whilst users are still in the process of boarding or alighting;
- Drivers do not announce upcoming stops and changes to stop names have not been updated on tickets;
- Carers of disabled users do not get concession as well;
- Lack of conductors on municipal transport to aid blind or visually impaired users with their license and with getting off at the correct stop; and
- Wheelchair users often have problems with accessing low-floor vehicles as drivers do not always stop near the edge of the pavement, meaning that the step is too high for them to access the vehicle.

2.88 It was also highlighted that there is a distinct problem with the operational reliability of public transport (e.g. vehicles do not follow scheduled timetable, which is most crucial for wheelchair users that can wait for an hour for their low floor vehicles), and the frequency / intervals between vehicles on some routes is poor.

2.89 Another prominent point raised was the poor service reliability caused by traffic / congestion and the cancellation of popular routes. This is believed to be due to a lack of transport and infrastructure planning and improvement schemes. In addition, all user groups raised the issue around poor parking practices near Privoz market (Panteleimonivs'ka St), which blocks tram movement in that area for hours.

2.90 In general, users expressed that they would expect transport provision to meet the following criteria:

- Arrive and depart in a timely manner, sticking to the scheduled timetable;

- Provide comfortable seating / travel arrangements (including temperature control / air conditioning) for all user groups, including room for wheelchair users or buggies;
- Drivers should adhere to road laws and drive in a safe manner;
- Drivers should be polite and provide assistance to users when necessary. Additional training should be provided to drivers of low floored or specially adapted vehicles so that they are able to help users board and alight safely;
- Service frequency should be increased during peak hours; and
- For municipal routes, conductors should be on vehicles and both visual and audible announcements for stops provided.

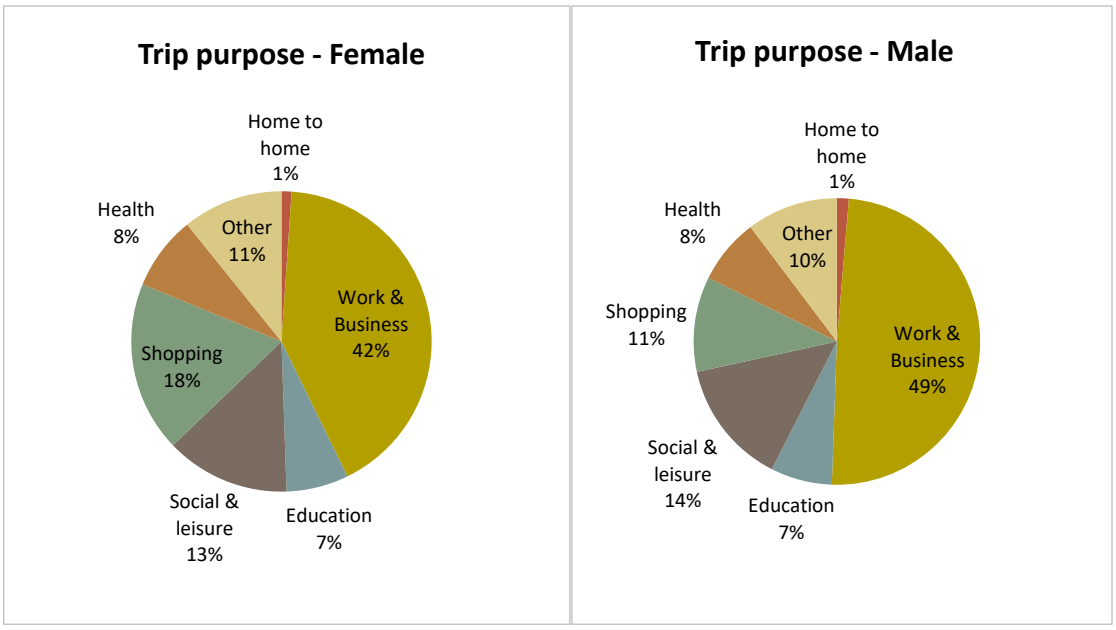
2.91 Taking account of the above criteria, respondents scored municipal transport higher than marshrutkas, despite the majority (except disabled users, parents with buggies the elderly) using marshrutkas more often. The main explanations for this were:

- Regardless of the reliability not being as good as other modes of transport, the higher frequency / availability of marshrutka services passing the stops means that users are more likely to be able to board a marshrutka, as opposed to communal transport;
- Communal transport doesn't connect to all intended destinations, so in some cases marshrutka is the only option available; and
- Between peak hours, marshrutkas journeys are faster than on the older communal transport.

## Gender analysis

2.92 A comparison of the findings from the traveller interview survey show that women in Odessa tend to make trips covering a wider range of purposes (Figure 2-33). This stems from the tendency to make fewer work trips and more shopping trips.

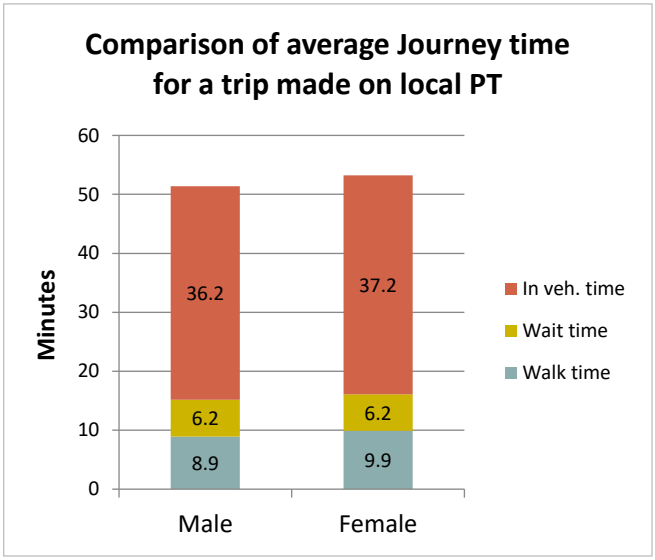
## Figure 2-33: Comparison of trip purpose, female and male




Source: Traveller interview survey, tourist trips excluded.

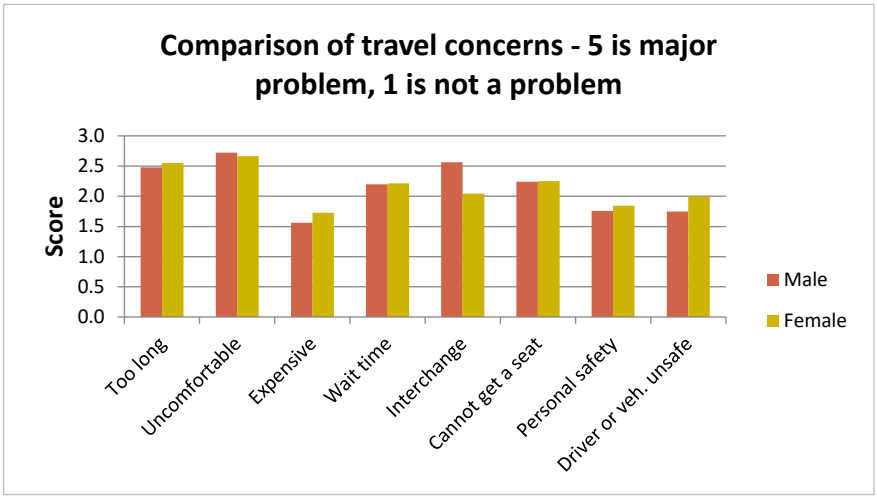
2.93 On average the trips undertaken by women are slightly longer than for men (Figure 2-34). Notably this includes a 10% longer walk.

## Figure 2-34: Comparison of trip duration, female and male




2.94 A comparison of travel concerns (Figure 2-35) shows that, when compared to male responses, women are more concerned about trip duration, cost, wait time, personal safety and vehicle/driver safety.

## Figure 2-35: Comparison of travel concerns, female and male




2.95 A focus group was held with women to investigate these concerns in more detail. Four important areas of concern were identified; comfort, driver attitude, safety and service reliability.

2.96 Comfort relates primarily to poor air conditioning or heating (particularly during the summer and winter months), poor cleanliness of marshrutka, overcrowded vehicles and having enough room for strollers/push chairs:

> *"In summer it is over 40 degrees hot – and marshrutkas turn into cattle carriers – it is almost impossible to be there. There are some marshrutkas where you even can't open windows – it's like sauna there."*
>
> *"It's nearly impossible to seat with stroller into marshrutka, and no one will help you." "Marshrutkas are packed so tightly that all cracks are stuffed with people."*
>
> *"We have tram route 20 – these trams are in terrible state, they regularly burn and break… And very horrible rails, if they break – you will not ride anywhere from there"*

2.97 The attitude of drivers was criticised, especially marshrutka drivers:

> *"Drivers communication with passengers is just terrible. They say rude things, as If it doesn't suit you – get out of here". Mainly marshrutka drivers"*
>
> *"I've called at complained about 323 route – near the bus station, someone with bags wanted to go out from back door – driver told them to get out of the window, he'll not open back door."*

2.98 Furthermore, some marshrutka drivers do not always collect passengers who are travelling with concessionary passengers, for example children. This disproportionately affect women, as they are more likely to travel with dependants:

> *"It looks like marshrutka drivers hate concession categories and tell that they should ride by communal transport, or limit number of concession passengers up to two per route - not just the elderly, but also for students (they have discount on ride) and people from families with more than 3 children."*

2.99 The focus groups found women held more safety fears regarding public transport. These fears were based on personal experience and stories of others. Safety includes safe boarding:

> *"And another situation from marshrutka that I witnessed - when a grandmother boarded marshrutka, and her kid was just about to board, but it started driving and kid was hanging on grandmothers arm"*

Having safe ride – at peak hours women are pressed a little bit tougher than men

> *"Near Bolshevik at the morning it's nearly impossible to get in marshrutkas – not if anyone will fall out and save some place. Once my daughter was travelling – someone pinched her lungs and she couldn't breathe smoothly during several days afterwards, another time I saw how the door pinched the leg of one women so that even blood appeared."*

2.100 Time is precious for Odessa citizens, and many of the issues talked about in all focus groups related to bad timing and unpredictability of public transportation. Due to the twin pressures of caring for the family and earning a wage, women generally experience more 'time poverty'. Therefore, the poor availability and reliability of transport dis-proportionately affects them:

> *"Marshrutki have very unstable schedule – they can have very large break between two vehicles – and by this time if you know about gap you could have gone to another stop and board some other vehicle. Instead you are staying on the stop waiting."*

2.101 One female respondent stated that the irregularly of public transport in the evening was more of a concern than safety fears at that time of night. This also highlights the likelihood that women undertake trips are more irregular times of day:

> *"The only fear at 10 PM is that I will not be able to get home because public transport barely rides at this time."*

## Gender - key problems

2.102 Our gender research has shown that women are disproportionately more affected by poor levels of PT service than men. Women make more complicated journeys that involve a larger number of interchanges (multi-stage). Consequently, poor service reliability and the lack of availability of appropriate services, has a larger impact on their journeys. This is compounded by higher levels of time poverty.

2.103 Women are more likely to travel with dependants such as children or the elderly. As these groups receive concessionary status, marshrutka drivers often refuse to pick them up. As a result, women are more dependent on the municipal network which is limited in coverage and involves a greater number of interchanges. A woman who regularly takes her children to school may have her employment choice restricted to areas accessible by municipal bus.

2.104 Affordability of travel is more of a concern for women who earn 25% less than men on average [2]. This is compounded by the need to purchase additional single tickets when performing multi-stage journeys.

2.105 Moreover, the key concerns presented by women in the focus groups are journey comfort, driver attitude, safety and service reliability. This includes potential harassment on the vehicles, lack of room for strollers on vehicles and the negative attitude of drivers. Poor reliability and discomfort on the vehicles were identified as key issues, which disproportionately affect women because they tend to rely more on public transport.

## Fare affordability

2.106 In both Table 2-17 and Figure 2-32 fare is not identified as a problem or a consideration for passengers. This indicates PT fare levels are affordable to the majority of travellers in Odessa.

2.107 To determine the affordability of public transport fares, Caruthers et al (2005) developed an affordability index which compares the monthly cost to commute against monthly income:

$$Affordabilty\ index\ (\%) = \frac{60\ trips\ \times Average\ cost\ for\ one - way\ work\ trip}{Per\ capita\ income}$$

[2] World Bank, 2016. *Country Gender Assessment for Ukraine*, p61

2.108 Table 2-18 calculates the fare affordability index for each mode in Odessa. This is based on estimates of monthly income including:

- Average monthly wage in Ukraine: 708 USD PPP (https://tradingeconomics.com/ukraine/wages) which accords with monthly GNI per capita of 713 USD PPP (http://wdi.worldbank.org/table/4.210)
- Minimum wage in Ukraine: 308 USD PPP (http://blogs.elenasmodels.com/en/minimum-salary-in-ukraine-increase/)
- Income share held by lowest 20% is 10.3%. Derives a monthly income of 367 USD PPP (https://data.worldbank.org/indicator/SI.DST.FRST.20)
- In 2015the gender pay gap in Ukraine was 24%[3]. To represent affordability for women we have depressed by 12%[4] the average monthly wage (becomes 623 USD PPP) and the monthly income of the bottom 20% (becomes 323USD PPP).

### Table 2-18: Fare affordability

| Mode | Price of single ticket | | Ave. no. of stages | One-way fare, considering interchange | | Monthly cost (60 trips) | | Fare affordability index (Travel cost as % of monthly wage) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UAH | USD PPP | | UAH | USD PPP | UAH | USD PPP | Ave. wage | Ave wage, female | Min. wage | Botto m 20% | Bottom 20%, female |
| Tram | 3 | 0.29 | 1.3 | 3.9 | 0.38 | 234 | 23 | 3.2% | 3.6% | 7% | 6% | 7% |
| Trolleybus | 3 | 0.29 | 1.5 | 4.5 | 0.43 | 270 | 26 | 3.7% | 4.2% | 8% | 7% | 8% |
| Marshrutka | 5 | 0.48 | 1.1 | 5.5 | 0.53 | 330 | 32 | 4.5% | 5.1% | 10% | 9% | 10% |

2.109 Figure 2-36 compares the fare affordability calculated for Odessa against data for other countries, using PPP. Overall fares in Odessa are found to be low relative to wages when compared internationally. A regular commute on tram or trolleybus is found to be particularly affordable, as this would only consume 3% to 4% of average monthly income. For the average female wage, commuting by tram and trolleybus would use 4% to 5% of monthly wages, which is also considered affordable. This matches fare affordability in France. However, it is important to note that many passengers who use tram and trolleybuses in Odessa receive concessionary (free) travel.

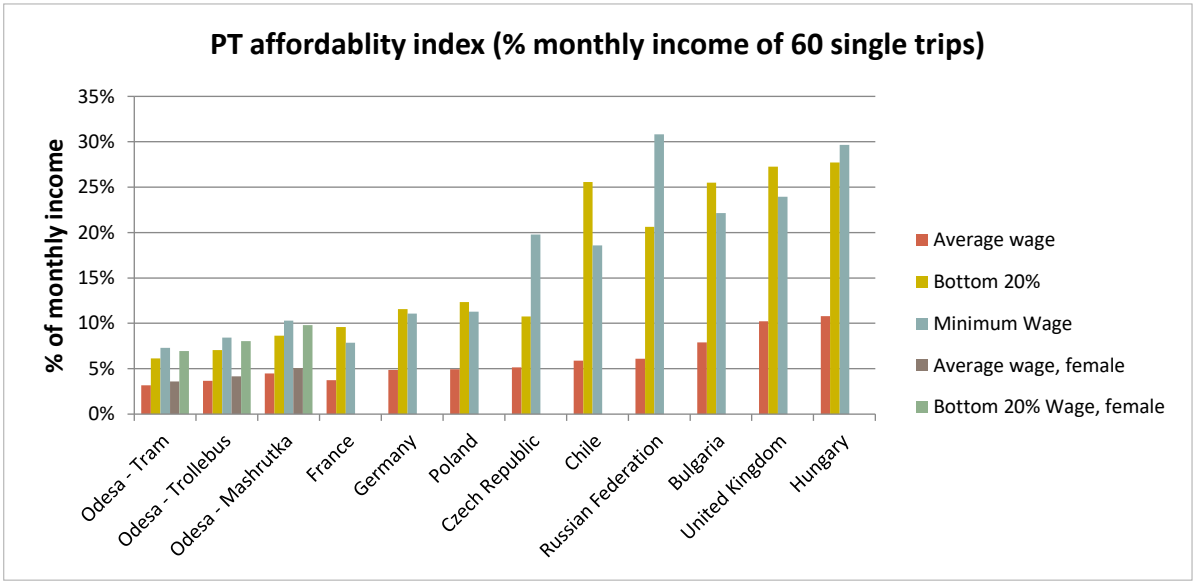
[3] World Bank, 2016. *Country Gender Assessment for Ukraine.* p61
[4] With a gender gap of 24%, men earn 12% more than the average, and women 12% less

2.110 A regular commute on marshrutka is more expensive, consuming 4.5% of the average monthly wage, this level is more in line with the average cost to commute in Germany, Poland and Czech Republic. When considering the lower average female wage, commute costs by marshrutka increase to 6% of monthly wage.

2.111 The cost to travel begins to become concerning for the poorest 20%. For this group the average commute by marshrutka would take 9% of monthly wages, and 10% of monthly wages for a woman.

2.112 While a number of commutes are going to involve a larger number of interchanges and will therefore take up a much larger proportion of monthly wages, overall fares are found to be affordable in Odessa.

Figure 2-36: International comparison of fare affordability




## Low income group analysis

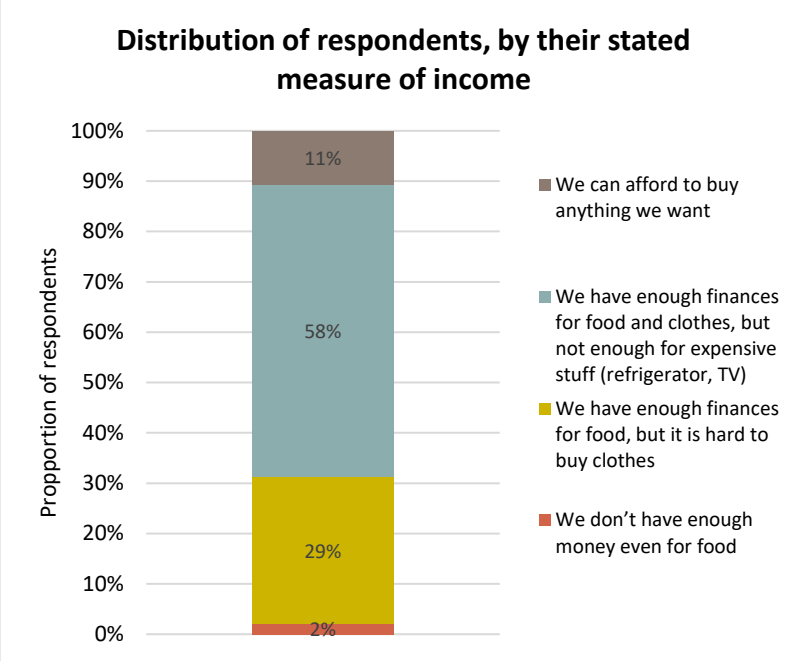
2.113 The traveller interview survey asked respondents to indicate their income level by inquiring as to which qualitative income bracket they felt best represented their financial status. These qualitative income brackets are presented in Figure 2-37 along with the distribution of respondents.

2.114 The majority of respondents (58%) reported to 'have enough finances for food and clothes, and we can spare some, but this is not enough for expensive stuff (refrigerator,

TV)'. At bottom end of the income scale, 2% of respondents reported to 'struggle to even pay for food' and a further 29% have 'enough money for food, but struggle to pay for clothes'.

2.115 For the purposes of further analysis the bottom two categorises will be grouped together into a 'bottom 30' and the top two categories grouped into the 'top 70'.

Figure 2-37: Income distribution of traveller interview respondents

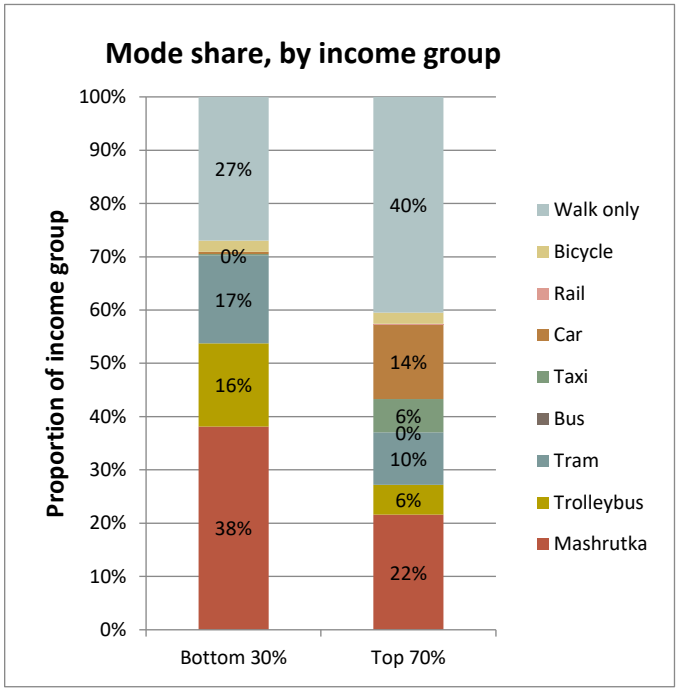



2.116 The two income groups (bottom 30 and top 70) have considerably different travel patterns. Figure 2-38 shows that the bottom 30 uses public transport (Marshrutka, trolleybus or tram) for 70% trips, while the top 70 only use PT for a minority of trips, 37% in total. Instead the top 70 use private modes (car and taxi) for 20% of trips, whereas the bottom 30 use private modes for less than 1% of trips.

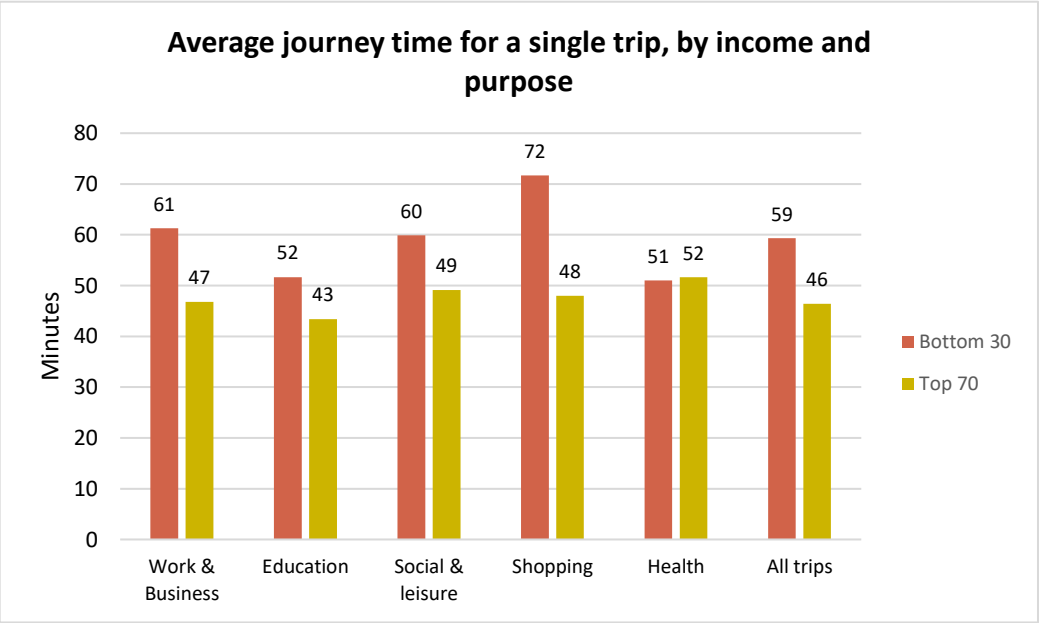
2.117 It is interesting to note that the top 70 are able to conduct more trips by foot. This indicates that they live closer to work and amenities. This may reflect the urban structure of the city where poor high-density neighbourhoods are located on the periphery of the city. As a consequence, the low income group is incumbered by longer trips that rely on public transport.

2.118 This finding is corroborated by Figure 2-39 which finds the average journey undertaken by the low-income group takes 1 hour to complete, whist this is only 45 minutes for the top 70.

## Figure 2-38: Mode share by income group




## Figure 2-39: Journey time by income group



The important considerations when choosing how to travel also differ by income group, as shown in Table 2-19. While journey time is most important to both income groups, the bottom 30 place a higher priority on 'having a seat' and 'cost/fare'. The low income group rely on PT, where getting a seat can be challenge, this is less of a concern for the top 70 who have greater access to private transport.

While 'Cost/fare' is important to the bottom income group, it is the lowest concern for the top 70. The top income group instead prioritise frequency of service, interpreted here as being able to travel when desired, and comfort and safety which they are willing to pay more for.

### Table 2-19: Priority of considerations when choosing how to travel, by income group

| Order of priority | Bottom 30 | Top 70 |
|---|---|---|
| **1** | Journey time | Journey time |
| **2** | Having a seat | Frequency of service |
| **3** | Cost/fare | Comfort |
| **4** | Frequency of service | Safety |
| **5** | Reliability | Having a seat |
| **6** | Safety | Reliability |
| **7** | Comfort | Cost/fare |

2.119 The analysis of the travel patterns and important considerations of the low income group shows that improvements to public transport will be of greater benefit to the bottom 30 who rely on PT. This group tend to make longer trips, therefore the development of faster and more varied cross city connections will be of considerable benefit this group. While it has been found that fares are affordable in the city, it should be remembered that fare levels is an important consideration to the bottom 30, therefore any fare increases should be used to improve the quality, speed and financial stability of PT services used so much by this group.

## Users with limited mobility

2.120 Elderly are dependent on getting to their destinations via the communal transport network (municipal trams and trolleybuses) or by using the limited number of social bus routes. This group had concerns they that are often ignored by marshrutka drivers when they were waiting alone at the stops. This limits their route and destination choice to where municipal and social transport go, even if they were willing to pay full fare on a marshrutka:

> *"I often see when elder person is alone on the stop – or person with stick – and marshrutka driver just flies forwards and doesn't stop, because he knows that it is "free rider"."*

2.121 In areas where there is no municipal transport, there are a limited number of 'social routes' where passengers can pay 1UAH to travel on a marshrutka. However, these routes are very infrequent and reportedly do not satisfy demand.

2.122 There was also concern that the lack of conductors on-board vehicles required elderly passengers to push through crowded vehicles to show their pension licence to the driver and exit through the front door. This was often tough and uncomfortable to do. Instead it would be preferable to have conductors on board so they can then alight from any door they need.

2.123 With regards to the physically challenged user groups, we understand that, following last year's city administration, there are regular meetings held with representatives of a disabled groups committee with the aim of understanding the current barriers to travel, including problems within the city, and the potential solutions that could be implemented. At each focus group/interview carried out during the diagnostic phase, we had at least one representative of the committee group that regularly takes part in such activity.

2.124 Respondents noted that the city administration initially started to implement some of these solutions, however these were often short-term fixes and the following problems are now reoccurring:

- Special tickets were introduced in communal transport for deaf or hard of hearing users, but they now only show the end stops of the route, making it difficult for users to board / alight at the correct stop;
- For blind or visually impaired users, communal transport introduced audible announcements for stops, however, it is often unavailable or not in use (especially on trams and trolleybuses); and

- Low floor vehicles were introduced for mobility impaired users, but not all drivers / conductors were trained to help disabled users when boarding.

2.125 The main problems that remain are systematic - while new vehicles are introduced, there are still only couple of them per route so wheelchair users need to often wait for up to an hour before one come. Reliability issues, therefore are common for all types of passengers, but affect people with limited mobility more than others:

> *"There are lowfloor trolleybuses now. The trouble is that there is no regularity. Even when at city council website each quarter they put schedule of movements of vehicles, adapted for wheelchair users, by routes – interval is one in hour, as I remember – there is no confidence that if you stay at stop for an hour, you'll see this bus – this vehicle could be lost somewhere on its route. That's why we have faith, but there is still too little of hope."*

2.126 Other specific problems for physically challenged passengers with limited movement are:

- **Accessibility**:
  - Not all transport is adapted for the boarding of people with limited mobility – for example, in old trolleybuses there is handrail in the middle of the doorway, through which wheelchair user can't pass;
  - Not at all transport it is easy to get in – often drivers don't stop near curbs and there is gap between entrance and sidewalk, which complicates entrance for people in wheelchairs (as well as people with strollers).

> *"They stop far from edge of sidewalk so that even at accessible vehicle you can't enter without help – and if you are looking for help, they rarely are eager to help us to ride in."*

- **Infrastructure problems:**
  - Not all stops have enough space for a wheelchair to wait, and for people with different levels of disabilities to sit or to hide from sun, rain or snow during their wait for a vehicle;
  - The designs to improve access should consider all types of disability. For example, hand rails that assist the bind at stops should be designed in a way that doesn't not restrict access for wheelchair users
- **Human factors:**
  - Drivers and conductors often don't know how to use the ramp inside low-floor vehicles when a wheelchair passenger needs to board;

*"Then at last [the trolleybus] arrived, everyone went to board it – I'm as unusual, sitting aside of crowd, driver and conductor even didn't pay any attention to me, like I was the same part of the environment as some passing by animal, cat, for example. They didn't consider me being their passenger."*

*The conductor shouted "Why should I bring him, how can I lift him, I won't do this!"*

- Drivers start moving before people finish boarding and can stop too abruptly – this is traumatic for people with limited mobility;
- Caregivers for disabled passengers are legally entitled to travel for free. However they typically pay on both municipal and marshrutka services.
- Drivers of marshrutkas are racing and "fighting for passengers" that leads to uncomfortable and unsafe trips for disabled users and dangerous situations on the road; it is very hard for partly immobilized people and nearly impossible for wheelchair users to protect themselves during such races.

2.127 The route choice for the elderly and disabled is typically limited to the municipal network, even when they would like to travel by marshrutka. A key problem identified with the municipal network is service reliability. This has a disproportionate effect on disabled users because most routes only have one low bus operating on it. If this bus does not arrive on schedule, the wait time becomes untenable. The lack of low floor vehicles themselves is the largest obstacle for disabled users. Their use of PT is also impeded by a lack of in-vehicle announcements, stop buttons and dis-courteous drivers.

## Potential areas for improvement

2.128 The following solutions were raised by focus group respondents to help improve current public transport service provision:

- Restructure stops to be more user friendly (e.g. wheelchair accessible);
- All stops should have route maps and up-to-date timetables;
- Implement Real Time Displays / Passenger Information Systems at stops to show when the next PT service is due to arrive;
- Provision of adequate, covered waiting shelters at stops to allow users to take shelter from the weather whilst waiting for their service;
- Redesign stops / add bus pull-outs so that low floored or specially adapted vehicles can be easily accessed by disabled users from the stop;
- Introduce bus lanes for public transport services along key routes;

- Replace marshrutkas with bigger buses or add additional bus routes (preferably municipal services)
- Reconnect districts through the provision of new or updated services and routes (such as Lenposelok and other districts), with return stops near the seaside;
- Introduce night routes and / or services;
- Enhance road and pedestrian route quality;
- Develop a network of safe cycle routes;
- Provide more stringent training for drivers and ensure they follow a code of conduct to enhance user experience;
- Review peak flow and user demand to ensure that routes and services are reflective of this, especially during commuting hours and on public event days;
- Enhance operational and behavioural efficient of public transport services and infrastructure;
- Implement a regular review process with passengers and drivers to ensure that services meet the needs of users and there are no barriers to travel;
- Police should introduce fines / enforce laws for drivers who break parking rules and block the movement of public transport or pedestrian access routes;
- Enhance municipal public transport (concession) to making it more reliable and accessible to all districts.
- Introduce / provide additional low floor vehicles on each of the main routes to allow better access for mobility impaired users (it is important that disabled users have the availability to travel from one city district to another, even with interchanges);
- Ensure that services on all key routes are blind and deaf user friendly e.g. visual and audible announcements and availability of a conductor;
- Introducing buttons for deaf or hard of hearing users to press when they want to stop on marshrutkas.

2.129 A prominent issue raised by all user group respondents was that drivers should adhere to Ukrainian law regarding concessions and concessionary travel for disabled and the elderly and to allow carers of disabled users to ride free as specified within the law.

# 3. Strategy for improving mobility

## Objectives to improve mobility

3.1 The provision of PT in Odessa should be improved to support the economic and social growth of the city, improve the passenger experience, develop an inclusive and easy to use PT network, and help to reduce air pollution, congestion and accidents.

3.2 Based on our assessment of the PT network, the following objectives are considered important for guiding the improvement of mobility in Odessa. These have been developed by considering the quantitative analysis on the condition of the PT network, user needs field research, and stakeholder engagement.

- Economic:
  - Reduce journey times and improve strategic accessibility across the city
  - Improve connectivity to poorly connected parts of the city such as Kotovsky
  - Improve reliability
  - Provide affordable, timely and reliable travel to all parts of the city
  - Increase operating efficiency and financial stability to enable re-investment in PT vehicles and infrastructure
  - Improve network capacity and resilience

- Social:
  - Improve levels of comfort on vehicles and at stops
  - Reduce stress for the traveller and city residents
  - Improve local access to the PT network in underserved areas of the city
  - Improve comfort, safety and mobility for women travellers.
  - Increase women's participation in the transport industry
  - Improve access for those with disabilities or other mobility constraints
  - Reduce accidents and increase safety
  - Improve passenger access to PT route information including routes, schedules and real-time information

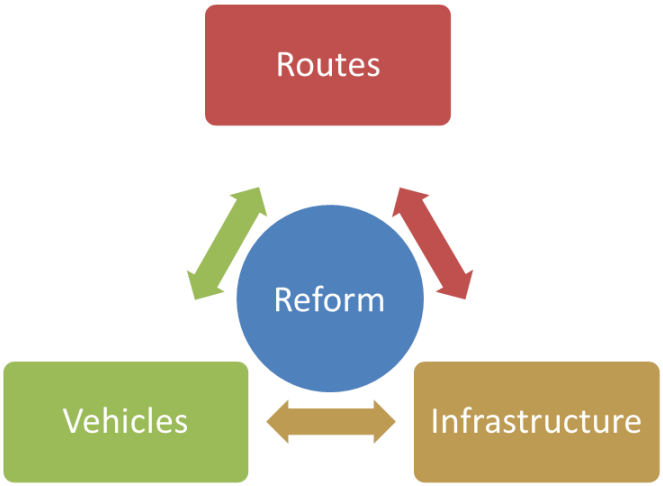
- Environmental:
  - Increase energy efficiency
  - Reduce the emission of local and GHG pollutants
  - Reduce congestion and its associated impacts of noise, air pollution and stress

## Integrated approach

3.3 The factors that contribute to the provision of public transport in a city are complex, multi-dimensional and involve a variety of different stakeholders[5]. Consequently, an integrated approach must be taken into to achieve a step-change in improvement.

3.4 Figure 3-1 presents the four elements of our integrated approach. The improvement of routes, infrastructure and vehicles all support each other. But for improvements in these areas to have the desired impact, reform of the PT industry is necessary. Each of the four elements of the approach are detailed in the chapter 4.

Figure 3-1: Integrated approach to improve PT




3.5 The integrated approach for improving PT in Odessa ties in with the City's Economic Strategic Goals and Tasks as identified in the *Economic & Social Development Strategy 2022*[6]. Goal 4.3 of this strategy emphasises the need to:

[5] Kumar, A & Zimmerman, S. 2015. *Lessons in design and implementation of world bank urban transport projects: what makes it so difficult?*

[6] Odessa City Administration, 2013. *Odessa Economic and Social Development Strategy 2022.* http://omr.gov.ua/images/File/DODATKI2013/strategia_eng.pdf

- Provide the city with quality and efficient infrastructure including comfortable conditions, and higher quality of road transport provision
- Modernise transport infrastructure, including upgrading the infrastructure of the city electric transport and replacing most of its rolling stock

## City goals

3.6 The City Administration of Odessa has recently adopted a conceptual plan for improving the urban transport system. It presents the following 10 goals:

1) Develop an information base on PT routes their patronage and associated infrastructure as well as private vehicle flows and road infrastructure.
2) Develop a backbone (strategic) network including the creation of dedicated lanes for public transport.
3) Increase the capacity and reliability of the PT network. Key to this is optimising the balance of modes. Greater efficiency and passenger comfort can be gained by moving passengers from 9m vehicles onto 12m buses, trolleybuses and trams.
4) Optimise PT routes as well as truck and car movements.
5) Optimising the fare and compensation policies for carrying concessionary passenger to make investment attractive. This should help to foster an effective competitive environment in the urban passenger transport market.
6) Improve road infrastructure
7) Improve the traffic management system
8) Create an automated dispatch control and monitoring system
9) Establish an e-ticketing scheme to enable the objective accounting of revenue and increase the information available on the use of PT routes.
10) Improve the management of urban passenger transport by endowing the City with powers to function as an Integrated Transport Authority which procures routes on a gross-cost contract basis.

3.7 Achieving these goals will require ambitious institutional development and wholescale reform of the PT industry. Such reforms will be complex, challenging and cannot be completed in a single step. There are however, actions that can be performed in the short, medium and long term to achieve the goals.

## Strengths of the PT network

3.8 When developing the objectives for improving mobility in Odessa it is important to build on the network's strengths. These are found to be:

- Current high levels of public transport use (46% of all trips, including walking). This high mode share should to be locked-in now before mass car use, by providing a quality PT system that is more attractive than the car.
- Extensive PT network served by a large PT fleet
- Significant PT infrastructure exists such as tracks and catenary for trams and trolleybuses. 75% of the tram network is segregated from the road. Electro-transport is more energy efficient and less polluting than diesel buses.
- Fares are affordable on all modes
- There is a large municipal operator, OGET, that has the institutional capacity to expand and upgrade their operations
- Odessa has many dense residential neighbourhoods that are well suited to be served by public transport.

## North-south tram route

3.9 As identified in paragraph 2.52, a key problem with PT accessibility within Odessa is the disconnect between the north and the south of the city, and poor connections between the north (Kotovskoho) and the city centre. This is because the tram network is split in two at Peresypskyi Bridge, in the middle of the city, and marshrutka services from the north get stuck in traffic.

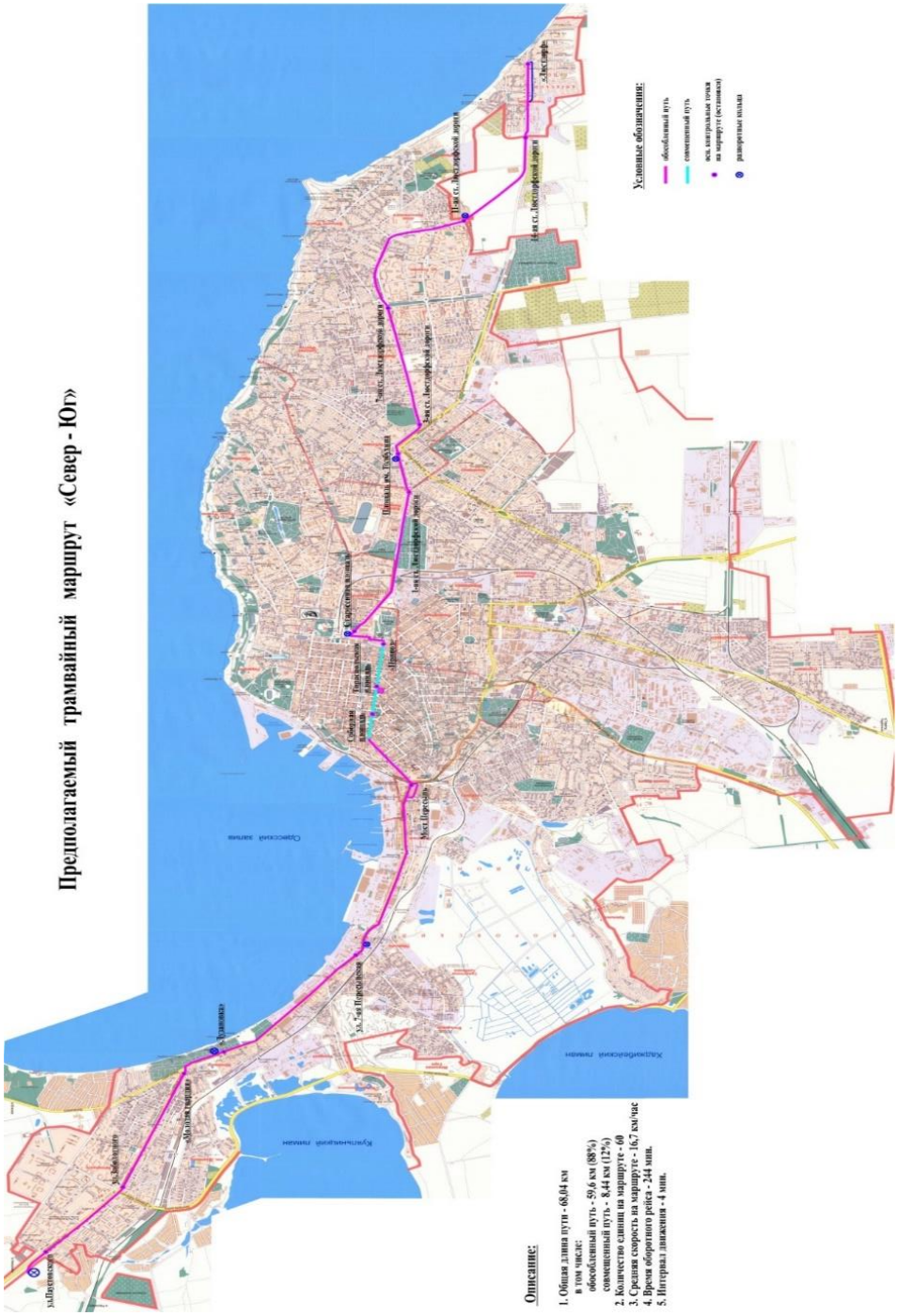
3.10 To resolve this matter the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) are funding through loan a project to connect the north and south tram lines by laying a new track along Sofiiva'ka St and Preobrazhens'ka St in the city centre (Figure 3-2). This project also includes the purchase of new tram units and the upgrade track sections to improve speeds. This project is currently ongoing and is expected to be complete in 2018.

3.11 Because most tram tracks in Odessa are segregated from general traffic they have the potential to provide mass rapid transit to many areas of the city. A comprehensive upgrade of this network, including measures to reduce traffic on mixed roads, could see operating speeds increase from 14.5kph to 22kph[7]. This study therefore presents an opportunity to reorganise the PT network to support, and take advantage of, the current tram upgrade works and future tram upgrade works which might be proposed by this study.

3.12 The network reorganization proposed in the analysis may lead to a much higher demand level for the tramway, compared to the current assumptions. The operational characteristics of the tramway might need to be adjusted to reflect the network reorganization.

[7]Average commercial speed for trams in EU-15, UITP, *Metro, light rail and tram systems in Europe*, p31

## Figure 3-2: Location of the north-south tram improvements




3.13 Chapter 4 presents a list of additional interventions which should be considered to improve the quality of service, and sustainability, of PT services in Odessa in the short and medium term.

# Strategic PT network

3.14 A strategic PT network for the future has been defined to help plan, and give structure to, the proposed improvement measures. This enables us to focus on route and infrastructure changes so that operational efficiency, city-wide accessibility and passenger experience can be improved in a targeted and more cost-effective way.

3.15 The strategic network has been developed by considering the current supply of PT routes, how PT capacity and arrangement relates to land use, observed trip demand, the new north-south tram route, current location of key interchanges and accessibility maps that identify areas of weakness in the network. This analysis is presented in chapter 2.

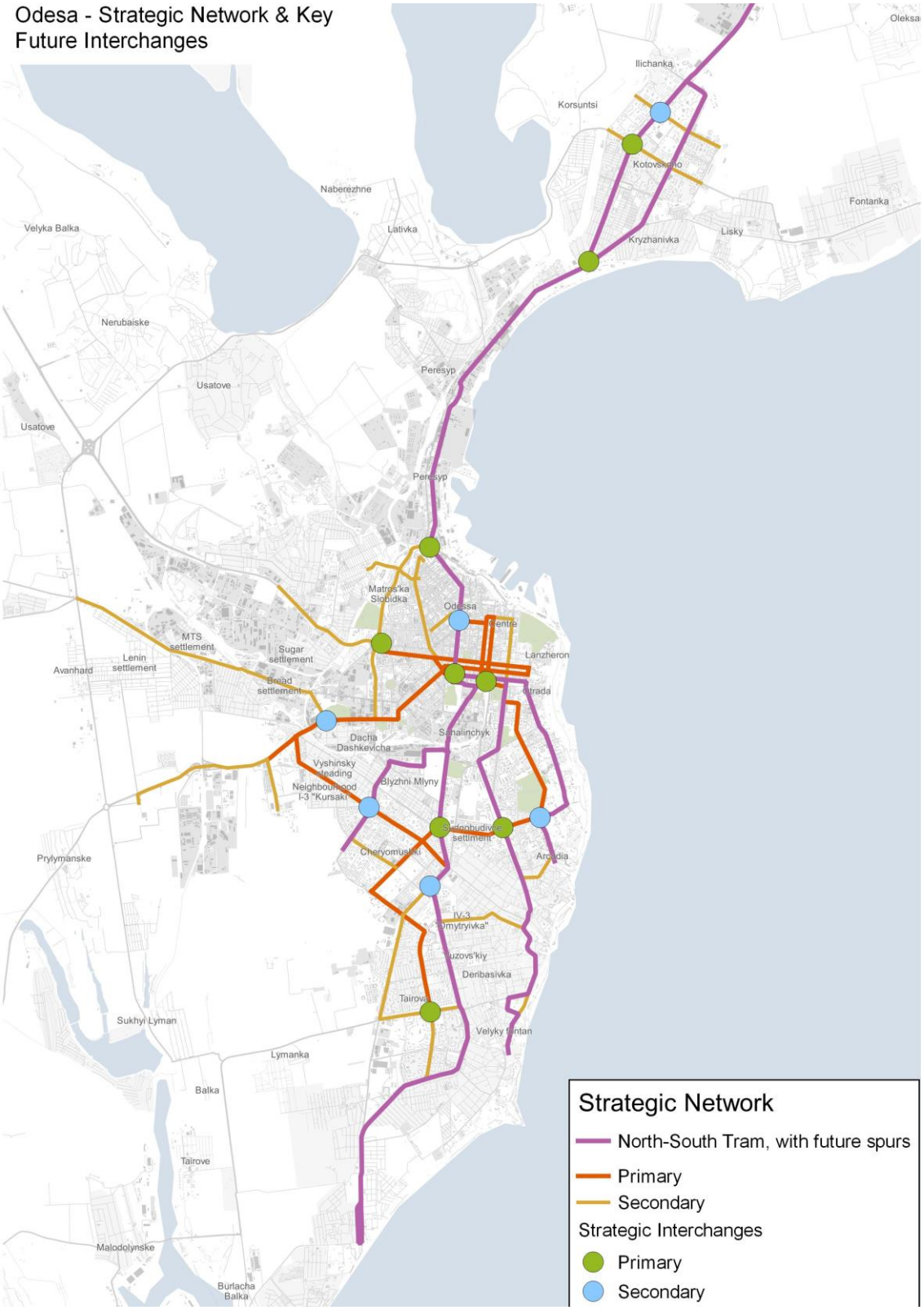
3.16 The strategic network is presented in Figure 3-3. It is defined by key PT corridors that connect to key interchange hubs. The key PT corridors comprise:

- New north-south rapid tram route (purple line). Which will become the main mass transit line in the city
- Primary PT trunk corridors (red lines). Where fast travel speeds and high LOS should support the largest passenger flows in the city. This includes:
- Radial corridors on Shevchenka Ave, Mel'nyts'ka St/Bohdana Khmel'nts'koho St and through Cheryomushki and Tairova which are connected by an orbital corridor on Akademika Filatova St/Admiral's'kyi Ave/Chernyakhovs'koho St, within the city centre a cross of one-way streets
- Secondary PT trunk corridors, (green lines) which provide key distributor functions.

3.17 The key interchange hubs (green and blue circles) where infrastructure should be upgraded to enable passengers to change vehicles and modes more easily, and to facilitate the movement of PT vehicles. These locations include:

- The rail, suburban and intercity bus terminals
- Locations where high numbers of passengers currently interchange, e.g. Peresyp Bridge/Khersonskyi Square
- Locations that are expected to become major interchange locations in the future, e.g. 1st station Lyustdorfs'ka Road when the north-south rapid tram route is complete.

## Figure 3-3: Proposed strategic PT network



# 4. Implementation plan

## Better management and operations

4.1 Improving the way public transport is managed and operated is an essential step towards a more efficient transport system. The Odessa City Administration as managers and regulators and both public and private operators shall take a number of steps to improve quality of transport delivered to the users.

### Short term

4.2 In the short term, the following actions could be made:

- Unhealthy competition on the road for passengers can be reduced. This can be done by rationalising the PT routes, with emphasis on reducing the direct competition between municipal and marshrutka services. Table 4-7 lists 7 marshrutka routes that should be closed because they directly compete with OGET services. Table 4-8 lists a further 7 routes that should be closed because they are near duplicates of other routes.
- The City Administration should send a clear signal to the marshrutka operators that a stepwise change in vehicle quality and operational performance will be required in the coming years. This will allow owners enough time to decide whether to invest in new vehicles and facilities or exit the market.
    - The next round of contract permits should make it clear to operators that an improvement in vehicle quality is required, including interiors, body work and seating. This should encourage more modern second hand marshrutka vehicles to be purchased.
    - The contracts should also require some basic driving standards.
    - A monthly operators fee to could be introduced to encourage low performing operators to exit the market. Such an instrument was used in Tbilisi in 2001, charging a monthly fee of $308.
- The City Administration should gain capacity to contract out, monitor and enforce route contracts that include quality criteria. Capacity includes personnel as well as technical ability, such as the ability to collect and process GPS readings from GPS loggers onboard marshrutka. Capacity is also required in the realm of PT planning

[8] Finn, B. 2008. *Market role and regulation of extensive urban minibus services as large bus service capacity is restored – Case studies from Ghana, Georgia and Kazakhstan*. Research in Transportation Economics, No.22 p118-125

and the implementation of the supportive infrastructure works, for example PT priority lanes and junction improvements. To ensure the development of inclusive policy we would welcome the employment of more women by the City within their transport planning team.

- The City may develop a Code of Conduct for marshrutka drivers to understand and sign up to. This would be accompanied by a driver training course that includes disability and gender awareness. A poor driver behaviour reporting mechanism should also be set up, such as the Zusha scheme deployed in Nairobi[9].
- The City Administration should define and enforce the new quality criteria associated with route permits. These quality criteria may include:
  - Annual vehicle inspections
  - Limits on driver hours
  - Women participation in the operating companies
  - Enforce traffic rules and positive driving behaviour
  - Frequency and reliability of services
- Review the current fare levels to reflect the operating costs. The City Administration is already in the process of reviewing its fare levels to reflect the operating costs and ensure the financial sustainability of the system.
- Establish an electronic ticketing (e-ticking) system, with associated GPS reporting system for all operators to use. The project would have three aims:
  1. Enable the objective accounting of revenue
  2. To collect information on the PT system, the patronage on individual routes, understand how they are operated and help assess whether the quality criteria related to frequency and reliability are being met.
  3. Enable greater transparency and predictability of the fare for passengers
- The City should develop an electronic database for the monitoring and contracting of routes. This would build on the existing system of route passports. The database should include all routes, traffic schedules and carriers (GTFS), as well as the ability to collect passenger and operational data to inform how to further optimise/structure network. GTFS and GPS data for all bus routes should also be opened up to outside organisations so they can develop route planning apps and communicate real time information.
- OGET should begin to operate 12m buses on select routes. This could include taking over operation of the existing marshrutka routes 148, 214, 121, 175 and 198 which are proposed to be modified in the short term.

[9] http://zusharoadsafety.org/

- The trial of the electric bus should be conducted to ascertain what operational challenges they present and how these can be overcome.

## Medium term

4.3 In the medium term institutional reform should include the consolidation and formalisation of the marshrutka companies. This will improve the managerial, organisational and financial capacity of the operators. It will also help to enable private operators to purchase and operate larger buses.

4.4 A move to use larger buses is preferable because they offer better passenger comfort, are easier to access (step on/off), cause less congestion and generate less GHG and local emissions. The poor comfort, lack of space and trouble accessing marshrutka are serious problems for the travelling public.

4.5 Currently there are approximately 800 marshrutka vehicles (9m long) in the city which carry 492,000 passengers per day. This equates to 615 passengers per vehicle per day (which incidentally is the same as in Kyiv: at 616 per day). In contrast a large bus in Kyiv currently carries an average of 1,480 passengers per day. Therefore, all of the daily trips currently conducted on the fleet of 800 marshrutka, could theoretically be carried by a fleet of just 332 large buses. However, in practice there would still be a need for small 9m marshrutka to ply minor and feeder routes.

4.6 The purchase of larger buses, by the private operators requires a step change in access to capital and major changes in maintenance capabilities. The City would have to play a key role to shape the industry by changing the contracting and regulatory environment to facilitate the consolidation. This would require the City to play a larger regulatory/monitoring and enforcement role to drive up standards, ensure higher LOS is provided & to coordinate network.

4.7 Table 4-1 presents the structure of the current marshrutka companies in Odessa. The estimates of daily patronage derive from the on-board surveys carried out by this study. There are 3 major operators, Virazh, Pivnichtrans and Turyst. Each carries over 100,000 passengers per day. The remaining 8 operators carry 128,000 daily passengers combined. Therefore, consolidation of the industry could focus on the 3 major operators.

### Table 4-1: Structure of the current marshrutka companies

| Private Operator | Number of routes | Estimated daily patronage | Forecast number of units |
|---|---|---|---|
| Virazh | 9 | 125,814 | 203 |
| Pivnichtrans | 20 | 125,350 | 203 |
| Turyst | 14 | 115,385 | 187 |
| SAM | 4 | 36,053 | 58 |
| ATP Kinostudii | 5 | 26,079 | 42 |
| Hlenkor Pivden | 2 | 19,109 | 31 |
| Avto-Servis | 5 | 14,881 | 24 |
| Avtorukh servis | 2 | 14,368 | 23 |
| Avtotrans Ukraina | 2 | 11,411 | 18 |
| Stars Trans | 1 | 5,862 | 9 |
| ATP 15106 | 1 | 180 | 1 |
| **Total** | **65** | **494,494** | **800** |

4.8 Consolidation and formalisation would require:

- The companies to become owners of the vehicles and employ the drivers and maintenance workforce.
- Use of operator permits for fit and proper companies. This would require operators to meet conditions such as providing fair wages to drivers, and gender and equality targets.

4.9 Under this regulatory environment, it is expected that some small operators would withdraw voluntarily from the market as vehicles reach the end of their useful life based on age and condition.

4.10 The City would need to expand the quality criteria for operation and enforcement to match. This should include the specification of permitted vehicle GHG emissions, engine technology, level access and CCTV. The use of quality contracts could also be considered if the route is to be allowed to use PT priority infrastructure such as bus lanes.

4.11 The City could work with the operators to establish 3 new depots from which to operate larger buses from.

4.12 Using the e-ticketing system, the larger companies should become capable of receiving compensation for carrying concessionary passengers. Therefore, as part of the contract it would become required that these vehicles must carry any concessionary passengers waiting to board. This would therefore open up the marshrutka network to concessionary passengers. The e-ticketing system could be used to check whether concessionary passengers were being carried.

4.13 As the marshrutka industry is formalised, and routes rationalised further, we would recommend an increase in the standard fare on OGET services to match that of the marshrutka. This would increase the cost to commute using OGET services from 4% of the average wage to 6% which would bring it in line with the affordability of fares in Germany, Poland and Czech Republic.

## Long term

4.14 The long-term goals for industry reform should be the development of an integrated transport network overseen by a body with the powers of an Integrated Transport Authority. This is the 10th goal set out in the City's conceptual plan. Different options should be considered for the way in which routes should be contracted and put to competitive tender. Such as Gross Cost Contracting or Net Cost Contracting.

4.15 The choice of a contractual model 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.

4.16 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 sometimes 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 Elsmshorn 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.

4.17 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.

4.18 Transport authorities need to commit considerable management resources to procure and then to supervise contracts such as those described. Experience in many European

countries has shown that substantial cost savings are achievable when a transport authority first moves to competitive tendering for bus services. The benefits also depend on the existence of a genuine competition among qualified operators for the services being procured by the transport authority. If there are very few credible bidders or if bidders collude in their tender submissions, the potential value for money benefits for the city are diminished or may not exist at all.

4.19 In contracting for transport services, a city's transport authority needs to decide the geographical extent of the services to be contracted for. This can be on a route-by-route basis, where single routes are tendered individually, although a single operator may be successful in winning a number of tenders.

4.20 An alternative to tendering route-by-route is to invite tenders for a bundle of routes or for a geographical area. This approach is less administratively burdensome than tendering individual routes and it favours larger operators, who have the resources to provide a fleet, depot and management at a larger scale. The size of the bundle may be defined by a geographical area (such as routes connecting certain residential areas to the central business district) or linked to the size of a depot.

4.21 The establishment of an Integrated Transport Authority will also facilitate the establishment of a multi-operator ticketing scheme. This would enable a single ticket to be purchased for a trip regardless of the number of interchanges made. Such a development would be of benefit to women passengers who tend to make more interchanges and therefore currently have to pay twice.

4.22 Starting from the existing contracts, Odessa shall consider making incremental improvements using models that are pragmatic given other constraints. Specifically, it is necessary to begin with a net-cost approach until there are mechanisms in place that can provide reliable means for network wide revenue collection, revenue security, and enforcement of performance management regimes.

## Better routes

4.23 Route changes should be made to the public transport network in Odessa to improve operational efficiency, improve accessibility levels for passenger and reduce competition for the passenger on the road. Routes changes should be made at different stages of the reform process, as some changes require industry reform or infrastructure improvements.

4.24 In the short term new routes can be added to the network, e.g. new trolleybus routes. Additionally, in negotiation with private operators, certain routes can be merged or closed. However, the scope for rationalisation is limited without industry reform. The short-term route changes, specified below, seek to meet the following objectives:

- Increase strategic and local connectivity and accessibility
- Reduce the number of overlapping routes
- Increase the level of service on routes – begin operating 12m buses
- Close underperforming routes

4.25 In the medium to long term the following route changes should be made to further support the short-term changes:.

- Introduce electric bus routes when feasible
- Route changes to support north-south tram
- New tram routes following infrastructure improvements
- Following industry reform – wholescale re-alignment of routes across the city

## Short term changes

4.26 Table 4-2 shows the impact of the routes changes proposed for the short term. These changes should be supported by new vehicles and ideally by infrastructure development such as public transport priority lanes, junction priority and new bus stops and interchanges. The supporting requirements for vehicles and infrastructure are outlined in sections starting at paragraphs 4.41 and 4.58 respectively.

4.27 In the short term we recommend the total number of routes is reduced from 91 to 73. This results from the net effect of adding 5 new routes while closing 25 routes. A further 16 routes are modified (Table 4-3).

4.28 As a result of the route changes, there is a shift in passengers from marshrutka to trolleybus and tram routes. We also recommend the 8 largest marshrutka routes should also be upgraded to be plied by 12m buses.

4.29 Trolleybus passengers increase because of the opening of new routes and the closure of duplicative marshrutka routes. The increase in passengers, and the need to add capacity to overcrowded routes necessitates the need to purchase extra trolleybus vehicles (Table 4-12). As a result, trolleybus mileage in the peak hours will increase. But

by better matching the frequency of trolleybus services to the change and demand through the day, the total daily veh-kms can remain the same.

### Table 4-2: Impact of the network rationalisation upon private and public passenger share

| | Existing | | | Result of Action | | |
|---|---|---|---|---|---|---|
| Mode | No. of Routes | Daily Passengers | Veh-kms | No. of Routes | Daily Passengers | Veh-kms |
| **Mashrutka12m** | - | - | - | 8 | 211,960 | 33,749 |
| **Mashrutka9m** | 61 | 496,841 | 174,995 | 32 | 256,090 | 94,148 |
| **Trolleybus** | 11 | 148,096 | 17,357 | 13 | 173,437 | 17,340 |
| **Tram** | 20 | 298,825 | 30,267 | 20 | 302,275 | 30,267 |
| **Total** | **91** | **943,762** | **222,620** | **73** | **943,762** | **175,503** |

### Table 4-3: Breakdown of new, deleted, modified and merged routes

| Action | No. of routes |
|---|---|
| **New routes** | 5 |
| **Modified routes** | 16 |
| **Deleted routes** | 25 |

### *New/modified routes to add strategic or local connectivity*

4.30 Through the optimisation process, we have identified a total of five new routes that can be implemented in the short term, illustrated in Figure 4-1. Three new marshrutka routes: N1, N2, N3 are identified in the figure below which attempt to solve current strategic and local access issues in Tairova, Cheryomushki, Velyky Fontan and west of

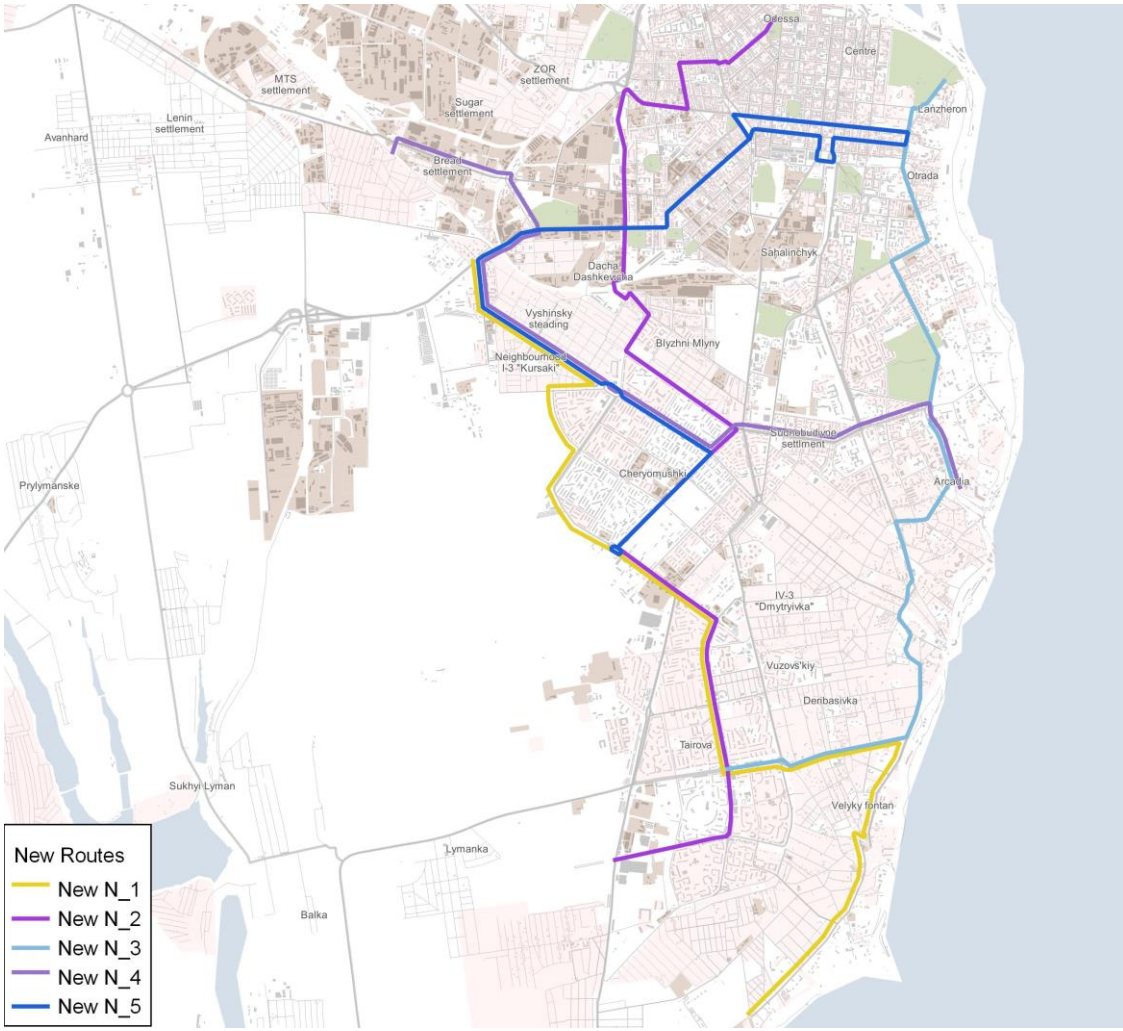
the city centre. Additionally, two new trolleybus routes – N4 and N5 have also been proposed to expand upon the current trolleybus network.

4.31 Table 4-4 shows the intended operating frequency and peak vehicle requirement for the new routes. It is intended to pilot these routes with a minimum headway of 15 minutes, to ascertain passenger demand. Overall, these new routes would require a peak vehicle requirement of 29 9m buses and 23 trolleybuses to operate at the pilot frequency.

### Table 4-4: New Routes

| Route | New Mode | 1-way length (km) | New Frequency (buses per hour) | New Round Trip Time (hours) | New PVR |
|---|---|---|---|---|---|
| **N1** | Marshrutka 9m | 16.1 | 4 | 2.2 | 9 |
| **N2** | Marshrutka 9m | 16.7 | 4 | 2.3 | 10 |
| **N3** | Marshrutka 9m | 12.2 | 4 | 1.7 | 7 |
| **N4** | Trolleybus | 11.2 | 4 | 2.3 | 10 |
| **N5** | Trolleybus | 15.8 | 4 | 3.1 | 13 |

## Figure 4-1: New routes to address local and strategic access issues




4.32 Additionally, we recommend that five routes are modified to provide additional local and strategic access within Odessa, illustrated in Figure 4-2. In particular, routes MT104, MT145 and MT250 have been realigned to provide additional local access in Kotovskoho. These are detailed in Table 4-5 below. In sum, a peak vehicle requirement of 141 vehicles would be required for these routes.

## Table 4-5: Modified routes to improve strategic and local access

| Route | Proposed change | | | | |
|---|---|---|---|---|---|
| | Action | New 1-way length (km) | New daily patronage* | New Frequency (buses per hour) | New PVR |
| **MT104** | Realign | 11.6 | 1,831 | 3 | 6 |
| **MT111** | Extend | 12.0 | 5,721 | 7.5 | 15 |
| **MT127** | Realign | 21.4 | 7,358 | 6 | 20 |
| **MT145** | Realign | 28.6 | 27,597 | 13.5 | 60 |
| **MT165** | Extend | 20.9 | 1,477 | 1.58 | 6 |
| **MT250** | Realign | 19.0 | 17,655 | 13 | 40 |

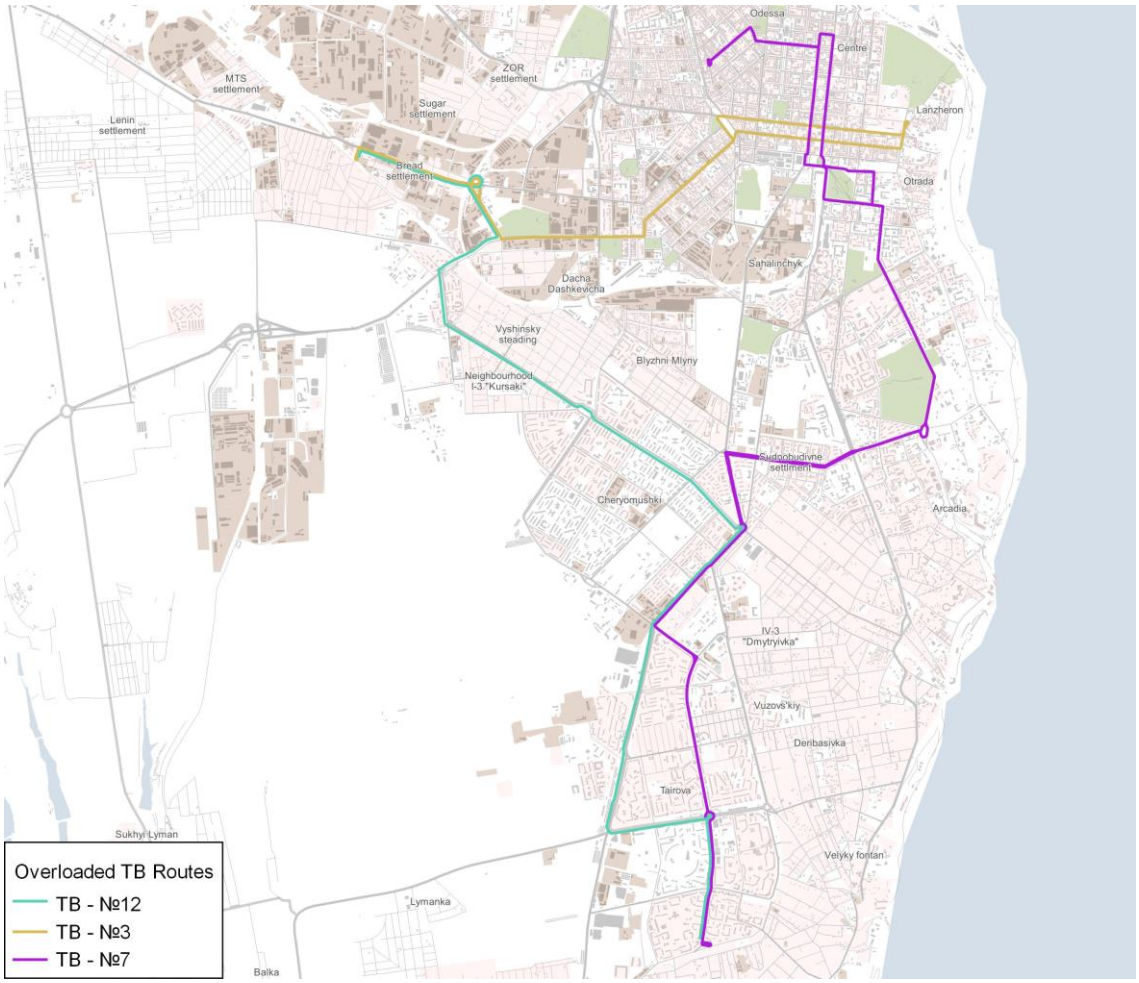
*Includes abstraction of passengers from closed routes

## Figure 4-2: New alignment of modified routes to address local and strategic access issues

### *Increase frequency on overloaded trolleybus routes*

4.33 Three overloaded trolleybus routes were identified through the optimisation process – TB3, TB7 and TB12. As identified in Table 4-6 the current patronage per vehicle on these three routes exceeds 120 passengers per vehicle trip. The frequency of the routes prescribed in the route passports is sufficient to carry the demand, but OGET are not operating these routes with enough vehicles to attain the target frequencies. In order to increase capacity and maintain recommended frequencies, it is proposed to increase the number of vehicles serving each route.

Figure 4-3: Overloaded trolleybus routes



### Table 4-6: Increase capacity on overloaded trolleybus routes

| Route | Existing | | | Proposed Change | |
|---|---|---|---|---|---|
| | Existing Daily Patronage | Patronage per veh trip | Current No. of vehicles | New Frequency (buses per hour) | New PVR |
| **TB_3** | 17,293 | 130 | 5 | 6 | 11 |
| **TB_7** | 17,699 | 128 | 11 | 4 | 14 |
| **TB_12** | 26,354 | 140 | 8 | 6 | 19 |

## *Close/modify routes to reduce public/private competition*

4.34 A total of seven marshrutka routes have been identified that directly compete with OGET services and the new North-South rapid tram route (Table 4-7). Of these, six marshrutka routes are recommended for deletion, with patronage reassigned to OGET services. A further one marshrutka route is recommended for modification (shortening) to reduce competition with the North-South tram, whilst maintaining existing local and strategic access.

### Table 4-7: Routes modified or closed to remove public v private competition

| Duplicative Route | Existing Daily Patronage | Action | Duplicates this OGET route (passengers move to this route) |
|---|---|---|---|
| **MT9** | 17,806 | Delete | TB9 |
| **MT121** | 14,434 | Modify | New MT121 |
| **MT130** | 1,759 | Delete | N-S Tram |
| **MT131** | 1,129 | Delete | N-S Tram |
| **MT210** | 7,535 | Delete | TB10 |
| **MT215** | 381 | Delete | T18 |
| **MT223** | 180 | Delete | T18 |

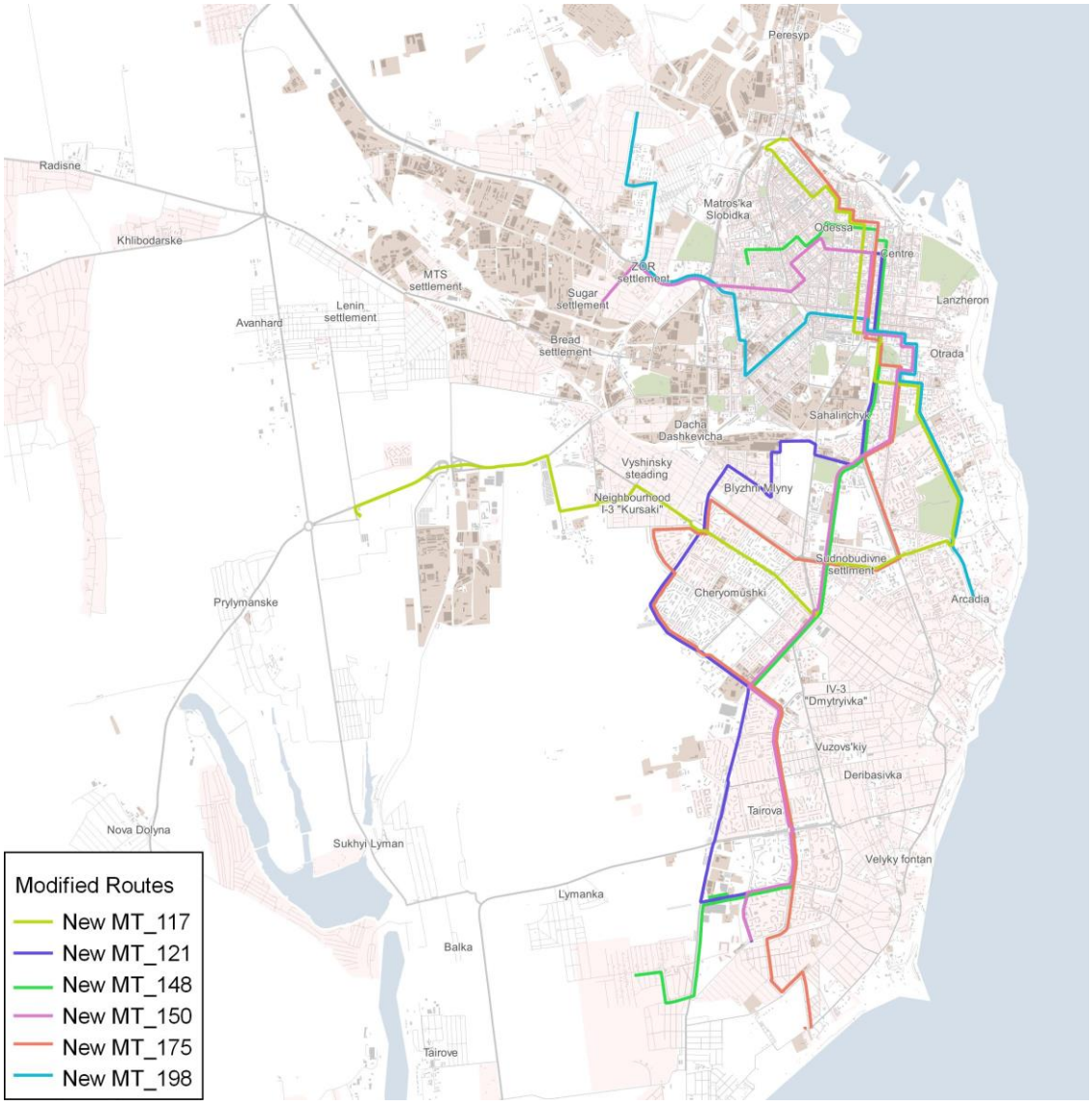
### *Close/modify to merge similar routes*

4.35 Seven highly overlapping routes (more than 70% duplication of another route) have been identified to be merged with their partner (Table 4-8). It is recommended that these routes are closed, with six of the remaining routes modified to better serve their patronage. These routes are illustrated in Figure 4-4.

#### Table 4-8: Highly overlapping routes to be merged

| Route to be Deleted | | | Patronage goes to | | |
|---|---|---|---|---|---|
| Route | Existing Daily Patronage | | Route | New patronage | New PVR |
| **MT115** | 2,767 | | New MT198 | 19,514 | 18 |
| **MT120** | 2,992 | | MT190 | 20,998 | 20 |
| **MT124** | 3,488 | | New MT150 | 11,953 | 29 |
| **MT137** | 5,044 | | New MT175 | 28,869 | 26 |
| **MT149** | 5,862 | | New MT121 | 20,741 | 19 |
| **MT221** | 7,143 | | New MT148 | 37,163 | 32 |
| **MT4** | 3,495 | | New MT117 | 7,428 | 20 |

## Figure 4-4: New alignment of routes to accommodate merging



### *Close poorly performing routes*

4.36 Nine routes with patronage of less than 2,000 passengers per day have been identified that can be closed without affecting local access (Table 4-9).

Table 4-9: Poorly performing routes to close

| Route to be Deleted | | | Patronage goes to | | |
|---|---|---|---|---|---|
| Route | Existing Daily Patronage | | Route | New patronage | New PVR |
| **A112** | 1,391 | | New MT111 | 5,721 | 15 |
| **A155** | 802 | | MT190 | 20,998 | 20 |
| **A162** | 445 | | New MT121 | 20,741 | 19 |
| **MT105** | 764 | | MT_105A | 3,352 | 10 |
| **MT237** | 393 | | New MT214 | 23,151 | 6 |
| **MT288** | 620 | | New MT6 | 8,585 | 6 |
| **MT7** | 1,362 | | New MT18 | 4,781 | 14 |

### *Operation of large buses*

4.37 In the short term OGET could begin to operate 12m buses on the marshrutka routes with the largest passenger flows. The following table presents the eight most suitable marshrutka routes.

Table 4-10: Routes suitable for operation by large buses

| Route | 1-way length (km) | New Daily Patronage | New Frequency (buses per hour) | New PVR |
|---|---|---|---|---|
| MT_185 | 20.3 | 28,270 | 15 | 41 |
| MT_190 | 18.5 | 20,998 | 8 | 20 |
| MT_232A | 29.3 | 33,254 | 11 | 42 |
| New MT_148 | 19.5 | 37,163 | 12 | 32 |
| New MT_214 | 20.5 | 23,151 | 8 | 22 |
| New MT_121 | 16.8 | 20,741 | 8 | 19 |
| New MT_175 | 23.5 | 28,869 | 8 | 26 |
| New MT_198 | 12.4 | 19,514 | 10 | 18 |
| **Total** | | | | **223** |

## Medium and long term changes

4.38 To support industry consolidation, formalisation and the development of an integrated transport network further route optimisation would be required to provide more exclusive passenger base for operators.

4.39 In the long-term, we recommend the upgrade and extension of the tram network. This would facilitate the development of additional north-south tram routes, helping to provide much needed strategic connectivity to the Kotovkoho district. These recommendations are outlined in a section beginning at paragraph 4.72.

# Better vehicles

4.40 Modern, larger, more accessible and energy efficient vehicles shall bring comfort to the users, financial benefits to the operators and social, environmental and economic benefits to the city of Odessa.

## Existing fleet

4.41 Table 4-11 shows the number of vehicles in the current public transport fleet by age. There is a large number of old and tired OGET vehicles:

- 206 trams over 30 years old
- 128 trolleybuses over 15 years old

4.42 In the short term the trolleybus vehicles should be replaced with new, while the City's program for tram refitting should be continued.

4.43 Furthermore, while the age of the fleet of 800 marshrutka vehicles is unknown (In Kyiv most are between 5 – 10 years old), the majority of these vehicles are of substandard quality. Industry reform should encourage either the upgrade of vehicles and the purchase of more modern second-hand vehicles. In the long term much of the marshrutka fleet should be replaced with larger buses that offer more comfort, space and lower operating costs.

### Table 4-11: Current PT fleet by age

| Operator | Vehicle type | Years old, as of January 2018 | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 0--5 | 5--10 | 10--15 | 15—30 | 30+ | |
| **OGET** | Tram | 1 | 3 | 7 | 11 | 206 | 228 |
| | Trolleybus | 10 | 16 | 15 | 122 | 6 | 169 |
| | Bus | 4 | 10 | 2 | 2 | 0 | 18 |
| **Private** | 9m Marshrutka | | | | | | ~800 |

## Vehicle specification

4.44 The following sets out the recommended vehicle requirements in terms of features and technology for new vehicles. New buses, trolleybuses and trams should have:

- An element of low floor access to enable access for those with mobility difficulties
- Audible stop announcements to aid impaired users
- Stop buttons to aid impaired users
- GPS with mobile network connectivity to enable real-time passenger information
- CCTV, but this is most appropriate for OGET services in the short term

4.45 For high patronage marshrutka routes, larger 12m buses can be introduced either by OGET, or private operators following industry reform. Large buses offer a higher level of comfort, operating efficiency and reduce congestion and emissions. Indicated costs per unit for 9m and 12m buses are provided in Table 4-13.

4.46 Figure 4-5 below provides examples of suitable low floor 9m and 12m buses.

### Figure 4-5: Example of suitable low-floor buses, 9m and 12m

12m bus, on the right, is a Bogdan A701 http://busbogdan.com.ua/bus/a701/

## Electric buses

4.47 Electric buses are currently being introduced and trialled in many PT networks around the world, although often through large subsidies. The PT network in Shenzhen, China is nearly fully operated by electric buses[10]. While the technology is still under development, it is very promising. Electric buses have lower operating costs over their lifecycle, and typically cut up to 75% in energy and associated emissions (on site) compared to diesel.

4.48 Unit costs are reducing while range is increasing, as such, electric buses would be well suited for operation in Odessa in the future. However, costs for the associated

[10] http://thecityfix.com/blog/in-a-global-first-shenzhen-steers-toward-100-electric-bus-fleet-xiangyi-li-sebastian-castellanos-schuyler-null/

infrastructure must be considered. Eventually electric buses may present a replacement mode for trolleybuses if the cost to operate electric buses is less than the cost to maintain the trolleybus catenary and substations.

4.49 The City is due to trial an electric bus in 2018. It is recommended that the City strongly considers the purchase of electric buses when the city begins to buy larger 12m buses in the future. Consideration would be needed as to the type of technology used, e.g. slow charging or fast charging. Figure 4-6 presents an electric bus made by Bogdan in the Ukraine.

Figure 4-6: Example of 12m low-floor Bogdan bus, A70100 electric bus


Source: http://bogdan.ua/en/now-electric-bus-bogdan-can-override-250-kilometers-single-charge

## Short term

4.50 Table 4-12 outlines the vehicle requirements for the short-term route changes presented in the section from paragraph 4.26 to 4.37. The existing public transport fleet comprises of 1,197 units, including ~800 9m marshrutka, 169 trolleybuses and 228 trams. Without considering the replacement of old vehicles, the net impact on total vehicle fleet is an increase in 44 units. But represents an addition of 223 large buses and a reduction in small marshrutka of 170.

4.51 The current vehicle requirement identifies how many vehicles would be needed today to operate the routes using comfortable levels of occupancy in each vehicle. Many

marshrutka services are currently overloaded, if these routes were to be operated at a comfortable capacity the city would need a further 114 marshrutka vehicles.

4.52 There is only a need for 7 more trolleybuses. However, it is assumed that today many of the 169 trolleybuses are not used on a daily basis. Therefore, the number of trolleybuses in use on the street would increase under the proposals.

### Table 4-12: Change in fleet resulting from short-term route changes

| Mode | Current fleet size | Current vehicle requirement, based on comfortable capacity | New vehicle requirement, based on comfortable capacity | Change in fleet size |
|---|---|---|---|---|
| **Marshrutka 12m** | - | - | 223 | +223 |
| **Marshrutka 9m** | 800 | 914 | 630 | -170 |
| **Trolleybus** | 169 | 147 | 176 | +7 |
| **Tram** | 228 | 228 | 228 | - |
| **Total** | **1,197** | **1,255** | **1,241** | **+44** |

4.53 Table 4-13 outlines the individual unit costs and total cost of fleet renewal and replacement in Odessa, aligning to Table 4-11 and Table 4-12. The short-term renewal of the tram fleet is estimated to cost around $6m, whilst replacing the trolleybus fleet with new vehicles and purchasing 7 additional vehicles to cope with additional demand (Table 4-2) would cost approximately $20m.

### Table 4-13: Short term vehicle purchase and re-fit costs

| Action | Per unit cost (USD) | Units required | Total Cost (USD) | Source of unit cost |
|---|---|---|---|---|
| **Refit old trams** | 30,000 | 206 | 6,180,000 | Tram refit in Lviv cost $25,000 each, 2016* |
| **Replace old trolleybuses with new** | 150,000 | 128 | 19,200,000 | New Odessa trolleybuses cost $140,000 each, 2017 |
| **Purchase additional trolleybuses** | 150,000 | 7 | 1,050,000 | |
| | | | | |
| **Purchase 12m diesel buses** | 120,000 | 223 | 26,760,000 | Bogdan 12m bus cost $115,000, 2015 |
| **Or purchase 12m electric buses** | 250,000 | 223 | 55,750,000 | Odessa City Administration |

* http://www.metro-report.com/news/metro/single-view/view/rebuilt-tram-presented-in-lviv.html

## Trams

4.54 The current tram fleet is unsuitable over the long term, because of the high internal floors which make them in-accessible, or hard to access for many users. In the long term the tram fleet should be replaced with longer low floor units enabling greater carrying capacity, improved operational efficiency and enhanced access.

4.55 However, the introduction of these units is dependent on the renewal of tram track along existing tram routes, as the use of low-floor trams requires a smoother track and higher traction (more energy). Additionally, the operation of these units is expected to require depot upgrades.

Figure 4-7: Example of low-floor tram operating in Prague


4.56 Table 4-14 illustrates the costs of purchasing new tram units. The cost of replacing the fleet with new low floor unit's totals $100m, with the option of purchasing 200 single unit vehicles or 100 long unit vehicles, such as operated in Prague.

Table 4-14: Cost of tram fleet purchase

| Type | Per unit cost (USD)* | Units required | Total Cost (USD) | Source of unit cost |
|---|---|---|---|---|
| **Tram – single unit** | 500,000 | 200 | 100,000,000 | Odessa Tatra Ukraine |
| **Tram – long unit (5 sections)** | 1,000,000 | 100 | 100,000,000 | Electron trams, Kyiv 2015* |

* http://www.metro-report.com/news/metro/single-view/view/kyiv-receives-elektron-tram.html

# Better infrastructure

4.57 The proposed investments in infrastructure range from bus stops improvements to new modern interchange facilities and dedicated bus lanes.

## Short term

### *Bus stop improvements*

4.58 Bus stop improvements should be made on the public transport network in the short term to support route changes and new vehicles. As a minimum, improved bus stops should feature:

- Easy access – including ramps and/or tactile paving where feasible
- Maps and timetables
- Real-time information displays (because of long headways/unreliability)
- Sheltering and lights
- Low-floored access, perhaps facilitated by bus pull-outs
- CCTV

4.59 An example of a sheltered, low-floored access tram stop is shown in Figure 4-8 below, and an example low-floored access bus stop with bus boarder is provided in Figure 4-9, and real-time bus information in Figure 4-10.

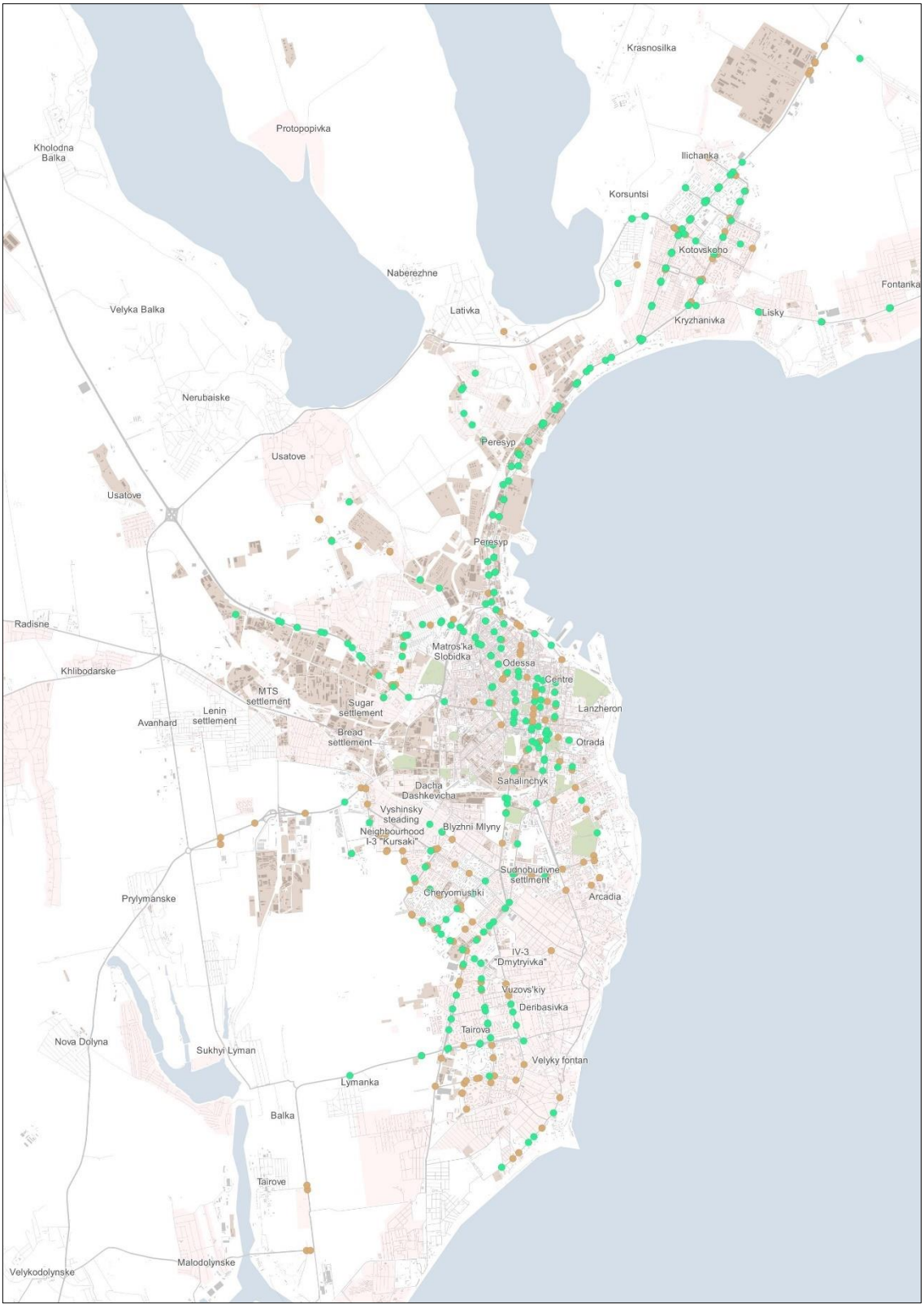
Figure 4-8: Example of low-floored access tram stop

Figure 4-9: Example of low-floor access bus stop with bus boarder

## Figure 4-10: Example of real-time passenger information


4.60 It has been identified that there are currently 600 stops in the city which handle patronage of more than 250 passengers per day (including tram stops). These would be recommended for improvement, at a total cost of $6m (Table 4-15). Additionally, it is recommended that 300 stops are fitted with real-time passenger information at a total cost of $3.0m.

## Figure 4-11: Bus stops recommended for improvement



## Table 4-15: Costs of bus stop improvements

| Improvement | Per stop cost (USD) | No. of stops to be improved | Total Cost (USD) |
|---|---|---|---|
| **Bus stop improvements (maps, timetables, sheltering, low-floor access)** | 10,000 | 600 | 6,000,000 |
| **Real-time passenger information** | 10,000* | 300 (of the 600) | 3,000,000 |

* Based on UK: Oxford, Surrey, Gloucestershire, Middle Sussex Councils

### *Intersection control improvements*

4.61 From investigations of public transport speed data and site visits (see GPS spot speed map in Figure 2-30 and constraints map in Figure 2-29) several critical intersections have been identified where congestion and a lack of traffic control impact upon PT speeds. These are presented in Figure 4-13.

4.62 At these key locations the following improvements should be made:

- Channelization at large intersections
- Demarking of space to prevent parking at intersection
- Coordinated signal control, including priority for public transport such as tram

## Figure 4-12: Signals providing bus priority at junctions

## Figure 4-13: Location for intersection improvements

### *Priority lanes for public transport*

4.63 Figure 4-15 illustrates the locations recommended for public transport priority. These locations are based on the strategic network illustrated in Chapter 3. In total we recommend 60km of dedicated priority lanes to be used by trolleybus, marshrutka and trams where relevant. This included 14.8km of one-way priority within the city centre. The approximate cost to install these lanes would be $5m, as outlined in Table 4-16.

Figure 4-14: Example of priority bus lane in Krakow, Poland


### *Preobrazhensk'ka St & Panteleimonivs'ka St relief*

4.64 Preobrazhensk'ka St and Panteleimonivs'ka St require special attention. They are presented as the red lines in Figure 4-15. These roads are heavily congested and are where the north-south rapid tram route will go.

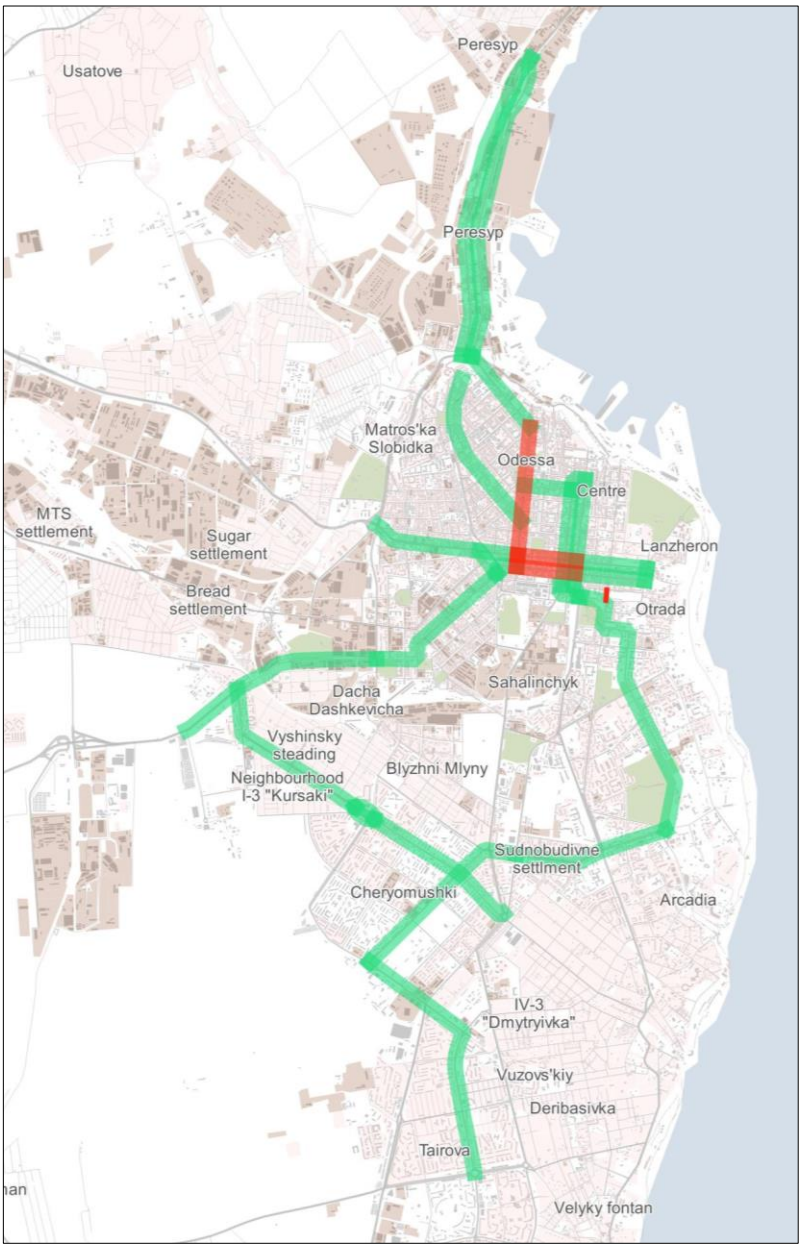
4.65 Additional relief and re-planning of the street is recommended to improve traffic flow and remove potential obstructions for buses, trams and trolleybuses. This should involve the redesign of the streets, in consultation with stakeholders and the public, involving measures such as:

- Parking reduction & redesign – aimed at removing obstructions preventing the efficient movement of public transport and allowing for priority

- Public transport priority – dedicated segregated lanes and prioritised signal timing at junctions
- Junction redesign – creating more logical layouts to prevent conflicting manoeuvres made by general traffic
- Left turn bans – to prevent conflicts at junctions which slow the general flow of traffic

4.66 These measures should be developed as part of a comprehensive traffic management plan study, to investigate the impacts of such measures, particularly the displacement of traffic and the impact of turning bans.

## Figure 4-15: Location of public transport priority lanes




## Table 4-16: Bus priority cost of installation

| Action | Per km cost (USD) | Length required (km) | Total Cost (USD) |
|---|---|---|---|
| **Exclusive lanes for public transport (15km 1-way roads and 45km 2-way roads)** | 83,000 | 60 | 2,000,000 |

## Medium and long term

### *Interchange improvements*

4.67 In the medium term, 9 major and 6 minor strategically important interchanges should be improved to better serve public transport passengers in the city. Good examples of how the interchanges could look can be found in Figure 4-16. The major interchanges are identified in Figure 4-17 below and include strategic locations such as the Intercity Bus Terminal and the Central Rail Station & Pryvokzal'na Square.

4.68 Works should include:

- Improved layout and organisation of stops that handle different routes. Longer bus stops to make it easier for buses to pull out
- Better signage, route maps, timetable and real time information for passengers
- Bus lanes into and out of interchanges
- Improve paths and walkways at interchanges, clear crossing points for pedestrians, minimum of 3m pavement width with lighting. Ramps or lifts to assist disabled access.
- Sheltered and safe waiting areas, toilets, places to sit

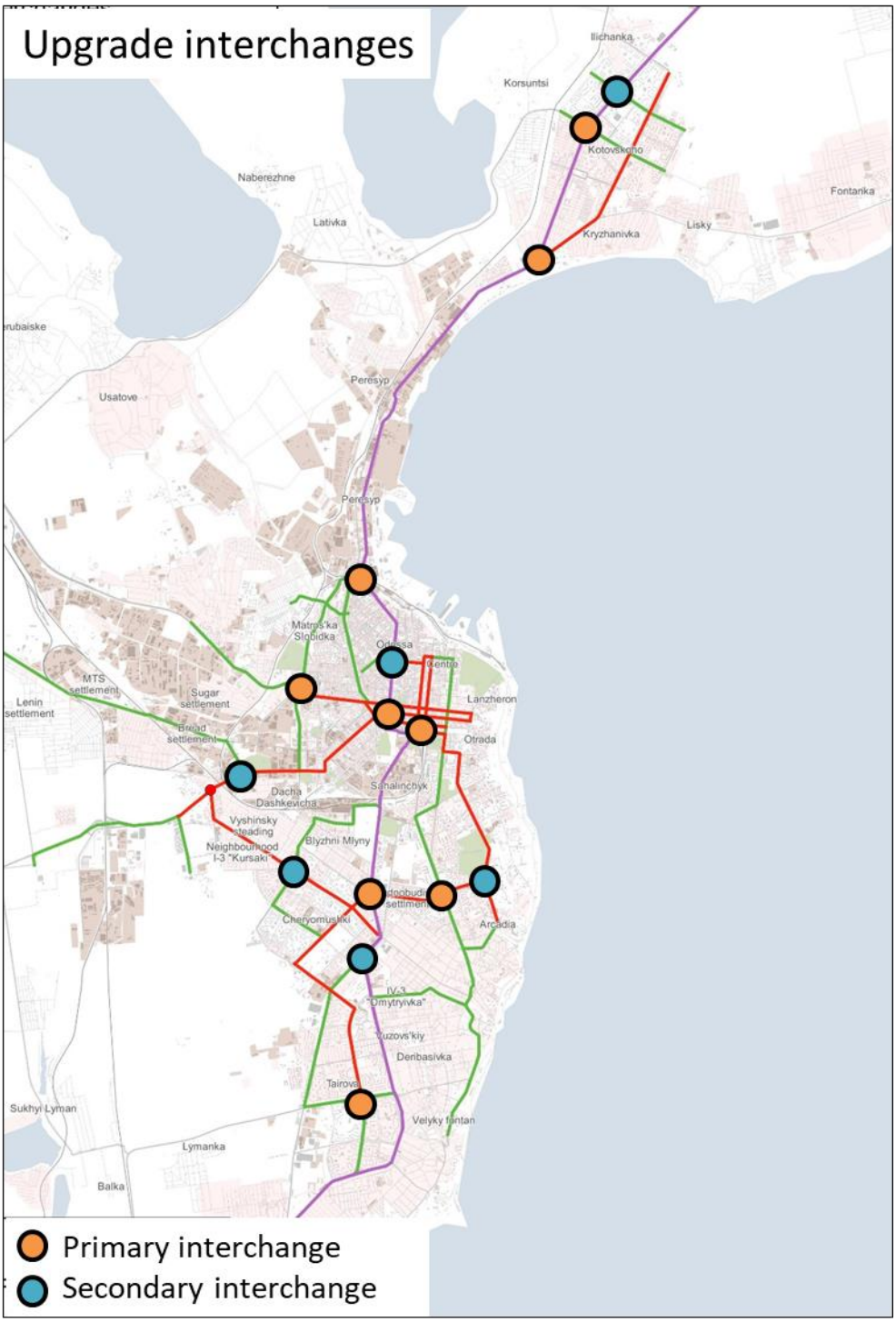
Figure 4-16: Examples of city centre transport interchanges

4.69 Table 4-17 outlines the costs of improving these strategic interchanges. At a cost of $500,000 per interchange, the total cost of improving the 9 major and 6 minor interchanges in the city would be $7.5m.

### Table 4-17: Cost of interchange improvements

| Action | Per interchange cost (USD) | Interchanges required | Total Cost (USD) |
|---|---|---|---|
| **Upgrade of 9 major and 6 minor interchanges** | 500,000 | 15 | 7,500,000 |

Figure 4-17: Location of strategically important interchanges



### *Renewal of track & catenary, signalling & substations*

4.70 The existing tram infrastructure has been identified as old and deteriorating, which prevents trams from operating at their maximum efficiency. An example of this is provided in Figure 4-18. In order to improve operating speeds and thus reduce journey times, it is recommended to renew tram track, catenary, signalling and substations. This is particularly important with regards to the purchase of new low-floored trams, as the existing track will need to be upgraded to cater for the additional weight and traction of these vehicles.

Figure 4-18: Example of deteriorating tram track

4.71 200km of track and catenary has been identified by the city which should be upgraded, alongside substation upgrades. Where feasible this should be segregated from pedestrians and parking to remove obstructions which prevent the efficient movement of trams. Table 4-18 details the cost of these upgrades.

Table 4-18: Cost of tram infrastructure renewal

| Action | Per km cost (USD)* | Length of track required (km) | Total Cost (USD) |
|---|---|---|---|
| **Tram track, catenary, signalling and substation upgrade and renewal** | 4,000,000 | 200 | 400,000,000 |

### *Tram extensions*

4.72 In the longer term, several key tram extensions could be made to improve strategic and local access on the tram network. The first is a 5.5km tram line extension in Kotovskoho along Dnipropetrovs'ka Road and Paustovsk'koho Street, enabling better public transport connections from the eastern areas of Kotovskoho. This extension could be served as a deviation of the North-South tram route or as a feeder route. The intended alignment of the route is shown in Figure 4-19. Table 4-19 outlines the costs of this extension.

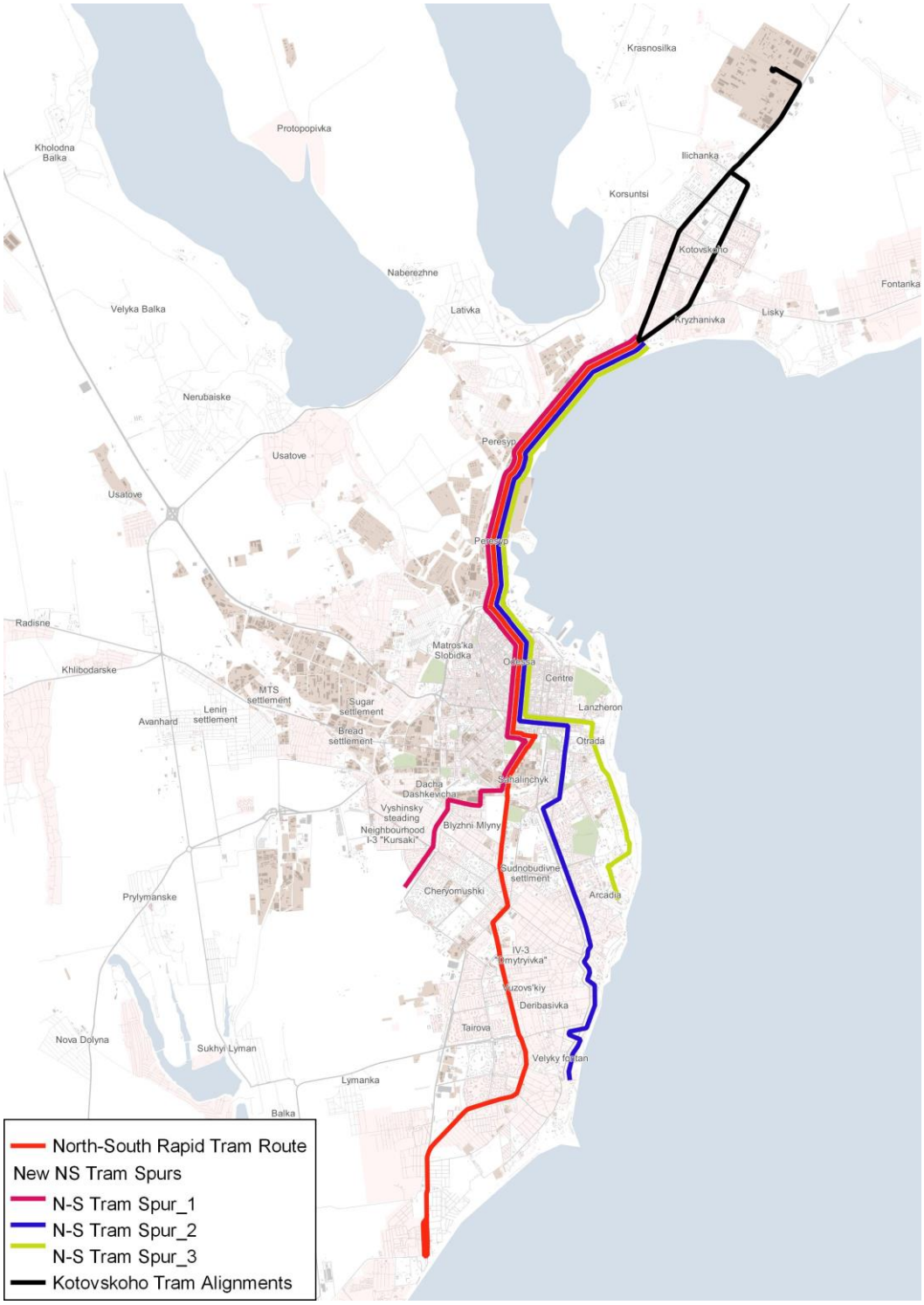
Figure 4-19: Intended alignment of Kotovskoho tram extension


Table 4-19: Kotovskoho tram extension costs

| Action | Per km cost (USD)* | Length of track required (km) | Total Cost (USD) |
|---|---|---|---|
| **Kotovskoho tram extension** | 4,000,000 | 5.5 | 22,000,000 |

4.73 Additionally, following track renewal and track extension in the city centre, three new North-South tram spurs could be implemented, illustrated in Figure 4-20. This would enable faster operating speeds on a wider number of tram routes, and would improve strategic access across the city.

## Figure 4-20: Alignment of additional North-South rapid tram spurs



# 5. Implementation plan and expected impacts

5.1 This section summarizes the key recommendations in the form of an implementation plan, including their preliminary investment costs for the infrastructure and vehicle components, and estimate the economic and environmental impacts of the short-term implementation plan.

## Summary Implementation Plan

5.2 Table 5-1 to Table 5-3 collates the short, medium and long-term recommendations into an implementation plan.

Table 5-1: Short term measures

| Routes | Vehicles | Cost | Infrastructure | Cost | Reform |
|---|---|---|---|---|---|
| • 5 new routes,<br>• 16 route modifications<br>• 25 routes closed | Refit 206 trams | $6.18M | PT (bus) stop improvements at 600 stops | $6M | • Send clear signal to marshrutka owners that a step-change improvement in vehicle quality and performance will be expected |
| Pilot to increase frequency on struggling trolleybus routes | Replace 128 trolleybuses | $19.2M | Real Time Passenger Information at 300 stops | $3M | • City administration to gain staff and technical ability to manage contracts and implement improvements |
| Increase frequency on overloaded trolleybus routes | Purchase 7 additional trolleybuses | $1.05M | 60km of PT priority lanes | $5M | • New contracts to require minimum vehicle and driving standards |
| OGET to begin operating 12m buses by taking over the operation of some of the busiest marshrutka routes | Purchase 223 12m diesel buses or 223 12m electric buses | $26.76M or $55.7M | Relief of Preobrazhensk'ka St & Panteleimonivs'ka St (4km) | | • Code of conduct for marshrutka drivers, driver training and system to report poor driver behaviour<br>• Establish e-ticketing system<br>• Develop electronic database to monitor and contract routes |
| | Encourage purchase of newer marshrutka vehicles | | Improve 15 major junctions | | • OGET begin to operate 12m buses |

## Table 5-2: Medium term measures

| Routes | Vehicles | Cost | Infrastructure | Cost | Reform |
|---|---|---|---|---|---|
| Further route changes to support North-South tram<br><br>Further route optimisation to support consolidation and formalisation of marshrutka industry | Encourage marshrutka owners to purchase 12m buses | | PT interchange improvements: 9 primary & 6 secondary sites | $7.5m | • Consolidate and formalise the marshrutka operators<br>• Companies to become owners of vehicles and employ drives on fair wage<br>• Encourage marshrutkas to operate 12m buses<br>• To help marshrutka operators to finance new vehicles, further rationalise the PT network, and introduce contracts that are longer and have more permanent rights to routes and their passengers.<br>• Expand quality criteria for contracts to include vehicle emissions, low floor access, CCTV<br>• Help to establish 3 new depots for 12m buses<br>• Require marshrutka to carry concessionary passengers<br>• OGET fare increase |

## Table 5-3: Long term measures

| Routes | Vehicles | Cost | Infrastructure | Cost | Reform |
|---|---|---|---|---|---|
| 3 new north-south tram spurs plus Kotovsky tram line (5.5km)<br><br>Following industry reform – wholescale re-alignment of routes across the city | Replace old trams with new (low floor, on-vehicle announcements) | $100M | Renewal of tram track & catenary (200km) (Segregation from pedestrians, parking)<br><br>Tram extension in Kotovsky (5.5km) | $400M<br><br>$25M | • Provide the City with the powers of an Integrated Transport Authority<br>• Determine best contracting model, gross cost or net cost<br>• Develop sufficient management and planning resources to procure and manage contracts<br>• Introduce multi-operator ticketing |

# Impacts of short term network optimisation

5.3 The table below presents the impact of the short-term actions that optimise the balance of modes. Including route changes and purchase of large buses, as presented above.

5.4 Currently 53% of PT passengers are carried by small (9m) marshrutka. The changes promote a shift from small marshrutka to large buses and trolleybuses. As a result only 27% of passengers would be carried on small marshrutka vehicles. The remaining marshrutka vehicles should not be overloaded.

### Table 5-4: Impact of short term route changes upon patronage

| Mode | Current situation | | | Following short term changes | | |
|---|---|---|---|---|---|---|
| | No. of vehicles | Daily passengers | Split of passengers | No. of vehicles | Daily passengers | Split of passengers |
| Bus 12m | | - | | 223 | 212,000 | 22% |
| Marshrutka 9m | 800 | 497,000 | 53% | 630 | 256,000 | 27% |
| Trolleybus | 169 | 148,000 | 16% | 176 | 174,000 | 18% |
| Tram | 228 | 299,000 | 32% | 228 | 302,000 | 32% |
| **Total** | **1,197** | **944,000** | | **1,241** | **944,000** | |

5.5 The forecast impact of the short-term network optimisation and associated purchase of large buses is presented below. Two scenarios have been identified, one where the new 12m buses are diesel powered, and the other where they are electric.

5.6 Table 5-5 provides a headline comparison of scenarios performance against key benchmarks. It demonstrates that route optimisation delivers greater efficiency as the intensity of use of the vehicles increases, while energy use and operational costs decrease.

## Table 5-5: High level-level comparison of network performance

| Benchmarks | Measures | Current baseline | Short-term | | % Change | |
|---|---|---|---|---|---|---|
| | | | Diesel 12m buses | Electric 12m buses | Diesel 12m buses | Electric 12m buses |
| Physical and Operational Capacity | Total daily vehicle kms | 222,620 | 175,503 | | -21% | |
| | Number of passengers carried per vehicle Km | 4.2 | 4.9 | | +17% | |
| | Number of passengers carried per vehicle per day | 827 | 837 | | +1% | |
| Energy Efficiency | Total annual energy consumption (Energy TJ/year) | 863 | 704 | 540 | -18% | -37% |
| | Energy consumption per passenger (MJ / pax) | 2.8 | 2.3 | 1.7 | -18% | -39% |
| | Energy consumption per veh-km (MJ / vKm) | 12.6 | 13.1 | 10.0 | +4% | -21% |
| | Annual diesel consumption (1,000,000 Litre/yr) | 19.4 | 15.0 | 14.5 | -23% | -25% |
| | Annual electricity consumption (1,000,000 KWH) | 45.8 | 45.8 | 62.2 | 0% | +36% |
| Affordability to the city | Cost of network provision per passenger (UAH / passenger) | 2.7 | 2.2 | | -19% | |

5.7 The daily number of passengers carried per vehicle does not significantly increase because we are recommending that marshrutka vehicles should not be as over-crowded as they are now. This is demonstrated in Table 5-7 which shows how the intensity with which marshrutka vehicles are to be used reduces, as a result of short-term optimisation.

### Table 5-6: Average passengers carried per vehicle per day

| Mode | Existing | Short-term |
|---|---|---|
| Bus 9m | 621 | 447 |
| Bus 12m | | 1,044 |
| Trolleybus | 1105 | 1,084 |
| Tram | 1444 | 1,574 |
| **Average** | **827** | **837** |

5.8 Table 5-7 reveals the significant impact of the optimisation proposals on the total public transport network's length, number of routes, and vehicle kilometres travelled per day. The proposals reduce the total length of the operational transit network by 20%, and the number of routes by 20% as well, while average route distance increases slightly as some short routes are removed and strategic routes lengthened. These changes that include headway revisions and a shift to larger vehicles result in a 21% reduction in total vehicle kilometres travelled on an average operational day.

5.9 Within these overall changes there are significant shifts between the different transit modes. The optimisation proposals reduce the operational length of the 9m marshrutka networks by around 45%, while bus and trolleybus routes are extended.

## Table 5-7: Operational impact of short-term optimisation

| Mode | Baseline | | | | | Following short-term changes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total network length (2-way) | Number of routes | Average route length (1-way) | Daily patronage | Total veh-kms per day | Total network length (2-way) | Number of routes | Average route length (1-way) | Daily patronage | Total veh-kms per day |
| **Marshrutka 12m** | - | - | - | - | - | 322 | 8 | 20.1 | 211,960 | 33,749 |
| **Marshrutka 9m** | 2,142 | 61 | 17.6 | 496,841 | 174,995 | 1,166 | 32 | 18.2 | 256,090 | 94,148 |
| **Trolleybus** | 226 | 11 | 10.3 | 148,096 | 17,357 | 280 | 13 | 10.8 | 173,437 | 17,340 |
| **Tram** | 368 | 19 | 9.7 | 298,825 | 30,267 | 446* | 20 | 11.1 | 302,275 | 30,267 |
| **Total (Average)** | **2,736** | **91** | **(15.0)** | **943,762** | **222,620** | **2,213** | **73** | **(15.2)** | **943,762** | **175,503** |

5.10 The optimisation proposals create scope for transit operators to achieve significant fuel savings relative to their current operations. A combination of cleaner, larger vehicles, and the projected reduction in total vehicle kilometres are forecast to reduce the total energy required to operate the city's PT networks by around 18% when the new large buses are diesel powered, or 37% if they are electric powered.

## Table 5-8: Estimated impact on energy consumption

| | Baseline | | | Short term optimisation using | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 12m diesel buses | | | 12m electric buses | | |
| **Mode** | Energy (TJ/year) | Diesel consumed (Litres/yr (000's) | Electricity consumed (kWh/yr) | Energy (TJ/year) | Diesel consumed (Litres/yr (000's) | Electricity consumed (kWh/yr) | Energy (TJ/year) | Diesel consumed (Litres/yr (000's) | Electricity consumed (kWh/yr) |
| Marshrutka 12m | 0 | | | 164 | 4.6 | | 70 | | 19.5 |
| Marshrutka 9m | 698 | 19.4 | | 376 | 10.5 | | 376 | 10.5 | |
| Trolleybus | 64 | | 17.9 | 64 | | 17.9 | 64 | | 17.9 |
| Tram | 100 | | 27.9 | 100 | | 27.9 | 100 | | 27.9 |
| Total | **863** | **19.4** | **45.8** | **704** | **15.0** | **45.8** | **541** | **10.5** | **65.2** |

5.11 Table 5-9 sets out the estimates for changes to GHG emissions, 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.

5.12 The short-term optimisation proposals result in a total reduction in GHG emissions of 18% when the new large buses are diesel powered, or 29% when they are electric powered. These savings relate to a reduction in vehicle mileage as well as shift to electric modes.

### Table 5-9: Impact on GHG emissions (Annual CO2 equivalent tCO2e)

| Mode | Baseline | | Short term optimisation using | | | |
|---|---|---|---|---|---|---|
| | | | 12m diesel buses | | 12m electric buses | |
| | Annual total | Per pax | Annual total | Per pax | Annual total | Per pax |
| Marshrutka12m | | | 14,068 | 216 | 6,262 | 96 |
| Marshrutka9m | 60,017 | 393 | 32,289 | 411 | 32,289 | 411 |
| Trolleybus | 5,764 | 115 | 5,758 | 99 | 5,758 | 99 |
| Tram | 8,972 | 83 | 8,972 | 82 | 8,972 | 82 |
| **Total (average)** | **74,753** | **241** | **61,087** | **196** | **53,281** | **171** |
| | | | | | | |
| Total reduction GHG emissions per year | | | 13,666 | | 21,472 | |
| % GHG emissions saved per year | | | 18% | | 29% | |

5.13 Delivering the short-term optimisation proposals is expected to significantly reduce operational costs associated with PT provision. The shift to larger vehicles, and operationally cheaper trolleybus and tram modes is estimated to deliver 18% annual operating cost savings. Table 5-10 shows this equates to a net annual saving of 150.5 million UAH across all modes of travel, or 5.72 million USD.

5.14 These considerable annualised operating cost savings may assist the City, OGET and marshrutka 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.

Table 5-10: Projected change in annual PT operating costs (Million UAH)

| Mode | Baseline | Short term | % Change |
|---|---|---|---|
| Marshrutka12m | | 107.8 | |
| Marshrutka9m | 558.7 | 300.6 | -43% |
| Trolleybus | 95.9 | 95.8 | 0% |
| Tram | 167.3 | 167.3 | 0% |
| **Total** | **821.9** | **671.4** | **-18%** |

# Appendix 1

## Data collection

5.15 A substantial data collection exercise was undertaken, including consultation with stakeholders, city-wide surveys and the conduct of focus group discussions.

5.16 The following bodies were consulted as part of the assessment process to understand their view points on challenges and opportunities facing PT provision in Odessa.:

- Department of Transport for Odessa City
- Municipal bus operator, Odessagorelektrotrans (OGET)
- Centre for economic reform
- Civil society including Urbanists, Journalists and Cycling NGO

5.17 An extensive city-wide survey program of the public transport system in Odessa and its users was undertaken between April and September 2017. This was completed with the help of students from the Odessa Transport College, local volunteers, and a local network of professional interviewers. The surveys could not have been completed without the assistance provided by the Department of Transport and OGET.

5.18 Table 5-11 lists the surveys which were undertaken and the data collected, as well as any secondary datasets we were kindly provided with.

Table 5-11: Survey program and data collected

| Data type | Collection method / source | Collection dates | Size of sample or dataset |
|---|---|---|---|
| **PT route frequency and occupancy data** | Roadside count conducted at 15 locations in city | 29 May – 19 June | 20,000 vehicle movements were observed |
| **Boarding, alighting and load data** | On-board surveys conducted on 84 routes. Using TransitWand smart phone app | 17 May – 18 June | 36,000 boarding and alighting movements were observed |
| **Origin-destination (trip demand) data** | On-board surveys conducted on 74 routes. Using OD Capture smart phone app | 19 July – 28 Aug | 5,300 trip details captured |
| **Traveller interviews** | On-street interviews. ODK smart phone app | 7 Sept – 11 Sept | 976 responses |
| **Speed data derived from on-board GPS trackers** | OGET provided GPS tracks collected by all trolleybus and trams | June 2016 – July 2017 | 1.3 GB of GPS tracks |
| **Route patronage data** | OGET | Average daily passengers for winter, spring. Summer and autumn | |
| **Route passport information** | Odessa Transport Department | | |
| **Land use & mapping** | OpenSteetMap www.openstreetmap.com | | |
| **PT financial data** | OGET annual accounts | 2016 and 2017 | |
| **Infrastructure constraints** | OGET control centre<br>Site visits across the city | | |

# Focus group methodology

5.19 Four focus groups were conducted with Odessa residents to identify particular issues related to gender, the elderly and users with reduced mobility. These were conducted on September 12 and 19. Findings from the focus groups are presented in chapter 2, with detailed analysis contained in Appendix 1.

5.20 The group structure was as follows:

11) Gender (4 age groups (including special quota for elderly people); and 4 administrative regions of Odessa, with a total of 10 participants) - users of public transport;
12) Women (4 age groups, 4 administrative regions of Odessa, with a total of 9 participants) - to understand the modes of transport that they use; and
13) Disabled users:
    a) Mobility impaired Users (2-3 groups, with a total of 8 participants) - who use private cars / taxi or PT;
    b) Blind or visually impaired users - All users of PT, balanced by gender.
    c) Deaf or hard of hearing users.

5.21 In order to capture a more strategic view of the barriers to travel for deaf or hard of hearing users, we also conducted an in-depth interview with Aleksandr Babin, chairman of the Odessa regional organisation of the Ukrainian Society of the Deaf.

# Appendix 2

## Detailed focus group findings

# Focus group report

## General view of Odessa citizens (Women and PT users groups)

To find what are special problems of categories of women and elderly people, we needed to get ground view of common passengers (to be able to compare). That is why first two groups were conducted to collect general pull of views on problems with public transportation situation in Odessa, specifically focused on problems that were brought out by women and elderly people.

One group consisted of public transportation users (weighted by gender, age groups and administrative regions) that use mainly public transport more than 4 days a week.

Second was group of women only – with women that use different modes of transport to get through the city (weighted by age, modes and administrative regions). That allowed to depict what lead part of them not to choose public transport as their main travel mode.

### *General tendency*

Generally, estimation of recent changes in transport situation varies from neutral to negative. Two main positive changes are mentioned – new vehicles on communal routes; connection between some districts became a little bit better. Also at this moment respondents are waiting for the result of building of North-South tram route and hope that it'll simplify their lives at least a little bit, though yet they were not ready to evaluate this change.

In other hand, traffic jams, parking problem that lead to slower work of public transportation, uncertainty in schedule of routes that they need, repair works throughout whole city center make people to think about development of public transportation system as negative one.

### *Problems with public transport and other modes*

All problems that are mentioned could be separated to three main categories: issues, connected with unregulated city and transport planning; uncertain timing; bad drivers culture.

**Unregulated planning** leads to the problems that influence on public transportation system and passengers convenience:

- imbalance between policy of new buildings and residential complexes and old existing roads and routes that connect them with other districts.

> *"I live in Kotovskogo, we have two main roads there, at ours, Dnipropetrovska road – they have build too many new houses, and road remained narrow. Number of cars has grown, amount of marshrutkas – too, but traffic jam doesn't grow smaller because of that facts. In the morning it is impossible to go anywhere!" (R1, FG_Women)*

- Total repair all over city center that leads to lots of traffic jams and spoiling the part of public transport system that provides services at the city center

*"During this year situation is terrible because there are total repair works all through the city center – it would be better to make such works by points – repair one crossroad – open it – start with another. But not because of this total repairs you can never predict even marshrutkas schedule – so if you need to go through city center it would be much easier to go by foot." (R9, FG_PT_users)*

*"Traffic jams are as well because of digging everywhere, and repair works are conducted during day, not at night" (R1, FG_PT_users)*

- Dismiss or cutting numbers of vehicles on suitable routes

*"On Balkivska there was nice tram 30. Then it started to ride more rarely. Then they digged out rails and told that they'll make trolleybus route here instead – they didn't" (R9, FG_PT_Users)*

*"5 trolleybus has schedule – goes 1 time per 3 hours. 5 shifts per day. Trolleybuses are killed now, only trams survive." (R4, FG_PT_users)*

*"215 route was killed – it was very nice route, went right to the seaside. Firstly, they lowered number of vehicles at route and frequency turned to be from one in a 20 minutes to one in a 40, now one in an hour. Now it is around 8-9 vehicles at the route – before it was nearly 30 vehicles." (R2, R9, FG_Women)*

*"Tram №3 was cancelled – and it is very inconvenient now to get to (the center) – either you go large distance by foot, or with interchanges" (R2, R4, FG_Women)*

*"But our trolleybuses are dying in city center because city doesn't live possibility to move around city center, with all this bad drivers culture – when they park anywhere they like – and with this buildings and repair works everywhere" (R1, FG_PT_users)*

- In peak hours and other popular timing everything is stuffed with people – respondents consider that's because it is not enough vehicles on the routes and capacity of marshrutkas is too little for this passenger flow. It leads to safety problems.

*"Once we come inside 242 marshrutka and between seat and door there is tiny opening – at this opening young woman was standing. Marshrutkas are packes so tightly that all cracks are stuffed with people." (R5, FG_PT_users)*

*"At the day when city celebrated its birthday it was nearly impossible to get out of city center. There were long queues to board vehicles and I saw how one marshrutka was packed so tightly that it could barely move because*

*of overweight. They could give more vehicles on that routes at that time!" (R5, FG_Women)*

**Time** is precious for Odessa citizens, and part of issues that they are talking about is strongly connected with **bad timing and unpredictability** of public transportation:

- Often routes are not functioning according to their schedule

  *"Marshrutki have very unstable schedule – they can have very large break between two vehicles – and by this time if you know about gap you could have gone to another stop and board some other vehicle. Instead you are staying on the stop waiting." (R5, FG_PT_users)*

- It is hard to predict timing of trip, because vehicle could be stuck in traffic jam or in case of marshrutka could make lots of extra stops to collect people

  *"Marshrutkas stop everywhere - between two stops there could be 3-4 extra stops where people are waving. That enlarges time, spent for the trip." (R4, FG_PT_users)*

  *"Or on contrary - you stay alone on the stop and driver goes to the second line and doesn't stop at all" (R5, FG_PT_users)*

  *"So they make extra stops for taking passengers, but if you need to have extra stop to align – you often can hear that "Here we can't make stop because it isn't official stop". And in 10 meters he makes stop to take someone on board." (R9, FG_PT_users)*

- As the touristic city, Odessa lacks routes that are circulating late at night, or at least after 10 PM, because after that time routes are circulating very rarely

  *"Lenposelok – there are no communal transport coming there, and last marshrutka (from railway station) goes there at 22:00; and it is last one route, other stops coming after 20. And if I need to come to city center – last marshrutka rides at 21:20. And this district is considered to be part of Odessa!" (R2, FG_PT_users)*

  *"Late at evening even if by schedule marshrutkas have to ride, they can have already finished coming at route. Their drivers are on their mind and can be not responsible for their schedule" (R5, FG_PT_users)*

  *"If you are not living in city center, and you need to go to 7 fountain station, latest time you need to board something is 23:30 – it means you can't stroll in city center later than that." (R7, FG_PT_users)*

Actually, it turned out that right now there are illegal "night routes" in Odessa.

> *"Some local drivers make their own night routes – 30-40 hrn per person – and they'll drive full marshrutka to Kotovskogo at night. Not Bogdans, smaller, but it drives you home and you even can sit." (R5, FG_PT_users)*

And special topic of discussions is **bad drivers behavior** (though most complaints are about marshrutkas drivers). Most of this points are based on the tendency of marshrutka drivers to be more profit-oriented and treat passengers only as source of money. This includes:

- Rude attitude

> *"We've got situation with the same 242 route – we aligned at our stop, and we saw that all passengers are following us. We asked what happened – and they told that driver had commanded them to get out of the vehicle. It turned out that he wanted people to align past front door, and marshrutka was full and someone asked to get out from back door – he got mad and asked everyone to get out." (R5, FG_PT_users)*

- Providing additional rules and "punishing" passengers

> "Actually in marhshrutkas it is possible to align from back door, but you should give money ahead before stop comes. And if someone extra walked off the back door, not paying, then driver "punishes" others by letting them align only from the front door on further stops." (R6, FG_PT_users)

- Ignorance of some categories of passengers (especially those with concessions)

> *"It looks like marshrutka drivers hate concession categories and tell that they should ride by communal transport, or limit number of concession passengers up to two per route - not only for elderly, but also for students (they have discount on ride) and people from families with more than 3 children." (R3, FG_Women)*

- Risky driving and breaking traffic rules (that is about both PT drivers and private cars drivers)

As for bad practices of ***car drivers***, there are two additional points that should be mentioned

- Problems with parking – cars are parked so that they block pavement for pedestrians and rails for trams (for example, on Privoz – actually, all 4 groups mentioned this point as the most problematic one)

> *"They can leave a car parked on the rails – and be gone for hours – and trams are stuck" (R3, FG_PT_users)*

- Not taking in account pedestrian crosswalks (pedestrians feel very unsafe crossing popular routes because they never know, whether cars will stop or not)

### *Special issues for women*

Women differ in their view on transportation problems in matter of priority. Actually, all issues that were mentioned by them on groups could be classified on two groups: comfort and security.

**Comfort** here consists of:

- Clean inside vehicle (marshrutkas frequently are dirty)
- Comfort in planning of trip – vehicles are not coming according to the schedule and are not reliable
- Comfort in communication – attitude of some drivers, especially in marshrutkas, is horrible:

> *"Drivers communication with passengers is just terrible. They say rude things, as "If it doesn't suit you – get out of here". Mainly marshrutka drivers" (R9, FG_Women)*

> *"I've called at complained about 323 route - near bus station people with bags wanted to go out from back door – driver told them to get out of the window, he'll not open back door." (R7, FG_Women)*

- Having spare seats inside vehicles
- Adequate temperature conditions

> *"In summer it is over 40 degrees hot – and marshrutkas turn into cattle carriers – it is almost impossible to be there. There are some marshrutkas where you even can't open windows – it's like sauna there. (R4, R6, FG_Women)"*

- Comfortable being near fellow passengers:

> *"I know these trams, there are lots of homeless people warming up in winter, and they smell so badly" (R7, FG_PT_users)*

As for the **safety**, women have more fears about public transport, perhaps lead by feeling of being weaker than man. Those fears are based on their experience and stories of others. Therefore, safety factor includes:

- Safe boarding (especially with strollers) – drivers often don't wait or don't notice that people are not finished with boarding:

> *"It's nearly impossible to seat with stroller into marshrutka, and no one will help you.*

> *"Once it was absolutely horrible situation. I've got two kids – at that time one was 3, another 2 years old. Elder entered trolleybus, I started to put my stroller with younger inside – and door closes and only handles of my stroller are left between them. And I held those handles and run after this door over*

*100 meters – I was so stressed that I even couldn't say anything, and of course I couldn't release those handles. And passengers started to shout on driver "Stop! What are you doing?!"" (R9, FG_Women)*

*"One driver started to ride when I was one leg at the steps inside vehicle – he didn't close the door, just started moving, and I was hanging there.*

*And another situation from marshrutka that I witnessed - when grandmother boarded marshrutka, and kid was just about to board when it started driving and kid was hanging on grandmothers arm" (R8, FG_Women)*

*"And once I saw in the 232 marshrutka – blind girl boarded and her (I suppose) granny was seing her off – and she wanted either to board, or to hug her goodbye – and marshrutka started going. And this poor granny fall on the ground and was pulled for 3-4 meters" (R9, FG_Women)*

- Having safe ride – at peak hours women are pressed a little bit tougher than men

*"Near Bolshevik at the morning it's nearly impossible to get in marshrutkas – not if anyone will fall out and save some place. Once my daughter was travelling – someone pinched her lungs and she couldn't breath smoothly during several days afterwards, another time I saw how door pinched leg of one women so that even blood appeared." (R7, FG_Women)*

- Safe driver behavior – driver should (but rarely do):
  - Drive with safe speed and not to break traffic rules
  - Not to speak on phone all way long

*"I was riding at 168 marshrutka – driver was on phone from my boarding up to bus station, that is around 40 minutes!" (R6, FG_Women)*

- State of vehicle – if it is too old, women are frightened of it to break during its ride. Actually, one tram route has reputation of route with worst and oldest vehicles on it:

"We have 20 tram [route near Usatovo, lower road] – these trams are in terrible state, they regularly burn and turn over. The older and the most horrible trams – at winter looks like you ride on the street. And very horrible rails. And if it breaks – you will not ride anywhere from there, it's the only public transport there. (R5, FG_Women)

- Thefts

*"Once I was in marshrutka – in front of me stood young couple, hugging each other. I needed to align, squeezed between them and in a minute it turns out that my bag was cut in the middle. There was a time when we even know thefts by routes – it was that blondy on 149 route, for example, and I*

> *even don't mention 168 route – 3 militioneers, acquaintance of mine, were robbed there." (R8, FG_Women)*

And despite of previous assumptions, women ***are not afraid to come home late*** – they tell that they have enough reasons to fear whole day long.

> *"The only fear at 10 PM is that I will not be able to get home because public transport barely rides at this time." (R4, FG_Women)*

As for other types of transportation, as strollers barely fit into marshrutkas, if some communal route is canceled, for moms with strollers it's easier to go to some park near home than to go anywhere else.

Three respondents ride on the bicycle, but only inside their own district as they ride mainly by sidewalks. For travel on far distances between districts they need to go by main roads – but they are afraid to ride there, because it is not safe.

### *Special issues for elderly people*

As most part of concession categories, elderly people use mostly communal transport and when it is not coming – it's better for them to walk by foot to their destination.

Except general will to have more new communal vehicles and more vehicles on the routes that they need, there are several options that elderly people specify:

- Conductors inside vehicle – to be able to align from any door they need, because it's difficult for them to get through narrow aisle to show driver their pension license.
- Marshrutkas drivers are ignoring elderly people on the stop or not always allowing them to ride without payment

> *"I often see when elder person is alone on the stop – or person with stick – and marshrutka driver just flies forwards and doesn't stop, because he knows that it is "free rider"." (R6, R7, FG_Women)*

- In districts where there is no connection by municipal transport, there are three routes of "social bus" where all passengers pay 1 hrn for a ride, but three routes don't fully satisfy transport demand of elderly people, so it would be better to have more accessible routes like that.

### *Requirements for public transport and evaluation of nowadays transport*

Respondents have opportunity to generate main requirements for ideal public transport and afterwards to evaluate nowadays state of different types of public transport by these criterias, with the scale from 1 to 5 where 1 means totally bad, 5 – absolutely satisfying.

First groups created such lists of requirements and evaluation.

Table * Requirements for public transport and evaluation of current services by common users

| ***Requirement*** | ***Marshrutkas*** | ***Trams*** | ***Trolleybuses*** |
|---|---|---|---|
| Capacity | 3 | 4 | 3-5 |
| Reliability (punctuality, coming according to schedule) | 1-2 | 3-4 | 1-3 |
| Safety | 1 | 4 | 4 |
| Comfort | 0-1 | 3 | 3-5 |
| Having place to seat | 1-3 | 2-4 | 2-5 |
| Speed | 1-4 | 3-4 | 2-3 |
| Ecology | 1 | 4-5 | 4-5 |
| Fare | 4 | 5 | 5 |
| Exit from any door | 2-3 | 3-5 | 3-5 |
| Accessibility | 1 | 4 | 4-5 |
| Polite driver | 3 | 3-5 | 3-5 |

Out of this list, changes of first priority are capacity, reliability and third place is shared by comfort and security.

Table ** Requirements for public transport and evaluation of current services by women

| ***Requirement*** | ***Marshrutkas*** | ***Trams*** | ***Trolleybuses*** |
|---|---|---|---|
| Comfort | 1-2 | 2-4 | 1-4 |
| Reliability (coming according to schedule) | 1-2 | 1-4 | 1-4 |
| Safety (technical state of vehicles) | 1-2 | 1-2 | 1-2 |
| Polite driver | 1-3 | 3-5 | 3-5 |
| Number on the route (in peak hours) | 2-3 | 1-3 | 1-3 |
| Fare | 5 | 5 | 5 |
| Speed | 1-5 | 1-5 | 1-5 |
| Accessibility | 1-5 | 5 | 5 |

Women have similar priorities, but gave them another values, putting comfort, reliability and safety at first three places respectively.

Interesting fact is that despite marshrutkas got lower scores nearly at all criterias, all respondents except elderly people are using them more often than communal transport. Main reasons of this decision are:

- Though reliability is not so good for all modes of transport, because of higher amount of marshrutka routes that are passing by the stop, probability to board marshrutka is higher than one or two routes of communal transport that are passing by;
- Communal transport doesn't connect all destination where people need to go so in some cases marshrutka is the only option;
- Between peak hours marshrutkas ride on faster speed than old vehicles of communal transport.

*Wishes*

### Changes in network:

- Add night routes (especially people under 35 are asking). Its touristic city, people need to travel after midnight as well. (R2,R7, FG_PT_users)
- Add routes that would be direct connections between:
    - Lenposelok – anywhere else (now there are only two marshrutkas to Pryvoz and one but with interval of 30 minutes – to Tairova); preferably add at least one municipal route
    - Kotovskogo (Dniprovska road) – Slobodka
    - Dalniye Melniki – city center (at least to Privoz)
    - Schorsa- Francuzkyy boulevard (because there is sea)
- Add municipal transport routes to Kotovsky district – because Tairova has wide structure of municipal transport network, and Kotovsky distric – only one tramline.
- Add municipal bus routes (additional reason - for passengers to be able to have abonements at non-electric transport)
- Add more social bus routes
- Return stops near seaside (previously routes drove right to the sea beach – now there are lots of parkings instead of former stops)
- Maybe it would be better to think wider: add water public transport or ground metro line (line in the air, kind of monorail)

### Infrastructure:

- Place maps and precise schedules of routes at stops
- Use GPS for following PT vehicles and make board on stop that will show when next vehicle will arrive
- Arrange stops as bus pullouts (and put trash bin at each stop)
- Put new vehicles on the road (and replace very old)
- Replace marshrutkas with buses (vehicles with higher capacity)
- Introduce electronic tickets (though not all who propose this change seem to be acknowledge of factual meaning of 'electronic ticket' concept)
- Build bridges between Sea Port – Luzanovka, Sea Port – Tairova or start waterroutes between these points
- Make separated lines for trams and separated lines for public transport (on the roads).
- To pay attention not only to roads, but also to sidewalks quality, because they mostly are in very bad condition now (which results to bicycle riders, people on rollers, wheelchairs, moms with strollers). (R1, FG_PT_users)
- If there'll be nice network of cycle roads – some people would switch to cycles. For now in city center cyclists have to use those slopes on sidewalks that were made for wheelchairs and strollers.

### Services:

- Choose drivers more carefully and instruct them better (they should drive safely)
- Take rapid and wise measures to control and adapt to passenger flow in peak hours and popular events days

- Control technical state of public transport
- Introduce controllers of time that was spent driving.

> "There was an accident when marshrutka got off the road because driver was sick - before that happened he worked 4 days long without stops. One girl died then." (R1, FG_Women)

- Regularly conduct evaluation of quality of providing services – especially at marshrutkas.
- Police should charge fines and/or evacuate those who break parking rules and block movement of public transport or pedestrians
- To increase level of comfort in marshrutkas: add more space for legs in front of seats, wash regularly inner places of vehicles with some disinfectant substance
- Widen amount of people with concessions that is allowed to ride at marshrutkas
- Not to rise fare for ride, and if rise – self-value of trip should be counted and this information should be publicly available

People don't believe that rising fare will be accompanied by changes in quality of services because from their point of view it never was, so they are strongly against it. Though they are convinced that in comparison to other regions, Odessa society is ready to adjust to any changes.

> *"Here we have other people than in Lviv, for example. There when carriers raised fare, people told that we'll not ride for this sum and carried rally – fare lowered to previous amount. Here people just will get used to changes." (R6, FG_PT_users)*

## Disabled subgroups:

It turned out that during last years city administration regularly holds meetings with representatives of disabled groups ("meetings of accessibility committee") that are aimed to figure out list of problems that they meet, including problems with city travelling and solve it. At each group/interview we had one representative of group that regularly takes part in such activity.

As respondents noticed, city administration really started to solve some problems but not all solutions lasted long enough. For example:

- regarding wishes of deaf people, tickers were introduced in communal transport, but nowadays they show only end stops of the route;
- for blind people communal transport has system of stops announcements, but it is in use not so often (rarely at trams, nearly not used in trolleybuses);
- in case of fully or partly immobilized people, lowfloor vehicles were introduced, but in this vehicles not all drivers and conductors know what to do if people in wheelchair want to board it.

## Fully and partly immobilized people (people with movement restrictions: wheelchair users, crutch users and other disabled persons of 2-3 groups)

Group was conducted in the sport club for people with limited mobility in Cheryomushki subdistrict, collecting 8 respondents that have these health problems more than 10 years (most – whole life), leave mainly in Kyivsky district (except two from Suvorovsky and Prymorsky distircts); two of whom were wheelchair users and two – use private cars instead of public transport.

Generally, this group of disabled noted that during last years situation with public transport had changed for the better – because there appeared some lowfloor vehicles (mostly trolleybuses, 1-2 trams and maybe some marshrutkas though they had barely see one on the common city route).

> *"It becomes better than it was. Those who are disabled for more than 10 years definitely could compare situations when there was no transport at all, and now if you wait for 20 minutes you can see at least some transport." (R3, FG_Limited_mobility)*

### *Problems with public transport and other modes*

Though there are still enough problems, that people with limited mobility meet during travel by city.

Main problem that they underline is nonsystematic changes – while new vehicles are introduced, there are still only couple of them per route so wheelchair users need to wait for an hour before one come.

> *"Generally, development of public transport turned its face to disabled, first of all there are lowfloor trolleybuses now. The trouble is that there is no regularity. Even when at city council website each quarter they put schedule of movements of vehicles, adapted for wheelchair users, by routes – interval is one in hour, as I remember – there is no confidence that if you stay at stop for an hour, you'll see this bus – this vehicle could be lost somewhere on its route. That's why we have faith, but there is still too little of hope." (R4, FG_Limited_mobility)*

Actually, there is one option to solve this problem that representative of Mobility committee regularly uses – to call to dispatcher and ask when vehicle that is needed will arrive to your stop, but as discussion revealed, not all disabled have enough courage to disturb dispatcher.

Reliability issue is common for all types of passengers, but influences people with limited mobility more than others.

Other specific problems for disabled with limited movement are:

- Accessibility:
  - not all transport is adapted for entrance of people with limited mobility – for example, in old trolleybuses there is handrail in the middle of the doorway, through which wheelchair user can't pass;
  - not at all transport it is easy to get in – often drivers don't stop near curbs and there is gap between entrance and sidewalk, which complicates entrance for people in wheelchairs (as well as people with strollers).

    *"They stop far from edge of sidewalk so that even at accessible vehicle you can't enter without help – and if you are looking for help, they rarely are eager to help us to ride in." (R3, FG_Limited_mobility)*

- Infrastructure problems:
  - not all stops have enough space for wheelchair to stay waiting, and for people with different levels of disabilities to sit or to hide from sun, rain or snow during their wait for vehicle;
  - sometimes improvements for other disabled categories are complicating movements of members of other category – installation of handrails for blind should take into account possibility for people in wheelchairs to ride on the same stop, too.
- Human factor:
  - drivers and conductors often don't know how to use ramp inside low-floor vehicle when the wheelchair passenger needs to board;

    *"Couple of years ago I was invited to take part in brief reportage – that was when new lowfloor trolleybus started riding. Director and crew were waiting for me at the end stop of this trolleybus, asked when this trolleybus should come – they were told the time. They asked me to come at that time, so I came, they prepared all their stuff – and no trolleybus was there. Not in a 40 minutes. Then at last it arrived, everyone went to board it – I'm as usual, sitting aside of crowd, driver and conductor even didn't pay attention to me, like I was the same part of environment as some passing by animal, cat, for example. They didn't consider me being their passenger. But there was camera ahead of us and operator had already started shooting. Then driver realized that all this was shot by journalists – and shooting crew told him "Let disabled person to enter".*

    *And here starts second episode, completely different. And before that conductor shouted "Why should I bring him, how can I lift him, I won't do this!" (I am aware of that was pretty aged woman and it indeed may be complicated to her) – and there you need to drop the platform. Driver*

*witnesses this, rushes to me out of his door and here starts bustle – "Everyone, step back", conductor is outraged, seeing that no one supports her anxiety – on the whole, they brought me inside almost without help of ramp, fasten some belts – it turns out there are even some special belts in that trolleybuses. And we ride for two stops – we didn't need more." (R4, FG_Limited_mobility)*

  - drivers start moving before people finish their boarding and can stop too abruptly – which is traumatic for people with limited mobility;
  - problem with concessions: for 1 group of disabled (wheelchair users) trip is free in any public transport; though for disabled of 2-3 group legally trip should be free as well, but if in communal transport they indeed travel without payment, marshrutkas' drivers rarely allow this. Also legally attendants of disabled of 1 group should also travel free, but in all public transport (both communal and private) they pay for the ride;
  - drivers of marshrutkas are racing and "fighting for passengers", being fully stuck, that leads to uncomfortable and unsafe trips and dangerous situations on the road; it is very hard for partly immobilized people and nearly impossible for wheelchair users to protect themselves during such races;
  - in summer even drivers of those vehicles that have air conditioning rarely use it.
- Parking places: for those disabled with limited mobility, who use cars for moving through city, most important problem is lack of parking places for disabled – and even if there are parking places for them, usually some car of common people has already been parked there.

Additionaly, disabled are aquainted with general transportation problems:

- traffic jams, especially near Privoz (it is hard for them to stand inside vehicle for long time while it happens, especially if disabled of 2-3 group actually are forced to stand);
- peak hours (wheelchair users try to avoid them and travel after 11 is it is possible; also they rarely use marshrutkas because *"my conscience is against occupying such lot of space in such stuffed vehicle"(R4, FG_Limited_mobility)* )
- dangerous driving style of car-users – sometimes they try to nick the way even for wheelchair users.

### *Requirements for public transport and evaluation of nowadays transport*

Ideal transport for people with limitations of movement is the electro transport (it's bigger and more ecologically friendly), with high accessibility, frequency, coming at schedule time, with polite driver that helps if needed and drives smoothly, and where it is not too hot.

Table ***. Requirements for public transport and evaluation of current services by people with limited mobility

| ***Requirement*** | ***Trolleybuses*** | ***Trams*** | ***Marshrutkas*** |
|---|---|---|---|
| Accessibility (of entrance) | New (low floor) – 2-3 | For wheelchair users – 0 | For wheelchair users – 1 |

| | Common – 0-2 | Other disabled - 3 | Other disabled – 2-3 |
|---|---|---|---|
| Number on the route | New (low floor) – 2<br>Common – 3 | For wheelchair users – 0<br>Other disabled - 4 | 4 |
| Reliability (coming according to schedule) | 1 | 3 | 0-1 |
| Polite driver | 3 | 4 | 0-1 |
| Comfortable temperature (conditioning at summer) | New – 4<br>Old – 2 | 4 | 1 |
| Network | New (low floor) – 1<br>Common – 4 | 4 | 1 |
| Number of people inside | 0 | 0 | 0 |
| Concessions | 4 | 4 | 0 |

Out of all existing modes of travel they prefer communal transport, wheelchair users – especially trolleybuses because they have some accessible vehicles on their routes, but for traveling inside their own district wheelchair users prefer their own wheelchair. As for the seaside trips, they rent private marshrutkas with special floor. They are dreaming of having more lowfloor vehicles at tram routes – as it is depicted in evaluation table, generally trams are valued a little bit better, for now they are just less accessible for fully immobilized people.

Disabled people dislike marshrutkas – wheelchair users for not having enough place for them to ride, other people with limited mobility – for worse drivers and safety policy, and for not providing concessions to them.

### *Wishes*

Basic wish is to have more specialized lowfloor vehicles, at least couple for main routes – to connect all city with network of accessible transport. It is very important to disabled to have availability to come from one city district to another (even with interchanges).

> *"For example, I need to get from one part of city to another. Half of this way I can go on public transport – for example (let's dream a little bit) by speed tram. Then I align – and there is end of tram route and no other route that I can board. We need to avoid such situations, we need some general view of system that will allow [wheelchair users] possibility of interchanges and reaching our final points" (R4, FG_Limited_mobility)*

Having special vehicles on each main route of at least communal transportation will benefit not only to fully or partly immobilized people.

> *"Unified system of accessible transportation helps to all, not only to wheelchair users. If vehicle is adapted for wheelchair, it means that it is also suitable for: elderly people – it is easier for them to enter; moms with strolls – it is easy for them to ride inside; for people on cranes – for everyone. All*

> *categories of people with limited mobility will board happily "vehicles for disabled"" (R3, FG_limited_mobility)*

Out of all directions, wheelchair users are additionally interested to get from Cheremushki to Kotovskogo where another special sportclub is situated.

Also, to enrich accessibility there was strong recommendation to have special selection of drivers and conductors that are riding in lowfloor vehicles – or at least to train them additionally on what should they do if someone wants to ride into their vehicle, and preferably also how should they behave with disabled people.

Another important point is to have available and reliable schedule of routes, with note on which vehicles would be lowfloor ones. At least it would be good to ride according to published schedule.

## Blind

Group was conducted in the canteen of Odessa training and production enterprise UTOS (Varnenska str. 21) – place that provides job places for blind people and people with sore eyesight. All respondents were Odessa citizens for more than 5 years that regularly use all types of public transport, at least to get to work and back home.

Out of changes in situation with public transport during last years, respondents tell about two main positive changes: new modern vehicles on routes of communal transport and tactile tiles on some stops and pavement.

As negative changes they pointed out:

- Cancellation of 11 trolleybus route (it nearly doesn't work anymore) and rarer shifts of 7 trolleybus, though both routes were very convenient to their aim of getting from dormitories to workplace. "And now you not only earn so little, you are also late at work
- Lots of stops that are between end stops were disassembled and not put up back, so disabled and elderly people don't have a place to sit while waiting for their ride of to hide during rainy days.

### *Problems with public transport*

Actually, all problems of blind people could be divided into three groups: accessibility, comfort and attitude.

Main and most emphasized problems of blind people are related to **drivers' behavior**. Drivers with bad attitude happen mostly (but not in all) in marshrutkas, though there were some examples of drivers of communal transport as well. Bad attitude includes:

- Not stopping to catch blind passenger if he is alone on the stop

> "There are different situations. And it's not so crucial about electric transport, but for marshrutkas… Sometimes driver sees blind person alone at stop and don't stop to take him or stops further to disembark passengers." (R2, FG_Blind*)*

- Not announcing stops in communal transport
- Not asking blind people on entrance where they need to go and not warning about this stop afterwards in marshrutkas
- Not warning about extra stops in marshrutkas

> *"Once it was a case when we were travelling with friend, we warned driver what is our stop – and afterwards he made extra stop before ours – but we were counting stops and decided that it was ours and went to get off. And driver didn't warn us at all! We had to walk one more stop by foot." (R5, FG_Blind)*

> *"So I boarded marshrutka – and they make stops not only at stops. But I'm counting everything! So he stops somewhere between official stops – and I think that it is my stop and align. And so I even don't know where I'm stuck – and in best case it's good if someone will notice me and ask if I need help." (R2, FG_Blind)*

- Not letting blind's person attendant to travel free in transport
- Not all marshrutka drivers want to give free ride to blind person (though this is regulated by Ukrainian law) and if he insists, can "punish" him

> *"It happens that drivers are ignoring disabled – not stopping at stop or stopping with doors in front of pillar or deep puddle as mockery. I wish he tried to be in our state and then return to his working place, then he'll understand (how it is difficult to be blind). I'm not talking about all routes, for example 197 marshrutka when I'm in hurry never was bad one, driver even asks "would you like to stop before traffic light or after?" – that is the case when people want to understand you and to help. (…) And another driver is already angry because you don't give him extra 5 hryvnas.*
>
> *I think, it is not we who are blind, but those are blind, who don't notice people who can't see." (R4, FG_Blind)*

Also sometimes conductors are rude because they don't believe in blindness of person while he doesn't show his stick.

**Comfort** includes first of all **having conductors inside vehicle**, because it allows to walk out from closest door; otherwise blind person needs to go to the driver through aisle, often full of people, to demonstrate him documents, which is very inconvenient.

> *"Not so long ago we had a situation – we were riding in 28 tram with my husband (blind as well) from Privoz – hands full of bags, you know, and very crowded vehicle. At first one granny needed to go out at Kanatna street, asked to open last door, she has her pension certificate – but driver is not stopping. All tram started to beg her to stop.*
>
> *Then near Musical theater we started to ask to open middle door, we have certificates as well – driver again ignored our claims and assurance of our blindness from other people. While we pushed to the front door, my husband couldn't hide his indignation, and driver told us "I don't care, it's your problem!""(R8,FG_Blind)*

Also that is:

- Narrow aisles
- Bad conditions of old vehicles
- Temperature conditions (only new vehicles have conditioning and warming devices, though not all of them are using them regularly)
- Too fast speed (in case of marshrutkas)
- Disassembled commodities on stops

And **accessibility** group of problems includes:

- Not regular schedule

> *"Trams are riding worse than before. Not all routes, of course, near 1 station it's ok, but at other places… It happens that 28 and 3 trams are riding "by crowds" (one after another and then long pause)" (R.5,3, FG_Blind)*

- Bad care about pavement for blind people at winter time, when they are covered with snow:

> *"When there is lots of snow – often there is only one tiny path cleared to some point of getting on vehicle and all our special pavements are covered with snow – so following this only path people like us can find ourselves under the wheels of trolleybus" (R4, FG_Blind)*

- No announcing system about what route has arrived – if there is no one else at stop, only driver himself can help

> *"On the other hand, when some marshrutkas' drivers see alone blind person at the stop – they are stopping with the door near him and ask what route does he need. That is very good attitude" (R2, FG_Blind)*

### *Requirements for public transport and evaluation of nowadays transport*

Table **** demonstrates general requirements for public transport that respondents generated and evaluation intervals of current services on these parameters. As it can be

noticed, according to this evaluation communal transport is better for blind people, but they are forced to use marshrutkas in cases when they are in a hurry because marshrutkas are riding more often than communal transport routes that they need.

Table ****. Requirements for public transport and evaluation of current services by blind people

| ***Requirement*** | ***Trolleybuses*** | ***Trams*** | ***Marshrutkas*** |
|---|---|---|---|
| Decent (courteous) driver | 3-**4**-5 | 4 (5) | 3 |
| Stops announcement | 2 | 3-4 | 0-1 |
| Comfort inside | 2-4 | 3-4 | 1-2 |
| Conductors (guarantee of doors availability) | 1 | 1-4 | 0 |
| Satisfactory schedule of routes | 2-4 | 2-4 | 4 |
| Speed | 3-4 | 4 | 2 |
| Comfortable temperature (warm at winter, conditioning at summer) | Old – 2; New 4-5 | Old – 2; New – 4 | 2 |

### *Wishes*

Out of all previous requirements, respondents consider drivers' attitude to be the first task for improvement. Decent driver is required to:

- Announce stops (in communal transport)
- Ask about required stop and announce it, warning if blind person starts alignment in the wrong one (in private transport)
- Stop precisely at the stop (especially if there is special tactile pavement on stop)
- Stop near blind person and announce what route this is if this person is alone on stop
- Do not humiliate disabled people
- Do not ask blind people and their attendants to pay for the trip
- If it is crowded and there is no conductor inside communal vehicle – to believe at least to other passengers about persons' blindness.

Also it would be better to introduce conductors at least at those routes that are connecting main points of blind community (dormitory, plant, Pryvoz market)

Second point is improvement of schedule of public transport, especially communal one (because it is more suitable and more adapted for blind people) – and if possible return 11 trolleybus route.

And third accent is on renewing vehicles and buying new, more comfortable ones.

Out of other wishes it was mentioned:

- To assemble stops back
- To clear tactile pavement at winter
- Maybe to give drivers of marshrutkas some microphones to announce stops
- To add some external dynamics to announce name of route that came.

## Deaf

For information about problems of deaf people it was nearly impossible to arrange focus group discussion because of specifity of their illness, so instead in-depth interview with the head of local deaf community and his secretary/translator was conducted.

As previous group, respondent also indicated positive dynamics of public transport development because of new vehicles on electric transportation routes and appearance of ticker in them.

Though he underlined two main problems:

1. Those **tickers in communal transport are not working properly**. At first, when they were introduced on the deaf society claim, they worked well, but now they show only final stop to which vehicle is heading. It's not so crucial to local deaf people, because they could know stops, but it is essential to deaf city guests that come to seaside or events, because they don't know stops at all.

> *"Except our local deaf people at tourist season here come deaf tourists as well, besides, deaf community each year conducts "Patriot games" – here come deaf people from all regions of Ukraine and sometimes from abroad (Moldova) – for this people it is complicated to orient themselves by the city"*

2. Second big problem is connected with **marshrutkas**. Drivers could skip official stops **and it is very inconvenient for deaf people to give some sign that they need to stop** at some precise place. *"Once one of ours shouted so loudly for driver to stop that he frightened driver and vehicle was very close to cause car accident"*. They are asking city government to add special stop buttons inside marshrutkas, but for now this claim wasn't satisfied yet. So for now they wish at least to have not so lot of people inside marshrutkas – to take in amount of passengers that is written in technical capacity – because this will provide possibility for deaf people to get to the driver from back rows and give a sign that they need to go out.

Actually, there are two more problems hidden:

- Deaf people even don't think that they have to be preferential categories in marshrutkas – maybe that is why it is the only category of disabled that isn't complaining to drivers' behavior;
- Luckily, nearly all points between which they are travelling most frequently are connected by both communal and private public transport routes – this allows deaf people to choose whether they want to pay or get free ride in communal transport. Except Dal'niki region, where deaf people leave as well, but there is no communal transport that connects this region with others.

Out of wishes, they mentioned:

- reactivation of ticker in communal transport;

- stop buttons in marshrutkas (or enough space in aisles)

- maybe additional stop between 2 station of Fountain and 6 Polyclinics, because it's rather long gap and deaf dormitory is situated on Segedska street right between these points – usually they have troubles in marshrutkas to ask exactly for this stop.

- to create screens on each stop on the street that'll show arrival time of next vehicle of the route.

Also 11 trolleybus was mentioned again – before it was rather suitable connection between dormitories for deaf people and city center.

# Appendix 3

## Frequency and PVR recommendations for short-term optimisation

| Route Name | 1-way length (km) | Daily patronage | Peak PPHPD | Peak Frequency | Round Trip Time | Peak Vehicle Requirement |
|---|---|---|---|---|---|---|
| **A_126** | 10.1 | 1216 | 83 | 3 | 1 | 5 |
| **A_135** | 9.1 | 1484 | 107 | 4 | 1 | 5 |
| **MT_105A** | 3.5 | 3352 | 470 | 16 | 1 | 10 |
| **MT_11** | 15.1 | 8139 | 290 | 10 | 2 | 21 |
| **MT_110** | 12.3 | 1129 | 66 | 2 | 2 | 4 |
| **MT_129** | 17.6 | 2968 | 110 | 4 | 2 | 9 |
| **MT_146** | 30.9 | 29446 | 466 | 16 | 4 | 64 |
| **MT_16** | 22.9 | 1070 | 38 | 2 | 3 | 6 |
| **MT_168** | 33.3 | 32365 | 474 | 16 | 4 | 70 |
| **MT_171** | 9.6 | 4582 | 261 | 9 | 1 | 13 |
| **MT_185** | 20.3 | 28270 | 640 | 15 | 3 | 41 |
| **MT_190** | 18.5 | 20998 | 541 | 8 | 3 | 20 |
| **MT_191** | 22.3 | 17806 | 403 | 13 | 3 | 41 |
| **MT_197** | 22.2 | 11565 | 282 | 9 | 3 | 28 |
| **MT_201** | 17.2 | 13473 | 397 | 13 | 2 | 31 |
| **MT_208** | 21.2 | 4659 | 138 | 5 | 3 | 14 |
| **MT_23** | 13.4 | 3545 | 160 | 5 | 2 | 10 |
| **MT_232A** | 29.3 | 33254 | 539 | 11 | 4 | 42 |
| **MT_280** | 21.3 | 1452 | 52 | 2 | 3 | 5 |
| **MT_8** | 15.0 | 1702 | 79 | 3 | 2 | 6 |
| **SB_13** | 11.0 | 2695 | 150 | 5 | 2 | 8 |
| **SB_18T** | 9.5 | 551 | 45 | 2 | 1 | 3 |
| **SB_25** | 23.6 | 6367 | 163 | 5 | 3 | 17 |
| **SB_31** | 3.9 | 6304 | 718 | 10 | 1 | 7 |
| **SB_39** | 7.4 | 2908 | 224 | 7 | 1 | 9 |
| **SB_59** | 3.8 | 4697 | 579 | 8 | 1 | 6 |
| **SB_67** | 15.4 | 1316 | 63 | 2 | 2 | 5 |
| **SB_68** | 21.7 | 1584 | 55 | 2 | 3 | 6 |
| **T_1** | 16.9 | 29044 | 320 | 6 | 3 | 17 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **T_10** | 8.0 | 27635 | 688 | 10 | 1 | 14 |
| **T_11** | 2.7 | 7221 | 519 | 7 | 1 | 5 |
| **T_12** | 9.4 | 10150 | 210 | 6 | 2 | 9 |
| **T_13** | 8.1 | 8039 | 197 | 4 | 1 | 6 |
| **T_15** | 7.6 | 24834 | 642 | 9 | 1 | 12 |
| **T_17** | 7.0 | 5072 | 155 | 2 | 1 | 3 |
| **T_18** | 10.0 | 30263 | 591 | 8 | 2 | 14 |
| **T_19** | 1.9 | 1094 | 135 | 4 | 0 | 2 |
| **T_20** | 7.1 | 2079 | 93 | 2 | 1 | 3 |
| **T_21** | 4.9 | 7791 | 298 | 4 | 1 | 4 |
| **T_26** | 11.1 | 9958 | 181 | 3 | 2 | 7 |
| **T_27** | 19.1 | 10135 | 126 | 3 | 3 | 8 |
| **T_28** | 5.6 | 19086 | 671 | 10 | 1 | 10 |
| **T_3** | 19.5 | 23271 | 229 | 5 | 3 | 15 |
| **T_31** | 15.1 | 12315 | 168 | 4 | 2 | 11 |
| **T_5** | 8.6 | 31426 | 733 | 12 | 1 | 17 |
| **T_6** | 7.6 | 3697 | 120 | 2 | 1 | 3 |
| **T_7** | 13.5 | 36280 | 512 | 12 | 2 | 26 |
| **TB_10** | 13.3 | 23338 | 371 | 6 | 3 | 16 |
| **TB_11** | 13.4 | 8523 | 125 | 4 | 3 | 11 |
| **TB_12** | 15.2 | 26354 | 365 | 6 | 3 | 19 |
| **TB_13** | 5.8 | 6347 | 222 | 4 | 1 | 6 |
| **TB_14** | 8.2 | 2936 | 68 | 4 | 2 | 7 |
| **TB_2** | 5.4 | 12435 | 492 | 7 | 1 | 9 |
| **TB_3** | 8.4 | 17293 | 438 | 6 | 2 | 11 |
| **TB_5** | 8.1 | 2839 | 66 | 4 | 2 | 7 |
| **TB_7** | 16.6 | 17699 | 217 | 4 | 3 | 14 |
| **TB_8** | 7.9 | 17330 | 471 | 7 | 2 | 12 |
| **TB_9** | 10.8 | 38343 | 788 | 11 | 2 | 25 |
| **New N_S Tram** | 39.0 | 2888 | 65 | 1 | 6 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **New MT_104** | 11.6 | 1831 | 104 | 3 | 2 | 6 |
| **New MT_111** | 12.0 | 5721 | 262 | 9 | 2 | 15 |
| **New MT_250** | 19.0 | 17655 | 456 | 15 | 3 | 40 |
| **New MT_6** | 31.2 | 8585 | 166 | 6 | 4 | 23 |
| **New N_4** | 16.1 | | | 4 | 2 | 9 |
| **New N_5** | 16.7 | | | 4 | 2 | 10 |
| **New N_6** | 12.2 | | | 4 | 2 | 7 |
| **New N_7** | 11.2 | | | 4 | 2 | 10 |
| **New N_8** | 15.8 | | | 4 | 3 | 13 |
| **New MT_150** | 18.7 | 11953 | 335 | 11 | 3 | 29 |
| **New MT_148** | 19.5 | 37163 | 830 | 12 | 3 | 32 |
| **New MT_203** | 15.8 | 9389 | 316 | 11 | 2 | 23 |
| **New MT_214** | 20.5 | 23151 | 538 | 8 | 3 | 22 |
| **New MT_145** | 28.6 | 27597 | 472 | 16 | 4 | 60 |
| **New MT_165** | 20.9 | 1477 | 53 | 2 | 3 | 6 |
| **New MT_127** | 21.4 | 7358 | 200 | 7 | 3 | 20 |
| **New MT_18** | 17.8 | 4781 | 163 | 5 | 2 | 14 |
| **New MT_121** | 16.8 | 20741 | 579 | 8 | 2 | 19 |
| **New MT_175** | 23.5 | 28869 | 576 | 8 | 3 | 26 |
| **New MT_198** | 12.4 | 19514 | 707 | 10 | 2 | 18 |
| **New MT_220A** | 22.1 | 12363 | 299 | 10 | 3 | 30 |
| **New MT_117** | 21.5 | 7428 | 200 | 7 | 3 | 20 |