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Research Article

Design of a GNSS-Based Bus Stop Positioning and Real-Time Bus Tracking System with Web Map Integration

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Abstract This study presents a comprehensive approach that integrates GNSS-based measurements with web mapping technologies to enhance the spatial accuracy of public transport stops in the city centre of Karaman and digitally strengthen the existing transport information infrastructure. Increased mobility in urban public transport, rising user demand for real-time information, and the obsolescence of the existing inventory over time have necessitated the re-measurement of stop locations and their accessibility on a digital platform. In line with this, in the first phase of the research, all stops across the city were measured in the field using an RTK-supported GNSS receiver, obtaining position information with centimeter accuracy. The coordinates obtained were compared with the route-stop data set obtained from the municipality, incorrect points were corrected, and missing, duplicate, or location-uncertain records were filtered out to create an up-to-date and reliable stop database. In the second phase, real-time location data in JSON format obtained from GPS devices on buses was processed and integrated into an OpenStreetMap-based web map interface using Leaflet.js. The interface offers users an interactive experience with features such as stop search, route filtering, route viewing, and dynamic pop-up information. The results demonstrate a significant improvement in spatial accuracy and show that the system's scalable structure makes a strong contribution to urban transport management.

Keywords: Geospatial Data Integration, GNSS, Intelligent Transport Systems, Public Transport, Web-Based Mapping.

1. INTRODUCTION

Today, the efficient operation of urban transport systems has become one of the key determinants of sustainable city management. Increasing population density, rising demand for mobility, and diversifying expectations regarding journey times necessitate the support of public transport infrastructure with digital technologies. Advances in location-based technologies, in particular, enable public transport operations to be monitored and managed with real-time data, making vehicle tracking systems a strategic element in modern urban management [1]. In Turkey, in line with similar needs, it is observed that examples of applications focused on public transport and rail-based transport policies are becoming widespread in medium-sized cities [2].

Among positioning technologies, GNSS (Global Navigation Satellite System) is widely used in urban transport planning due to its high level of accuracy. In particular, RTK (Real-Time Kinematic)-supported GNSS measurements offer significant advantages in obtaining the precise coordinates of public transport stops [3]. However, GPS-based vehicle tracking systems, which are widely used in buses, provide important information for both passengers and decision-makers by integrating real-time vehicle location data into web-based maps [4]. In this context, the integration of GNSS and GPS-based tracking technologies into public transport plays a critical role in many processes, such as creating stop inventories, dynamically monitoring routes, and developing user information systems [5].

In recent years, studies evaluating the accuracy and performance of location-based technologies have also increased. In a study conducted by Stipancic et al. [6], five different map-matching algorithms used to correctly match GNSS data obtained from smartphones to the road network were compared in terms of accuracy and speed. Topological Map Matching (TMM) and Fast Hidden Markov Model (Fast HMM) algorithms were found to exhibit the highest accuracy and best overall performance. Fuzzy (FMM) and standard HMM algorithms, on the other hand, were found to have relatively low accuracy and longer processing times.

Comprehensive studies on the impact of real-time data usage on public transport operations support the importance of location information in planning and operational processes. Ibarra-Rojas et al. [7] noted that real-time location data significantly improved planning, operations, and control stages in bus operations; in particular, the dynamic calculation of travel times between stops and the communication of estimated arrival times (ETA) to users have become fundamental components of modern public transport. Similarly, Foell et al. [4] found that real-time tracking information via the Urban Bus Navigator (UBN) system reduced passenger waiting times and increased public transport preferences. Al Shammary and Saudagar [8] emphasized that real-time location displays provided by GPS-based tracking systems on Google Maps offer transparency and confidence to users.

In addition, the use of big data analytics and machine learning methods in the field of public transport is becoming increasingly widespread. For example, the graph neural network (GNN)-based ETA prediction model developed by Google Maps offers higher accuracy in predicting urban travel times compared to traditional methods [9]. Similarly, in a study conducted by Goel et al. [10], the distribution of pedestrians, cyclists, and public transport users was estimated using Google Street View (GSV) images; the results obtained were found to be highly consistent, particularly with bicycle and public transport indicators. These findings demonstrate that vehicle tracking systems have evolved from structures that merely provide real-time location sharing to advanced decisions that support mechanisms capable of generating forecasts through big data and intelligent analysis methods. Furthermore, in recent years, studies aimed at determining vehicle speed and queue density at intersections in real time using image processing and deep learning-based methods have gained momentum [11].

The ability of GNSS/RTK technologies to determine the locations of measurement points with centimeter-level accuracy provides a significant advantage in creating urban stop inventories [3]. Minetto et al. [5] examined how different satellite combinations affect navigation accuracy in their GNSS test environment for smart cities and demonstrated that GNSS performance is of critical importance, particularly in complex urban environments.

An examination of studies conducted in the field of intelligent transportation systems (ITS) in Turkey reveals that significant infrastructure projects are underway at the national level. Developed by the General Directorate of Highways, ITS projects have a broad component structure encompassing road condition monitoring, traffic density monitoring, sensor-based measurements, and driver information modules [12]. However, it is noteworthy that the majority of current applications focus on macro-scale national projects, while integration efforts for bus stop location and real-time public transportation tracking in medium-sized cities remain limited. A study conducted by Tufan [13] stated the need to create a national ITS architecture specific to Turkey and emphasized the importance of integrating existing systems within a framework compatible with international standards. In this context, the literature suggests that national projects should be supported by intelligent transportation architectures like K-ITS, in line with the principles of data integrity and interoperability [14].

Studies conducted from a sustainable transport perspective have demonstrated that integrating GNSS, sensor networks, and big data analytics can enhance energy efficiency, reduce traffic emissions, and enable smarter route planning [15]. Similarly, Van Manh and Hai [16] emphasized the potential of location-based data infrastructures in transport planning by demonstrating that their developed traffic information system can produce city-wide speed estimates and traffic density maps based on GNSS data. When literature is evaluated holistically, three fundamental gaps stand out:
(1) the lack of GNSS-based stop databases in medium-sized cities, (2) the failure to make real-time bus location information publicly available via web maps, (3) the inadequacy of low-cost systems that integrate GNSS + GPS + web maps.

This study aims to determine the locations of public transport stops in the city centre of Karaman with centimeter-level accuracy using GNSS technology and to make this data available to the public via web-based maps. Additionally, real-time vehicle tracking has been achieved by integrating real-time location data obtained from GPS-based tracking systems installed in existing buses with web maps. In this respect, the study fills a gap in the literature by offering a low-cost, feasible, and scalable model, particularly for medium-sized cities, and proposes a technical infrastructure that can be implemented by municipalities in Turkey. Furthermore, the digital infrastructure created serves as a database that could form the basis for mobile applications to be developed in the future. These contributions strengthen the original value of the research from both an academic and practical perspective.

2. WORK AREA AND DATA SET

2.1. Work Area

This study was conducted in the provincial centre of Karaman, located in Turkey's Central Anatolia Region, which has a population of approximately 210,000 [17]. The public transport network in the city centre consists of bus routes operated by the municipality, with route density, stop locations and passenger demand varying at the neighbourhood level. Urban focal points such as educational institutions, industrial facilities, public institutions, and new development areas are the main factors determining the distribution of public transport demand.

The failure to fully transfer public transport routes and stop locations to a digital environment in Karaman results in the current system offering limited accessibility to users. It is difficult for passengers to track the exact locations of stops, the routes followed by lines, or the real-time locations of buses; the lack of real-time data leads to longer waiting times at stops and negatively impacts time management. This situation has made Karaman a suitable case study for GNSS-based stop positioning, real-time vehicle tracking using GPS data, and web map integration.

Geographically, the city centre has a largely flat topography, which provides an advantage for GNSS measurements. However, typical urban limitations such as multipath signal reflections and a partially narrowed satellite view angle are observed in areas with high settlement density. Therefore, the use of RTK-supported GNSS technology has been considered a methodological requirement that enhances accuracy in urban measurements [3, 5].

2.2. Data Sets

The data sets used in the study are grouped under four main headings:

(1) GNSS field measurement data,

(2) municipal public transport data,

(3) bus GPS data, and

(4) web map services.

Each of these data sets is described in detail below.

2.2.1. GNSS Field Measurement Data

An RTK-enabled GNSS receiver was used to determine the positional accuracy of bus stops with high precision. This method enables the geographical coordinates (latitude-longitude) and orthogonal coordinates (Y, X) of the stops to be obtained with centimeter-level accuracy. Each stop was physically visited in the field, and measurements were completed by recording at least 30 seconds of epoch data. The raw data obtained was processed and converted into KML and GeoJSON formats; this data formed the main component of the stop database, which was the basis of the study.

2.2.2. Municipal Public Transport Data

Data obtained from the Karaman Municipality Transport Unit has been verified and updated by comparison with GNSS measurements. This data set contains the following components:

- Route numbers
- Route descriptions
- Bus Stop names
- Stop–route relationships
- Approximate location information for some stops

This information was used to create unique stop identifiers, match them with GNSS measurement results, and prepare stop information pop-ups displayed on the web map interface.

2.2.3. Bus GPS Data

Within the scope of this study, data obtained from GPS-based vehicle tracking systems currently installed on buses were provided in JSON format. As in many applications in the literature, these systems are effectively used to track the real-time location information of vehicles [4, 8].

The GPS data set consists of the following components:

- Instantaneous latitude and longitude information
- Bus speed
- Time stamp
- Vehicle identification number

These data are updated at specific intervals and transferred to the web map interface via API. This allows users to view the instantaneous locations of buses in real time.

2.2.4. Web Map Services and Software Components

OpenStreetMap-based web map services were utilized to digitally present stop, line, and bus location data. The platform's selection was motivated by its user-friendly API support, the direct integration of data layers such as KML/GeoJSON, and its open-source nature, which allows for interactive map design. Similarly, the OpenStreetMap infrastructure has been effectively used in the development of web-based applications focused on personal security and location tracking [18]. The data layers created in the study were organized into three groups:

- Stop layer (point data)
- Route layer (polyline data)
- Real-time bus location layer (dynamic data)

These layers have been integrated into a browser-based web interface, enabling users to view stops, examine routes, and track the real-time movements of buses.

3. METHOD

This study is based on determining the locations of public transport stops in the city centre of Karaman using high-accuracy GNSS measurements, verifying and updating the municipal route-stop dataset, processing real-time GPS data obtained from buses, and integrating all datasets into a web-based map infrastructure. The method applied in the study consists of the following processes: (i) determining stop locations through field measurements, (ii) validating municipal data, (iii) processing bus GPS data, and (iv) integrating all data layers into GIS and web map services. Figure 1 shows the methodological flow followed in the study within a holistic structure.

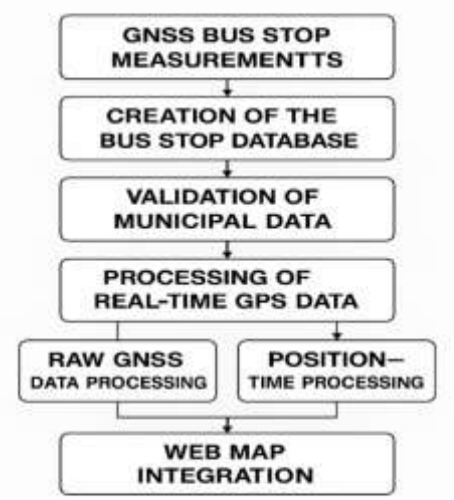

Figure 1. Combined method flow diagram of the study.

3.1. Determination of Bus Stop Locations Using GNSS

In the first phase of the study, all public transportation stops in the Karaman city center were visited in the field and RTK (Real-Time Kinematic)-supported GNSS measurements were conducted. The RTK technique is a reliable positioning method that provides real-time position correction with differential correction signals, offering centimeter-level precision [19]. It is stated in the literature that RTK-based measurements are frequently preferred in urban transportation planning, stop location, intelligent transportation systems, and infrastructure mapping applications due to their high accuracy [3, 5]. Furthermore, multi-GNSS evaluations conducted across Turkey show that the use of multiple constellations not only increases location accuracy but also improves satellite visibility [20].

At each station, the GNSS receiver was positioned at the point representing the physical centre of the station; epoch data was recorded for at least 30 seconds. During the measurement process, satellite visibility, signal quality and potential multipath effects were evaluated. As a result of these measurements, latitude–longitude and orthogonal coordinate values were obtained with high accuracy for each station.

3.2. Verification of Route–Stop Data Obtained from the Municipality

The route–stop data set provided by the Karaman Municipality Transportation Unit has been verified by comparing it with GNSS measurement results. The data set includes route numbers, stop names, route descriptions, and approximate coordinate information for some stops. During the verification process:

- Stop names were matched with stops measured by GNSS,
- Stops with incorrect or missing locations were corrected,
- Unique identifiers were assigned to stops with the same name,
- Stop lists were restructured for each route.

This stage is critical for ensuring the spatial accuracy of the stop database.

3.3. Processing Real-Time GPS Data Collected from Buses

Real-time location data was obtained in JSON format through the GPS-based vehicle tracking system used in buses. Similar systems in the literature are widely used for dynamic monitoring of vehicle locations [4, 8]. The GPS data set contains the following components:

- Instantaneous latitude–longitude information,
- Vehicle speed,
- Timestamp,
- Vehicle identification number.

These data are updated at specific intervals and transferred to the web map interface via API.

3.4. Data Integration into the Web Map Infrastructure

The web map component design utilizes an open map service based on OpenStreetMap (OSM) to ensure a flexible and scalable infrastructure. Map rendering and tile management are performed using the Leaflet.js library, while stop and route layers are dynamically loaded from GeoJSON-based data sources on the client side. This makes the system adaptable to real-time updates and improves client-side data processing performance. This architectural approach is technically similar to web map models used in OSM-based location tracking and security applications [18]. On the map interface:

- Stops were displayed as point symbols,
- Routes were represented using polyline structures,
- Bus locations were updated at specific time intervals.

Pop-up windows for each stop included the stop name, associated routes, and explanatory information.

3.5. Data Model and File Structure

Stop information, route numbers, scheduled arrival times and other attributes are stored in CSV (Comma-Separated Values) format; the geometric structure of the routes is stored in GeoJSON format. This structure enables fast data transfer and high compatibility in web-based applications.

3.6. Real-Time Location Update Mechanism

The movement of buses on the map is managed by a time-based update algorithm linked to the JSON data stream. Location updates are performed using the JavaScript setInterval function. The algorithm works as follows:

- The defined list of stops for the route is read.
- The time difference between stops is calculated.
- The intermediate location is determined using time interpolation.
- The SVG (Scalable Vector Graphics) based bus icon is moved on the map.
- The speed and time information for the new location is updated in the pop-up.

3.7. User Interface and Interaction Functions

Various interaction modules have been developed to facilitate user access to stops and routes:

- Stop Search: The entered stop name is automatically highlighted on the map.
- Route Filtering: Data for routes other than the selected one is made semi-transparent.
- Pop-up Information Windows: All explanatory information about the stop/route is displayed.
- Bus Tracking: Real-time information can be viewed by clicking on the moving vehicle icon.

These features enhance the digital accessibility of the public transport system by creating a functional output for the user.

4. FINDINGS

This section presents and evaluates the spatial data, map-based visualization outputs, dynamic information windows (pop-ups) and user interaction functions of the web-based public transport information system developed within the scope of this study. The findings are discussed in terms of both the spatial accuracy of the stop and route data and the functional performance of the developed interface.

Figure 2. Visualization of the stops and routes of a selected line in the provincial centre of Karaman on a web map.

4.1. Visualization of Routes and Stops on a Web Map

The stop locations determined by GNSS measurements and the route data obtained from Karaman Municipality were combined on an OpenStreetMap (OSM)-based web map interface, and the routes defined for each route were transferred to the map using the GeoJSON format. Symbolizing different routes with distinct colours enabled the comparison of routes and the analysis of complex route structures in a more comprehensible manner. Figure 2 shows one of the initial visualization outputs presented on the web map for a selected route, displaying its stop points and the route it follows.

When multiple lines are selected simultaneously, the relationships and intersections between the lines become more apparent. This view is important for examining the spatial density zones of the public transport network. Figure 3 shows the situation where multiple lines are visualized at the same time.

The integrated view, in which all lines and all stops are displayed simultaneously on the web map, is shown in Figure 4. This view comprehensively reveals the general structure of the public transport network in the Karaman provincial centre, stop densities and route distribution.

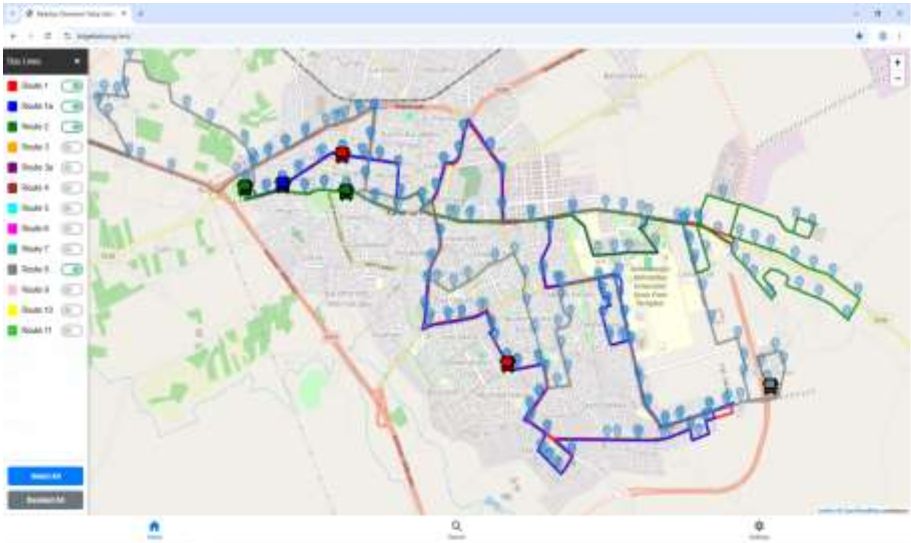

Figure 3. Visualization of the public transport network created using multiple route selection

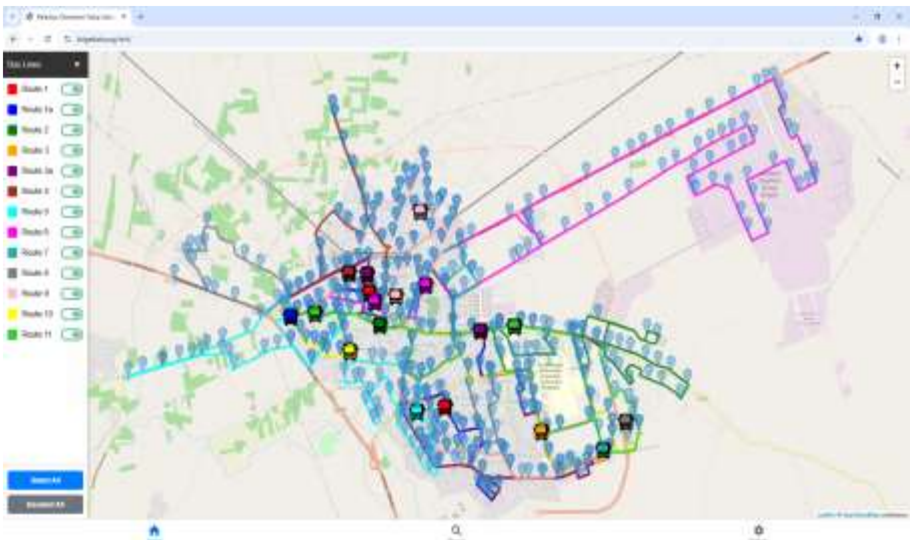

Figure 4. Overview of all public transport routes and stops in Karaman city centre

4.2. Pop-up Windows and Dynamic Information Displays

The developed web map interface includes pop-up windows that provide users with quick access to detailed information about stops and routes. Pop-up structures dynamically display attributes such as stop name, stop number, associated routes, estimated arrival times, and vehicle movement information. Figure 5 shows an example popup window displaying the location and estimated arrival time for the next stop on a route.

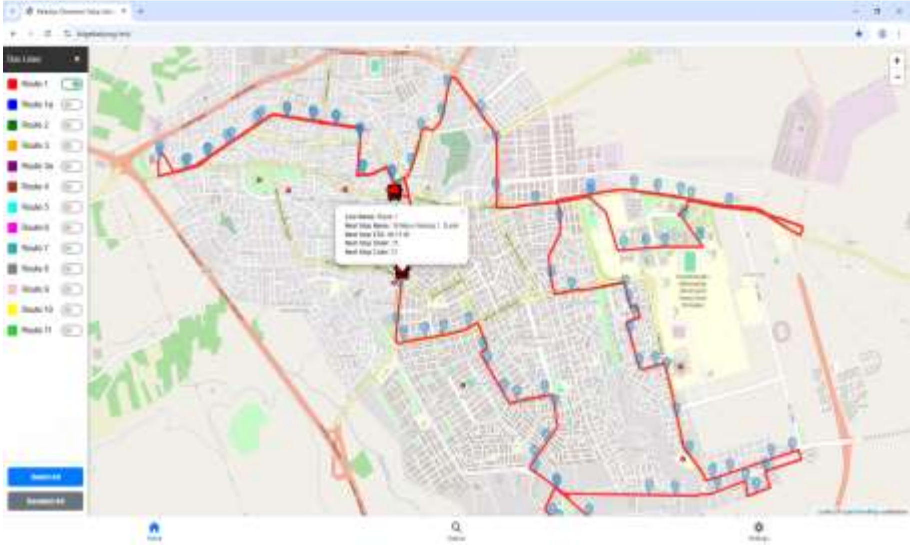

Figure 5. Route-based pop-up window: display of estimated arrival time for the next stop

Pop-up windows designed for stop-based data presentation list the estimated arrival times of the selected stop's incoming routes. Figure 6 shows an example output of this information window created for a stop.

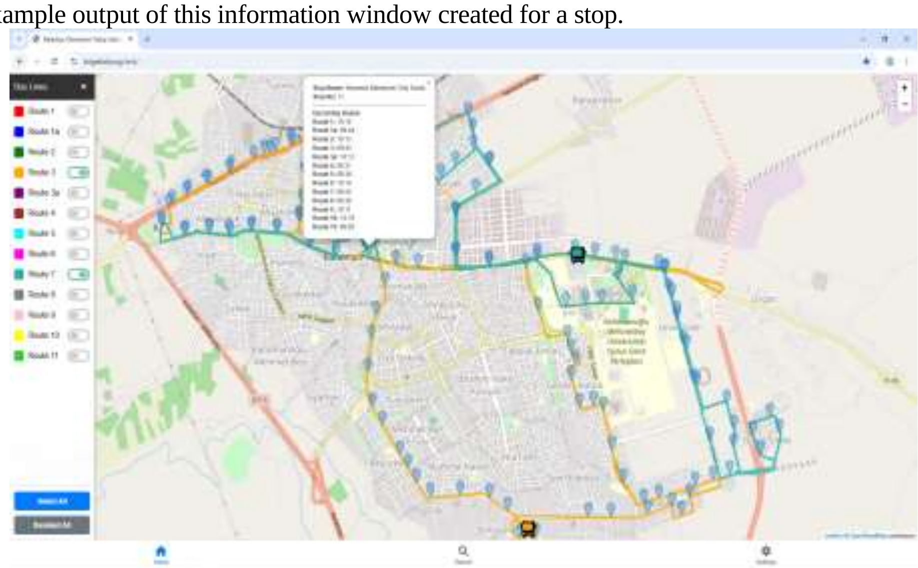

Figure 6. Stop pop-up window: routes arriving at the selected stop and estimated arrival times

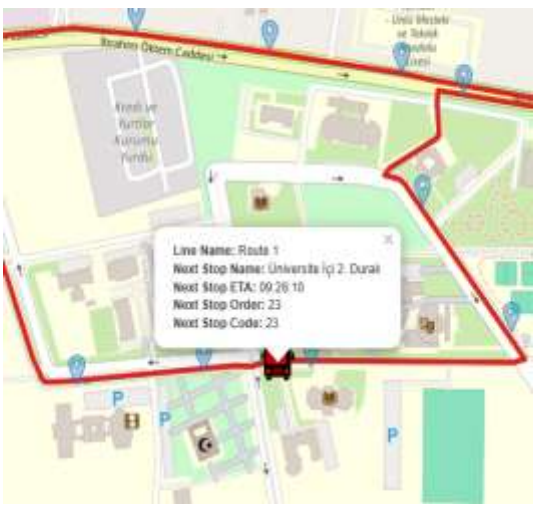

Figure 7. Dynamic bus pop-up window: vehicle ID, next stop name, stop sequence and estimated arrival time

The real-time movement of buses on the map is also supported by dynamic pop-up structures. Figure 7 shows an example of a dynamic pop-up window that appears when a moving bus is clicked, containing variables such as the vehicle ID, next stop, estimated arrival time, and stop sequence.

An example pop-up output for stops in the university area is shown in Figure 8. The accurate calculation of estimated arrival times in the campus area, which has high passenger density, demonstrates the functionality of the system created.

Figure 8. University bus stop pop-up window: bus stop name, bus stop number and information about upcoming buses

4.3. User Interaction Functions: Stop Search and Route Filtering

Stop search and route filtering features have been developed to enhance user interaction on the web interface. The stop search box, equipped with an autocomplete feature, automatically lists relevant stops when the user enters only part of the stop name. This function improves the user experience, particularly in urban areas with a large number of stops. Figure 9 shows the stop search function with the autocomplete feature on the web interface.

Figure 9. Stop search feature: interface view of the auto-complete function

The visualizations and interactive functions presented in this section demonstrate that the developed system is both spatially accurate and reliable, and that it functions effectively with a user-friendly interface. Determining stop locations with GNSS accuracy, correctly visualizing route–stop relationships, and presenting real-time information flow through dynamic pop-ups increases the system's usability in public transport planning and user information processes.

5. DISCUSSION

This study is based on the high-accuracy positioning of public transport stops in the city centre of Karaman using GNSS, the verification of route-stop information obtained from the municipality, and the integration of all data into a web-based OSM (OpenStreetMap) interface. The findings present an innovative system that is consistent with studies in literature in terms of spatial accuracy, data integrity, user information capacity, and interface functionality, and is suitable for practical application.

5.1. GNSS-Based Bus Stop Positioning and Accuracy Evaluation

Thanks to RTK-supported GNSS measurements, stop coordinates were obtained with centimeter precision, producing reliable results in terms of location accuracy and repeatability. These findings are consistent with literature demonstrating the effectiveness of GNSS-based methods in location determination applications requiring high accuracy [3, 5]. Furthermore, studies on multi-GNSS implementation emphasize that multi-satellite constellations both increase location accuracy and improve solution stability [20].

Comparing stop coordinates obtained from the municipality with GNSS measurements revealed significant positioning errors at some stops. This situation demonstrates the necessity of a field-based GNSS inventory and parallels the literature emphasizing the importance of creating up-to-date and reliable databases in public transport infrastructures. In this regard, correcting the errors identified in the municipal dataset contributes to the sustainable operation of the system in the future.

5.2. Discussion of Web Map-Based Visualization

The integration of all routes and stop data on the web-based OSM infrastructure has enabled the spatial structure of the urban public transport network to be presented in a more comprehensible manner. The differentiation of routes using different colours and the symbolic representation of stops have facilitated the effective analysis of the network's overall structure by both users and decision-makers.

Web map-based visualization is considered an effective tool in processes such as transportation planning, bus stop density analysis, and route optimization. This study, with an application conducted in Karaman, confirmed the contribution of web maps to urban mobility analysis and demonstrated the applicability of this method to medium-sized cities as well. The presented solution also aligns with the user-centricity and data integrity principles adopted in intelligent transportation systems [14].

5.3. Dynamic Information Display and Passenger-Focused Functions

The dynamic pop-up windows created have ensured the effective use of passenger information functions by presenting stop-based information alongside estimated arrival times for upcoming buses. This feature is compatible with user information services, defined in the literature as one of the most critical components of real-time transport systems.

Due to the inability to regularly obtain real-time GPS data on some routes, a location update approach based on time interpolation has been implemented. This method is similar to simulation-based location update models proposed in the literature and offers practical solutions, particularly in situations where data is missing. In this context, the developed system is a hybrid model that both supports the existing data flow and generates predictions in the event of data gaps.

5.4. Strengths of the System

The key strengths of this study can be summarized as follows:

- GNSS-based stop location accuracy: The inventory created based on field measurements has increased the reliability of stop coordinates and significantly reduced spatial errors.
- Verification and improvement of municipal data: Identifying and updating missing or incorrectly located stops has contributed to ensuring data integrity and creating an up-to-date transport inventory.
- Interactive usage features: Functions such as stop search, route filtering, pop-up information windows, and bus location tracking have enriched the user experience and increased the system's accessibility.
- Low-cost and sustainable structure: The system can operate without requiring external server infrastructure and offers a long-term sustainable solution as it can be operated even with static data files.

These strengths demonstrate that the developed application is a practical, accessible, and viable alternative for both municipal management and passengers.

5.5. Limitations and Points for Discussion

As with any application, this study has certain limitations. These limitations are summarized below:

- Irregularity of real-time GPS data: Time interpolation was applied as a continuous data flow could not be ensured on all lines.
- Inconsistencies in vehicle GPS devices: Some devices occasionally produced erroneous or incomplete data.
- Incomplete municipal route data: It was found that route data for some routes was not up to date.
- No system load testing was performed: The platform's performance under heavy user load has not yet been evaluated.

These limitations indicate areas for improvement in future work to enable the system to be applied on a larger scale.

5.6. Discussion on Contribution to Literature

This study contributes to literature in various ways:

- Creating a GNSS-based public transport stop inventory at the local level and ensuring high accuracy of location data through field measurements,

- Verifying the collected data by comparing it with municipal records and creating a more reliable database by correcting missing/incorrect stop information,
- Integrating real-time GPS data into the system and enabling the tracking of bus movements in real time,
- Establishing a low-cost, scalable, and sustainable structure based on open data formats (GeoJSON, CSV, JSON).

In these respects, the study presents a valuable practical example of the verification, updating and real-time traceability of urban public transport data; it offers a practical and applicable model, particularly for medium-sized cities.

6. CONCLUSION AND RECOMMENDATIONS

This study aimed to determine the locations of public transport stops in the city centre of Karaman using high-accuracy GNSS-based measurements, to verify the route-stop information obtained from the municipality, and to integrate all data on a web-based map service, presenting it through a user-friendly interface. The results obtained demonstrate that urban public transport data has been significantly improved in terms of both spatial accuracy and digital accessibility.

The GNSS measurements taken as part of the study ensured that stop locations were obtained with centimeter-level accuracy and enabled the correction of errors identified in the municipal dataset. Standardizing the data formats used (CSV, GeoJSON, JSON) ensured that the data became organized, updatable and compatible with web map services. The web-based map interface created offered practical and accessible functionality for both passengers and local authorities, featuring visualization of route paths, stop search, route filtering, and dynamic pop-up windows. Time-location interpolation, applied in situations where real-time GPS data could not be fully provided, supported the continuity of the system by consistently reflecting the estimated locations of vehicle movements. The integration of all route and stop information on a single platform forms an important basis for spatial density and accessibility analyses of urban transport.

Based on the findings, several recommendations can be made to transform the system into a more advanced structure. Firstly, it is important to strengthen real-time GPS integration and enable the system to operate in full real-time mode by ensuring a regular flow of data from municipal vehicles. Furthermore, creating additional data layers such as stop density, passenger demand and frequency of use will increase the system's analytical capacity. The study need not be limited to bus routes; it could be expanded to cover other modes of transport such as minibuses, cycle paths or scooter parking areas. Adapting the web map interface to a mobile application format will facilitate passenger access to the system and increase its usage rate. Furthermore, supporting advanced functions such as route suggestions, stop optimization, and estimated journey time calculations with artificial intelligence and machine learning models will strengthen the system's usability as a decision support mechanism. Regular data sharing by the municipality will enable the system to be offered to a wider audience in line with open data principles, while periodic repetition of GNSS measurements will contribute to maintaining data integrity in the face of route changes and new stop additions.

Overall, while this study was conducted specifically in the province of Karaman, it presents a flexible, low-cost, and sustainable public transport information system model that can be easily implemented in all medium-sized cities across Turkey. The integration of web map infrastructure with GNSS-supported location accuracy provides a strong foundation for local authorities' digital transformation processes in public transport and contributes significantly to data-driven decision-making processes in transport planning.

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Authors’ Contributions

FB led the conceptualisation of the study and the development of the methodology, carried out GNSS data collection and analysis processes, and contributed to the validation and writing stages. AP carried out software development, web map integration, data processing and visualisation processes, and supported the validation and writing process. ÖS was responsible for providing municipal transport data, verifying the stop inventory, field coordination and resource management, and contributed to the writing and evaluation stages. All authors contributed equally to the design, interpretation and writing of the study; they read and approved the final version of the paper.

Competing Interests

The authors declare that they have no conflict of interest.

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