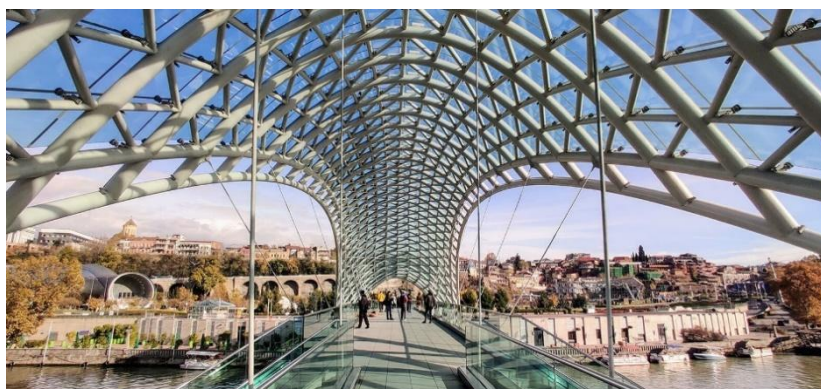




Asian Development Bank
NPLE Tbilisi Development Fund

Data Collection and Model Update Related to Transport in Tbilisi

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Additional Manual Data Collection Report

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AMDC	Additional Manual Data Collection
BPR	US Bureau of Public Roads
CAPI	Computer Assisted Personal Interviewing
EA	Executing Agency
ED	Effective Date
FSU	Final Sampling Unit
FVO	Frequency and Vehicle Occupancy
GIS	Geographic Information System
GPS	Global Positioning System
HH(s)	Household(s)
HHS	Household Survey
HTS	Household Travel Survey
IA	Implementing Agency
O/D	Origin and Destination
PT	Public transport
PWDs	People with disabilities
RRP	Random Route Procedure
SPSS	Statistical Package for Social Science
SrV	System of Representative Travel Surveys
SSU	Secondary Sampling Unit
TAZ	Transportation Analysis Zone
TBT	Tbilisi Bus Transit
TCH	Tbilisi City Hall
TDF	Tbilisi Development Fund
ToR	Terms of Reference
TUDA	Tbilisi Transport and Urban Development Agency

1. INTRODUCTION

The assignment titled “**Data Collection and Model Update Related to Transport in Tbilisi**” funded by ADB and implemented with the Tbilisi City Hall (TCH), Executing Agency (EA), and Tbilisi Development Funds (TDF), Implementing Agency (IA), via the Tbilisi Transport and Urban Development Agency (TUDA), collected data reflecting citizens’ transport habits and update the transport demand model to improve transport services within Tbilisi contributing to the promotion of sustainable urban transport network.

The contract for this assignment has been awarded to the Consortium led by Lattanzio KIBS with REDAS Engineering and ACT Global (hereafter “The Consortium”) in July 2024. The Contract came into force and effect on 1st July 2024, date set out as Effective Date (ED).

The specific objectives of the assignment are to:

- Carry out an **update of the Household Survey (HHS)** done in 2016, which would help in updating the knowledge on the travel habits of the citizens of Tbilisi (Task 1).
- Conduct **Additional Manual Data Collection (AMDC)**, including surveys on public transport, so that it can adequately support the definition, evaluation, and possible implementation of mobility management policies in line with the recently developed Tbilisi Transport Plan (SUMP) (Task 2).
- Update the **Tbilisi Transport Demand Model** (Task 3).
- Conduction of **Capacity Building** activities on the updated model, to provide knowledge transfer and training to the Client’s technical team (Task 4).

This document describes the **AMDC Implementation and Summarized Results** and falls under Task 2: Additional Manual Data Collection (AMDC). Indeed, it provides information on the Methodology (Section 2), Recruitment and Staffing (Section 3), the Surveys’ Preparation (Section 4), AMDC Implementation (Section 5), Data Quality Control (Section 6), Ethical Considerations (Section 7), AMDC Processing (Section 8), Outcomes, Results and Deliverables (Section 9), and Conclusions (Section 10).

The main implementer of the AMDC was ACT Global (ACT), Georgian member of the Consortium.

2. METHODOLOGY

The chapter of methodology describes goals and objectives and a general methodological approach.

2.1 OBJECTIVES

The main objective of the AMDC was to investigate in detail use of Public Transport (PT) by people living in Tbilisi, including residents and domiciled, and to verify the PT operations, mainly followed routes and travel time, to properly and efficiently support the Update of the Tbilisi Transport Demand Model. The AMDC activity included the four different components described below:

Table 1 – Survey Types and Objectives

Types	Objectives
On Board Bus Counts	<i>To count passengers boarding and alighting at each stop on buses and minibuses serving all public transport routes within the urban and suburban areas. This activity also included the verification of the actual routes followed by vehicles in service on each line, as well as the precise location of all stops made.</i>
Frequency and Vehicle Occupancy (FVO) Survey	<i>To collect information about public transport services at stops, such as bus type, level of occupancy and respect of planned timetables.</i>
Transfer Survey	<i>To collect information about the ratio of public transport users using multiple lines of road/metro public transport and having interchange at specific locations.</i>
Counting at Metro Stations	<i>Counting passengers boarding and alighting the metro at all stops.</i>

Overall, it was planned to gather a comprehensive and reliable database describing the actual mobility in Tbilisi.

Detailed data from the database was used to update the transport demand model and could support any modelling exercise deemed necessary to estimate the impact of possible interventions on the transport systems in Tbilisi.

2.2 GENERAL METHODOLOGICAL APPROACH

As reported in the AMDC Technical Approach, to reach the above-mentioned goals, the AMDC was conducted in Tbilisi and its neighborhoods.

All activities focused on the morning peak hour between 8:30 AM and 9:30 AM, for the following reasons:

- It is the most congested time window for the road network and the most crowded for public transport.
- The traffic model of the city refers to this morning peak hour.

An exception was made for the on-board data collection due to the extended duration of most public transport services. The majority of the services in the different public transport lines exceed one hour, and this required an extension of the data collection time window.

Collected data in the different surveys was checked by:

- relative comparisons between data collected on different buses in the same line;
- additional sample counts made by supervisors.

During data collection process, whenever relevant, the information gathered referred to all type of users, without any distinction or pre-selection based on gender, age or any other personal characteristics.

Each component was conducted through different techniques, as explained below:

- **On-Board Bus Counts** were conducted using special application TransitWand on tablets or mobile phones;
- **Transfer surveys** were conducted using CAPI technology;
- **Counting at metro stations** and **FVO Survey** were conducted manually using paper-based tally sheets.

The following section describes the Consortium's approach for each AMDC Components.

2.2.1 ON-BOARD BUS COUNTS

Surveyors worked on board of any selected vehicle, namely **buses or minibuses**, during the morning peak period of a weekday between Tuesday and Friday¹.

It was planned that, on a specific working day, surveyors would monitor two consecutive services (a full round-trip) operated by a specific vehicle on a specific bus line.

The surveyors boarded the selected vehicle for the first trip for monitoring around 8:30 AM. Boardings between 8:20 AM and 8:40 AM were considered acceptable, and major changes were considered in case in a specific line there were no buses/minibuses starting a service in this time window (exceptional cases when the interval between buses was more than 25-30 minutes).

Surveyors remained onboard the same bus for two consecutive services (a full round-trip): they boarded the selected vehicle at terminal A (end of the line), travel to terminal B (opposite end of the line), and travel back again to terminal A, without changing the bus. In case the selected vehicle took an extended break at terminal B, surveyors switched vehicle and carry out the monitoring of the return route onboard a second vehicle operating on the same line.

The second work shift for the same line required surveyors to board the first trip to be monitored at terminal B. This second survey was carried out on the same day as the first one by a different group of surveyors.

The duration of trips varied according to the length of lines, the weather conditions, and the level of congestion.

The designated staff used an application that enabled route tracking, allowing them to trace the completed route and to georeferenced stops accurately. This data was recorded in case it was needed for some specific analysis or use. By using the app, surveyors recorded the number of passengers boarding and alighting at each stop. If the bus did not stop at certain stops, the surveyor did not record anything.

To obtain the most accurate results, one surveyor was assigned at each door.

¹ See Chapter 5 "AMDC Implementation"

Surveyors avoided data collection in heavy rain and/or snowy days, as these conditions affected the number of passengers and the travel times.

2.2.2 FREQUENCY AND VEHICLE OCCUPANCY SURVEY

To perform FVO surveys, surveyors worked at **10 pre-defined bus stops** during the morning peak period of a usual weekday (from Tuesday to Thursday) between 8:30 AM and 9:30 AM.

Surveyors stand on the sidewalk or stop area and collected information about the following elements:

- Type of vehicle (type of buses and minibuses;
- Number of the lines served by the specific stop;
- “Qualitative” level of occupancy (i.e., empty, 25%, 50%...);
- Exact arrival time at stop for each single vehicle.

Surveyors avoided data collection in heavy rain and/or snowy days, as these conditions affected the performance of the services and the number of users.

The form used to collect data related to this survey is presented in Annex 1.

2.2.3 TRANSFER SURVEY

For transfer surveys, surveyors worked at 15 pre-defined bus-to-bus or metro bus/bus to metro area (interchange hub). Surveyors worked in the selected hubs during the morning peak period of a weekday (Tuesday to Thursday) between 8:30 AM and 9:30 AM.

3,000 interviews with passengers (up to 200 interviews per stop) were planned, and **3,191 interviews were effectively collected**.

The sample was selected entirely at random, although the primary objective was to interview as many public transport users as possible to better analyze the aspect of intermodal transfers - that is, the use of multiple services in sequence to complete a single trip. The structure of the questionnaire allowed to define:

- The ratio of people who were making an interchange between two different PT lines (bus-bus or bus-metro);
- The ratio of people who were travelling with PT to or from the interchange hub but without making any interchange between different PT lines;
- Which PT lines have been used to arrive at the interchange hub (by all interviewed respondents) and/or expected to be used to move away from it, if any.

For each interview, the surveyor recorded the gender and age of the respondent. This information could be used at a later stage for specific analyses that may be relevant to this project and/or other related projects.

The questionnaire used for the interviews at the interchange hubs is presented in Annex 3

2.2.4 COUNTING AT METRO STATIONS

At each metro station, surveyors worked during the morning peak period of a weekday (Tuesday to Thursday) between 8:30 AM and 9:30 AM.

The surveyors counted **people entering and exiting any metro station** by staying close to turnstiles at the respective entrances and exits.

At Station Square, it was planned to distribute the surveyors along the platforms to facilitate passenger counting and to distinguish between users of the different lines, namely First Line and Saburtalo Line. Although a manual survey was initially planned, a site inspection conducted prior to the start of data collection revealed that the high volume of passenger traffic, particularly during the morning peak hours, posed significant operational challenges. As a result, an alternative approach was deemed necessary, consisting of the following two components:

- Manual counting of passengers entering and exiting the Station Square metro station, to be interpreted as transfer flows between the public transportation hub and the surrounding urban fabric;
- Identifying an alternative method to estimate the number of passengers boarding and alighting metro trains on the respective platforms by leveraging the station's existing CCTV system. After careful consideration, it was concluded that it was not yet possible to definitively determine the technical feasibility of this approach, as it heavily depends on both the number and precise positioning of the available video cameras.

At the time of this report's preparation, these evaluations were still ongoing, as access to the actual footage recorded inside the station had not yet been granted.

The form used to collect data related to this survey is presented in Annex 2

3. RECRUITMENT AND STAFFING

The following table summarizes the staff members of the Consortium involved in the completion of the AMDC and their main responsibilities.

Table 2 - Staffing

Position	Responsibility
Team Leader	Responsible for the overall project implementation, elaboration of study approach, and supervision of involved parts.
AMDC Team Leader	Responsible for implementation of AMDC.
AMDC Field Manager	Responsible for AMDC data collection and control procedures.
Supervisors	Responsible for the performance of surveyors.
Surveyors	Responsible for collecting data.
CAPi Assistant	Responsible for technical support during AMDC completion on-field.
Database Specialist	Responsible for preparing cleaned databases and outputs.
Quality control specialists	Responsible for controlling data quality and consistency.
Coding specialist	Responsible for coding open-ended questions.

Apart from the Team Leader, all the other staff members described in the table were skilled and experienced ACT staff.

With the supervision of the AMDC Team Leader, several internal technical meetings with key and non-key experts of the team were organized to assign:

- tasks to each team member involved in the AMDC;

- responsibilities for the on-field activities of the AMDC.

The **AMDC Team Leader**, responsible for supervising and coordinating all project activities, including those related to the AMDC, coordinated various key and non-key ACT staff members who supported him in managing these phases of the work.

The **AMDC Field Manager's** duty was to coordinate the AMDC team, especially those involved in field activities. In full coordination with the Team Leader, the AMDC Field Manager prepared the detailed Operative Plan. The AMDC Field Manager was responsible for communicating and explaining the finalized Operative Plan to all relevant staff members, ensuring that its guidelines were properly understood and followed. Additionally, the AMDC Field Manager supervised all activities carried out by Supervisors, CAPI Assistant, Database Specialist, Quality Control and Coding Specialists.

Six Supervisors were coordinating sub-groups of surveyors, verifying the daily completion of on-field activities, ensuring timely replacement of surveyors, who were no longer available due to unexpected events, and informing encounters on possible mitigation measures to implement. Supervisors were always fully coordinated with the AMDC Field Manager. Surveyors were responsible for conducting interviews. Each surveyor was always fully coordinated with their assigned Supervisor.

CAPI Assistant supported surveyors in case of technical problems occurring during on-field activities. The CAPI Assistant was always fully coordinated with the AMDC Field Manager and the Supervisors.

The **Database Specialist** was responsible for the preparation of a well-structured database in which all data collected on-field was made available for further data analysis and elaborations.

Quality Control Specialists were responsible for validating the database by verifying its completeness and fixing any possible gaps or errors. Quality Control Specialists were always fully coordinated with the Team Leader and the AMDC Field Manager.

The **Coding Specialist** was responsible for running data coding, including specific directions/addresses mentioned in Transfer Survey and its finalization in case of error. The Coding Specialist was fully coordinated with the Team Leader and the AMDC Field Manager.

Overall, data collection management was implemented by the Field Manager under direct supervision of the AMDC Team Leader. Each staff member was promptly informed on their designated contact person, following the hierarchical structure of the working group down to the Team Leader, if necessary. Each member of the working group, in accordance with their assigned role and responsibilities, was able to make any necessary decisions to address critical issue, should they arise, with the understanding that such decisions had to be communicated to all members of the group to ensure they could take note and adjust their activities accordingly.

For most AMDC components, the same surveyors who had participated in the HHS were invited to take part. These individuals had a solid understanding of this project's goals and specifics, along with prior experience in both large-scale and transport-related projects. Due to the extensive workload, additional surveyors were involved in the research, all of whom underwent general training.

For those involved in the On-Board Bus Survey, an additional selection criterion was familiar with the TransitWand app, including its navigation and functionality.

For fulfilling the AMDC activities, a total of **76 surveyors** were selected and trained. Of these, 68 surveyors were involved in the fieldwork, while 8 extra surveyors were secured as a backup team to guarantee the smooth and uninterrupted implementation of fieldwork.

In total, the number of surveyors, including extra surveyors, assigned to each component was as follows:

- On-Board Bus Counts: 73 surveyors involved;
- FVO Survey: 20 surveyors involved;
- Transfer Survey: 19 surveyors involved;
- Counting at Metro Stations: 33 surveyors involved.

4. SURVEYS' PREPARATION

The preparation of the fieldwork included specific activities such as the development of instruments, pilot surveys, and detailed training sessions for surveyors, all of which were completed as described in the following chapters.

4.1 PREPARATION OF INSTRUMENTS

Prior to the AMDC implementation, four different survey instruments were developed for field use:

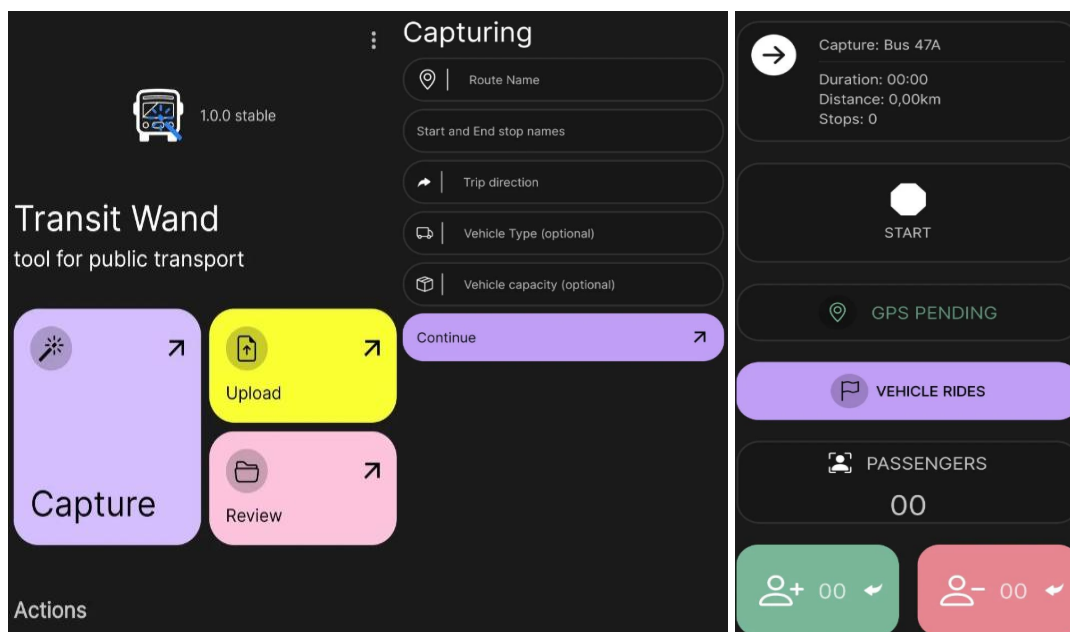
1. **On-Board Bus Counts:** the TransitWand application was installed on all devices designated for fieldwork use. The following section provides a detailed description of the application.
2. **FVO Survey:** a specialized paper-based form was developed to record all necessary data.
3. **Transfer Survey:** a brief questionnaire was designed and implemented using CAPI.
4. **Metro Station Counts:** a dedicated paper-based form was created for data collection at metro stations.

All survey instruments were shared with the Client in advance, and are presented in Annexes 1, 2, and 3.

4.1.1 TransitWand Application

TransitWand is an Android² and iOS³ app designed for the collection of Boarding/Alighting data using the phone's GPS. This makes the survey easier to carry out and the data richer. The exact location of each stop is recorded using the phone's GPS. This allows for all stops to be captured, including informal stops.

Figure 1 - TransitWand user friendly interface



Here a short description of the procedures used to collect data with the TransitWand app is proposed.

² https://play.google.com/store/apps/details?id=com.promobility.one&pcampaignid=web_share

³ <https://apps.apple.com/us/app/transitwand/id6742113808>

- User Authorization
 - The researcher logs into the application using individual credentials.
- Trip/Route Launch
 - Before starting the trip, the researcher activates the recording mode, which captures the current GPS position. From this moment, continuous movement tracking begins.
- Logging Key Events During the Trip
 - While in transit, the researcher can manually record key events, including “start and end of stops” and “passengers boarding and alighting”.
- Data Storage and Transmission
 - All collected data is stored locally on the user's device. After the trip is completed, the data is transferred to the server for further processing.
 - Backend Data Analysis
- The collected information is processed in the server environment, where it is integrated with Geographic Information Systems (GIS) and databases.

Using the website⁴ and Unit Id of the devices involved in the survey, it is possible to obtain the survey results. Output and analysis of data are made simply by extracting and elaborating the data collected with the TransitWand app.

4.2 PILOT SURVEY

A **pilot survey** was conducted for the On-Board Bus Counts and the Transfer Survey. No pilot tests were carried out for the FVO Survey and the Metro Station Counting forms; however, it was agreed that these instruments already contained all the necessary information.

The goal of the **On-Board Bus Counts pilot** was to test how the TransitWand application functioned across different devices. Initially, it was developed for Android, then the app was updated to support iOS as well. Testing was conducted from 17th to 21st February. Following the testing phase, observations were shared with the support team, based on which final updates were implemented in the application.

The goal of the **Transfer Survey pilot** was to test the structure of the questionnaire, its contents, and comprehensibility for respondents. The pilot survey took place on 16th April at three locations: Didube, Isani, and Baratashvili Street. Over 100 interviews were conducted during this round. Six experienced surveyors, with prior experience with HHS and duly trained, participated in the pilot.

After completing the pilot survey, the AMDC Team Leader and the Field Manager conducted a debriefing session to discuss any difficulties encountered and to identify possible modifications or refinements to the questionnaire.

All surveyors participating in the pilot survey attended the debriefing session. The surveyors were asked to report their general impressions or challenges encountered during the data collection process and to provide recommendations. All technical or logical inaccuracies, as well as any problem that occurred in the interviewing process, were reported and analyzed.

⁴ <https://tw.pro-mobility.org:8085/form>

The pilot survey confirmed that the questionnaire was appropriately concise for use in street settings and suitable for interviewing passengers who were in a hurry. However, several observations led to the following adjustments:

- **Arrival by Private Vehicle:** Some passengers were dropped off by private cars by a family member, for example. To reflect this, the answer option “I came/I was brought by car” was added.
- **Arrival from Outside Tbilisi:** At Didube station, an intercity transport hub, some respondents arrived from suburban cities. Similar cases were observed at Isani, where minibuses from the Kakheti region operate. Consequently, a new answer option was introduced: “I arrived by bus/minibus/car from another city/village. Additionally, the question “Did you arrive at this stop by bus/minibus/metro?” was updated to specify “from Tbilisi”.
- **Uncertainty about Bus Choice:** Some respondents were certain of their destination but uncertain about which specific bus to take, particularly when multiple buses traveled in the same direction. To address this, the question was revised to allow for multiple responses.
- **Lack of Information about Transport Mode:** In a few cases, respondents did not know which bus to take and planned to ask the driver. Others were unsure which bus they had arrived on. To address these situations, an “I don't know” option was added to both questions.
- **Multiple Modes of Transport:** For respondents using more than one mode of transport, it was decided to collect information on the last mode used, when they arrived and on the first mode to be used when they were going to board.

Both the contents and technical features of the digitalized Transfer Survey questionnaire were tested in the CAPI system. The CAPI script was initially tested by the internal staff of ACT to make sure that coding of the questionnaire was done properly and that any logic and/or skip patterns were addressed correctly. Testing enabled the team to identify and correct all technical inaccuracies related to the programming of the software and make it more user-friendly and applicable.

4.3 TRAINING FOR SURVEYORS AND SURVEY STAFF

All surveyors were invited to the training sessions at ACT head office. Below are the schedule and the content of trainings:

Table 3 - AMDC Training Topics and Schedule

DURATION	TIME	TOPIC
On-Board Bus Counting		
3 hours	February – March 2025 ⁵	• Information about the survey • Introduction of all attendees • Observation and Working on TransitWand application • Questions & Answers (Q&A)
Frequency and Occupancy Survey		
1.5 hours	April 2025	• Information about the survey • Introduction of all attendees • Observation and completion of survey forms • Q&A
Transfer Survey		

⁵ Exact training dates are not provided because (1) multiple training sessions were conducted for each survey component, and (2) some enumerators participated in more than one component, leading to combined training sessions.

DURATION	TIME	TOPIC
4 hours	May 2025	• Information about the survey • Introduction of all attendees • Discussion on questionnaire • Discussion of typical problems and mistakes during interviews and their solutions • Working in pairs in a role of interviewer and respondent • Q&A
Metro Station Counts		
1.5 hours	May 2025	• Information about the survey • Introduction of all attendees • Observation and completion of survey forms • Q&A

All training sessions began with an introduction by the AMDC Team Leader, who presented the goals and objectives of the survey. Then, it was followed by a joint presentation by the AMDC Team Leader and the Field Manager, who introduced various survey instruments. Each session concluded with a Q&A session to ensure that all surveyors were fully prepared for fieldwork.

In addition to the surveyors, the training sessions were attended by Supervisors, the Quality Control team, a Coding Specialist, the Database Manager, and a CAPI Assistant.

A key component of the training focused on providing a detailed explanation of the survey instruments. This included the rationale behind each instrument, the type of data expected, specifically for On-Board Bus Counts, FVO Survey, and Metro Station Counts, and the anticipated responses from interviewed individuals, for the Transfer Survey.

It was essential for surveyors to have a thorough understanding of the instruments to guide respondents effectively and to provide any necessary clarifications. During the training, examples of common respondent misunderstandings and potential data collection errors were discussed. Additionally, surveyors were provided with detailed, question-by-question guidance to ensure accurate and consistent data collection.

Upon completion of theoretical **training for Transfer Survey**, a practical exercise with simulated interviews was conducted. Simulated interviews considered role plays: all training participants were divided into groups of two people, one of which was acting as surveyor and one as respondent. During the simulated interviews, roles changed to guarantee that all participants had the same exhaustive practical training. The process of simulative interviews ensured that each surveyor understood the challenges related to the survey and the questionnaire. Simulated interviews played a very important role in preparing surveyors for the actual fieldwork. They helped identify ambiguous or confusing questions, provided insights on how respondents would interpret questions and what were the best strategies of communication with irritated or not-interested respondents.

After completion of simulated interviews, any uncertainties, difficulties or observed mistakes were discussed in groups. After the discussion, a couple of additional instructions were formulated and distributed among all field AMDC team members.

For the **FVO Survey** and **Counting at Metro Stations**, surveyors practiced completing the survey forms, while for the On-Board Bus Counts, they trained using the TransitWand application. Whenever difficulties arose, the AMDC Field Manager and Supervisors provided additional guidance and clarification. To mitigate the risk of unforeseen issues in the field, such as technical issues or

potential data loss, paper-based forms for the On-Board Bus Counts were also distributed to surveyors. These were intended to be used in case the app fails to function properly.

For the FVO Survey and Metro Station Counts, no technical skills or specific equipment was required, as surveyors recorded data using paper forms. Similarly, the Transfer Survey did not require additional technical training or equipment, as most of the staff involved had prior experience with HHS.

However, the On-Board Bus Counts required a specific technical setup. As the TransitWand app required phones with certain specifications, a special request was issued in advance. The field team collected information about surveyors' mobile devices beforehand and invited to the training only those with compatible phones. Surveyors were asked to arrive at the ACT head office 1–2 hours before the training to install the TransitWand application. A portion of the surveyors used tablets, like those used in other surveys such as the HHS, while others worked on mobile phones.

Surveyors were provided with all materials needed for the fieldwork, such as:

- Tablets with the digital version of the questionnaire (for the Transfer Survey);
- Copies of printed survey forms;
- Logistic guidelines (specific bus/metro stops, distribution of interviews, timeline of each component, etc.).

Training materials and documents were submitted to the Client for review and approval. Based on their comments and suggestions, the final versions of any material and document were prepared.

5. AMDC IMPLEMENTATION

The AMDC survey encompassed various components of fieldwork activities, each of which is described in the following chapters.

Overall, the following data has been collected:

Table 4. Summary of collected data

COMPONENT	TOTAL
On-board bus counts	116 bus routes and 170 minibus routes surveyed.
FVO Survey	Observations at 10 stops.
Transfer Survey	3,191 completed interviews.
Counting at metro stations	Observations at 28 metro stations.

5.1 ON-BOARD BUS COUNTS

The fieldwork for the On-Board Bus Counts passenger was initially planned and conducted between 27th February and 28th May 2025. Specifically:

- The on-board survey of **buses in Tbilisi** was carried out from **27th February to 1st April**.
- The on-board survey of **minibuses in Tbilisi** was conducted from **1st April to 16th April**.
- The on-board survey of **buses and minibuses in the surroundings of Tbilisi** took place from **13th May to 28th May**.

The detailed analysis of the data collected in this period revealed some criticality: due to unexpected events or situations (i.e. heavy congestion), surveys on 30 services were made later than 11.00 AM, that is the end of the morning peak period (8.30 - 11.00). The critical survey were mainly concentrated in the longest lines, where the average end-to-end travel time is quite high.

To fix this problem, **additional data collection was planned and conducted in October 2025**. The new data collected was used to replace those considered not representative of the peak hour and was also used to update any elaboration presented in this report and/or delivered.

According to the approved methodology, in all surveys conducted on-board **two to four surveyors** were typically assigned to each bus (one per door), while **one surveyor** was assigned to each minibus. The number of routes covered by an individual surveyor varied depending on three main factors:

1. Whether the surveyor was working on a **bus or minibus**;
2. Whether the surveyor was working **within Tbilisi or in surrounding areas**.
3. Whether the surveyor was involved in **other AMDC components**, as well.

The number of surveyors deployed in the field also varied from day to day.

In total, **116 bus routes** and **170 minibus routes** were surveyed.

Several challenges emerged during fieldwork that slightly hindered the overall process. However, ongoing discussions and step-by-step mitigation measures helped ensure a smooth continuation of activities. In particular:

- **On days with adverse weather conditions or unfavorable forecasts**, fieldwork was suspended. This occurred **a couple of times** during the data collection period.
- **Overcrowding on certain routes** occasionally made it difficult to count passengers. As a mitigation measure, assigning **one surveyor per door** proved to be the most effective solution.
- **Technical issues related to the mobile application** also arose, most commonly due to **intermittent internet connectivity or issues with the app**. In such cases, surveyors used **paper-based forms**, specifically structured to record the number of passengers boarding and alighting at each stop. The collected data was subsequently **entered into the system manually**.

Since the On-Board Bus Counts Survey was the largest component of the AMDC, the possibility of extending the fieldwork to include Fridays was discussed prior to its launch. Given that the survey period took place during winter and early spring, seasons often marked by unfavorable weather and occasional disruptions, it was ultimately decided to conduct the fieldwork **from Tuesday to Friday**. The working period was unchanged - from 8:30 AM to 9:30 AM.

5.2 FREQUENCY AND VEHICLE OCCUPANCY SURVEY

The **FVO Survey** was conducted on **8th April 2025**, from **8:30 AM to 9:30 AM** at the pre-agreed **10 stops**.

Two surveyors were assigned to each stop. The observations were carried out smoothly, without any disruptions or challenges. Additionally, the weather conditions were favorable for conducting the survey. Surveyors stood on the sidewalk or within the designated stop area and recorded information using paper forms. The exact locations of the observed stops are presented in the table below.

Table 5- Stops for Frequency and Vehicle Occupancy Survey

N	Stop Address
1	Technical University
2	Beliashvili-Balanchini Streets
3	Kakheti Highway
4	Metro Rustaveli
5	Sarajishvili Avenue
6	Mirian Mepe Avenue
7	Ortachala Station
8	Grigol Robakidze Avenue
9	Mevele Street
10	Aleksandre Kazbegi Avenue

5.3 TRANSFER SURVEY

The Transfer Survey was conducted from 13th May to 22nd May 2025. Surveyors were deployed at **15 pre-identified interchange hubs**, where transfers occurred between buses or between metro and bus lines. The survey was conducted from **Tuesday to Thursday, between 8:30 AM and 9:30 AM.**

At each interchange hub, surveyors were positioned at **two to four different strategic points** (one per location) to ensure broader geographic coverage. On average, **approximately 200 interviews were conducted per hub**, resulting in a **total of 3,191 completed interviews.**

There were **no strict sampling instructions** for selecting respondents, as detailed data on passenger flows and characteristics were unavailable. However, surveyors were instructed to follow general guidelines as described below:

- Focus interviews to passengers boarding or alighting specific bus lines;
- Ensure a balance between **age and gender** among respondents, to the extent possible.

The survey faced no major disruptions. Weather conditions were favorable, and the volume of passengers at most locations was sufficient. Passengers transferring between buses/minibuses, especially those waiting at stops, were generally cooperative and willing to participate.

The main challenge was encountered at **metro station entrances**, where passengers were typically in a hurry and less inclined to take part in the survey, as they did not have to wait and were moving quickly.

Since the survey was conducted using the CAPI technique, the interview data was uploaded to the system instantly.

The exact locations of the stops are presented in the table below.

Table 6- Stops for Transfer Survey

N	Stop Address	Number of Locations within stop
1	Vake Park	2
2	Metro Station Avlabari	3
3	Isani	4
4	Tbilisi Concert Hall	3
5	Metro Station Sarajishvili	3
6	Baratashvili Street_1	2
7	Baratashvili Street_2	2
8	Station Square_Tbilisi Central	3
9	Station Square_Tsotne Dadiani Street	3
10	City Mall	1
11	Delisi	4

N	Stop Address	Number of Locations within stop
12	Metro Station Akhmeteli Theatre	3
13	Didube	4
14	Technical University	3
15	Varketili	3

5.4 COUNTING AT METRO STATIONS

Passenger counts were conducted at metro stations on 7th and 8th May 2025. Surveyors were positioned in station halls near the turnstiles to ensure accurate counting of both boarding and alighting passengers.

A total of **28 surveyors** were assigned, with two surveyors per station, one responsible for counting boarding passengers and the other for alighting passengers. The observation period lasted from **8:30 AM to 9:30 AM**, during which surveyors also filled out forms recording the number of respondents.

The exact locations of the stops are presented in the table below.

Table 7- Metro Stations

N	Metro Station	M	Metro Station
1.	Varketili	15.	Didube
2.	Samgori (lower side)	16.	Ghrmaghele
3.	Samgori (upper side)	17.	Guramishvili
4.	Isani	18.	Sarajishvili
5.	300 Aragveli	19.	Athmeteli Theatre
6.	Avlabari	20.	Tsereteli
7.	Liberty Square	21.	Technical University (Pekini ave)
8.	Rustaveli	22.	Technical University (Sports Palace)
9.	Marjanishvili	23.	Medical University (Archive)
10.	Station square (Tbilisi Central)	24.	Medical University (Tashkenti Street)
11.	Station square (Children's World)	25.	Delisi (City Mall side)
12.	Station Square (Dadiani Avenue)	26.	Delisi (Asatiani street side)
13.	Nadzaladevi	27.	Vajha-Pshavela
14.	Gotsiridze	28.	State University

6. DATA QUALITY CONTROL

Comprehensive quality control procedures were implemented throughout the fieldwork to monitor activities in real time, ensure data accuracy, and provide ongoing feedback to team members. This approach enabled continuous improvement of processes and outcomes.

Due to the specific requirements of the AMDC, various data quality measures were applied:

- **Supervision:** Each surveyor was assigned to a dedicated supervisor. Supervisors spent time in the field observing performance and offering additional instructions when necessary. They were present at all locations during the FVO Survey, Metro Survey, and Transfer Survey. For the On-Board Survey, supervisors rotated across different routes, stops, and days to ensure broad coverage.
- **Data Entry for On-Board Bus Counts:** Data collected on paper forms during On-Board Bus Counts was manually entered into the system. The process included checks for internal consistency, such as verifying that total passenger numbers aligned with recorded boarding and alighting figures.
- **CAPI Logic for Transfer Survey:** For the Transfer Survey, CAPI tools included built-in logic to minimize respondent errors and improve data reliability.
- **Demographic Balancing:** During the Transfer Survey, age and gender distributions were monitored daily to ensure a balanced representation of demographic characteristics among respondents.

The data quality control conducted for the AMDC did not reveal any major issues that could have significantly affected the survey process and results.

7. ETHICAL CONSIDERATIONS

The current study was guided by internationally recognized **ethical principles and guidelines**. Also, the Consortium was fully complied with the requirements set forth by the Law of Georgia on Personal Data Protection.

Besides, for the Transfer Survey, oral informed consent was obtained from all respondents before the interview started. Interviews were completed only with those respondents who provided consent to participate in the survey.

Each respondent was thoroughly informed about their rights including the right to refuse participation or withdraw from the process at any point, even if the interview was already started, as well as the right not to share any personal information.

8. AMDC PROCESSING

Due to the specific nature of the AMDC, the **FVO Survey** and **Counting at the Metro Station** did not require extensive data cleaning. Information recorded on paper forms was entered into the system and reviewed for consistency and any obvious technical errors.

Data from the **Transfer Survey** was collected, checked, and validated using automated procedures designed to minimize errors and ensure data accuracy. These tools, used during direct interviews, significantly reduced the likelihood of incorrect entries. Nevertheless, a final data cleaning process was applied during the verification phase to ensure completeness and reliability.

For open-ended responses, such as transport directions or stop addresses, a separate dataset was generated upon completion of fieldwork. This dataset, containing manually entered responses, was shared with a coding specialist for coding.

The final data was cleaned in the special statistical program SPSS 27.0, with the program SPSS syntax. Final dataset was subject to further control and congruence checks:

- Typos or inaccuracies in the manual entry of information;
- Inconsistencies within the data that could not be identified through the controls and logic embedded in the questionnaire;
- Information or aspects requiring further verification - for example, trip records that indicate the use of an unusual mode of transport for a given location.

The cleaning process considered verification of the whole file, checking links between the variables, logic of the data, and validity of the database in general. In particular, the data cleaning process included:

- Check variable names and formats.
- Check variable types and formats.
- Check missing values (if any).
- Identify and check outliers.
- Check received data consistency.
- Check the possible duplication of cases.

9. OUTCOMES, RESULTS AND DELIVERABLES

9.1 DATA ANALYSIS

The data collected through the various surveys were processed using the most appropriate methodologies, resulting in the development of a series of user-friendly databases. These databases serve both the primary goal of updating the traffic model and the broader purpose of presenting the study's findings. The extensive dataset acquired has been used for multiple purposes, as detailed below:

- **Analysis of Public Transit Route Alignment.** The collected data were analyzed to verify the accuracy of the planned transit routes, especially those served by minibuses, against the actual paths followed by vehicles in operation. These analyses first enabled the integration of all active lines and their corresponding stops into the traffic model, significantly contributing to the enhancement of this strategic tool. During this phase, discrepancies between scheduled and actual routes/stops were identified and are currently the subject of targeted investigations.
- **Analysis of Public Transit Ridership.** One of the most significant outcomes of this effort was the creation of a comprehensive database containing information on the number of passengers boarding and alighting at each stop on every line. This was based on data from four observed trips per line (two per direction in typical working and school days, conducted during the morning peak). From this database, several GIS maps were produced, allowing for quick and intuitive interpretation of ridership volumes on selected lines of particular interest within the Study Area. A similar survey on boarding and alighting passengers was also conducted for all metro line stations. Here as well, the data was used to develop a comprehensive database and produce relevant GIS maps, which are presented in the following sections.
- **Analysis of Vehicle Occupancy and Service Frequency for Rubber-Tired Public Transit.** Although the monitoring covered a limited number of road segments during the morning peak period, a wealth of useful and insightful data was collected. These findings not only support the traffic model update but also provide a solid basis for future mobility studies in Tbilisi. Specifically, a detailed database was compiled, along with tabular summaries and GIS maps, offering both a comprehensive and detailed view of the collected information.
- **Assessment of Intermodal Transfers within the Public Transport Network.** In this case, the number of survey points was limited, but the strategic selection of these locations enabled the acquisition of a valuable information base. As part of this specific task, both databases and general-purpose cartographic outputs were prepared.

It should be noted that, unless otherwise specified, all collected data and analyses produced refer exclusively to the morning peak hour between 8:30 AM and 9:30 AM. In particular:

1. For FVO surveys or in the case of Intermodal Transfers, the data were collected on-field exactly within this time window.
2. For Public Transit Ridership, the data refer to trips on each public transit line with a departure time closest to 8:30 AM in each direction studied.
3. For Public Transport Routes, including recorded average speed of vehicles in service, the data were collected during the morning period; however, in this case, it is evident and appropriate to note that the exact time has no impact on the data collected, elaborated and presented.

9.2 MAIN OUTCOMES

The activities described have enabled the collection of a significant amount of data, which undoubtedly represents added value for the entire project. All surveys focused on public transportation in Tbilisi and its immediate surrounding areas, providing information that can serve multiple purposes, including:

- **Updating the traffic model:** all data collected was used at the highest level of detail, as the information gathered has allowed, and continues to allow for effective model calibration and validation;
- **Building a knowledge base** on public transport, primarily represented by the databases that will be delivered to the Client; and
- **Preparing selected analyses** considered relevant and valuable to the Client, which are presented in this report: the databases constructed were thoroughly analyzed and then used to produce selected outputs deemed useful for interpreting the project findings.

Concerning the last purpose, it was determined that the potential volume of similar analyses that could have been produced based on the surveys conducted would have made the collected information practically unreadable due to excessive complexity. Nevertheless, the Consultant remains available to prepare additional outputs like those already provided, referring to any specific line, stop, or area covered by the surveys, upon the Client's requests or areas of particular interest.

Below are several analyses conducted on different types of data collected. For each data type, the most relevant and meaningful analyses have been provided.

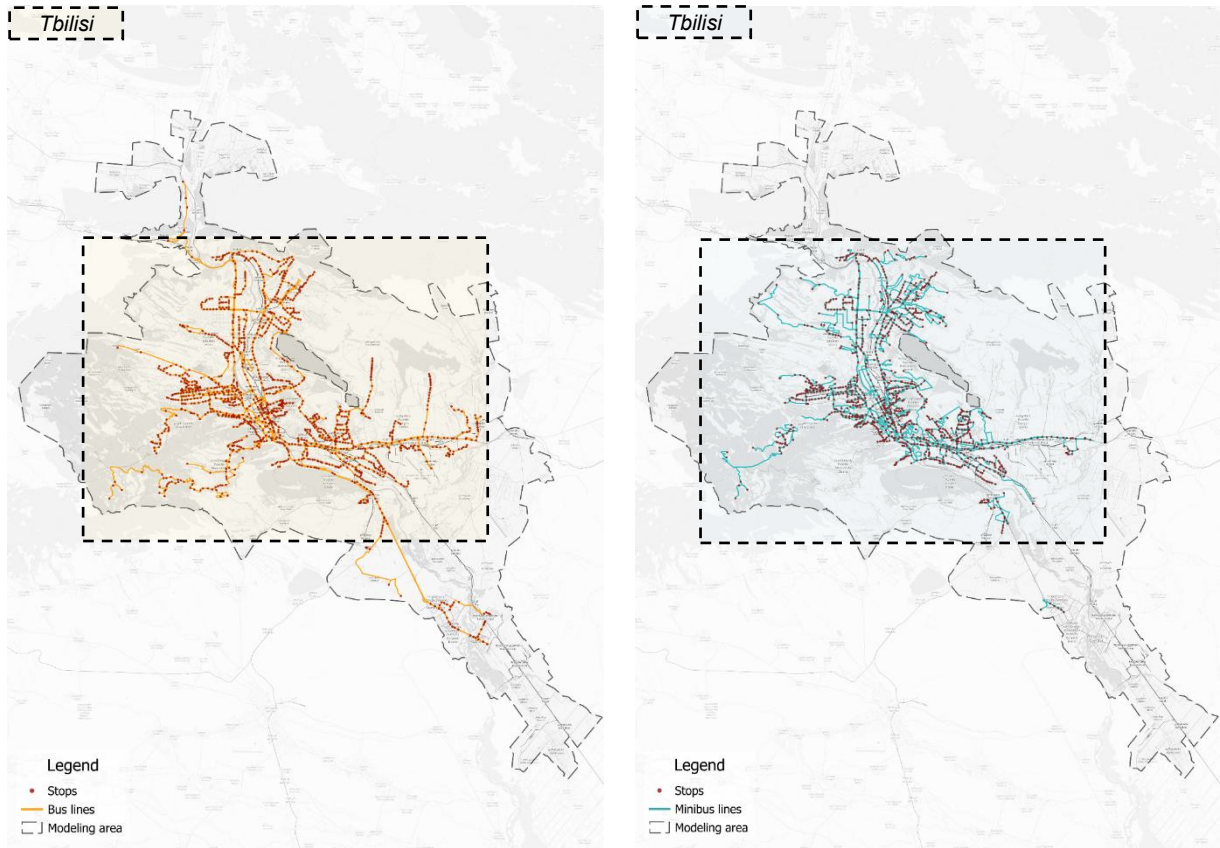
These surveys required the use of different tools (the TransitWand app and paper forms) and resulted in the collection of a very large amount of data, gathered during two different time periods (spring and fall 2025). Since the validation and processing phases for this data required highly detailed procedures, a dedicated technical document was prepared to describe these procedures in detail. Please refer to Annex 6.

9.2.1 ON-BOARD BUS SURVEYS

The first type of survey, which focused primarily on counting the number of passengers boarding and alighting from a sample of four trips on each line operating within the area covered by the traffic model, also included an important verification of the actual routes followed by the monitored vehicles and the precise location of stops. This activity therefore contributed to building a valuable knowledge base of the surface public transport network, encompassing both fixed-route lines and marshrutkas (minibuses).

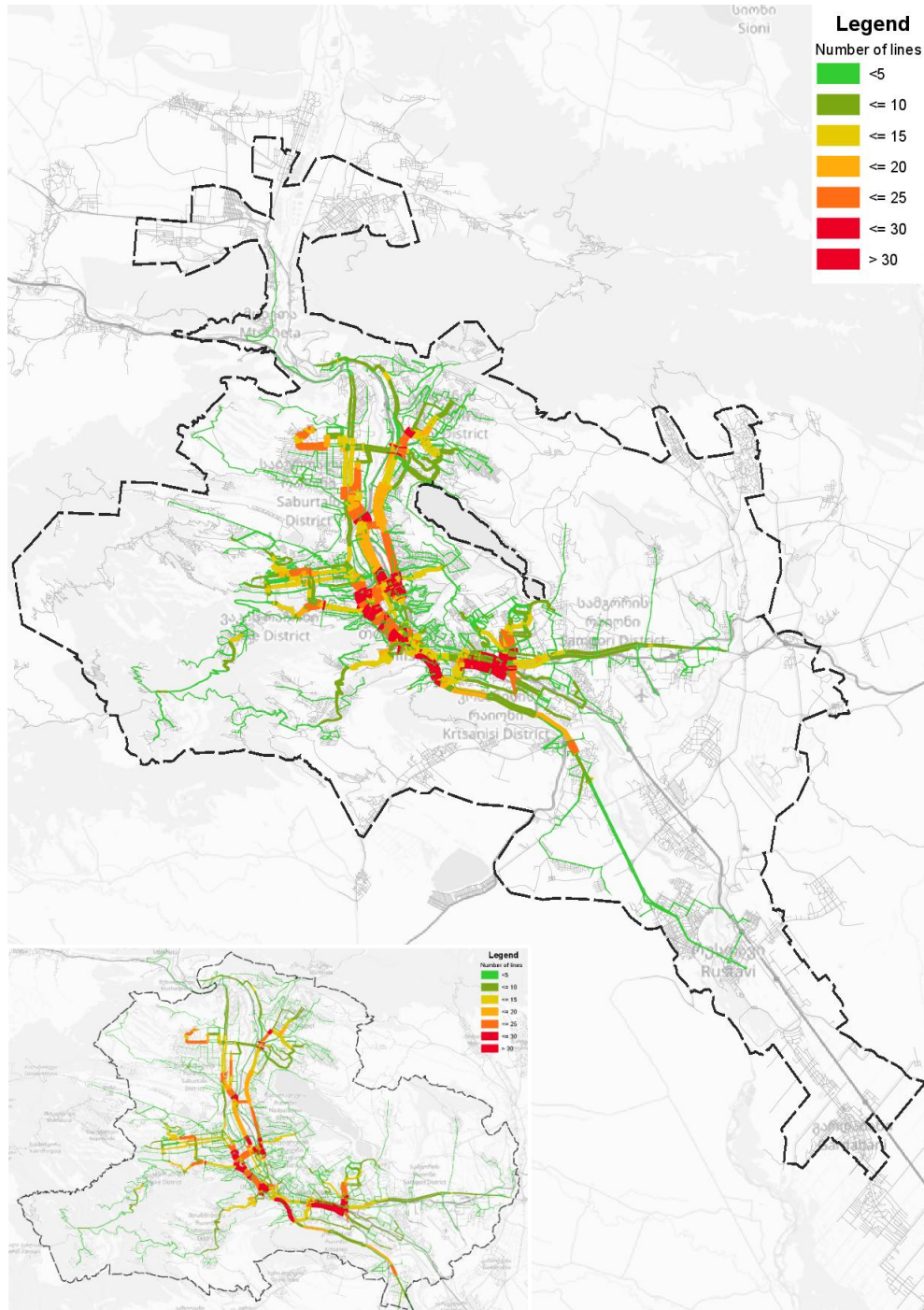
Figure 2 shows the **monitored lines**, providing a clear overview of the differences between those operating within Tbilisi and those integrated into the broader traffic model. For ease of interpretation, the maps are further divided into fixed-route lines and minibus services.

Figure 2 - Map of the public transport lines - Fixed lines and marshrutkas



An interesting analysis of the data collected during this phase is presented in Figure 3. The information gathered on the **routes** followed by the lines made it possible to visualize their actual **distribution across the network** integrated into the traffic model, highlighting—predictably—a very high concentration in the central area of the city.

Figure 3 - Number on PT lines



The areas with the least coverage are those located in the southernmost and northernmost parts of the territory included in the model. Their distance from the city center makes it relatively difficult to rely solely on public transportation for mobility.

The situation is less critical along the east-west axis: aside from the fact that internal distances within the modeled area are shorter, services are more numerous and better serve most of the urbanized areas.

It is important to note that this analysis only considers the number of transit lines. Service quality, of course, should also be evaluated based on factors such as service frequency and the total capacity offered, expressed in terms of seats per kilometer.

9.2.1.1 Passenger boarding and alighting counts

Passenger boarding and alighting counts were conducted twice per direction on all active transit lines. These field surveys were carried out on two weekdays of the same type (i.e., regular working days), starting with the first departure from one of the two terminal stops shortly after 8:30 AM).

Although variations between surveys may exist depending on the length of the routes, the scheduling approach adopted ensured that data was collected for each line and direction during two key time windows:

- The first corresponds to the morning peak hour (8:30–9:30 AM), which aligns with the timeframe used for other public transport surveys.
- The second covers the period immediately following the peak, but still within the morning peak period (8.30-11.00 AM).

To provide the most reliable representation of the passenger flows in each line, the average number of people boarding and alighting at each stop was used for most of the analysis, calculations and maps. In fact, in some cases the data collected in a single direction of a specific line were unbalanced (i.e. total number of people boarding much higher or lower than that of people alighting) or incomplete, and it was therefore considered preferable not to include them in the averaging process. This approach was preferred considering that these specific conditions were observed in less than 10% of the total number monitored services (counted as single direction of a specific line), and that the single trip data selected and used were consistent with the data of the same line in the opposite direction.

Given that several hundred lines were monitored, this report includes only the outcomes of the most relevant analyses, specifically those related to the lines that were found to have or are known to exhibit distinctive characteristics.

The following sections present analyses related to various **transit lines within the Tbilisi network**, selected among those that exhibited particularly noteworthy characteristics. As previously mentioned, the same type of analysis was carried out for all bus and minibus lines within the area covered by the traffic model and the most relevant results are presented below. The selected routes represent the most significant components of the city's public transport network. They include all TBT lines, which are the primary high-capacity bus corridors designed to ensure fast and reliable service connecting different districts with 18-meters buses. In addition, key city routes were chosen among those passing through the most important streets and connecting major residential, commercial, and institutional areas. These routes were selected for their strategic importance, high passenger demand, and broad coverage within Tbilisi. By analyzing these selected routes, coverage of the city's main stops and key transfer locations is also ensured. These routes intersect with other lines at major hubs, providing a comprehensive view of passenger movement and interchange

behavior across the network. As a result, the selected routes allow us to capture essential patterns in boarding and alighting without omitting critical nodes in the public transport system.

To prepare the maps presenting the number of passengers boarding and alighting at every stop for each transit line and in each direction, the following procedure was adopted:

1. For each line and direction, both data from the monitored trips were considered (except for the directions in which unbalanced or incomplete data were observed in one of the two monitored services).
2. Except for a few cases, the number of people boarding and alighting at each stop of each line was calculated as the average of the data recorded during the two monitored surveys. As mentioned above, data showing clear imbalances between the total number of people boarding and alighting, or incomplete due to missing values for one or more stops, were not used.
3. The calculated numbers for each line and direction were then multiplied by a coefficient defined as the ratio between the number of departures scheduled between 8:30 AM and 9:30 AM from the same terminal, on the same line and in the same direction and the number of investigated lines in the same line/direction (generally two). The number of departures was determined based on the official service schedule for each line.

Figure 4 - Boarding and alighting - Line 301 (Direction 1)

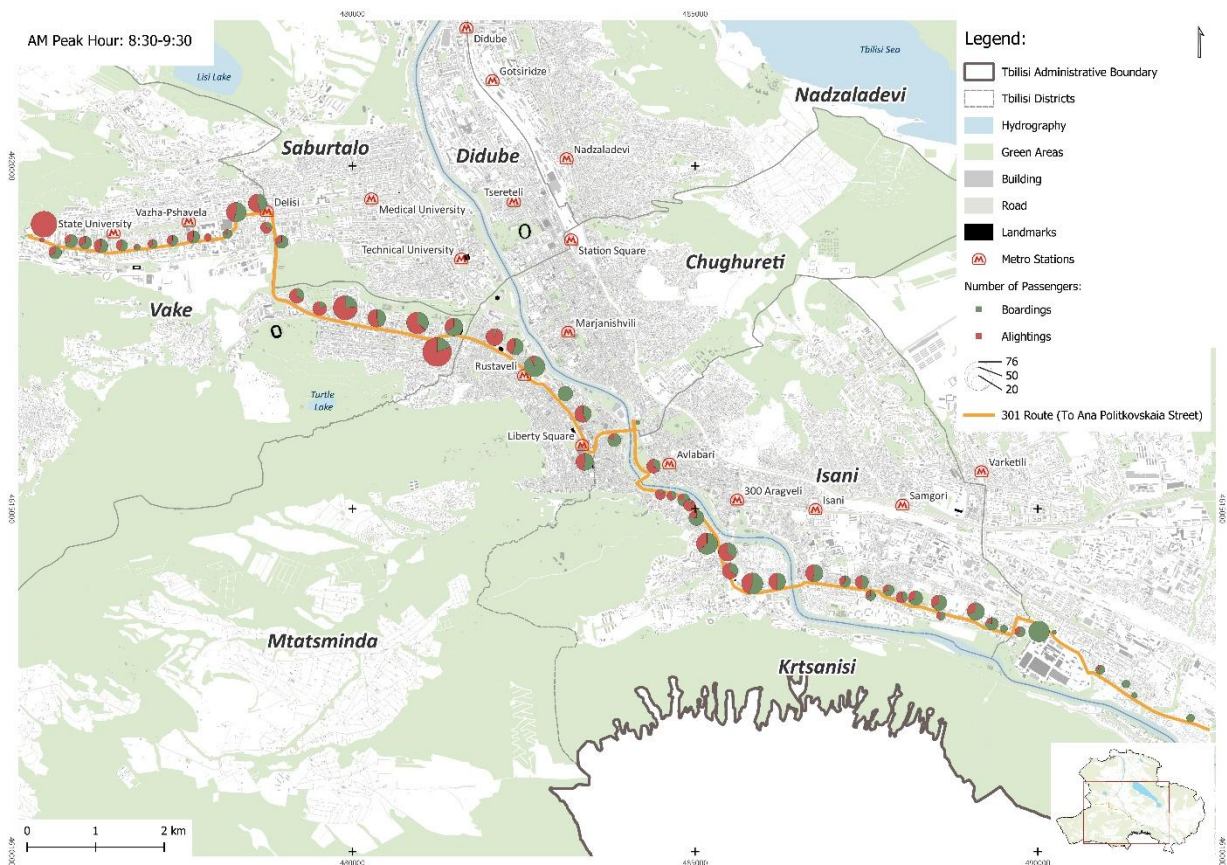


Figure 5 - Boarding and alighting - Line 301 (Direction 2)

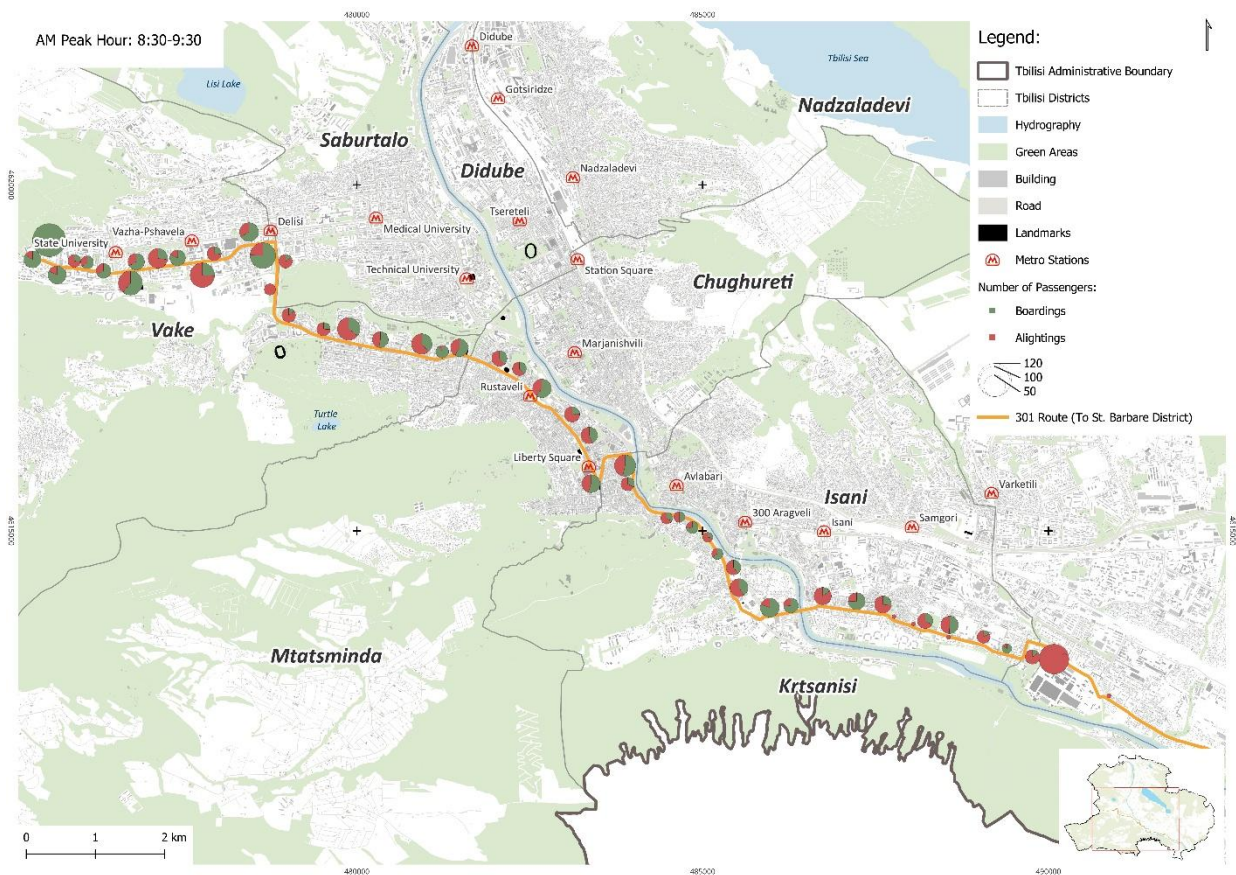


Figure 6 - Boarding and alighting - Line 302 (Direction 1)

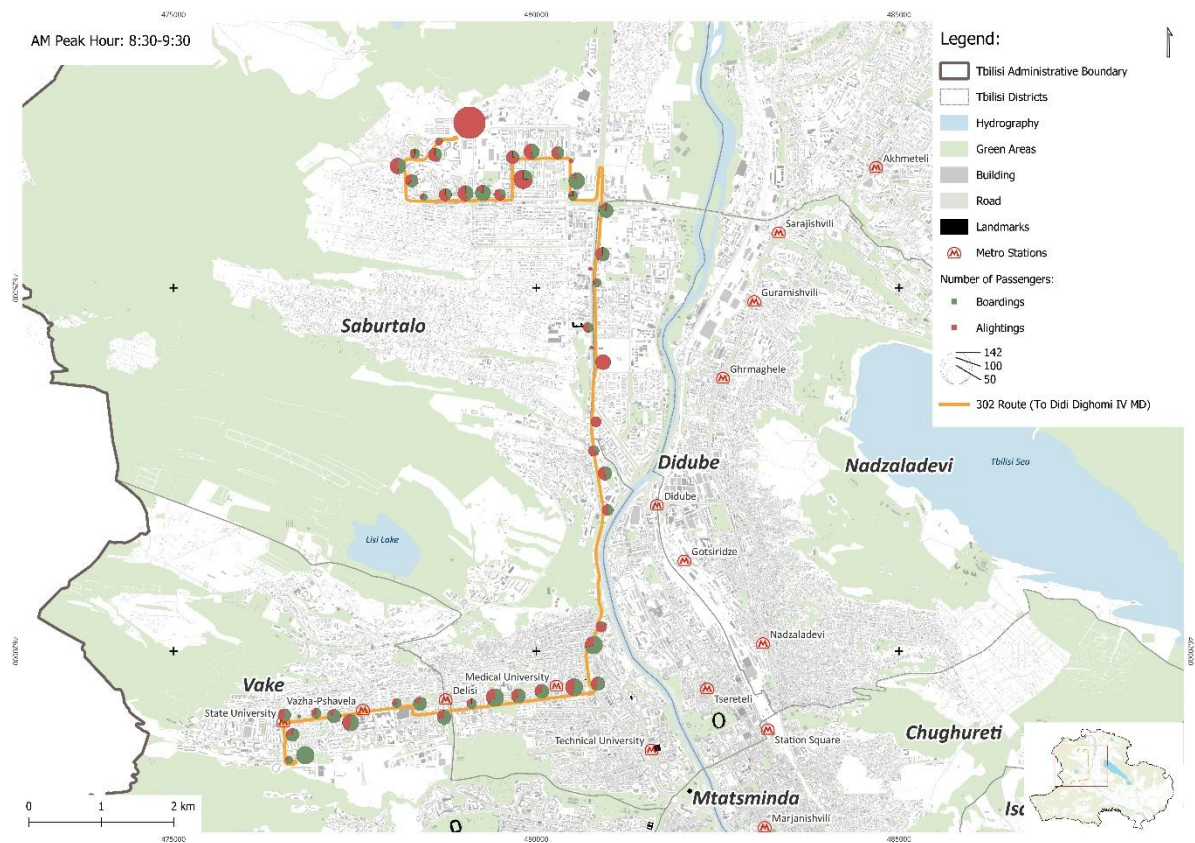


Figure 7 - Boarding and alighting - Line 302 (Direction 2)

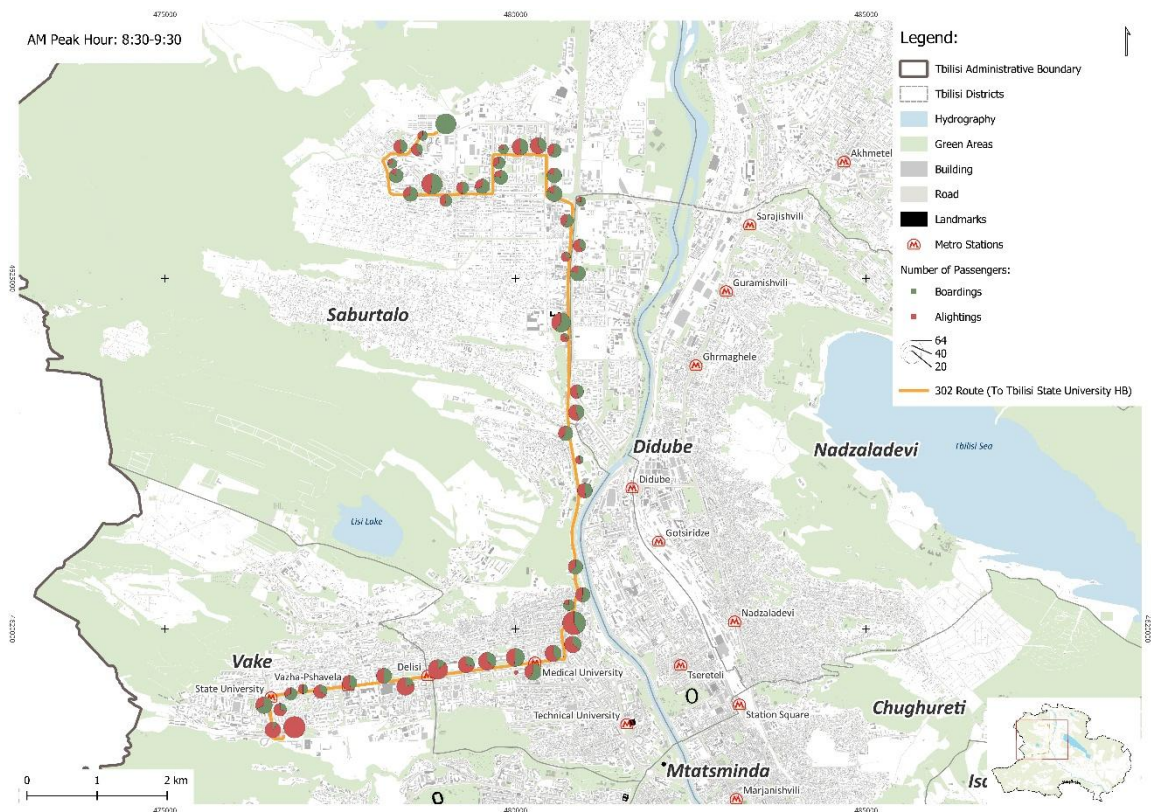


Figure 8 - Boarding and alighting - Line 550 (Direction 1)

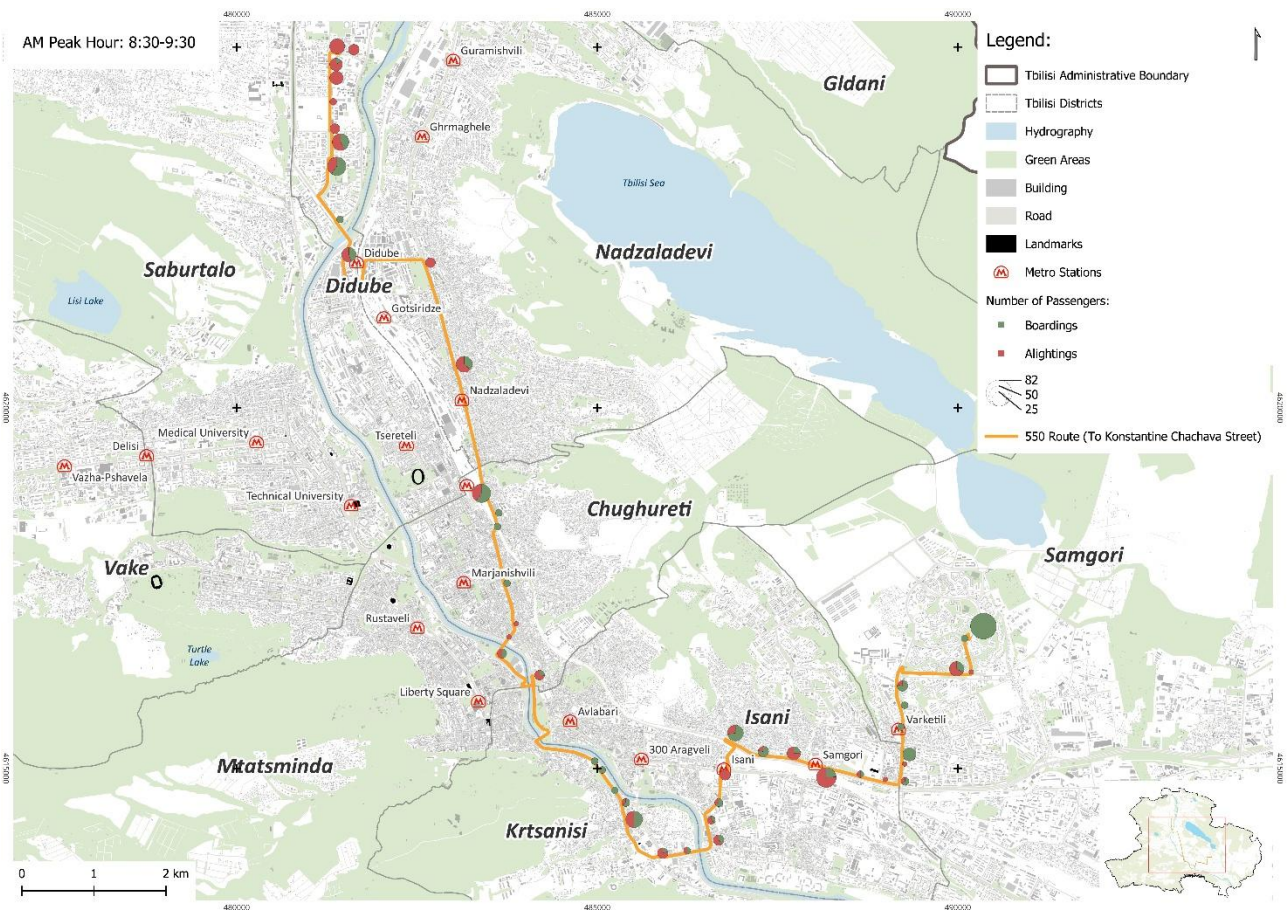
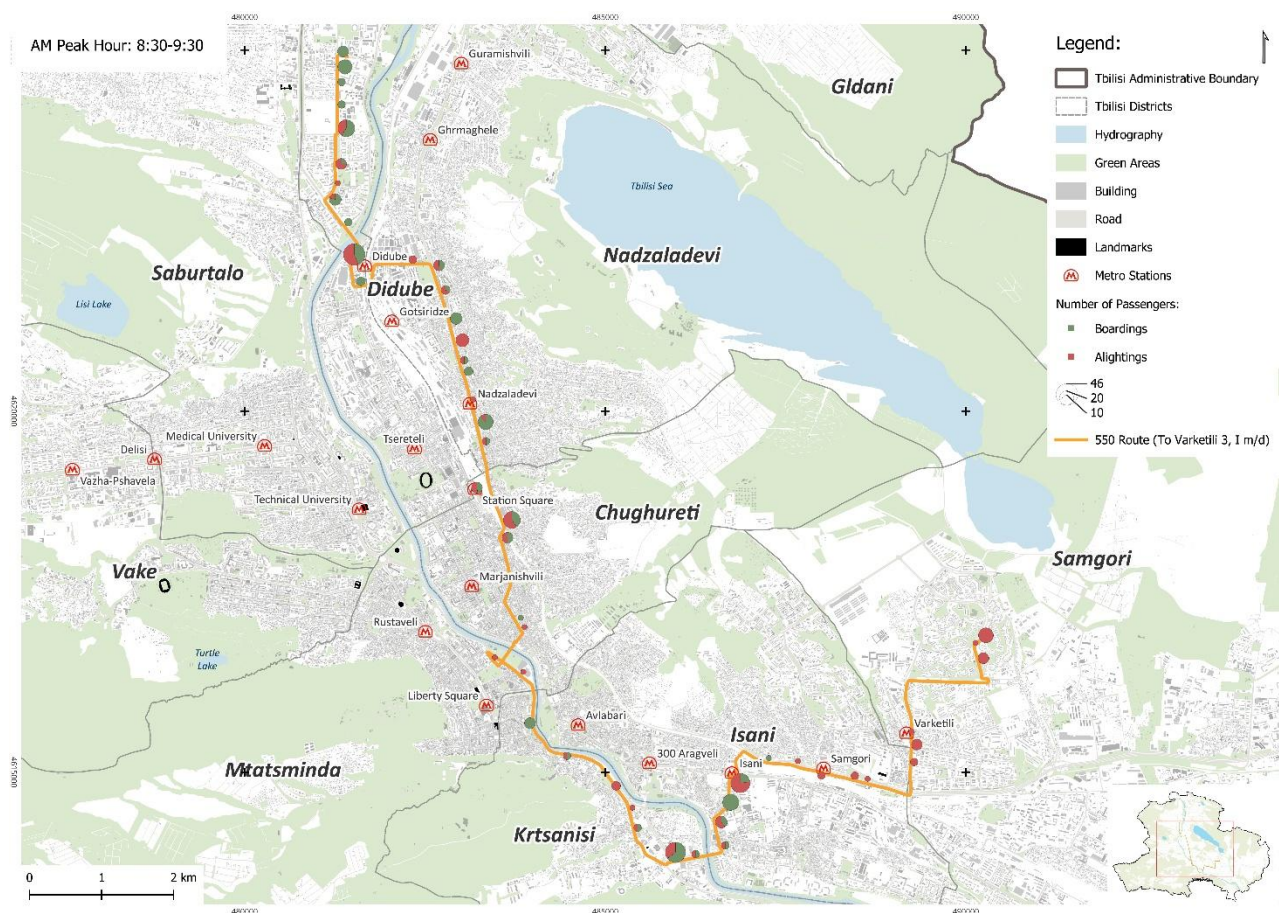


Figure 9 - Boarding and alighting - Line 550 (Direction 2)



As mentioned above, TransitWand application was used for this kind of activity, allowing the collection of all necessary data through a user-friendly interface and leveraging the capabilities of the portable devices on which it was installed.

Annex 5 presents a map showing the average speed on all monitored lines, as well as additional maps illustrating the number of people boarding and alighting at each stop on these lines. This second set of maps was developed to provide a comprehensive overview of the data: the maps are organized by the different districts of Tbilisi, thereby facilitating a clearer reading and understanding of public transport mobility demand within the city.

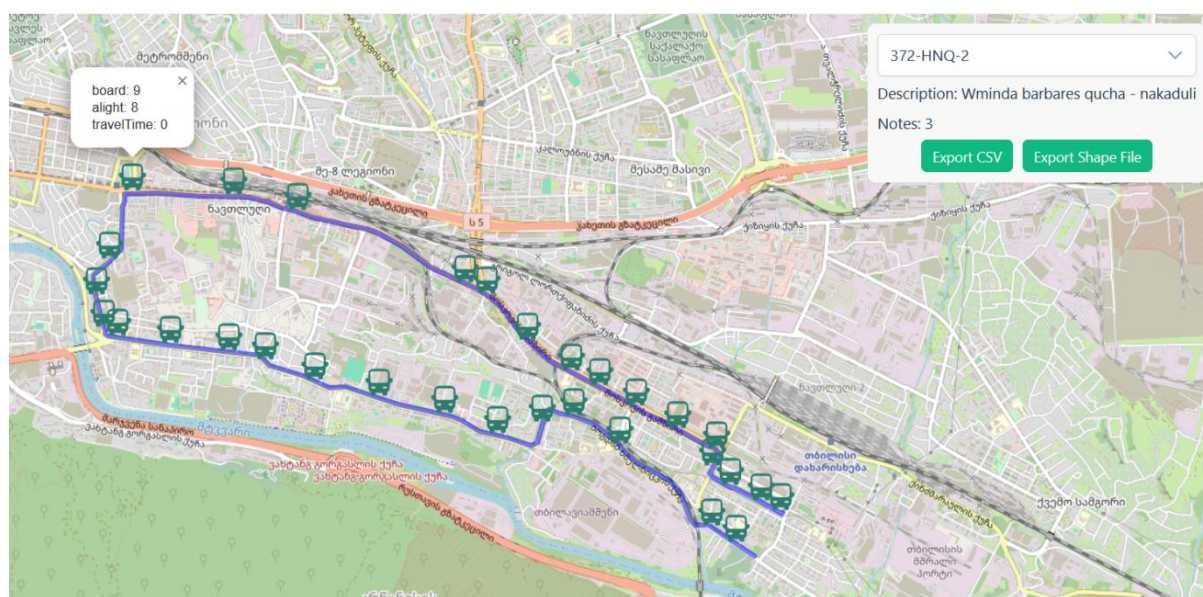
9.2.1.2 TransitWand app elaborations

A boarding and alighting survey requires a surveyor traveling along an entire bus route, recording the number of passengers who get on and off at each stop, as well as the arrival time at each stop. This type of survey provides insights into:

- The total number of passengers on each route and how these changes;
- The load of passengers, to identify those routes which are crushed;
- The popular boarding and alighting stops, to identify important interchanges;
- The speed of each route.

The next map shows the data of a single survey on bus route 372 in Tbilisi. The line shows the route the bus took, and the markers represent the stops made by that bus. By clicking on the stop marker, you can view the number of people boarding and alighting the vehicle.

Figure 10 - Elaboration of data collected with TransitWand app



To facilitate the elaboration of collected data, the TransitWand app offers the possibility to extract any collected information in CSV or SHP format.

Table 8 - Data extracted from the TransitWand app

unit_id	route_id	stop_id	stop_sequence	lat	lon	travel	dwell	arrival_time	departure_time	board	alight
▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
194532	156	1296	1	41.69649	44.804955	104	80	08:18:32	08:19:52	0	0
194532	156	1297	2	41.6915	44.81546	110	17	08:21:42	08:21:59	1	1
194532	156	1298	3	41.689293	44.82022	79	10	08:23:18	08:23:28	1	0
194532	156	1299	4	41.68747	44.82478	93	36	08:25:01	08:25:37	3	0
194532	156	1300	5	41.687103	44.827213	49	7	08:26:26	08:26:33	1	1
194532	156	1301	6	41.687386	44.83069	41	14	08:27:14	08:27:28	0	1
194532	156	1302	7	41.68692	44.83364	54	5	08:28:22	08:28:27	1	0
194532	156	1303	8	41.68683	44.83583	43	19	08:29:10	08:29:29	4	0
194532	156	1304	9	41.686142	44.841278	146	20	08:31:55	08:32:15	5	1
194532	156	1305	10	41.685913	44.84989	164	5	08:34:59	08:35:04	0	0
194532	156	1306	11	41.684925	44.85541	75	47	08:36:19	08:37:06	15	1
194532	156	1307	12	41.68409	44.85946	145	10	08:39:31	08:39:41	0	0
194532	156	1308	13	41.681087	44.867268	101	15	08:41:22	08:41:37	1	0
194532	156	1309	14	41.680344	44.86947	46	17	08:42:23	08:42:40	2	0
194532	156	1310	15	41.67958	44.871265	70	41	08:43:50	08:44:31	5	8
194532	156	1311	16	41.67672	44.87477	90	16	08:46:01	08:46:17	2	0
194532	156	1312	17	41.67473	44.878418	75	14	08:47:32	08:47:46	0	4
194532	156	1313	18	41.67392	44.88073	48	26	08:48:34	08:49:00	3	1
194532	156	1314	19	41.672634	44.883926	70	29	08:50:10	08:50:39	4	8
194532	156	1315	20	41.67108	44.88733	70	12	08:51:49	08:52:01	3	2
194532	156	1316	21	41.670048	44.890026	44	27	08:52:45	08:53:12	5	4
194532	156	1317	22	41.67241	44.894466	120	9	08:55:12	08:55:21	0	0
194532	156	1318	23	41.670063	44.90047	65	18	08:56:26	08:56:44	4	1
194532	156	1319	24	41.669113	44.904118	61	23	08:57:45	08:58:08	1	1
194532	156	1320	25	41.66733	44.908466	74	9	08:59:22	08:59:31	0	0

9.2.1.3 Analysis of route speed

The average speed of the vehicles in service on each line was calculated directly from the TransitWand (TW) measurement data. For each TW-recorded trip on each route, two data were initially derived:

- "Start time": the very first moment when the data collection for any trip was observed;
- "End time": the departure time at the last stop of the route.

The trip duration was then calculated as the difference between the Start and the End time. Using this duration together with the official route length, the average speed for each individual trip and direction was computed.

Finally, the average speed calculated for each one of the two services monitored in each line and direction were averaged to produce a single speed value for each route and direction.

The next Figure 11 uses specific colors to facilitate reading the average speed calculated for each route and provides also information about the occupancy level of vehicles, revealed by the width of the lines. A table summarizing the average speed for each route is provided in Annex 4.

9.2.2 FREQUENCY AND OCCUPANCY SURVEY

The surveys conducted along specific segments of the public transport network also enabled the collection of a substantial amount of highly valuable data for the project. In line with the goal of acquiring instrumental information to achieve the project's objectives, the selection of network segments to be monitored was made by carefully considering various factors, such as the type and number of transit lines operating along each segment, as well as the strategic importance of the segment itself in the development of the traffic model. The selection of observation points on the network was agreed upon with the Client to achieve at least two key objectives:

- To collect data from many lines, considering the specific routes of each line and, most importantly, the segments they share;
- To provide relevant input for the update and calibration of the strategic transport model.

The dataset collected through these surveys has been summarized in a table which, although extensive and content-rich, has been made easy to read thanks to a clear and well-structured layout.

Table 9 presents the data collected at the observation point located near the Technical University. For each passing vehicle, information was first recorded regarding the service provided, namely the vehicle type (bus or minibus) and line number. To assess the actual service frequency and compare field observations with the scheduled operations, the exact passing time of each vehicle was also recorded with one-minute accuracy.

Regarding vehicle occupancy levels, two different methods were used: for vehicles with very low occupancy, the exact number of passengers on board was counted; for all others, an estimated occupancy level was assigned using four categories (25%, 50%, 75%, and 100%).

The data excerpt shown here indicates that for both standard bus services and minibuses, occupancy levels were evenly distributed across the full range of categories. A more detailed examination reveals that, at least in this specific case, occupancy tended to decrease during the second half of the observation period, with more frequent occurrences around the 25% level and very few instances of full capacity (100%).

A more focused analysis by individual transit lines could support more accurate assessments. One such example is Line 512, where all observed vehicles were operating at full capacity.

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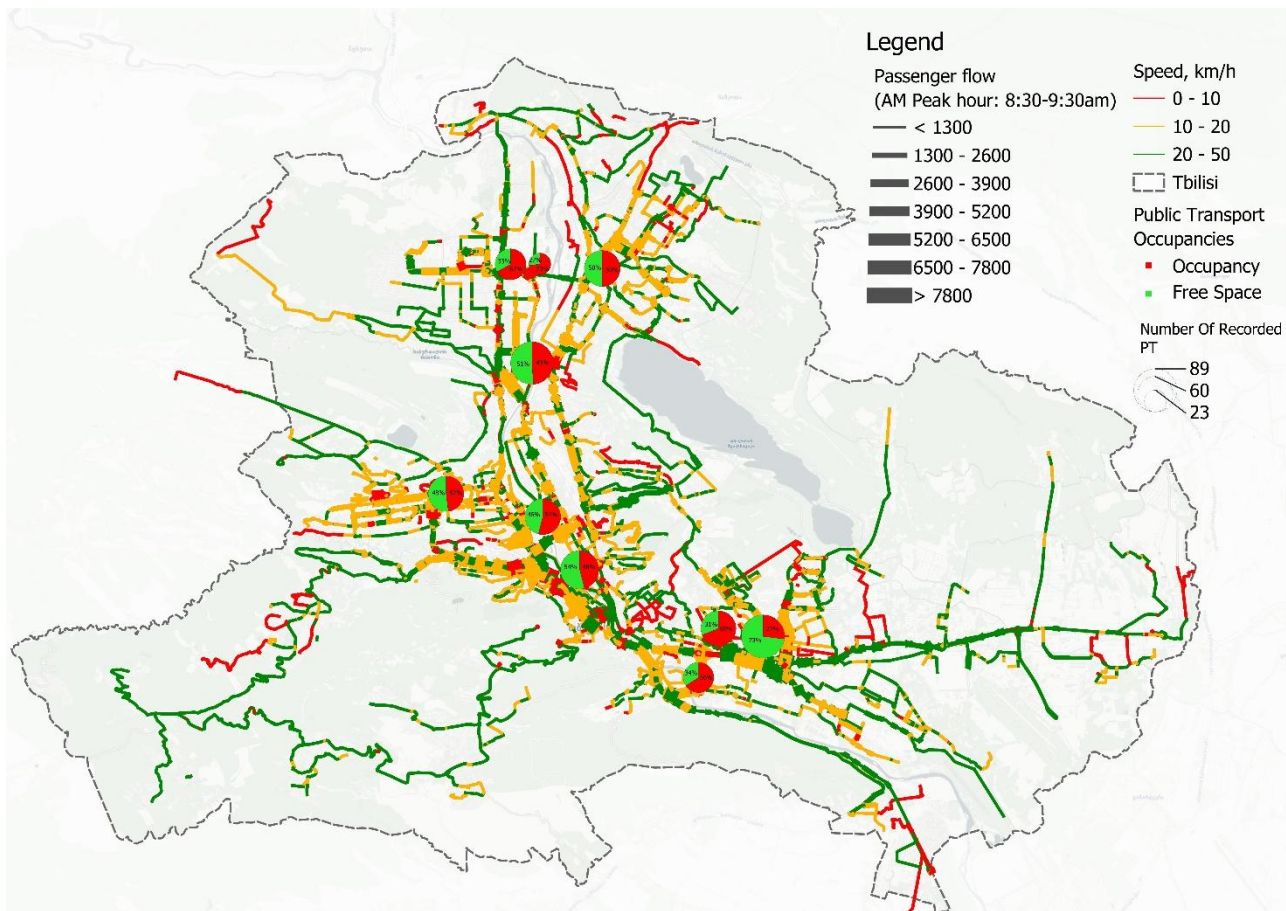
Table 9 - Frequency and occupancy survey - Technical University stop

#	Bus Stop	ID	form №	Line N	type of transport	Occupancy (N)	Occupancy (%)	Hour	Minute	TIME
1	Near Technial University	<u>1</u>	1	512	2		100%	8	32	08:32:00
2	Near Technial University	<u>1</u>	1	551	2	10		8	36	08:36:00
3	Near Technial University	<u>1</u>	1	534	2		75%	8	40	08:40:00
4	Near Technial University	<u>1</u>	1	464	2		50%	8	44	08:44:00
5	Near Technial University	<u>1</u>	1	431	2		75%	8	45	08:45:00
6	Near Technial University	<u>1</u>	1	551	2		25%	8	47	08:47:00
7	Near Technial University	<u>1</u>	1	472	2		100%	8	48	08:48:00
8	Near Technial University	<u>1</u>	1	593	2		75%	8	53	08:53:00
9	Near Technial University	<u>1</u>	1	551	2		25%	8	57	08:57:00
10	Near Technial University	<u>1</u>	1	512	2		100%	8	58	08:58:00
11	Near Technial University	<u>1</u>	1	532	2		100%	8	58	08:58:00
12	Near Technial University	<u>1</u>	1	431	2		50%	9	0	09:00:00
13	Near Technial University	<u>1</u>	1	534	2		75%	9	1	09:01:00
14	Near Technial University	<u>1</u>	1	472	2		75%	9	3	09:03:00
15	Near Technial University	<u>1</u>	1	551	2		75%	9	10	09:10:00
16	Near Technial University	<u>1</u>	1	464	2	0		9	10	09:10:00
17	Near Technial University	<u>1</u>	1	534	2		100%	9	19	09:19:00
18	Near Technial University	<u>1</u>	1	472	2		100%	9	25	09:25:00
19	Near Technial University	<u>1</u>	1	551	2		75%	9	26	09:26:00
20	Near Technial University	<u>1</u>	1	358	1		75%	8	33	08:33:00
21	Near Technial University	<u>1</u>	1	332	1		25%	8	33	08:33:00
22	Near Technial University	<u>1</u>	1	351	1		75%	8	34	08:34:00
23	Near Technial University	<u>1</u>	1	349	1	9		8	36	08:36:00
24	Near Technial University	<u>1</u>	1	326	1		75%	8	37	08:37:00
25	Near Technial University	<u>1</u>	1	385	1		100%	8	37	08:37:00
26	Near Technial University	<u>1</u>	1	300	1		50%	8	39	08:39:00
27	Near Technial University	<u>1</u>	1	314	1		50%	8	40	08:40:00
28	Near Technial University	<u>1</u>	1	392	1		25%	8	41	08:41:00
29	Near Technial University	<u>1</u>	1	391	1	10		8	43	08:43:00
30	Near Technial University	<u>1</u>	1	342	1		75%	8	44	08:44:00
31	Near Technial University	<u>1</u>	1	310	1		75%	8	48	08:48:00
32	Near Technial University	<u>1</u>	1	385	1		75%	8	48	08:48:00
33	Near Technial University	<u>1</u>	1	298	1		25%	8	52	08:52:00
34	Near Technial University	<u>1</u>	1	300	1		50%	8	55	08:55:00
35	Near Technial University	<u>1</u>	1	385	1		50%	8	57	08:57:00
36	Near Technial University	<u>1</u>	1	332	1		25%	8	57	08:57:00
37	Near Technial University	<u>1</u>	1	347	1		25%	8	57	08:57:00
38	Near Technial University	<u>1</u>	1	349	1		25%	9	0	09:00:00
39	Near Technial University	<u>1</u>	1	342	1		50%	9	1	09:01:00
40	Near Technial University	<u>1</u>	1	326	1		25%	9	1	09:01:00
41	Near Technial University	<u>1</u>	1	358	1		25%	9	1	09:01:00
42	Near Technial University	<u>1</u>	1	310	1		50%	9	2	09:02:00
43	Near Technial University	<u>1</u>	1	298	1		50%	9	4	09:04:00
44	Near Technial University	<u>1</u>	1	392	1	6		9	4	09:04:00
45	Near Technial University	<u>1</u>	1	385	1		25%	9	8	09:08:00
46	Near Technial University	<u>1</u>	1	351	1		100%	9	11	09:11:00
47	Near Technial University	<u>1</u>	1	332	1		25%	9	14	09:14:00
48	Near Technial University	<u>1</u>	1	314	1		75%	9	15	09:15:00
49	Near Technial University	<u>1</u>	1	342	1		25%	9	16	09:16:00
50	Near Technial University	<u>1</u>	1	310	1		50%	9	16	09:16:00
51	Near Technial University	<u>1</u>	1	358	1		25%	9	16	09:16:00
52	Near Technial University	<u>1</u>	1	391	1		25%	9	16	09:16:00
53	Near Technial University	<u>1</u>	1	349	1		25%	9	16	09:16:00
54	Near Technial University	<u>1</u>	1	385	1		50%	9	21	09:21:00
55	Near Technial University	<u>1</u>	1	326	1		75%	9	23	09:23:00
56	Near Technial University	<u>1</u>	1	300	1	8		9	23	09:23:00
57	Near Technial University	<u>1</u>	1	329	1		50%	9	24	09:24:00
58	Near Technial University	<u>1</u>	1	314	1		25%	9	24	09:24:00
59	Near Technial University	<u>1</u>	1	392	1		75%	9	26	09:26:00
60	Near Technial University	<u>1</u>	1	310	1		75%	9	29	09:29:00
61	Near Technial University	<u>1</u>	1	347	1		25%	9	30	09:30:00

Figure 11 below supports the interpretation of the collected data by illustrating the average occupancy levels observed across all vehicles passing through the survey points. However, this data should be interpreted with an understanding of three influencing factors:

- The values shown refer to the combined services of both standard bus lines and minibuses.
- The average was calculated based on the occupancy percentages estimated by field operators, which were limited to four predefined levels (25%, 50%, 75%, and 100%);
- The analysis does not consider the actual passenger capacity of the monitored vehicles and therefore does not allow for the extraction of absolute user numbers.

Figure 11 – Average speed and occupancy levels



9.2.3 TRANSFER SURVEYS

Transfer surveys focused on collecting qualitative information regarding people's behavior near key locations in the network where transfers can be made between different public transport modes - either between bus and minibus services, or between these and the metro lines.

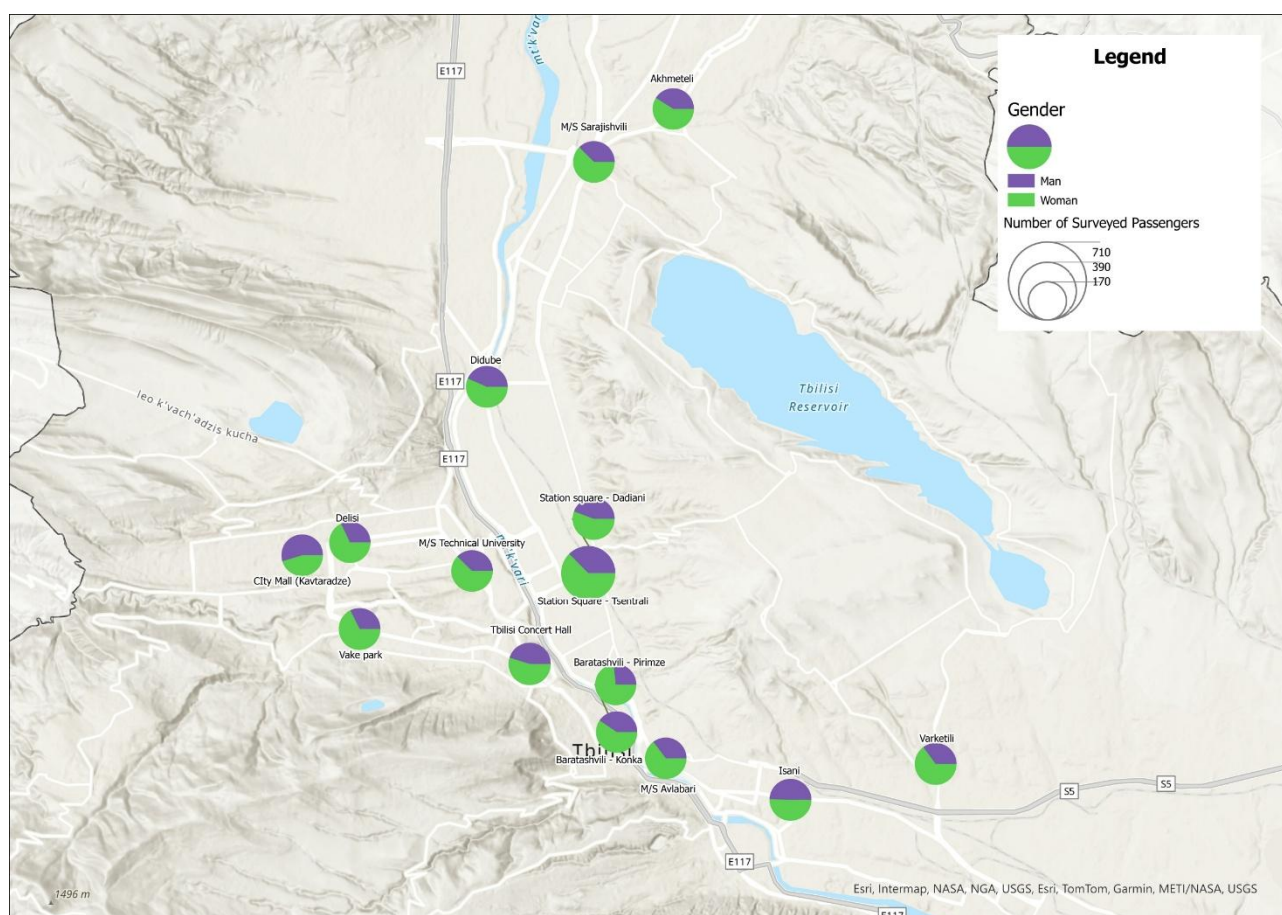
First, the most strategically relevant transfer nodes to be monitored were identified. In a subsequent phase, and following targeted site inspections, the exact points where interviewers should be positioned to conduct the planned surveys were determined. It is important to note that the methodological approach adopted—agreed upon with the Client—led to the interviewing of different "types" of individuals:

- Those who arrived in the survey area using public transport but did not intend to continue their journey by public transport;

- Those who arrived in the survey area on foot/by car but intended to continue their journey by public transport;
- Those who used the survey area as a transfer point between different public transport services.

The results of the surveys are provided to the Client in a structured database, allowing for detailed data extraction based on the interviews conducted. This includes specific references to the survey areas (transfer nodes) as well as to the transport lines used by respondents before and/or after passing through the node. The following section presents a selection of general analyses, which offer an initial overview of the results obtained. The data shown in Figures 12, 13, and 14 represent the responses of the individuals who were interviewed. Therefore, the size of the pie charts depends on the number of passengers surveyed.

Figure 12 - Gender distribution of interviewed people



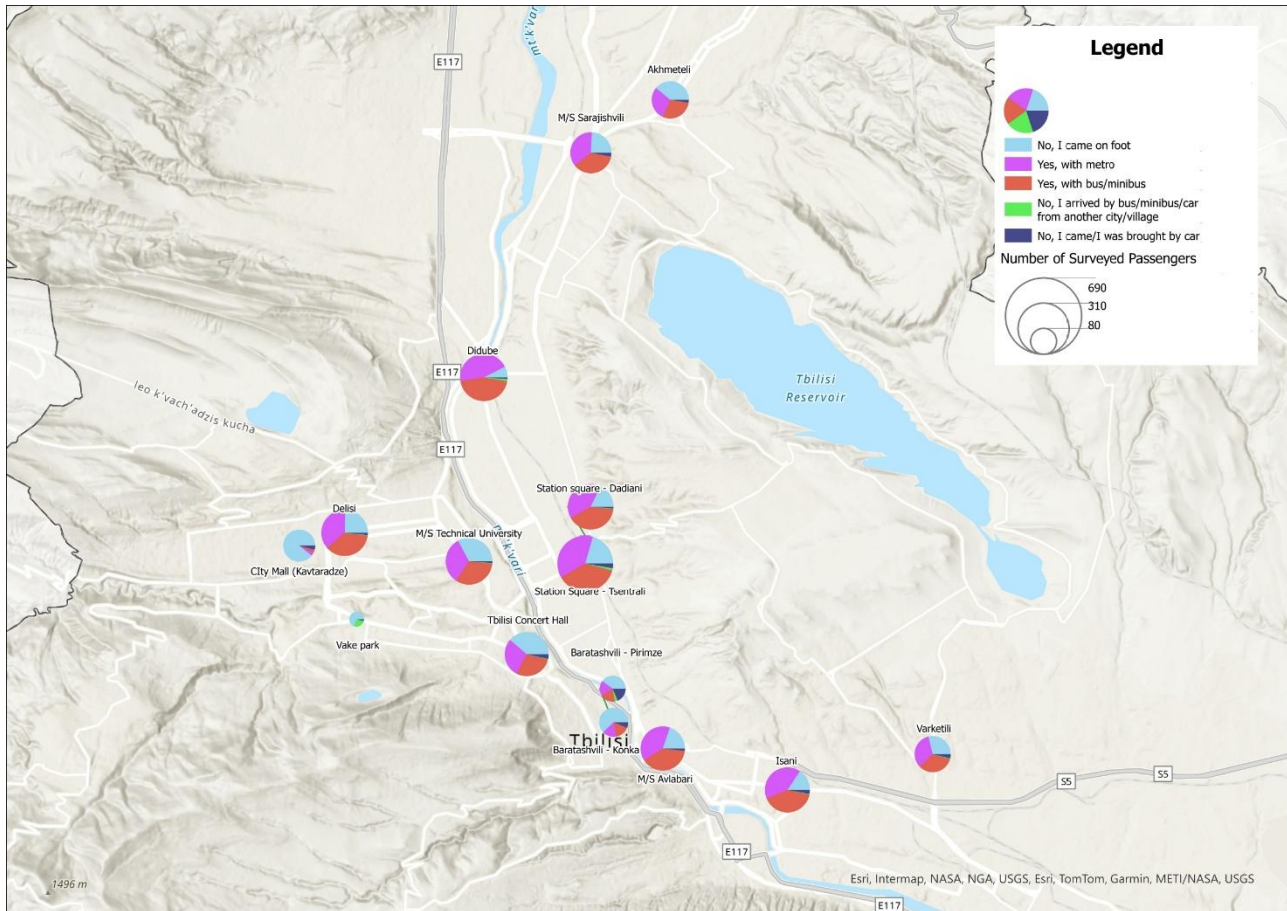
As shown in Figure 12, the sample at most transfer nodes consists primarily of women. This finding is broadly consistent with the results of the HHS, which also indicated a higher use of public transport among female respondents.

An initial and particularly relevant analysis concerns the means of transport used to access the transfer nodes where the surveys were conducted. The data presented in the following Figure 13 – *Mode of transport used to reach the investigated interchange nodes*, highlights several key findings:

- Except for the Didube node, all other locations were primarily accessed on foot, underscoring both their importance within the network and the extent of their respective catchment areas;

- At every node, respondents were identified who reported using a private car to reach the transfer point, although this percentage remains very low—except in a few central areas, such as Baratashvili;
- The high public transport usage rate previously identified through the HHS is confirmed here as well: while the data shown in this figure do not necessarily imply a PT-to-PT transfer, metro, bus, and minibus modes are frequently used;
- Only at the Vake Park node was there a noticeable share of respondents who reported arriving from other cities or villages.

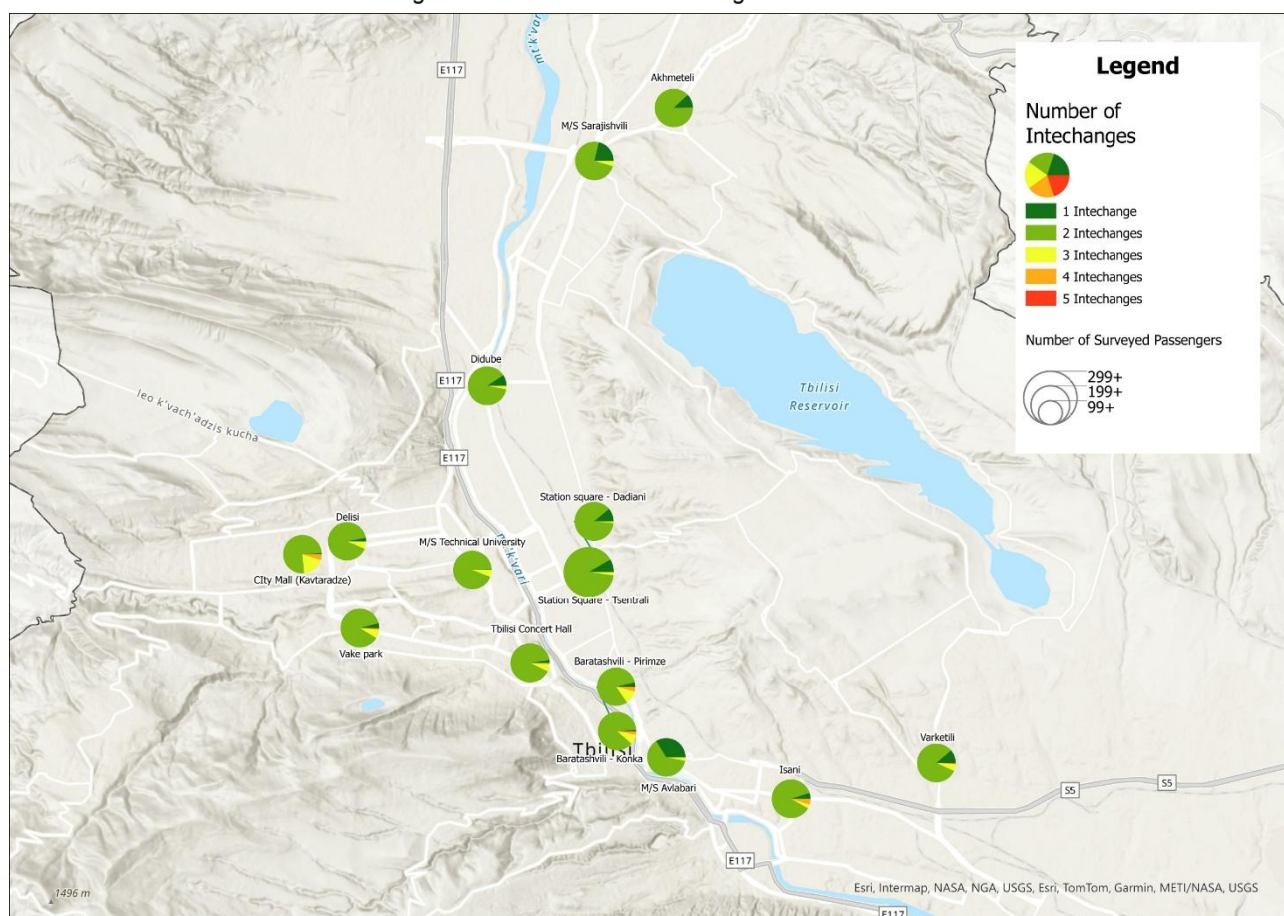
Figure 13 – Mode of transport used to reach the investigated interchange nodes



For this specific survey, another insightful analysis is presented in the following Figure 14, which provides a clear visual representation of the levels of public transport interchange observed at the surveyed nodes across the city. An initial review reveals several noteworthy points:

- The number of intermodal transfers is highest at stations located in the city center, which—while serving as major origin and destination points—also appear to function as key transit hubs for passengers making medium- to long-distance trips.
- Even at the westernmost node included in the survey, "City Mall," as well as at "Isani," a significant number of passengers were observed transferring between different modes of transport.
- Transfer activity is lower at nodes located further to the north and east, on the edges of the central area, compared to other surveyed locations.

Figure 14 - Number of interchanges at main nodes



9.2.4 COUNTING AT METRO STATIONS

An additional field activity involved passenger counts on the two metro lines. These counts were conducted at all stations on both lines during the morning peak hour, between 8:30 AM and 9:30 AM. The planning of this specific task required particular attention, given the high volume of passengers and the complex geometric configuration of station access points and platform layouts.

Despite these challenges, the survey design allowed for the successful collection of all intended data, which is summarized in Table 10 - People boarding and alighting at metro stations. It is important to emphasize that the data related to Station Square does not represent the total number of passengers boarding and alighting from all metro trains, but rather the number of travelers moving between the metro station and the immediately surrounding urban area.

As shown in the summary, the “Akhmeteli Theatre” station stands out as the busiest during the morning peak hour. Nearly 9,000 passengers were recorded at this station, accounting for approximately 11% of the total number of passengers across all metro stations (79,700 passengers in total). Specifically, boardings at Akhmeteli Theatre were around 7,600, by far the highest value among all recorded stations.

Other stations with a high number of users include “Didube” and “Varketili”, both with totals slightly exceeding 6,000 passengers.

On the other hand, several stations recorded lower passenger volumes: “Samgori” (on bus station side) had fewer than 600 passengers, while “Gotsiridze” and “Guramishvili” also showed modest numbers. The “Medical University” station similarly reported a relatively low volume.

A more nuanced situation was observed at certain stations where passenger numbers varied significantly depending on the specific access point surveyed. At “Delisi”, for instance, the number of passengers on the Asatiani Street side was much lower than on the City Mall side. At “Station Square”, the platform toward central Tbilisi had a low total of 672 passengers, compared to 1,295 on the side facing “Children’s World,” and 2,556 on the side toward “Tsotne Dadiani Street”.

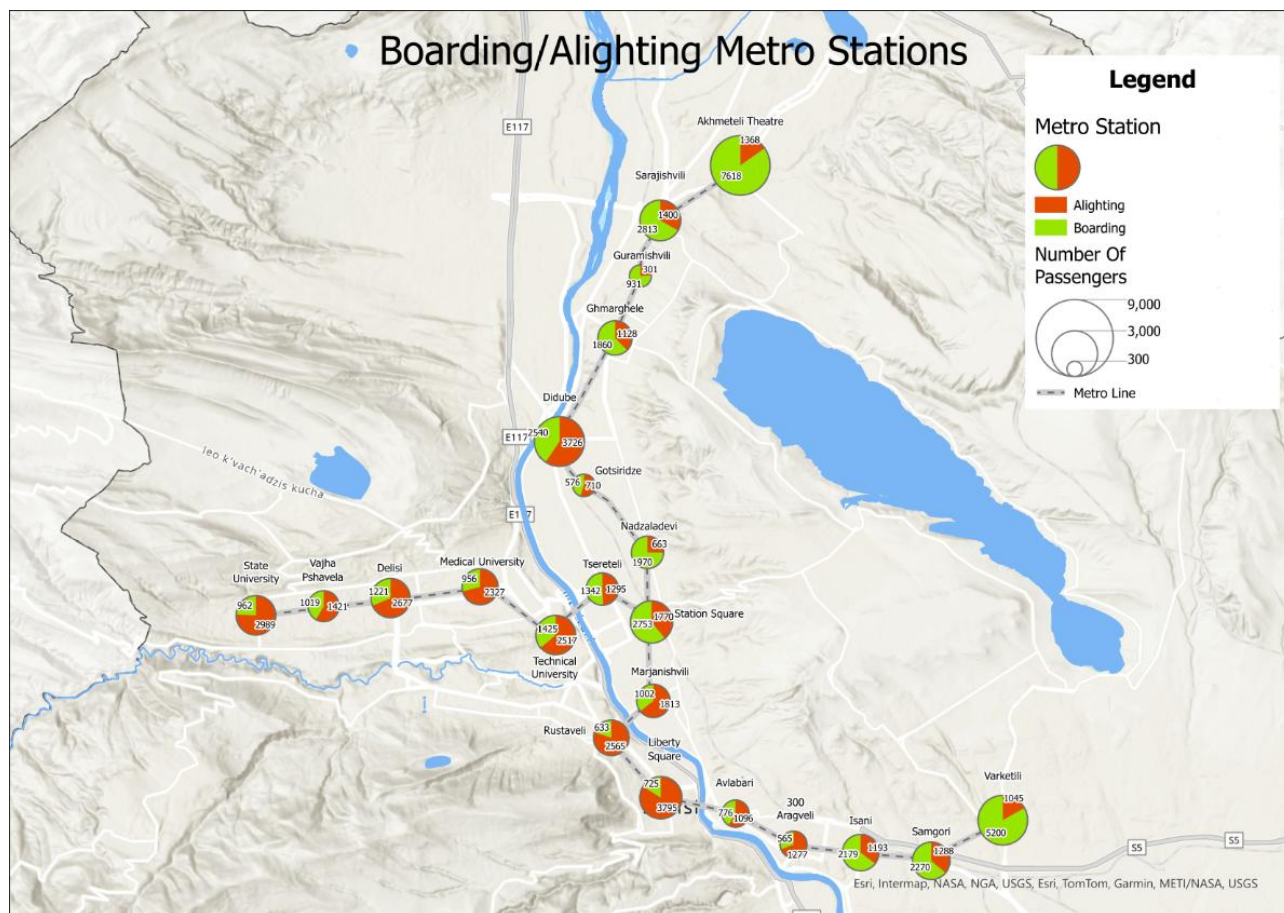
Table 10 - People boarding and alighting at metro stations

Code	Metro Station	Boarding/ Alighting	08:45	09:00	09:15	09:30	Total
1	Varketili	Boarding	1.146	1.097	1.484	1.473	5.200
1	Varketili	Alighting	256	272	237	280	1.045
2	Samgori (Navtlughi Bazaar Side)	Boarding	416	486	629	405	1.936
2	Samgori (Navtlughi Bazaar Side)	Alighting	171	193	352	316	1.032
3	Samgori (Bus Station Side)	Boarding	95	58	105	76	334
3	Samgori (Bus Station Side)	Alighting	77	58	58	63	256
4	Isani	Boarding	525	489	506	659	2.179
4	Isani	Alighting	311	265	303	314	1.193
5	300 Aragveli	Boarding	135	127	165	138	565
5	300 Aragveli	Alighting	252	332	365	328	1.277
6	Avlabari	Boarding	180	205	192	199	776
6	Avlabari	Alighting	320	332	201	243	1.096
7	Liberty Square	Boarding	195	132	165	233	725
7	Liberty Square	Alighting	1.151	1.080	911	653	3.795
8	Rustaveli	Boarding	157	138	173	165	633
8	Rustaveli	Alighting	710	650	535	670	2.565
9	Marjanishvili	Boarding	238	259	220	285	1.002
9	Marjanishvili	Alighting	245	415	341	812	1.813
10	Station Square (Tbilisi Central Side)	Entering	89	179	46	90	404
10	Station Square (Tbilisi Central Side)	Exiting	95	120	21	32	268
11	Station Square (Children's World Side)	Entering	102	66	125	141	434
11	Station Square (Children's World Side)	Exiting	140	266	239	216	861
12	Station Square (Tsotne Dadiani Street Side)	Entering	492	457	398	568	1.915
12	Station Square (Tsotne Dadiani Street Side)	Exiting	148	173	132	188	641
13	Nadzaladevi	Boarding	530	445	450	545	1.970
13	Nadzaladevi	Alighting	128	216	177	142	663
14	Gotsiridze	Boarding	143	143	139	151	576
14	Gotsiridze	Alighting	210	194	176	130	710
15	Didube	Boarding	610	570	620	740	2.540
15	Didube	Alighting	812	982	989	943	3.726
16	Ghmarghele	Boarding	450	447	438	525	1.860
16	Ghmarghele	Alighting	290	310	248	280	1.128
17	Guramishvili	Boarding	160	206	266	299	931
17	Guramishvili	Alighting	41	106	73	81	301
18	Sarajishvili	Boarding	603	585	755	870	2.813
18	Sarajishvili	Alighting	297	271	391	441	1.400
19	Akhmeteli Theatre	Boarding	1.724	1.744	2.000	2.150	7.618
19	Akhmeteli Theatre	Alighting	267	331	407	363	1.368
20	Tsereteli	Boarding	431	326	293	292	1.342
20	Tsereteli	Alighting	260	360	365	310	1.295
21	Technical University (Pekini Avenue Side)	Boarding	170	204	193	186	753
21	Technical University (Pekini Avenue Side)	Alighting	166	254	284	219	923
22	Technical University (Sports Palace Side)	Boarding	188	207	132	145	672
22	Technical University (Sports Palace Side)	Alighting	282	471	480	361	1.594
23	Medical University (Archive Side)	Boarding	135	114	101	126	476
23	Medical University (Archive Side)	Alighting	217	238	236	210	901
24	Medical University (Tashkenti Street Side)	Boarding	113	119	123	125	480
24	Medical University (Tashkenti Street Side)	Alighting	316	464	328	318	1.426
25	Delisi (Citi Mall Side)	Boarding	199	223	184	228	834
25	Delisi (Citi Mall Side)	Alighting	498	488	494	407	1.887
26	Delisi (Asatiani Street Side)	Boarding	91	114	76	106	387
26	Delisi (Asatiani Street Side)	Alighting	230	250	170	140	790
27	Vajha Pshavela	Boarding	210	238	273	298	1.019
27	Vajha Pshavela	Alighting	319	432	351	319	1.421
28	State University	Boarding	223	246	209	284	962
28	State University	Alighting	617	802	752	818	2.989

79.700

To provide a more immediate overview of the number of passengers boarding and alighting at metro stations along the two lines in operation, the following Figure 15 has been prepared. This visualization allows for the assessment of the generative and attractive capacity of each station during the morning peak hour, as well as for a comparison of ridership levels across all stations.

Figure 15 - People boarding and alighting at metro stations⁶



An initial review of the data collected at the various observation points reveals several interesting insights that could serve as a basis for further analysis during a potential update of Tbilisi's public transport plan, or in the development of broader urban mobility planning tools.

The key findings summarized below should ideally be cross analyzed with additional data, indicators, or contextual information that may have a significant impact on, or a clear influence over, the travel habits of the population. Main outcomes could be summarized as follow:

- The **metro lines are used mainly to move from peripheral areas to the city center**, as revealed by the unbalanced distribution of people boarding and alighting at different stops. Extreme stops in the South and North, respectively Varketili and Akhmeteli Theatre are clearly the most important generators of flows;
- The line heading to the West side of the city acts mainly as an attractor even if some more stops are acting the same way, especially the following:
 - Liberty Square, Rustaveli and Marjanishvili in the city center
 - Didube on the North side of the city center

⁶ Since the boarding/alighting survey at Metro Stations was conducted near the turnstiles, the number of transferring passengers between Line 1 and Line 2 at m/s "Station Square" is not included in this map.

10. CONCLUSIONS

The activities carried out under the AMDC component significantly expanded the knowledge base required to update the strategic traffic model and ensure that it accurately reflects the travel habits of residents of Tbilisi, as well as those who travel to the city for various purposes.

Specifically, in addition to confirming the findings from the HHS, namely the high usage of public transportation, the surveys conducted allowed for a deeper investigation into more specific elements. As previously mentioned, this detailed dataset can also be used beyond the scope of the current project to support the design of operational or strategic interventions, measures, or policies.

These in-depth analyses also revealed several issues summarized below, that could lead to the implementation of targeted corrective procedures:

1. **On-board bus surveys revealed discrepancies** compared to existing data sources, requiring thorough verification. In the short to medium term, it would be both important and beneficial to identify and understand the cause of these inconsistencies before resolving the issue and developing an updated data foundation.
2. **The same surveys showed that public transport ridership is relatively well distributed** along the full length of most lines. Only in a few cases were particularly low passenger volumes recorded at specific stops. This insight could support a refinement of the public transport network, potentially leveraging the capabilities of the strategic model to guide such improvements.
3. **Accurately determining passenger flows within Station Square remains a current challenge.** Given the strategic importance of this hub, it may be worthwhile to consider future implementation of control systems that improve data collection and availability for this critical node.

Observer's name and surname:	
Observer's code:	
Name of stop:	
Date (day/month/year):	Sheet #

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	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		
	1	2		25%	50%	75%	100%		

Annex #2 – Counting Form at Metro Stations

Counter's name and surname: _____

Counter's code: _____

Date (day/month/year): _____

Metro station:

1.	Varketili	15.	Didube
2.	Samgori (Navtlughi Bazaar side)	16.	Ghrmaghele
3.	Samgori (Bus Station side)	17.	Guramishvili
4.	Isani	18.	Sarajishvili
5.	300 Aragveli	19.	Athmeteli Theatre
6.	Avlabari	20.	Tsereteli
7.	Liberty Square	21.	Technical University (Pekini ave)
8.	Rustaveli	22.	Technical University (Sports Palace)
9.	Marjanishvili	23.	Medical University (Archive)
10.	Station square (Tbilisi Central)	24.	Medical University (Tashkenti Street)
11.	Station square (Children's World)	25.	Delisi (City Mall side)
12.	Station Square (Dadiani Avenue)	26.	Delisi (Asatiani street side)
13.	Nadzaladevi	27.	Vajha-Pshavela
14.	Gotsiridze	28.	State University

At the station: people alighting People boarding

Instruction: Your task is to calculate the number of passengers alighting or boarding the metro station. Fill in the number of passengers in the form below every 15 minutes. You start working at 8:30 AM, so you will need to enter the number of passengers four times at the following times: 8:45, 9:00, 9:15, 9:30.

8:45	9:00	9:15	9:30
_____	_____	_____	_____
Total Number of Passengers			

Annex #3 – Transfer Survey Questionnaire

Hello, I am _____ from the company ACT, and I am conducting a study on travel habits among the population of Tbilisi and its surrounding areas. The study is being carried out in collaboration with Lattanzio KIBS and REDAS Engineering, with the support of the Asian Development Bank (ADB). The collected information will be used to develop an updated model for the city's transportation demand. Please give me 2 minutes of your time and answer a couple of questions:

Interviewer: Please fill in the information provided in the table before starting the survey:

Interviewer's name and surname:	
Interviewer's code	
Name of interchange hub	
Time:	☐ 8:30 – 8:45 ☐ 8:45 – 9:00 ☐ 9:00 – 9:15 ☐ 9:15 – 9:30

D1 Indicate respondent's age: ☐ 14-18 ☐ 18-24 ☐ 25-35 ☐ 36-45 ☐ 46-55 ☐ 56-65 ☐ 66+

Terminate if the respondent's age is under 14.

Q1 did you arrive to this stop with a bus/minibus/metro from Tbilisi? (consider the last transport to this station).

Ask everyone!

1. Yes, with bus/minibus **go to Q1.1, then Q1.2**
2. Yes, with metro **go to Q1.2**

Q1.1 Indicate the bus/minibus line number _____

Q1.2 Specify the place/metro station from where you started your travel _____ (indicate as detailed as possible: district, street, number)

3. No, I came on foot
4. No, I came/I was brought by car
5. No, I arrived by bus/minibus/car from another city/village

Attention! If the respondents do not remember which bus/minibus they took, enter 999 instead of the number in question Q1.1.

Ask everyone!

Q2 Are you now boarding a bus/minibus line or metro station?

1. Yes, bus/minibus **go to Q2.1, then Q2.2**
2. Yes, metro station **go to Q2.2**

Q2.1 Indicate the bus/minibus line number (multiple answers possible) _____

Q2.2 Specify the place/metro station, where you are going _____ (indicate as detailed as possible: district, street, number; consider this transport you are taking)

3. No

Attention! If the respondent can list several different route numbers, indicate up to 3 numbers in question Q2.1. If they do not know which number goes to their destination and plan to ask a passenger or the driver, indicate 999.

D2 Indicate respondent's gender: ☐ female ☐ Male

Thank you for your cooperation!

Annex #4 – Datasets***Average speed by route***

Route name	Distance (km)	Average duration	Average speed (km/h)
№101_Varketili-3 IV M/D	23,43	1:38	14,30
№102_Baratashvili str.	27,05	1:17	20,85
№102_Prison Establishment #6	23,95	1:04	22,15
№293_Didi Dighomi I-II M/D	10,23	0:53	11,41
№294_Nodar Dumbadze Ave #10	4,21	0:37	6,82
№295_M/S Varketili	15,93	1:08	14,10
№297_M/S Akhmeteli Theatre	9,82	1:13	8,18
№299_M/S Didube	7,87	0:44	10,64
№300_Sq.Marijani str.	19,95	2:10	9,22
№301_Ana Politkovskaia Street	18,80	2:13	8,43
№301_St. Barbare District	19,58	1:52	10,41
№302_Didi Dighomi IV M/D	18,43	1:39	11,10
№302_Tbilisi State University H/B	16,88	2:00	8,40
№303_M/S Varketili	6,95	1:01	6,97
№304_Gldani Lake	20,02	1:41	11,89
№304_State University H/B	21,93	2:20	9,38
№305_Baratashvili str. (Konka)	15,91	1:34	10,08
№306_Akaki Belashvili St #179	14,15	0:59	14,19
№306_Baratashvili Str.	15,26	1:10	13,04
№307_Station Square	8,88	1:01	8,71
№307_Vake-Bagebi	8,03	0:48	9,84
№308_Gldani VII-VIII M/D	19,74	1:37	12,13
№308_Nikoloz Baratashvili Street	17,78	1:53	9,36
№310_State University H/B	25,56	2:32	10,08
№310_Varketili M/D-4	24,94	2:19	10,76
№316_Nikoloz Baratashvili Street	31,07	1:04	29,01
№317_Pirosmani Square	26,29	2:36	10,09
№318_"Isani" M/S	14,52	1:01	14,08
№318_Patara Lilo, Tamar Mepe St #74	15,70	1:01	15,45
№324_Baratashvili Str.	14,18	1:00	16,44
№324_Tsavkisi Shota Rustaveli St #86	13,00	1:02	12,60
№328_Marjanishvili Square	3,15	0:17	10,87
№328_Mnatobi Street	2,80	0:20	8,33
№329_Station Square	15,80	1:08	13,84
№329_Village Tkhinvali	10,49	1:09	9,40
№332_Nutsubidze II-IV M/D	12,41	1:26	8,60
№332_Station Square	13,98	1:28	9,58

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Route name	Distance (km)	Average duration	Average speed (km/h)
№333_David Aghmashenebeli Alley #213	26,62	2:32	10,49
№333_Vazisubani II M/D	30,54	2:30	12,18
№338_M/S Didube (kvemo)	15,53	1:15	12,34
№339_Gldani M/D VII,VIII	5,62	0:33	10,11
№340_Lobjanidze St (Isani)	11,07	0:59	11,13
№340_Varketili Farming	10,40	0:41	14,88
№343_Vazisubani II M/D	20,46	1:23	14,73
№343_Zemo Ponichala	19,20	1:20	14,30
№344_Nikoloz Baratashvili Street	14,28	0:48	17,90
№344_Zemo Ponichala	12,42	0:36	20,24
№345_Ponichala Nature Reservation	22,42	1:32	14,48
№345_Vake-Bagebi	22,99	1:46	12,93
№346_Hualing Tbilisi	19,29	1:12	16,58
№346_Ponichala Nature Reservation	19,04	1:25	13,45
№347_Station Square 2	10,92	1:06	9,92
№347_Nutsubidze I M/D, #33	9,56	1:01	9,40
№351_Gldani-Gldanula	26,33	2:18	11,40
№351_Bagebi Student's Hostel	27,38	2:32	10,76
№353_Kukia	6,83	0:35	11,51
№353_Station Square	7,19	0:45	9,42
№354_Station Square 1	19,85	1:16	15,74
№354_Batu Kraveishvili Street	18,92	1:03	18,03
№356_M/S Isani	11,68	1:03	11,16
№356_Orkhevi	11,50	0:44	15,73
№357_M/S Didube (Kveda)	24,60	1:34	15,64
№358_Baratashvili Str	12,06	0:48	15,11
№358_Nugzar Endeladze Square (Vake)	10,33	1:04	9,66
№361_Lilo-Lochini	17,72	1:02	17,13
№361_M/S Isani	16,21	1:06	14,73
№363_Tbilisi State University H/B	13,27	1:20	10,12
№363_Village Tkhinvala	13,78	1:25	10,31
№364_M/S Rustaveli	10,50	0:37	17,53
№364_Mtatsminda Park	10,08	0:39	16,65
№366_Varketili Zemo Plato	3,23	0:23	8,41
№368_9 Dzma Str-Tsaishi Str	4,94	0:35	8,28
№368_Station Square	3,88	0:34	6,77
№369_M/S Didube (Upper Exit)	1,75	0:10	10,39
№369_M/S Gotsiridze	1,75	0:09	11,65
№370_Pirosmani Square	27,76	2:55	9,51

Route name	Distance (km)	Average duration	Average speed (km/h)
№372_Nakaduli Str.	13,33	1:14	10,86
№372_St. Barbare District	13,64	1:10	11,59
№374_Baratashvili Str.	13,80	0:50	16,99
№374_Tabakhmela, Tamar Mepe St	15,64	0:44	21,27
№376_"Isani" M/S	8,80	0:51	10,18
№376_Kiziki Street #34	9,49	0:53	10,63
№377_Sea Plaza	9,50	1:01	9,35
№378_Japaridze Street	5,17	0:32	9,72
№378_Station Square 1	6,21	0:55	6,95
№382_Baratashvili str.	14,37	0:50	17,75
№382_Shindisi	13,28	0:51	15,68
№383_Baratashvili str.	12,23	1:11	10,47
№383_M/S State Universiteti	11,67	1:30	8,14
№385_Tandzia Street	8,48	1:13	7,60
№387_Vake	10,12	1:08	8,90
№390_Baratashvili Str	11,50	0:41	16,58
№390_Oqrokana	10,36	0:34	18,03
№391_Gotua Str	8,90	0:54	10,15
№391_M/S "Avlabari"	9,34	0:43	12,91
№392_State University H/B	9,54	1:21	7,05
№392_Station Square	9,63	0:50	11,54
№393_Kvareli Street (Metromsheni)	6,80	0:29	14,12
№393_Nikoloz Baratashvili Street	7,65	0:43	10,60
№396_Aerport Settlement	13,43	0:49	16,36
№396_M/S Isani	16,20	0:54	17,75
№397_Saburtalo	16,47	1:32	10,73
№398_M/S Delisi	7,29	1:03	7,04
№398_Nutsubidze M/D II-IV-V	7,03	0:42	10,06
№401_Ioseliani IV Lane	2,32	0:13	10,46
№401_M/S Technical University	2,43	0:13	10,91
№402_"Mrgvali Bagi" Square	7,11	0:35	12,15
№403_M/S "Varketili"	2,58	0:21	8,43
№403_Nikoloz Landia St. #21	2,41	0:16	8,62
№405_M/S Delisi	4,73	0:40	7,07
№405_Nutsubidze Plato M/D-5	4,48	0:24	10,99
№406_m/s "Varketili"	1,14	0:11	6,16
№406_Varketili, second row	2,29	0:05	23,24
№407_Shota Nadirashvili St.	5,30	0:33	9,38
№408_M/S Rustaveli	6,40	0:38	10,54

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Route name	Distance (km)	Average duration	Average speed (km/h)
№409_Batumi Street	7,23	0:30	14,49
№409_Kvemo Ponichala Center	4,00	0:18	12,88
№410_Ponichala Nature Reservation	8,54	0:44	11,53
№411_Aleksandre Beridze St. #28	2,83	0:11	15,21
№411_E. Mtskheteli St.	2,79	0:14	13,39
№412_Abkhazia St	6,64	0:32	12,27
№413_M/s "Varketili"	3,06	0:18	10,05
№413_Mikheil Gakhokidze St. N56	3,04	0:13	14,18
№414_Dzmobi II Street	2,66	0:16	9,95
№415_M/S "Varketili"	8,90	0:38	14,28
№415_Military Settlement 2nd Street	7,08	0:34	15,75
№416_Public School #11	7,76	1:27	5,31
№417_David the Builder #100	5,22	0:24	15,71
№417_M/S "Akhmeteli Theater"	5,13	0:38	8,54
№418_Meri Shervashidze St.	5,96	0:16	21,65
№418_Railway Passage Bridge	6,32	0:25	15,15
№419_M/S. University	6,18	0:48	9,20
№419_Village of Agarakebi	6,30	0:26	16,21
№420_M/S "Rustaveli"	5,45	0:25	13,25
№421_M/S Guramishvili	6,08	0:19	18,98
№421_Sea Area Lane	2,76	0:12	13,65
№422_M/S "Didube"	8,89	0:45	11,79
№422_Village Digomi Center	10,45	0:44	14,22
№423_Kaloubani Street #4	3,63	0:33	7,52
№425_M/S "Samgori"	11,04	1:03	10,50
№426_Gldani II-IV m/d	3,66	0:24	11,97
№427_Dmitri Gulia Square	6,54	0:59	6,64
№428_M/S "Isani"	2,94	0:25	6,97
№428_Metromsheni	2,96	0:09	18,08
№429_M/S "Akhmeteli Theater"	2,15	0:11	10,88
№429_Mukhiani IVb M/R	2,25	0:14	9,42
№430_Tetri Shop Street	15,00	0:43	20,71
№432_M/S Sarajishvili	4,51	0:30	8,92
№432_Shanava St.	5,42	0:19	17,93
№433_M/S "Didube"	9,50	1:01	9,34
№434_M/S "Avlabari"	3,12	0:22	8,84
№434_Niabi I Lane 39	3,36	0:27	12,67
№435_Crossing bridge	6,28	0:43	8,75
№435_David Ioseliani #204	6,22	0:23	15,90

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Route name	Distance (km)	Average duration	Average speed (km/h)
№436_ Java Street 73	5,91	0:40	8,71
№436_ Station Square	6,57	1:01	6,41
№437_ Passage bridge	6,73	0:25	16,34
№438_ Public School for Impaired Vision people #201	6,10	0:10	35,58
№438_ Station Valley	6,12	0:11	31,10
№439_ M/S "Akhmeteli Theater"	2,80	0:20	8,61
№439_ Roman Chelidze St	2,45	0:08	17,66
№440_ M/S "Avlabari"	2,40	0:28	5,07
№441_ Kazbegi Street #35	4,19	0:29	8,86
№442_ Didi Digomi IV M/R	10,74	0:38	16,70
№442_ M/S "Didube"	9,56	0:49	11,71
№444_ M/s "Sarajishvili"	6,32	0:45	9,16
№445_ Baron de Bais St.	8,96	0:33	15,95
№445_ M/S Didube	7,44	0:31	14,20
№446_ M/S "Akhmeteli Theater"	5,22	0:19	16,20
№446_ The intersection of Clara Kweesi and White Lake	5,33	0:21	17,79
№447_ Alexandre Kazbegi Avenue #44	3,29	0:20	9,78
№448_ Crossing bridge	5,88	0:29	12,20
№448_ Gomareti St	5,90	0:12	28,98
№449_ Vake Park	4,34	0:12	21,22
№450_ Kaklebi settlement (Ivane Machabeli Street #5)	4,16	0:15	16,39
№450_ Vake Park	3,78	0:15	14,93
№451_ M/S "Marjanishvili"	5,32	0:24	12,91
№453_ M/s "Akhmeteli Theater"	4,39	0:20	13,17
№453_ Zvezsubani IV m/d	4,34	0:31	10,07
№455_ M/S Varketili	7,64	0:29	15,46
№456_ Lilo Mall	12,29	0:25	29,41
№456_ M/S "Samgori"	14,43	0:22	37,92
№457_ Besiki St.	4,44	0:51	5,14
№457_ Station Square	4,80	0:49	5,82
№458_ M/S Didube	5,92	0:35	10,10
№458_ Station Square (minibuses)	6,08	0:32	11,68
№459_ Bob Walsh St	3,35	0:15	12,73
№459_ M/S "Sarajishvili"	3,67	0:08	24,89
№460_ Tbilisi Mall	8,92	0:41	12,95
№461_ M/S "Akhmeteli Theater"	7,59	0:26	17,15
№462_ Station Square	14,48	1:15	11,89

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Route name	Distance (km)	Average duration	Average speed (km/h)
№462_Varketili 3, settlement IIIa, near building #334	15,05	1:05	13,82
№464_ Station Square	16,05	1:05	15,90
№466_Shatterashvili St.	4,87	0:21	13,76
№466_ Station Square	5,69	0:22	14,95
№468_Nino Zhvania St.	4,13	0:28	8,75
№468_ Station Square (minibuses)	5,31	0:34	9,22
№470_M/S "Varketili"	2,98	0:18	9,67
№470_Varketili 3 village. IV m/r. building. 421	3,33	0:10	21,51
№471_M/s "Samgori"	5,02	0:42	7,16
№471_Varketili 3, I m/r	4,48	0:26	10,19
№472_Lobzhanidze St.	14,93	1:00	14,77
№472_Tbilisi State University H/B	14,82	1:05	13,66
№474_Kupatadze str.	15,91	1:08	13,92
№475_Grigol Khandzeli Str #78	9,02	0:35	15,11
№475_M/S "Sarajishvili"	8,89	0:26	19,96
№476_Mindeli St.	8,94	0:51	10,71
№476_ Station Square	8,67	1:07	7,93
№477_ Station Square	4,46	0:28	9,61
№477_Samshvili St.	4,36	0:21	12,30
№478_M/S Avlabari	10,39	0:36	17,31
№478_Mevele St. 1	10,61	0:36	17,47
№479_M/S "Isani"	10,54	1:02	10,17
№479_Mujirishvili St	10,54	0:58	10,73
№480_M/S "Akhmeteli Theater"	4,37	0:45	5,76
№481_Tskneti Center	12,67	0:27	28,02
№482_Akhaldaba village	5,21	1:31	3,43
№482_Tskneti	5,19	1:11	4,34
№484_A. Chavchavadze I st. (Tskneti)	3,15	0:43	4,35
№484_D. Amilakhvari III Alley	3,20	0:14	13,49
№485_Monument to Maya Tskneteli	2,55	0:27	5,66
№486_Gldanula Bridge	7,10	0:19	22,01
№486_Metro Station Akhmeteli Theatre	3,30	0:30	9,35
№487_Ioseb Grishashvili St. #49	4,18	0:29	8,61
№490_Mnatobi Street	3,87	0:18	12,33
№491_M/S "Samgori"	5,17	0:15	20,54
№491_Navtlughi II settlement, V street, opposite #59a	5,40	0:17	18,66
№492_Bertubani St	7,10	0:31	13,67

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Route name	Distance (km)	Average duration	Average speed (km/h)
№493_M/S Varketili	5,21	0:19	16,04
№493_Tbilisi Sea Plaza Shopping Mall	5,32	0:16	19,65
№494_Khandzti I Lane	8,59	0:33	15,52
№495_M/S "Varketili"	7,16	0:31	14,83
№495_Varketili Farm	6,94	0:20	20,56
№496_Gldani VIII M/R	3,40	0:19	10,64
№496_M/S "Akhmeteli Theater"	3,70	0:24	9,25
№497_M/S Technical University	3,79	0:27	9,27
№497_Tsulukidze St.	4,07	0:30	8,33
№498_Odishelidze St	4,83	0:45	6,45
№501_Railway Passage Bridge	5,16	0:46	7,92
№502_Makhata Mountain	5,33	0:17	18,88
№502_Railway Passage Bridge	5,40	0:35	10,70
№503_Tskneti Center	11,68	0:36	19,04
№504_Tianeti St.	9,65	0:45	12,91
№504_Tsinamdzgvishvili St.	9,53	0:58	10,11
№505_M/S "Delis"	5,10	0:20	17,55
№505_Oncology Research Center	4,67	0:26	10,91
№506_Lilo Settl 2nd Block	3,24	0:17	10,99
№506_Lilo Mall	4,38	0:11	22,43
№507_Seaside District, IV M/D, Building 10	13,70	0:54	15,18
№507_Station Square	14,14	1:25	9,94
№508_Avshni St. III Lane	3,18	0:10	17,62
№508_Metro Station Akhmeteli Theatre	3,19	0:26	7,85
№509_Leri Lagurashvili St. #5	1,59	0:08	11,01
№509_Metro Station Akhmeteli Theatre	2,41	0:17	9,26
№510_M/S "Sarajishvili"	9,85	0:31	18,72
№510_Niko Ketskhoveli #7	7,55	1:13	6,12
№511_Gldani III "A" M/D, Building #20	2,69	0:08	19,35
№511_Metro Station Akhmeteli Theatre	2,60	0:15	9,85
№512_Chavchavadze Avenue	19,50	1:53	10,35
№512_Gldani VI M/R	19,69	1:31	13,30
№514_Avchala 2 settlement, Svaneti II lane	3,59	0:15	14,70
№514_Lebanon Street, #118 School	3,59	0:31	6,79
№515_Avchala 2 settlement, Sulkhan-Saba Orbeliani Street #30	6,53	0:38	10,31
№517_Gldani VII M/D, Building 24	14,96	1:13	12,29
№517_M/S Station Square	15,03	1:21	11,02

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Route name	Distance (km)	Average duration	Average speed (km/h)
№518_Didi Digomi IV M/R	10,10	0:46	13,12
№518_M/S "Akhmeteli Theater"	10,39	0:52	11,98
№519_East Point	15,43	0:53	17,28
№519_Mevele St. 5	15,41	1:10	13,07
№521_M/S "Varketili"	3,69	0:28	8,27
№521_Meskheti Street	4,95	0:18	17,49
№522_Mujirishvili Street #12	8,09	0:32	15,70
№522_Station Square	7,15	0:30	14,22
№523_Mevele St. 5	22,14	1:56	11,75
№524_East Poin	11,51	1:02	11,02
№525_M/S "Avlabari"	6,07	0:26	13,77
№525_Makhata Mountain	6,57	0:34	12,37
№526_Zurgovana	8,60	1:15	6,81
№527_M/S "Didube"	10,93	0:48	13,47
№527_Zahesi settlement	11,30	0:31	21,85
№528_Nakduli Street #2Z	14,20	0:56	15,42
№528_Station Square (minibuses)	14,32	0:57	15,20
№529_Bezhanishvili St.	6,42	0:42	10,95
№529_Station Square (minibuses)	6,69	0:36	11,04
№530_M/S "Varketili"	3,59	0:27	9,20
№530_Viktor Kupradze Street #424	2,99	0:13	13,34
№531_Gegeshidze Garden (opposite Zakaria Paliashvili St. #33a)	23,25	1:19	17,46
№531_Gldani VI m/d, Konstantine Leselidze St.	20,92	1:31	13,70
№532_M/S "Freedom Square"	16,50	1:49	9,03
№532_Nodar Dumbadze Avenue Building #18	16,59	1:03	15,70
№533_Crossing bridge	4,92	0:28	11,78
№534_Varketili IV M/D	24,47	1:42	14,33
№536_Baratashvili Str.	11,93	0:57	12,51
№536_Hospitals' Complex	12,30	1:03	11,81
№537_m/s "Deli"	5,31	0:36	12,85
№537_Nutsubidze IV m/r	5,11	0:25	11,86
№538_Didube M/S	12,98	0:52	14,82
№538_Ortachala bus station	12,86	1:05	11,89
№539_Didi Digomi IV M/R	16,87	1:04	15,66
№539_Station Square	16,65	1:29	11,17
№540_Chavchavadze Avenue	20,48	1:34	13,02
№540_East Point	22,14	1:16	17,32

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Route name	Distance (km)	Average duration	Average speed (km/h)
№541_Amagleba St.	21,08	1:36	13,14
№541_Didi Digomi IV mountain range	21,21	1:31	13,94
№542_Railway Passage Bridge	7,15	0:42	10,17
№543_M/S "Sarajishvili"	5,74	0:40	8,61
№543_M/S Akhmeteli Theater	6,63	0:28	13,99
№545_M/S "Isani"	5,32	0:26	12,22
№545_Public School #106	5,42	0:23	13,60
№546_M/S "Technical University"	5,23	0:34	9,33
№547_Barataashvili Street	24,41	1:56	12,57
№548_Freedom St #70	8,72	0:30	17,22
№548_M/S "Akhmeteli Theater"	8,50	0:36	14,08
№549_Tsinanauri St.	6,06	0:31	11,46
№550_Konstantine Chachava St. #1	24,22	1:30	16,05
№550_Varketili 3, I m/d	23,76	1:38	14,50
№551_Ana Politkovskaia Street	21,76	1:31	14,24
№551_Tbilisi Mall	20,25	1:25	14,21
№552_Bazhan Kalandadze St.	4,44	0:32	8,23
№553_M/S Ghrmagele	5,47	0:48	6,77
№554_M/S Varketili	5,31	0:14	22,60
№554_Tvalchrelizi St.	6,65	0:18	22,12
№555_Shorapani II St. #11a	7,01	0:52	8,80
№556_Chechelashvili St.	7,30	0:50	9,55
№557_Krtsanisi Street	7,61	0:48	9,56
№557_Samgori Street	6,91	0:32	13,81
№558_M/S Crazy	4,11	0:27	9,43
№558_Nutsubidze I m/r	3,77	0:12	18,87
№567_George Ghviniashvili St #27	5,50	0:19	17,41
№567_Varlam Cherkezishvili Street #9	5,63	0:33	10,08
№580_M/S "Rustaveli"	15,80	1:04	14,79
№582_M/S "Varketili"	12,35	0:25	29,34
№582_Tengiz Sturua St. #2	12,22	1:03	13,26

Annex #5 – Set of maps and elaborations

Figure 16 - Speed and passenger flows on the network

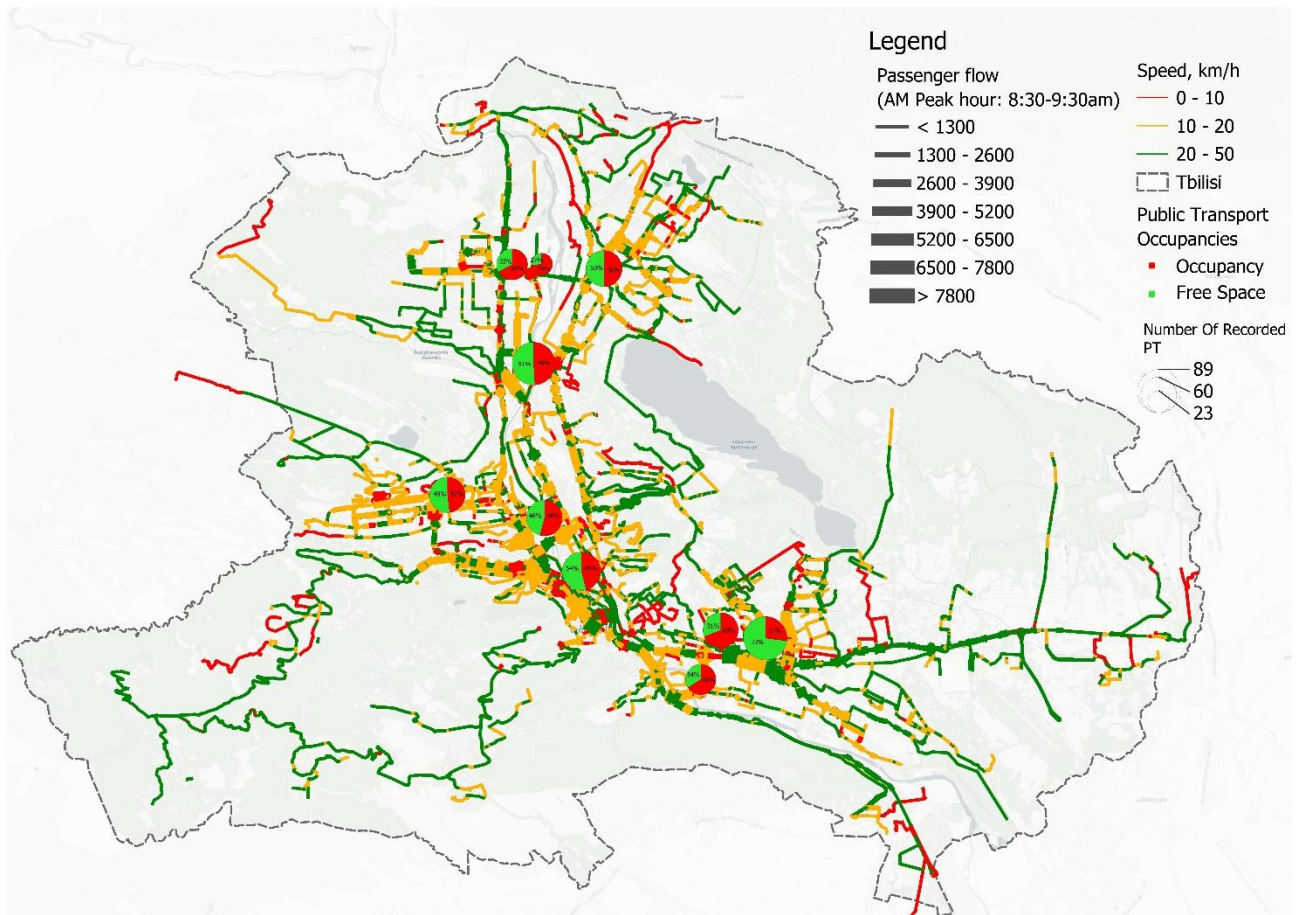


Figure 17 – The map for total boarding and alighting at stops in the Chugureti district



Figure 18 - The map for total boarding and alighting at stops in the Gldani district

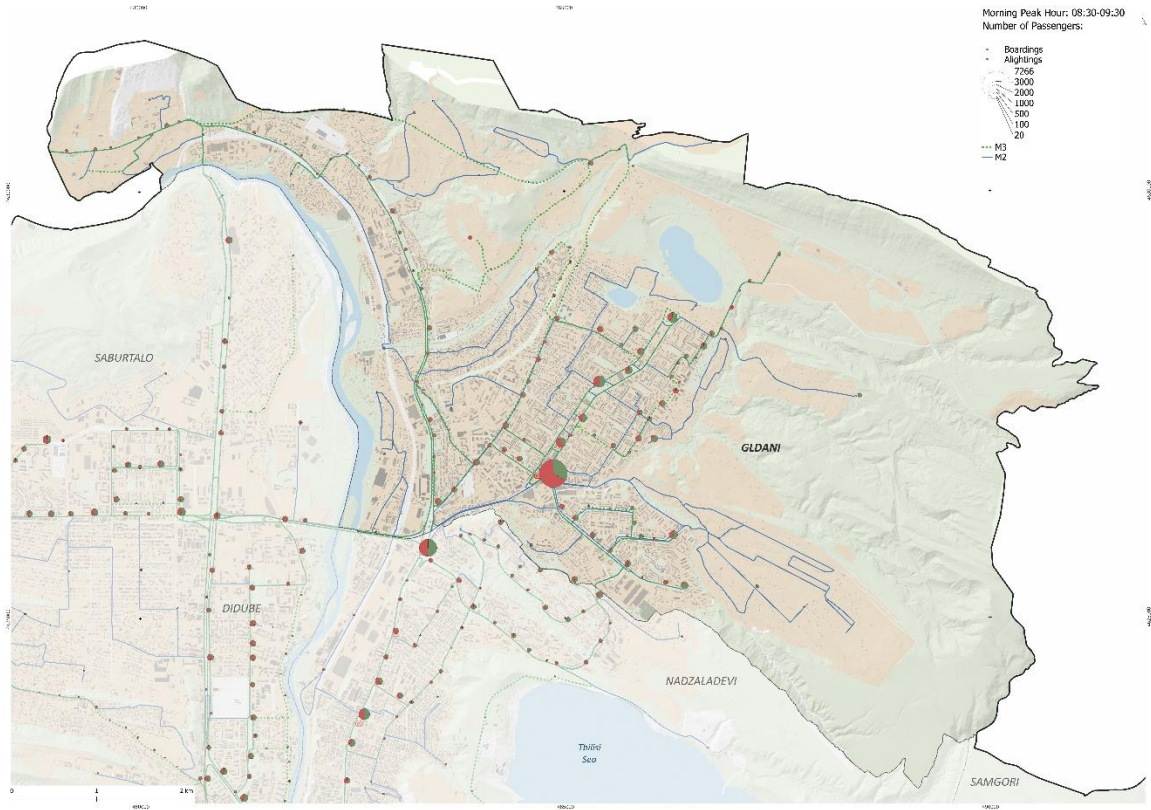


Figure 19 - The map for total boarding and alighting at stops in the Didube district

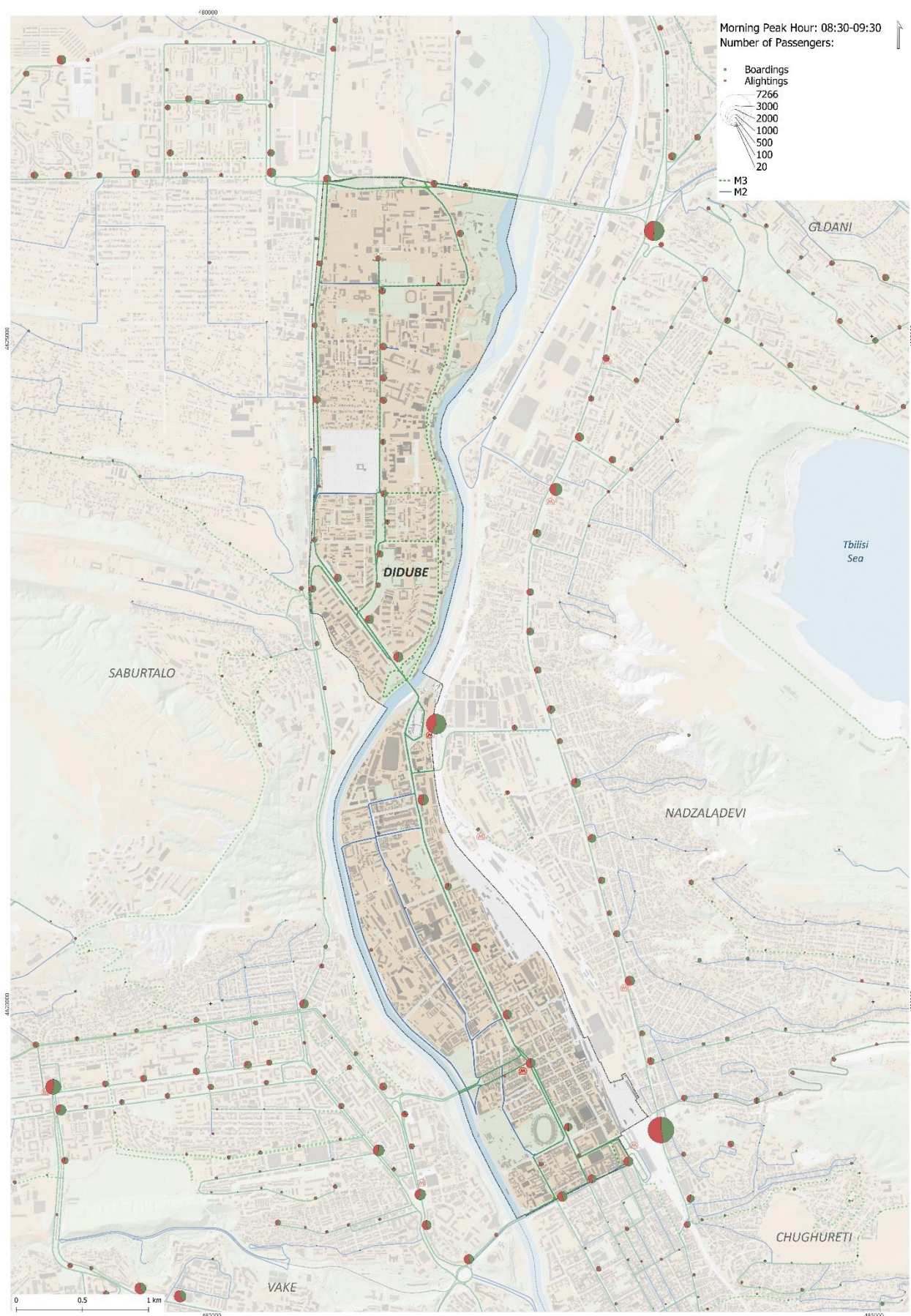


Figure 20 - The map for total boarding and alighting at stops in the Saburtalo district

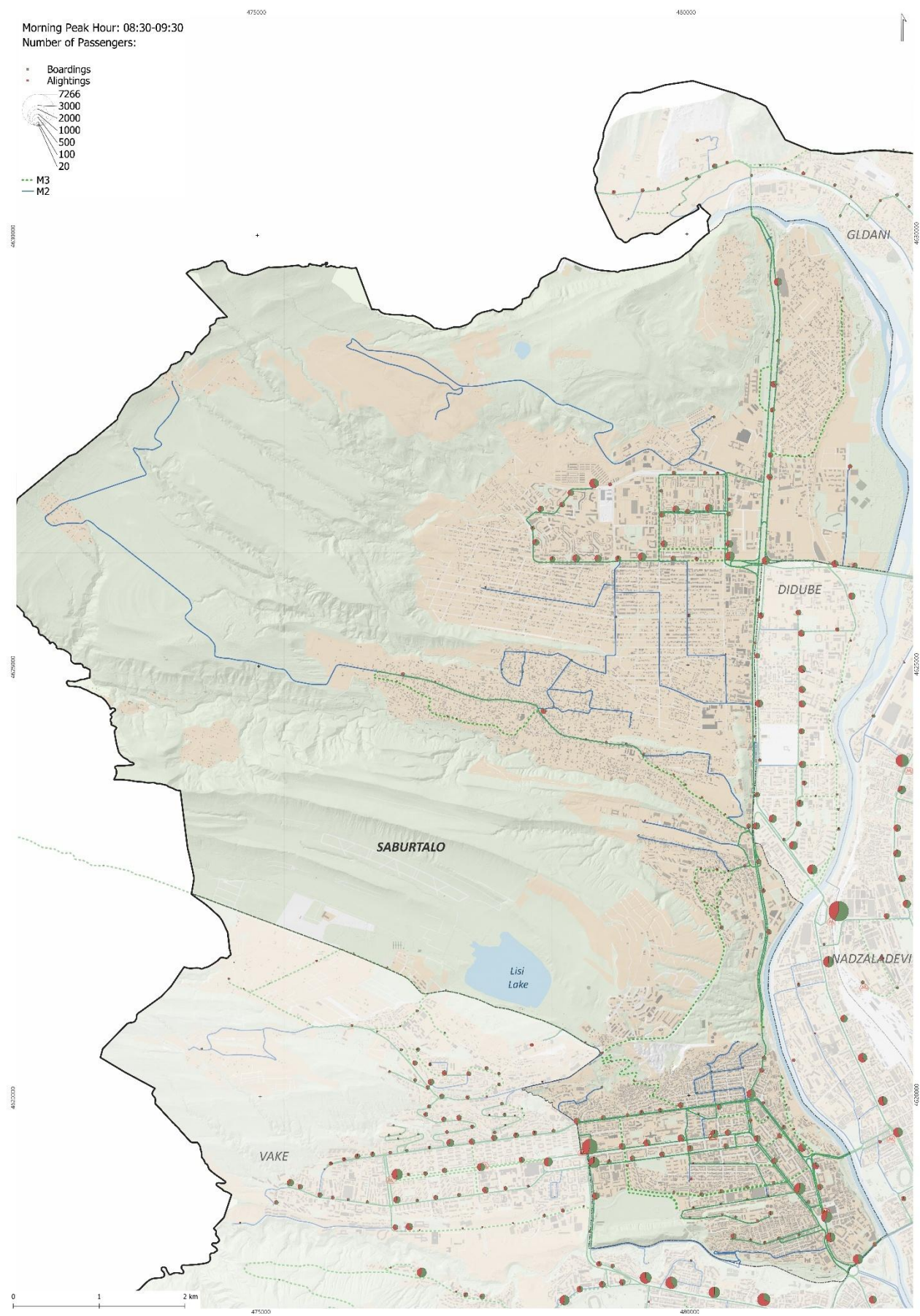


Figure 21 - The map for total boarding and alighting at stops in the Vake district

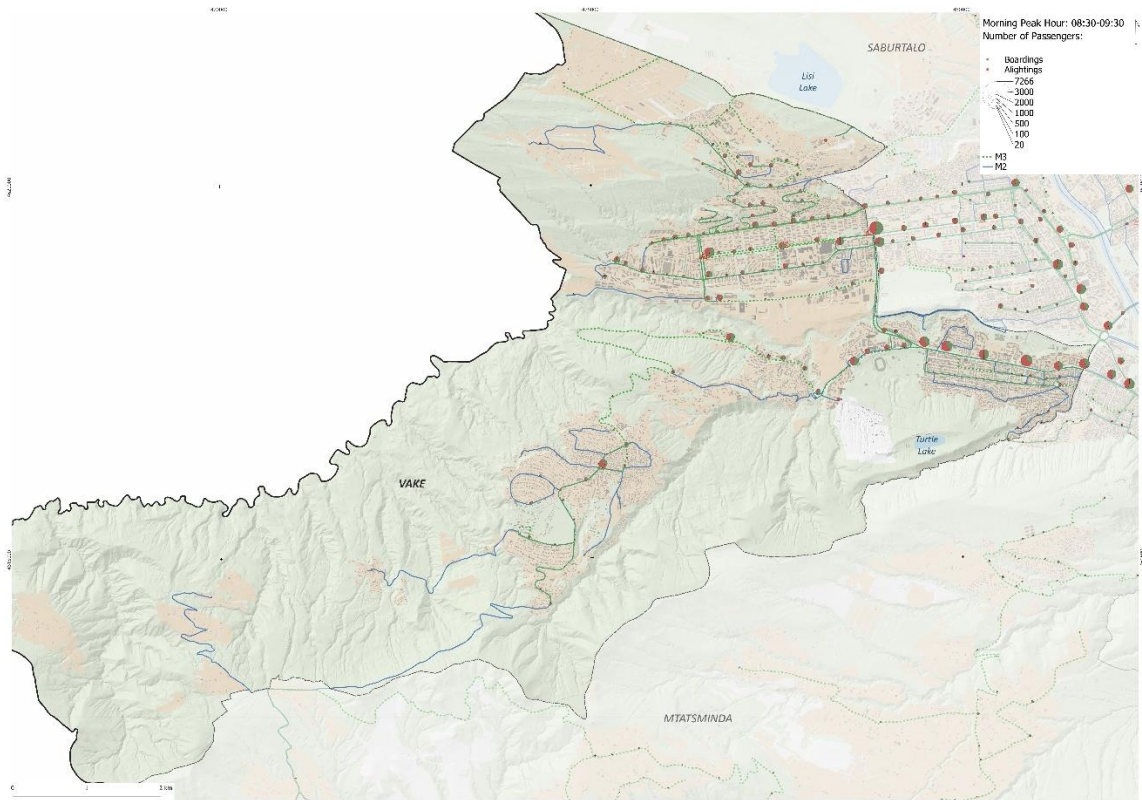


Figure 22 - The map for total boarding and alighting at stops in the Mtatsminda district

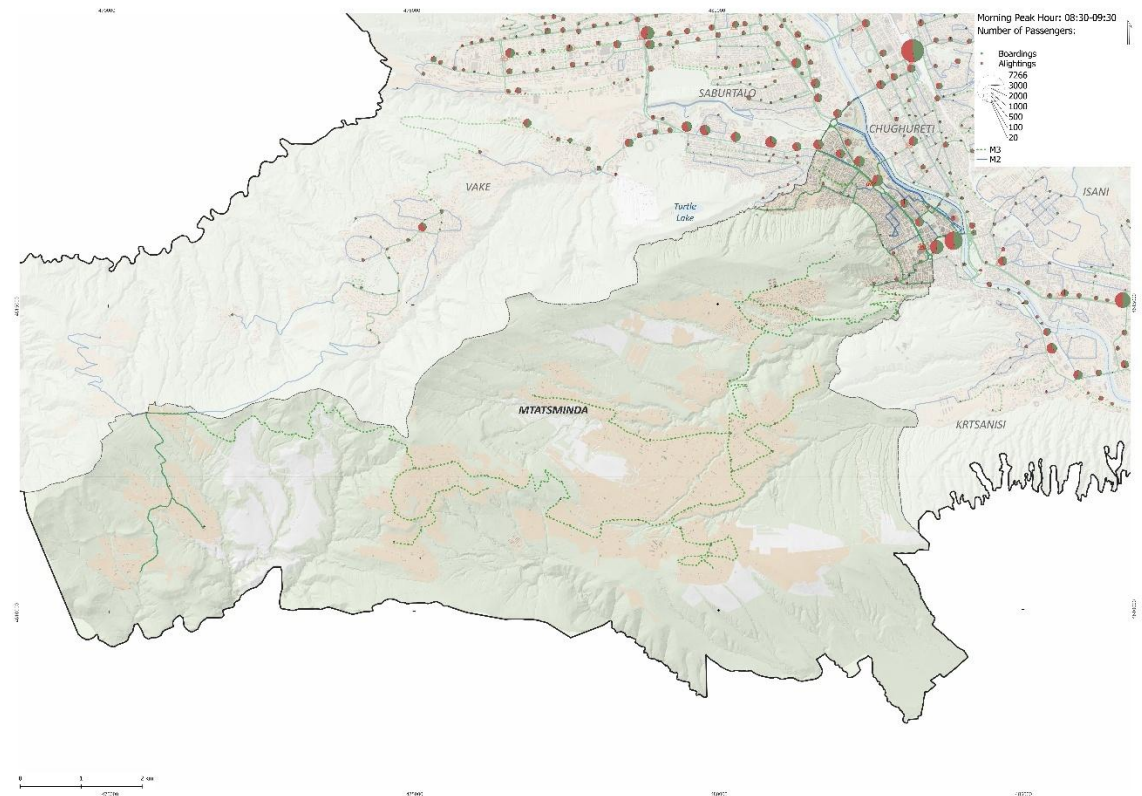


Figure 23 - The map for total boarding and alighting at stops in the Krtsanisi district

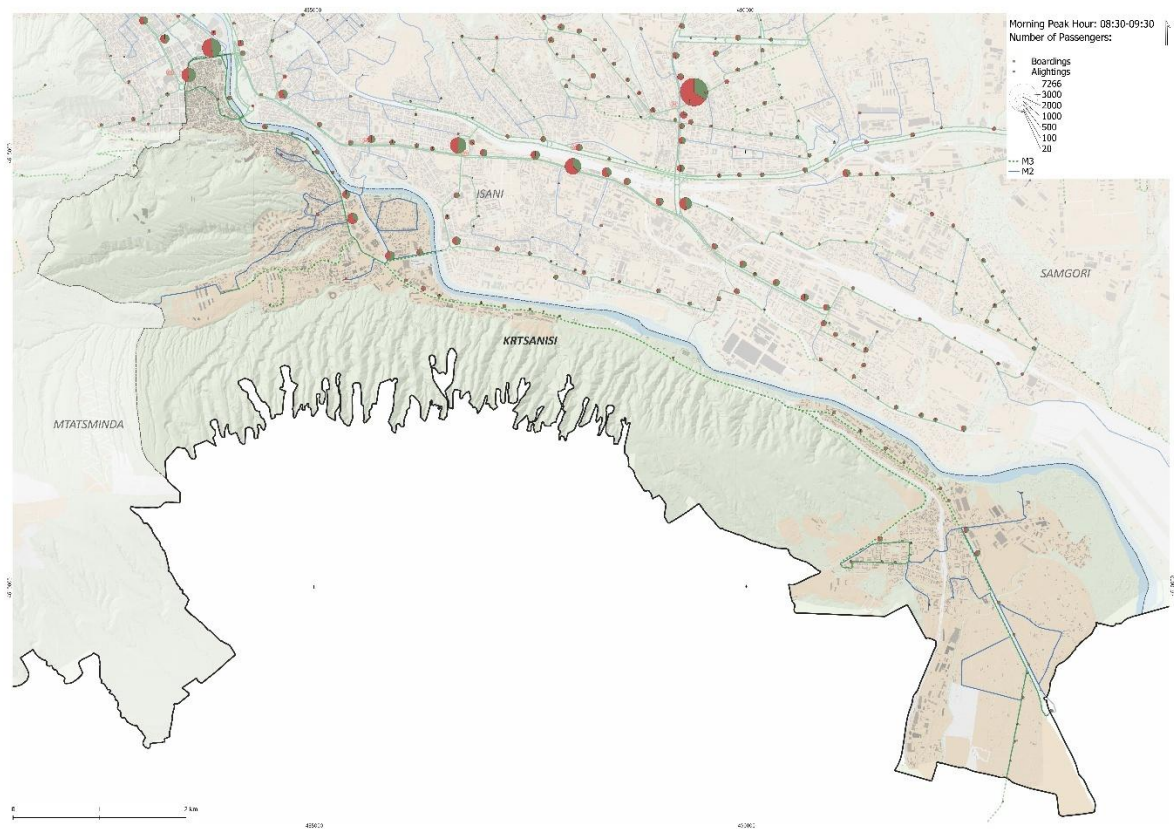


Figure 24 - The map for total boarding and alighting at stops in the Isani district



Figure 25 - The map for total boarding and alighting at stops in the Samgori district

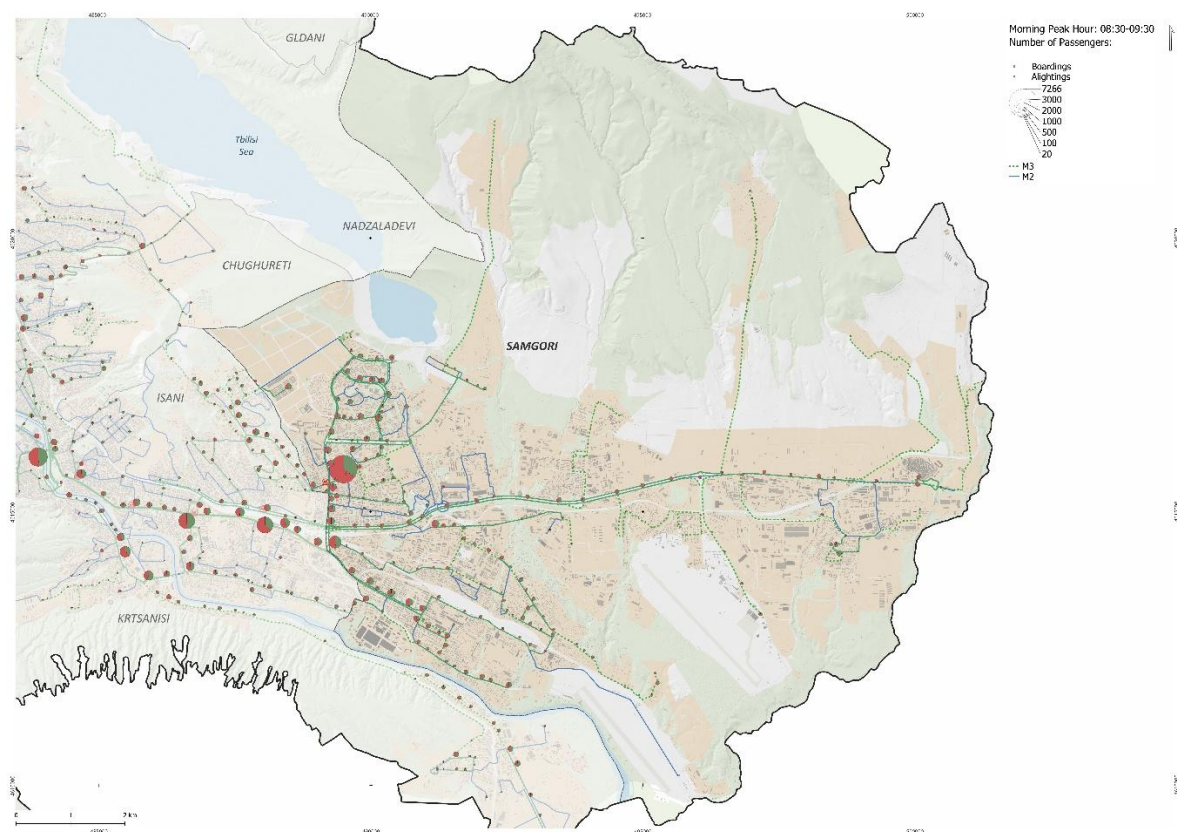
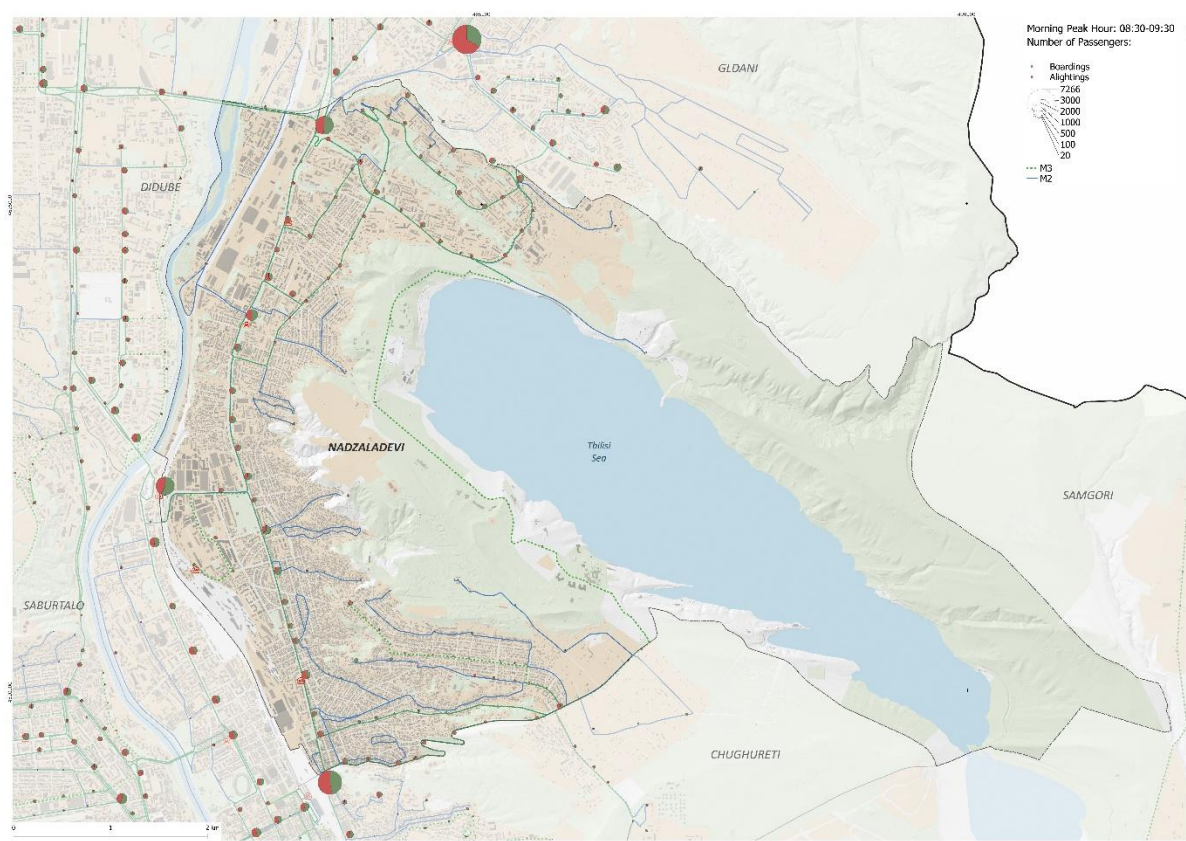


Figure 26 - The map for total boarding and alighting at stops in the Nadzaladevi district



Annex #6 – Technical Note for Processing Raw Data of Boarding-Alighting Survey

This document describes the workflow for preprocessing, unifying and aggregating survey data.

1. Data Sources and Storage

The data was collected using two methods:

1. *TransitWand* (TW) mobile application: surveyors recorded information on routes and stop-level information directly on their device.
2. Manual recordings: the surveyors recorded the data manually, and the data was later digitized and integrated in structured tables.

For each surveyed route, two trips were measured in each direction. Within a single trip, one or several measurements could be recorded, depending on the number of surveyors assigned to the survey group.

Regardless of the method, all raw data were consolidated into one database to ensure completeness and consistency. To enable further analysis, the raw records were supplemented with additional information:

- Time adjustments were made where necessary because some devices used fixed time zones that did not match Tbilisi time.
- Metadata was supplemented with route number, direction of travel, survey group, etc.
- Each measured stop was assigned to the corresponding official stop, ensuring that all data could later be aggregated.

The entire dataset was organized across several Excel worksheets:

- *TW_stops* – raw stop-level observations collected using the *TransitWand* app during February-April 2025. A few additional attributes from the *Final_routes* sheet were appended, but the stop-level content remains unprocessed.
- *Stops from paper* - raw stop-level results manually recorded during February-April 2025 and digitised afterwards. This is the second independent source of unprocessed data.
- *Final routes* - a consolidated table listing the measurements considered as relevant and reliable in the two raw sources (*TW_stops* and *Stops from paper*) collected in February-April 2025. These data contain trip-level metadata used to identify, describe, and interpret the corresponding raw stop-level records.
- *TW_UPD_stops* - additional *TransitWand* observations collected in October-November 2025. These measurements were added after the initial database was formed and therefore are not included in the *Final_routes* sheet. They represent updated trips, replacing earlier surveys that were conducted outside peak hours.
- **STOPS_TW&PAPER - main consolidated and cleaned database combining TW and paper measurements.** All raw stop-level data are merged here after validating the correct direction of each monitored service and matching any to the stops integrated in the model. This worksheet serves as the core dataset for all analyses and for generating aggregated results.

- **BA_AGGR** - final aggregated stop-level passenger boarding/alighting counts for each route and direction.
- **MEASUREMENTS_SELECTION** - selection of representative measurements to be used in the final aggregation. The column "first_trip" identifies measurements belonging to one trip, while all remaining measurements within the same direction are assigned to the second trip. The worksheet also contains the list of re-measured, outdated or irrelevant measurements, which are fully excluded from the final results (column "exclude").
- **Model_stoppoints_sequence** - contains the official ordered stop points sequences for every route and direction. Used to assign the internal stop identifier to each manually recorded stop.
- **stoppoints_stops_model** - contains the list of stop points with the corresponding internal stop identifiers. Used to match stop point identifiers from the *Model_stoppoint_sequence* sheet to the stops.

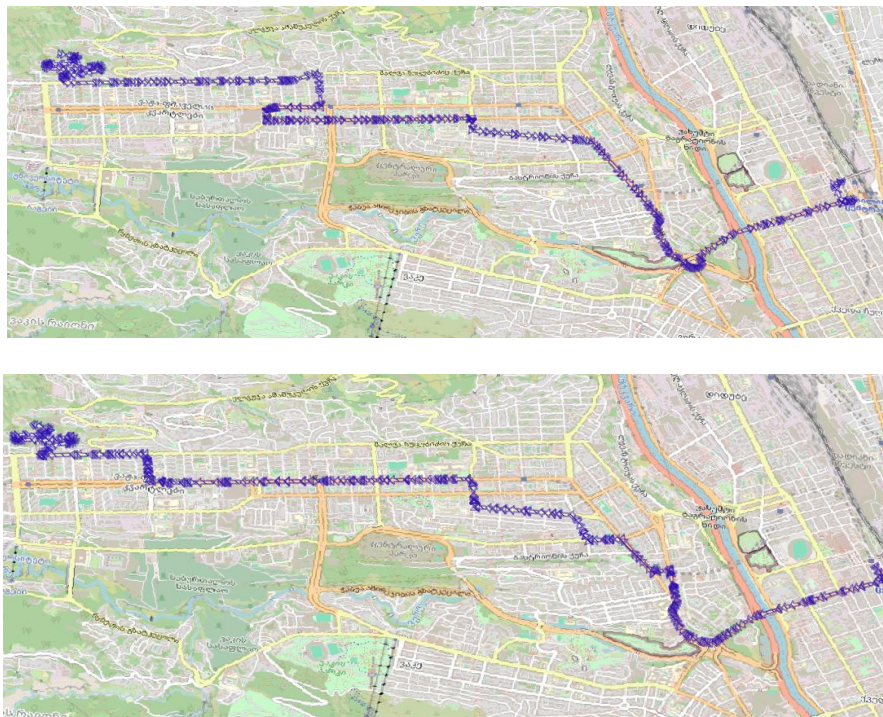
With this consolidated foundation in place, the data processing steps can be illustrated using the example of a single bus route. Since information was collected using both *TransitWand* and manual surveys, the initial workflows differ slightly, but they converge in later stages of processing.

2. Data processing

Example 1. Route 347 with TW measurements

To describe the data processing, route 347 which operates between Station Square and Nutsubidze M/D 1 in both directions (Figure 27 - Official alignment of route 347) is used as an example.

Figure 27 - Official alignment of route 347



For this route, the data were collected using the *TransitWand* (TW) application. According to the *Final routes sheet* (Figure 28 - Overview of the measurements on the Final routes worksheet on the 347 route), 4 trips with a total of 8 measurements were recorded: 3 in the direction of Nutsubidze M/D 1 and 5 in the direction of Station Square (see *Direction* column). In addition, each trip is identified by a unique *survey_full_id*. The measurements were recorded by two surveyor groups coded as GCX and PPD (see *group_code* column). GCX and PPD are the codes of the teams that worked in the same vehicle during the survey.

At this stage, the number of measurements between the two directions was unbalanced. Also, the same *survey_full_id* contained measurements assigned to conflicting directions. Such inconsistencies are quite frequent during on-field surveys and are generally due to surveyor mistakes (incorrectly indicating the travel direction, mislabeling the record in the application, etc.).

This issue, however, does not affect the reliability of the dataset. When checking and correcting the direction of trips, all measurements were cross-checked against the official route alignment.

Figure 28 - Overview of the measurements on the Final routes worksheet on the 347 route

survey_full_id	unit_id	route_id	bus number	group code	route number	point A and B	route_name	Direction
347- B1	306186	884	347	GCX	1	B	347	Station square 2 - Nutsubidze m/d 1
347- B1	790826	885	347	GCX	1	B	347	Station square 2 - Nutsubidze m/d 1
347-A1	634216	886	347	PPD	1	A	347	Nutsubidze m/d 1 - station square 2
347-A2	306186	915	347	GCX	2	A	347	Nutsubidze m/d 1 - station square 2
347-A2	790826	916	347	GCX	2	A	347	Nutsubidze m/d 1 - station square 2
347- B2	634216	917	347	PPD	2	B	347	Nutsubidze m/d 1 - station square 2
347-A1	446218	918	347	PPD	1	A	347	Nutsubidze m/d 1 - station square 2
347- B2	446218	919	347	PPD	2	B	347	Station square 2 - Nutsubidze m/d 1

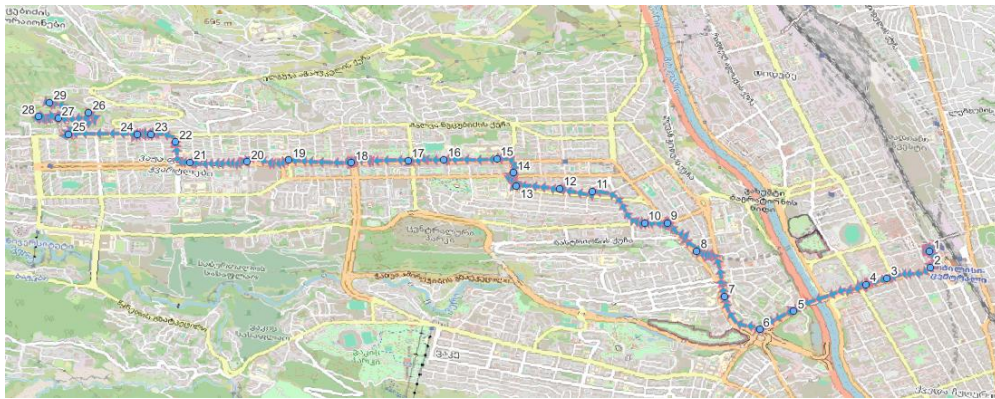
The *TW_stops* sheet (see Figure 29) contains the raw stop-level data collected with the *TransitWand* application. It includes detailed information recorded during each survey stop (boarding, alighting, GPS coordinates), as well as references to the corresponding trip-level data from the *Final routes sheet*.

Figure 29 - Example of data on the TW_stops sheet

	B	C	E	F	G	H	I	J	K	L	M	N	O
	unit_id	route_id	stop_id	stop_sequence	lat	lon	travel	dwelt	arrival_time	departure_time	board	alight	route_num
1													
2	306186	884	22442	1	41.7221	44.7968	0	178	08:16:41	08:19:39	11	0	347
3	306186	884	22443	2	41.7207	44.797	229	13	08:23:28	08:23:41	2	0	347
4	306186	884	22444	3	41.7194	44.7932	95	9	08:25:16	08:25:25	1	0	347
5	306186	884	22445	4	41.7187	44.7914	48	12	08:26:13	08:26:25	1	2	347
6	306186	884	22446	5	41.7157	44.7852	177	7	08:29:22	08:29:29	0	0	347
7	306186	884	22447	6	41.7139	44.7824	69	15	08:30:38	08:30:53	1	0	347
8	306186	884	22448	7	41.7165	44.7791	73	14	08:32:06	08:32:20	0	0	347
9	306186	884	22449	8	41.7203	44.7762	169	15	08:35:09	08:35:24	0	0	347
10	306186	884	22450	9	41.7226	44.7734	92	15	08:36:56	08:37:11	0	0	347
11	306186	884	22451	10	41.7224	44.7714	118	15	08:39:09	08:39:24	2	0	347
12	306186	884	22452	11	41.7248	44.7665	115	15	08:41:19	08:41:34	0	0	347
13	306186	884	22453	12	41.7248	44.7636	54	12	08:42:28	08:42:40	0	1	347
14	306186	884	22454	13	41.7247	44.7597	61	18	08:43:41	08:43:59	0	2	347
15	306186	884	22455	14	41.7258	44.7594	117	15	08:45:56	08:46:11	0	1	347
16	306186	884	22456	15	41.7269	44.7578	63	10	08:47:14	08:47:24	0	0	347
17	306186	884	22457	16	41.7264	44.7531	65	12	08:48:29	08:48:41	0	0	347
18	306186	884	22458	17	41.7261	44.75	98	17	08:50:19	08:50:36	1	0	347

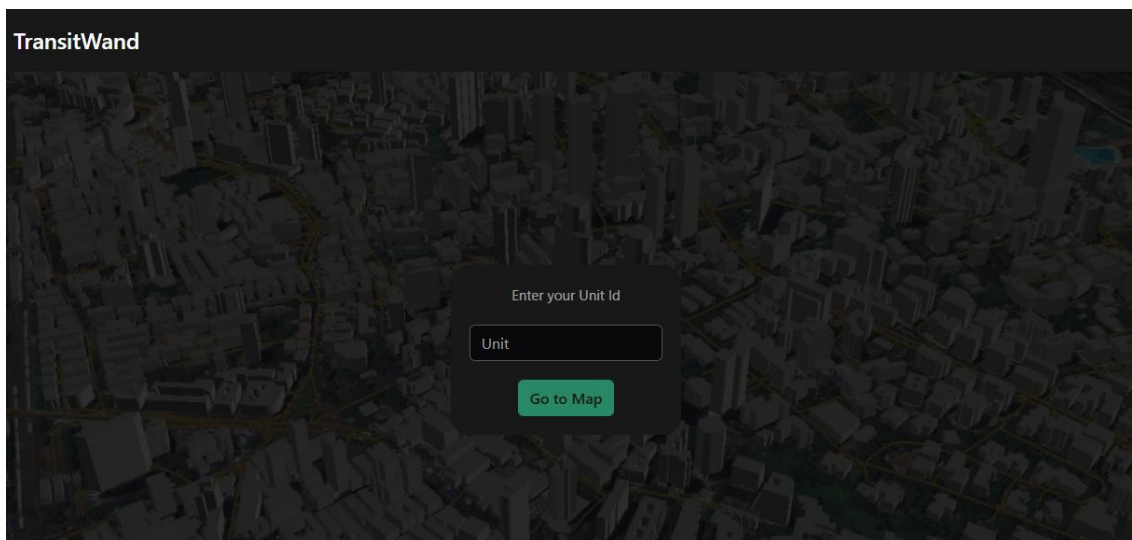
Every stop in the database is associated with precise GPS coordinates, so that the survey stops can be visualized on the map. As an example, Figure 30 shows the measurement with *route_id* = 884 with the stops recorded along the way.

Figure 30 - Tracing and stops of the measurement with route_id 884



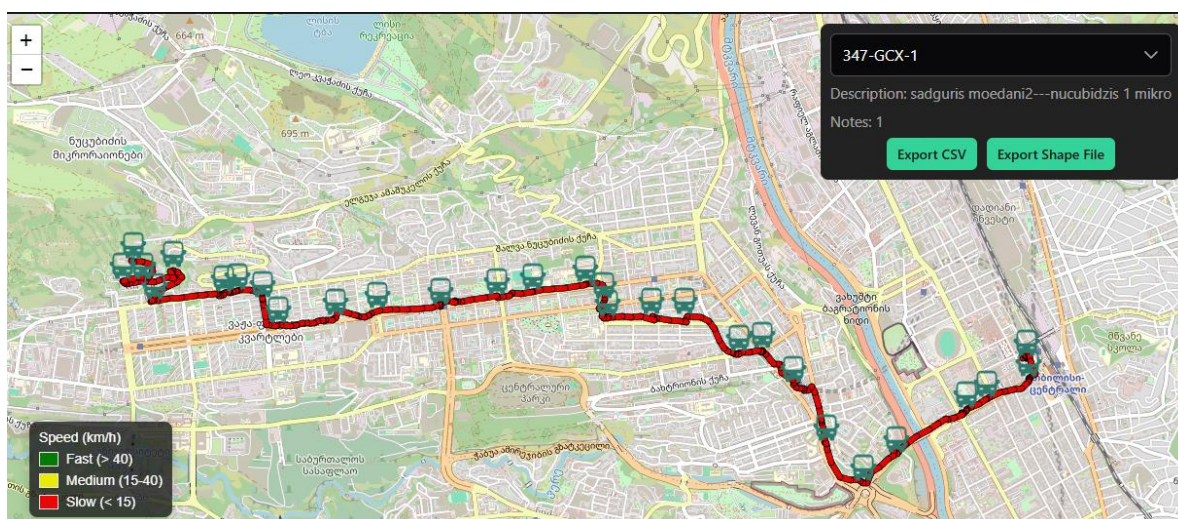
The same traces can be retrieved directly from [TransitWand](#). Each measurement (*route_id*) is linked to the surveyor's device (*unit_id*). By entering the *unit_id* into the *TransitWand* system (see Figure 31), it is possible to access all measurements collected by that surveyor, visualize their routes, and download the raw data.

Figure 31 - Accessing the data using unit_id



For example, the measurement with *route_id* = 884 was recorded on the device identified by *unit_id* = 306186. By entering this *unit_id* into *TransitWand*, it is possible to access the map with all measurements recorded by this surveyor. In this case, surveyor 306186 completed two measurements on route 347. By selecting these trips in the system, we can directly visualize the corresponding traces on the map and download the raw stop-level data (see Figure 32):

Figure 32 - Tracing of the measurement with route_id = 884 directly from TransitWand



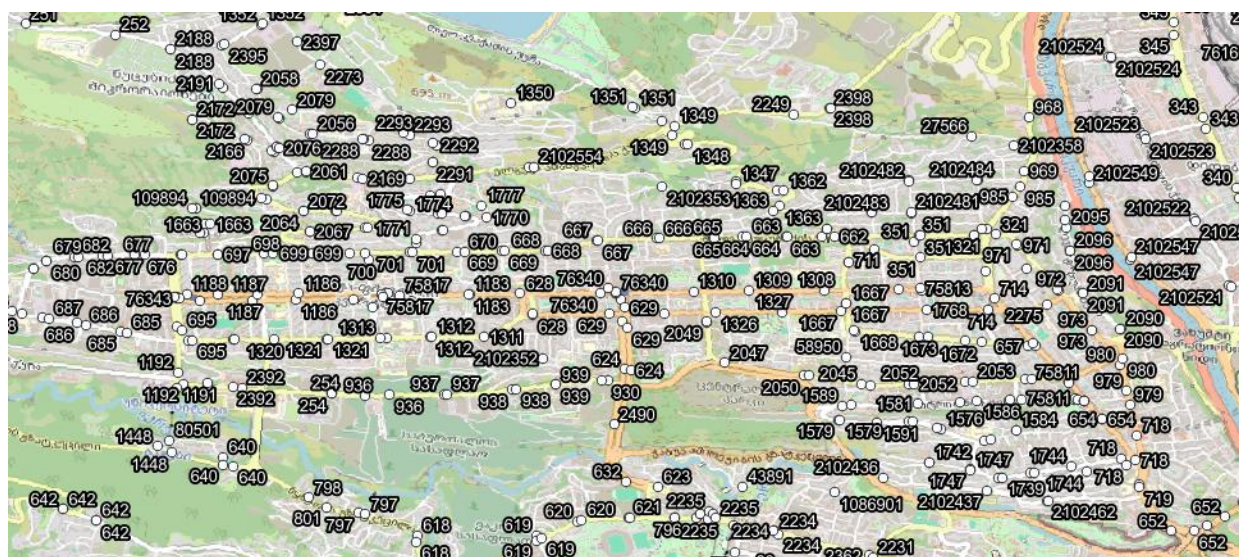
Stops adjustment

Stop coordinates were automatically recorded by the devices during the survey. Since several surveyors have been monitoring the same trips, and the recorded GPS points of stops were slightly different, it was necessary to standardize all observations by matching them to a single reference set of stops. In practice, this means that each measured stop was assigned to the corresponding official stop, ensuring that all data could later be aggregated.

To standardize the recorded stops, a set of official stops for each route was used as a reference (Figure 33). Every stop recorded during the survey was matched to the closest official stop along the route. To implement this step, a dedicated Python script was developed. The script automatically compares the GPS coordinates of each surveyed stop with the list of official stops on the corresponding route and assigns the closest match. As a result, every observation in the raw data is linked to a precise official stop ID.

The matched official stops were added to the data in the *STOPS_TW&PAPER* worksheet (see column *MODEL_STOP_ID*) This sheet consolidates both TW and paper-based measurements and it is the main database for further analysis.

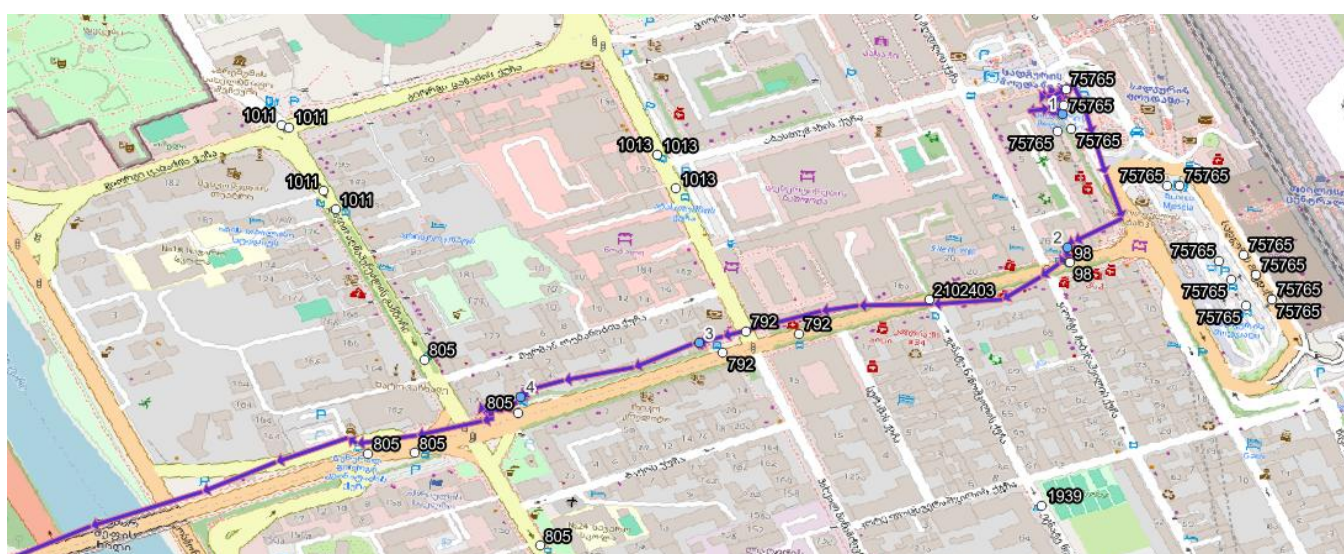
Figure 33 - Set of all official stops labelled by their identifiers



As an example, in the measurement with *route_id* = 884, the first recorded stop was matched to *MODEL_STOP_ID* = 75765, the second recorded stop was matched to *MODEL_STOP_ID* = 98, the third recorded stop was matched to *MODEL_STOP_ID* = 792, and the fourth to *MODEL_STOP_ID* = 805.

Figure 34 - Example of matched stops

B	M	O
route_id	Stop_sequence	MODEL_STOP_ID
884	1	75765
884	2	98
884	3	792
884	4	805



It is important to note that the sequence of measured stops does not always align with the official stop sequence. This is a quite common situation observed when conducting on-field surveys and can occur for several reasons:

- surveyors may not have recorded data at every official stop;
- additional stops may have been captured between official ones (for example, if a bus stopped outside the official stop to pick up or drop off passengers);
- vehicles occasionally skipped stops if no passengers boarded or alighted.

However, by matching all records to the official stops we corrected GPS inaccuracies, accounted for skipped stops, and removed extra points, which allowed us to obtain a consistent dataset for further analysis.

Directions adjustment

One of the issues in the data was that directions were not always recorded correctly by surveyors. Sometimes the same trip could be marked with different direction names. In addition, there were minor variations in the way directions were entered (differences in letter case, extra spaces, etc.). To ensure comparability across all measurements, it was necessary to standardize and unify the directions.

To achieve this, a Python script was developed. The script determines the actual travel direction by comparing the location of the first stop in the measurement with the first stop in the official route sequence. Based on this comparison, it assigns each measurement a unique standardized destination name (for example, “№347_Station Square 2” or “№347_Nutsubidze I M/D, #33”). The corrected direction names were added to the consolidated database (*STOPS_TW&PAPER* sheet - column *FINAL_DESTINATION*).

During the review of route 347, it was found that the measurement with *route_id* = 917 had been incorrectly labeled and assigned to the wrong direction (according to the raw data). Once the stop coordinates and route geometry were checked, it became clear that the trip in fact went from Station Square to Nutsubidze (see Figure 35). The script detected the mismatch, and the measurement was reassigned to the correct standardized direction. All such cases across the dataset were corrected and double-checked manually.

Figure 35 - Measurement with *route_id* 917 (from Station Square to Nutsubidze I)

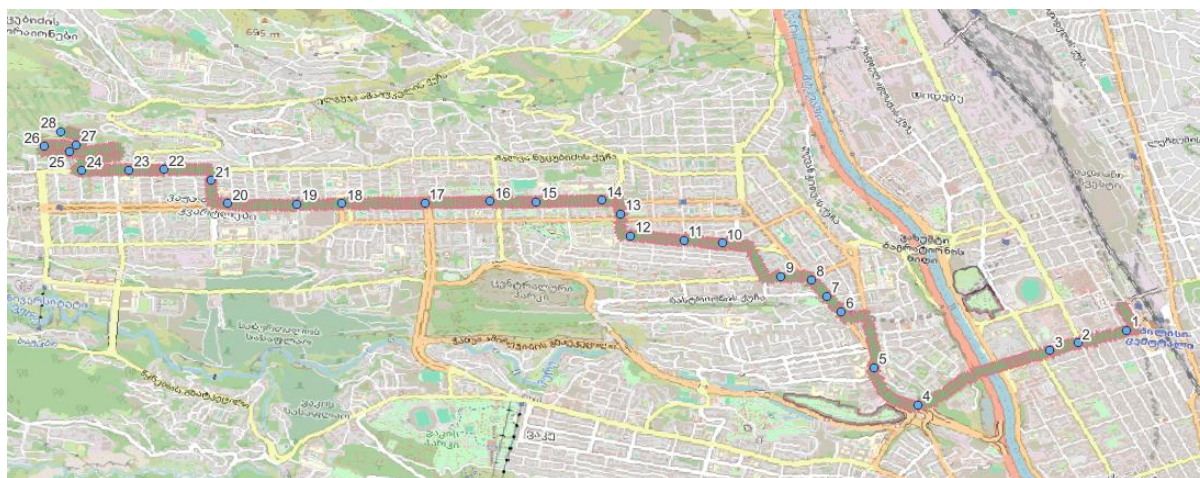


Figure 36 - Adjusted directions for route 347

B	G	AA
route_id	ROUTE_DIRECTION	FINAL_DESTINATION
884	Station square 2 - Nutsbidze m/d 1	N#347_Nutsbidze I M/D, #33
915	Nutsbidze m/d 1 - station square 2	N#347_ Station Square 2
918	Nutsbidze m/d 1 - station square 2	N#347_ Station Square 2
919	Station square 2 - Nutsbidze m/d 1	N#347_Nutsbidze I M/D, #33
885	Station square 2 - Nutsbidze m/d 1	N#347_Nutsbidze I M/D, #33
886	Nutsbidze m/d 1 - station square 2	N#347_ Station Square 2
916	Nutsbidze m/d 1 - station square 2	N#347_ Station Square 2
917	Nutsbidze m/d 1 - station square 2	N#347_Nutsbidze I M/D, #33

Peak hour adjustment

The surveys recorded only two observations per direction, and these data had to be scaled to represent the average peak-hour conditions. To achieve this result, each observation at any stop (people boarding and alighting) was multiplied by a specific coefficient based on the frequency of the route (number of buses per hour compared to number of observations). This adjustment allowed to convert the results of a single measurement into its peak-hour equivalent. The main data source for frequency data was the online service <https://ttc.com.ge/>.

The service frequency for route 347 was determined to be 1.5 buses per hour. Therefore, each observation at the stop level (boarding and alighting counts from a single measurement) was multiplied by 1.5 to represent its peak-hour equivalent. The results of this adjustment are presented in the columns **board_peak** and **align_peak** on the **STOPS_TW&PAPER** worksheet.

Measurement Selection and Aggregation

For each route and direction, two trips were surveyed. Each trip could include one or more measurements, collected by different groups of surveyors travelling in the same vehicle. To ensure a consistent and clear aggregation of the data, measurements were first assigned to one of the two trips.

Since minor inaccuracies could occur in the route descriptions provided by surveyors, the assignment of measurements to a specific trip was made with particular attention to the following criteria:

1. Direction of travel;
2. Surveyor group;
3. Measurement start time.

After preprocessing route 347 data, we obtained measurements from two groups, each covering both directions. In total, there were four measurements in one direction and four in the opposite direction. These were grouped into two trips per direction, with two measurements assigned to trip 1 and the remaining two to trip 2 (*trip_no* column).

Once trips were defined, the data was aggregated by three key identifiers: route number, direction, and official stop ID (MODEL_STOP_ID).

Aggregation by official stop ID is especially important because:

- some surveyors skipped certain stops
- buses made additional stops not included in the official list.

By relying on official stop identifiers rather than the raw stop sequence, all data could be consistently combined.

The final aggregation was carried out using a pivot table filtered by the `exclude_old_measurements` field, so that only relevant measurements were included in the results. The pivot output presents boarding and alighting values for each official stop, converted to peak-hour equivalents, separately for the first trip, the second trip, and as an average across the trips (see Figure 37).

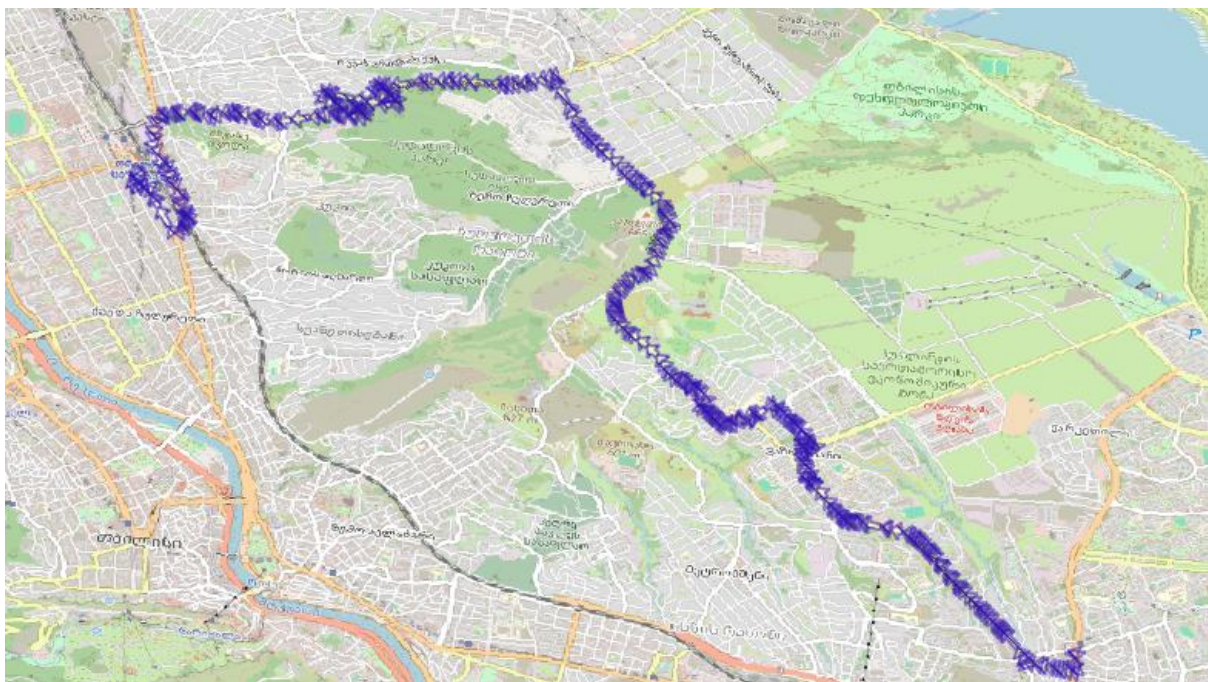
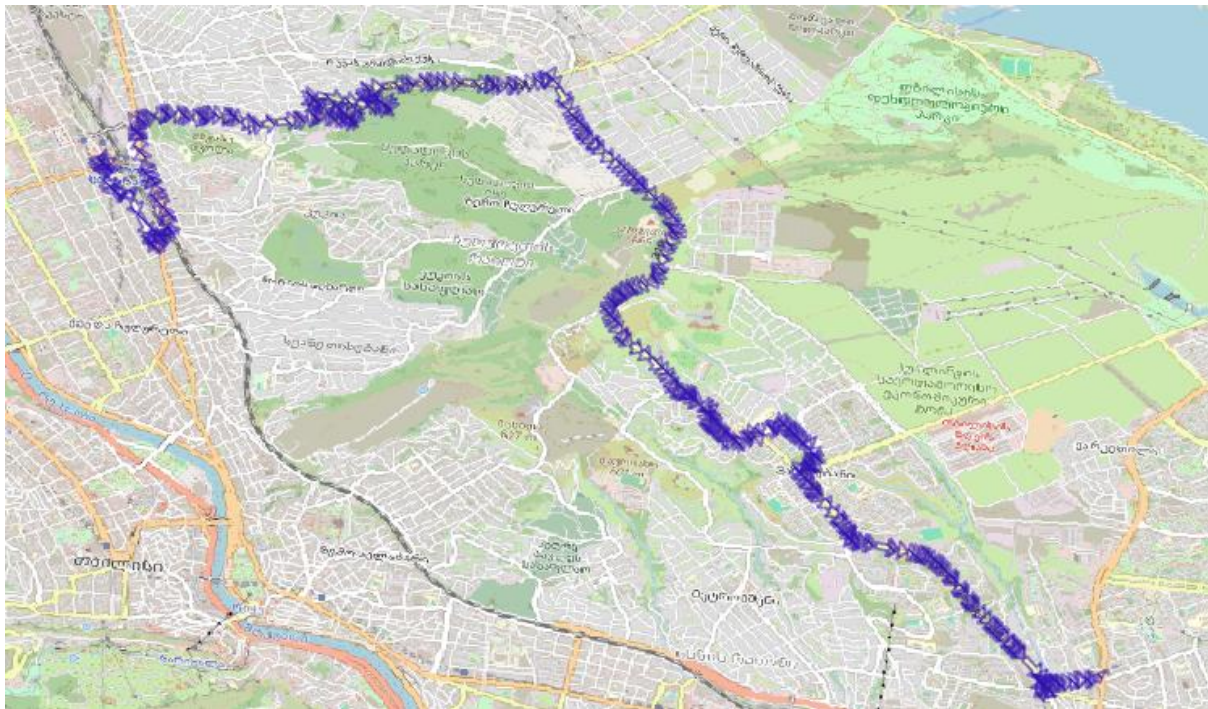
Figure 37 - Aggregated data for route 347 (on BA_AGGR sheet)

ROUTE_NUMB	FINAL_DESTINATION	MODEL_STOP_ID	trips	Value		Sum of		board_peak_avg		alight_peak_avg	
				1	2	1	2	1	2	1	2
347	Ne347_ Station Square 2	628	2	0.00	0.00	11	15	0	13		
347	Ne347_ Station Square 2	629	2	3.00	5.00	4	2	4	3		
347	Ne347_ Station Square 2	652	2	0.00	0.00	0	0	0	0		
347	Ne347_ Station Square 2	657	2	0.00	0.00	0	2	0	1		
347	Ne347_ Station Square 2	667	2	6.00	7.00	2	4	6.5	3		
347	Ne347_ Station Square 2	668	2	3.00	2.00	0	2	2.5	1		
347	Ne347_ Station Square 2	669	2	0.00	0.00	0	2	0	1		
347	Ne347_ Station Square 2	670	2	0.00	2.00	3	0	1	1.5		
347	Ne347_ Station Square 2	697	2	8.00	9.00	0	5	8.5	2.5		
347	Ne347_ Station Square 2	698	2	2.00	0.00	3	0	1	1.5		
347	Ne347_ Station Square 2	699	2	5.00	11.00	0	2	8	1		
347	Ne347_ Station Square 2	700	2	3.00	2.00	3	5	2.5	4		
347	Ne347_ Station Square 2	701	2	2.00	8.00	0	6	5	3		
347	Ne347_ Station Square 2	718	2	0.00	2.00	0	11	1	5.5		
347	Ne347_ Station Square 2	719	2	0.00	0.00	0	2	0	1		
347	Ne347_ Station Square 2	792	2	0.00	0.00	5	3	0	4		

Example 2. Route 319 with manual measurements

The second example concerns route 319, which is a bus route surveyed using manual paper forms rather than the *TransitWand* application. The route operates between Station Square and Varketili metro station (see Figure 38).

Figure 38 - Official alignment of Route 319



According to the *Final routes* worksheet, the data for this route were collected by two surveyor groups, WRV and BZB. In total, there were four measurements in one direction and four in the opposite direction, which provided balanced coverage of the route (See Figure 39).

Figure 39 - Overview of the measurements on the Final routes sheet on the 319 route

	A	B	C	D	E	F	G	H	I
	survey_full_id	unit_id	route_id	bus number	group code	route number	point A and B	route_name	Direction
920	319-A1	464793	319-A1	319	WRV	1	A	319	m/s Varketili - station saugre 1
921	319-A1	782293	319-A1	319	WRV	1	A	319	m/s Varketili - station saugre 1
922	319-A2	464793	319-A2	319	WRV	2	B	319	Station square 1 - m/s Varketili
923	319-A2	782293	319-A2	319	WRV	2	B	319	Station square 1 - m/s Varketili
924	319-B1	300135	319-B1	319	BZB	1	B	319	Station square 1 - m/s Varketili
925	319-B1	440868	319-B1	319	BZB	1	B	319	Station square 1 - m/s Varketili
926	319-B2	300135	319-B2	319	BZB	2	A	319	m/s Varketili - station saugre 1
927	319-B2	440868	319-B2	319	BZB	2	A	319	m/s Varketili - station saugre 1

The raw stop-level survey results are stored in the *Stops from paper* worksheet. These results contain the complete sequence of recorded stops for each trip, boarding and alighting counts for every stop, and supplementary trip-level information imported from the *Final routes* table (see Figure 40).

Figure 40 - Example of data on the Stops from the paper sheet

A	B	C	D	M	N	P	Q	R	S
unit_id	route_id	ROUTE_NUMBER	ROUTE_DIRECTION	board	alight	Date	Time	id	Stop_sequenc
464793	319-A1	319	m/s Varketili - station saugre 1	3	0	27/02/2025	08:30	94	1
464793	319-A1	319	m/s Varketili - station saugre 1	0	0	27/02/2025		94	2
464793	319-A1	319	m/s Varketili - station saugre 1	1	0	27/02/2025		94	3
464793	319-A1	319	m/s Varketili - station saugre 1	0	3	27/02/2025		94	4
464793	319-A1	319	m/s Varketili - station saugre 1	2	2	27/02/2025		94	5
464793	319-A1	319	m/s Varketili - station saugre 1	1	1	27/02/2025		94	6
464793	319-A1	319	m/s Varketili - station saugre 1	0	1	27/02/2025		94	7
464793	319-A1	319	m/s Varketili - station saugre 1	2	0	27/02/2025		94	8
464793	319-A1	319	m/s Varketili - station saugre 1	0	0	27/02/2025		94	9
464793	319-A1	319	m/s Varketili - station saugre 1	1	0	27/02/2025		94	10
464793	319-A1	319	m/s Varketili - station saugre 1	0	1	27/02/2025		94	11
464793	319-A1	319	m/s Varketili - station saugre 1	0	1	27/02/2025		94	12
464793	319-A1	319	m/s Varketili - station saugre 1	5	0	27/02/2025		94	13
464793	319-A1	319	m/s Varketili - station saugre 1	7	0	27/02/2025		94	14
464793	319-A1	319	m/s Varketili - station saugre 1	3	2	27/02/2025		94	15
464793	319-A1	319	m/s Varketili - station saugre 1	0	2	27/02/2025		94	16
464793	319-A1	319	m/s Varketili - station saugre 1	0	0	27/02/2025		94	17
464793	319-A1	319	m/s Varketili - station saugre 1	3	1	27/02/2025		94	18
464793	319-A1	319	m/s Varketili - station saugre 1	0	0	27/02/2025		94	19
464793	319-A1	319	m/s Varketili - station saugre 1	0	0	27/02/2025		94	20
464793	319-A1	319	m/s Varketili - station saugre 1	1	2	27/02/2025		94	21

Directions adjustment

In the raw paper-based data, the direction names were not always consistent as well. To fix these inconsistencies, we assigned each trip a standardized direction (destination) name manually. This was necessary not only to unify the paper-based measurements, but also to ensure that the labels of the directions could be directly compared and aligned with the *TransitWand* data.

As a result, for route 319, all trips toward Station Square were labeled as “№319_Station Square”, and all trips toward M/S Varketili were labeled as “№319_M/S Varketili” (see Figure 41). The standardized names were stored in the FINAL_DESTINATION column of the STOPS_TW&PAPER sheet, making both data sources fully compatible for further aggregation and analysis.

Figure 41 - Adjusted destination names

	B	G	AA
1	route_id	ROUTE_DIRECTION	FINAL_DESTINATION
2	319-A1	m/s Varketili - station sauqre 1	Nº319_Station Square
42	319-A1	m/s Varketili - station sauqre 1	Nº319_Station Square
158	319-B1	Station square 1 - m/s Varketili	Nº319_M/S "Varketili"
196	319-B1	Station square 1 - m/s Varketili	Nº319_M/S "Varketili"

Stop adjustment

To match the stops from the paper-based measurements with the official network of stops, we used the data on the *Model_stoppoints_sequence* worksheet. This worksheet contains the ordered sequence of official stops for each route and each direction.

The procedure was as follows:

- The direction of the survey trip was identified.
- Using the official stop sequence for that direction, the official stop ID was assigned to every stop in the measurement .

In Figure 42, an example of a stop sequence from one measurement is presented. In this case, the assigned destination is Nº319_Station_Square. The direction code represents a short internal code for this destination on the route, which simplifies further processing. On the *Model_stoppoints_sequence* sheet (Figure 43), the full ordered sequence of official stops for this route and direction is presented. By aligning the measured sequence with the official one, we assigned every stop in the survey to a corresponding official stop ID. The assigned IDs were added to the field *MODEL_ID* on the *STOPS_TW&PAPER* sheet.

Figure 42 - Example of a sequence of stops for one measurement.

B	G	M	O	Y	AA
route_id	ROUTE_DIRECTION	Stop_sequence	MODEL_STOP_ID	CORRE	FINAL_DESTINATION
319-A1	m/s Varketili - station sauqre 1	1	75768	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	2	1102	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	3	1290	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	4	1291	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	5	1287	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	6	1286	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	7	1294	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	8	1295	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	9	1284	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	10	1297	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	11	1298	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	12	1299	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	13	1279	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	14	1279	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	15	1278	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	16	1277	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	17	1122	<	Nº319_Station Square
319-A1	m/s Varketili - station sauqre 1	18	1121	<	Nº319_Station Square

Figure 43 - Example of an official stop sequence for the same direction code

B	C	D	J	L
LINEROUTENAM	DIRECTIONCODE	Route_num_wirh_d	RN_DIR_STOI	stop_id
319 <		319<	319<1	75768
319 <		319<	319<2	1102
319 <		319<	319<3	1290
319 <		319<	319<4	1291
319 <		319<	319<5	1287
319 <		319<	319<6	1286
319 <		319<	319<7	1294
319 <		319<	319<8	1295
319 <		319<	319<9	1284
319 <		319<	319<10	1297
319 <		319<	319<11	1298
319 <		319<	319<12	1299
319 <		319<	319<13	1279
319 <		319<	319<14	1279
319 <		319<	319<15	1278
319 <		319<	319<16	1277
319 <		319<	319<17	1122
319 <		319<	319<18	1121
319 <		319<	319<19	1119

Peak hour adjustment

To use the survey results to represent the average peak hour conditions, all observed data were scaled using the estimated service frequency. For route 319, the frequency was determined to be 8.6 buses per hour. Accordingly, each recorded observation at the stop level (boarding or alighting during a single trip) was multiplied by 8.6 and thus converted into its peak-hour equivalent.

Measurement Selection and Aggregation

The route 319 data were organized into four groups: two groups per direction, with two measurements in each group. At 08:30, two surveyor groups started their measurements in opposite directions. After completing the first trips, both groups moved to the return trip and started recording data. The measurements, which started at 8:30, were marked as trip_no = 1 and remaining measurements – as trip_no = 2 (see Figure 44).

Figure 44 - Assigning trips for aggregation

unit_id	route_id	survey_id	ROUTE_NUMBER	Date	Time	UNI_ROUTE_ID	FINAL_DESTINATION	trip_no
300135	319-B2	319-B2	319	2/27/2025	9:35:00 AM	P-100	Nº319_Station Square	2
440868	319-B2	319-B2	319	2/27/2025	9:35:00 AM	P-101	Nº319_Station Square	2
464793	319-A1	319-A1	319	2/27/2025	8:30:00 AM	P-94	Nº319_Station Square	1
782293	319-A1	319-A1	319	2/27/2025	8:30:00 AM	P-95	Nº319_Station Square	1
464793	319-A2	319-A2	319	2/27/2025	9:40:00 AM	P-96	Nº319_M/S "Varketili"	2
782293	319-A2	319-A2	319	2/27/2025	9:40:00 AM	P-97	Nº319_M/S "Varketili"	2
300135	319-B1	319-B1	319	2/27/2025	8:30:00 AM	P-98	Nº319_M/S "Varketili"	1
440868	319-B1	319-B1	319	2/27/2025	8:30:00 AM	P-99	Nº319_M/S "Varketili"	1

The measurements were aggregated in a pivot table using three key identifiers: route number, direction, and MODEL_STOP_ID. This aggregation produced boarding and alighting peak-hour values at each official stop on the 319 route, separately for the first trip, the second trip, and as an average across the trips (see Figure 45).

Figure 45 - Aggregated data for route 319 (on BA_AGGR sheet)

				Value	trip_no						
				Sum of			Sum of			board_peak_avg	alight_peak_avg
ROUTE_NUMBER	FINAL_DESTINATION	MODEL_STOP_ID	trips	1	2	1	2				
319	№319_M/S "Varketili"	1119	2	0.00	0.00	18	18			0	18
319	№319_M/S "Varketili"	1121	2	9.00	18.00	9	18			13.5	13.5
319	№319_M/S "Varketili"	1122	2	0.00	0.00	18	18			0	18
319	№319_M/S "Varketili"	1234	2	18.00	9.00	0	0			13.5	0
319	№319_M/S "Varketili"	1247	2	43.00	0.00	0	0			21.5	0
319	№319_M/S "Varketili"	1277	2	0.00	0.00	26	34			0	30
319	№319_M/S "Varketili"	1278	2	18.00	35.00	0	0			26.5	0
319	№319_M/S "Varketili"	1279	2	35.00	18.00	0	0			26.5	0
319	№319_M/S "Varketili"	1280	2	0.00	0.00	9	18			0	13.5
319	№319_M/S "Varketili"	1284	2	0.00	0.00	0	0			0	0
319	№319_M/S "Varketili"	1286	2	9.00	0.00	0	0			4.5	0
319	№319_M/S "Varketili"	1287	2	0.00	9.00	9	35			4.5	22
319	№319_M/S "Varketili"	1290	2	0.00	0.00	34	69			0	51.5
319	№319_M/S "Varketili"	1291	2	0.00	0.00	26	60			0	43
319	№319_M/S "Varketili"	1294	2	0.00	9.00	18	18			4.5	18
319	№319_M/S "Varketili"	1297	2	26.00	26.00	17	0			26	8.5