

An Open Source Framework for Routing and Event Management in University Campuses

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Abstract

The ever-evolving nature of university campuses presents unique challenges for web-based routing and event coordination, as physical layouts frequently change due to ongoing construction and development. To address these dynamic spatial and logistical needs, this paper designs and develops an open-source, web-based framework for routing and event management. The framework implements routing functionalities based on OpenStreetMap using Open Source Routing Machine (OSRM). The framework supports three distinct user groups: (i) guests, (ii) registered students and staff, and (iii) supervisors. To assess OSRM's reliability in a campus setting, we compared its route distances with those obtained from the legacy geospatial database. For pedestrian and bicycle modes, strong correlations of 90% and 89% were found across thousands of routes connecting 78 campus units, confirming OSRM as a reliable routing solution. A key strength of the framework lies in its modular, open-source architecture, which makes it easily adaptable and replicable across other campus settings with minimal customization. The replicability workshop demonstrated that six out of seven participants coming from different backgrounds have successfully launched the application on their own computers. The framework is referred to as *ROAMer*, intended to stand for *Replicable OSRM Application for Campus Routing and Event Reporting*.

Project's GitHub Repo: <https://github.com/ROAMer-Geo/Web>

1. Introduction

University campuses function as microcosms of cities, offering a controlled yet complex environment to analyse spatial dynamics, optimize mobility and accessibility, and manage infrastructure and resources efficiently for sustainable development. Many geographical information science and technology research studies take university campuses as their region of study ranging from walkability (Mu & Lao, 2022) to achieving net-zero energy campuses (Chaer, Ozarisooy, Elnour Ismail, Salari, & Zhihui, 2025). Furthermore, studying university campuses provide a basis for establishing proof of concepts, as the developed systems can be scaled to different urban areas. One of the critical tasks in this context is the modelling of university campuses' road network. Routing is not only important for newcomers but also for visitors to the campus. Moreover, events are often held in specific buildings, making effective navigation crucial (Regalia, McKenzie, Gao, & Janowicz, 2016).

Universities may choose to have their own geodatabase to store their road network and buildings. However, it is a costly process requiring technical expertise to maintain and update such databases. This includes regular updates to reflect new constructions, changes in building usage, or modifications in road layouts, all of which demand coordinated efforts between departments. Without proper maintenance, the geodatabase can quickly become outdated, reducing its effectiveness for routing, facility management, and emergency response planning. Therefore, while a dedicated geodatabase provides autonomy and precision, universities must carefully consider its long-term sustainability and explore opportunities for integration with open-source or publicly available spatial data platforms (Pourabdollah, Morley, Feldman, & Jackson, 2013). OpenStreetMap (OSM) has consistently attracted new users and contributions, demonstrating robust growth that is projected to continue expanding its coverage across various study areas (Arsanjani, Mooney, Helbich, & Zipf, 2015; Chen, Liu, Ding, & Jiang, 2024).

The quality of OpenStreetMap (OSM) data has been an active research area for almost two decades. Initial assessments established OSM's positional accuracy to be approximately six meters, and although "the information quality can be, indeed, very good", it is important to note that inconsistencies may occur due to the differences between the digitization process of many volunteers (Haklay, 2010). Although this finding was further supported by considering completeness, geometric, and attribute accuracy; the heterogeneity of OSM data could be a serious issue due to the lack of interest of volunteers to digitizing the under-mapped areas (Girres & Touya, 2010). On the other hand, recent studies show a continuous increase in OSM data completeness (reaching up to 80%), and that the uneven spatial coverage particularly for features like buildings have mostly been resolved in many urban centers (Herfort, Lautenbach, Porto de Albuquerque, Anderson, & Zipf, 2023). Therefore, it is not surprising that all stakeholders - including national mapping agencies (Du, Alechina, Jackson, & Hart, 2017), non-governmental bodies (Zook, Graham, Shelton, & Gorman, 2010), and international companies (Ma, Fan, Li, & Ding, 2020) are interested in sustaining the development of OSM.

Fitness for purpose can be considered as the fundamental conceptual data quality criterion, encompassing various measures such as accuracy, granularity, completeness, and consistency, among others. Routing is one of the application areas in addition to geocoding and POI search (Ballatore & Zipf, 2015). Open Source Routing Machine (OSRM) is a high-performance, web-based routing engine designed to calculate the shortest routes between locations using OSM data. It is one of the pioneering projects that leverage and add value to the OSM road network and has been in use for nearly 15 years (Luxen & Vetter, 2011). OSRM not only provides the shortest path between two points for three different transportation modes (car, bike, and foot), but can also be extended to estimate journey times (Huber & Rust, 2016) and support routing for wheelchair users (Li, Storandt, Müller, & Weber, 2021). The readily available

Application Programming Interface (API), as well as the Docker image of OSRM, facilitate seamless integration into web-based systems and enable rapid deployment of customized routing services on local servers (Shamshad & Haq, 2020).

The importance of computational reproducibility and replicability (R&R) in geographical analysis has already been highlighted by esteemed researchers (Brunsdon, 2016; Kedron, Frazier, Trgovac, Nelson, & Fotheringham, 2021). There is also a growing demand in academic publishing requesting authors to comply with computational reproducibility (Nüst et al., 2018), which in turn would likely advance the education quality (Hodza, Berendsen, & Hamerlinck, 2021). Although utilizing Free and Open Source Software for Geospatial (FOSS4G) and relying on open-data are crucial for R&R, public reusability of the developed tools are also critical to gain broader benefits of reproducible research (Boeing, 2020).

The aim of this paper is to design and develop an open-source web-based framework for campus mapping and event reporting. Consequently, routing within-campus units and location-based event management are realised. The web-based framework leverages open-source tools and technologies, so that setting up the system for another university does not require a proprietary software or any additional financial cost. Specifically, the system architecture integrates several open-source technologies: geographic data is sourced and managed through OSM, while routing functionality is provided by OSRM. The backend infrastructure is built using Node.js, supported by a PostgreSQL/PostGIS database for efficient spatial data storage and querying. On the client side, a React-based frontend and Material UI ensures a dynamic and responsive user interface. The outline of this paper is as follows. Second section describes the literature review. Third section focuses on the OSRM route analysis between obtained from the new framework and the legacy database. Fourth section introduces the open-source framework. Fifth section describes the replicability workshop of an earlier version of the framework. Finally, sixth section presents the conclusions and future research directions.

2. Literature Review

Universities utilize web GIS technologies across a wide range of tasks from administrative and academic processes to campus life management. The transition to web-GIS has strengthened location-based decision support mechanisms and facilitated easy access to spatial information for various stakeholders, including administrators, academics, students, and visitors. This ease of access, combined with stakeholder participation in data collection, has brought significant benefits to university administrations (Rinner, Keßler, & Andrusis, 2008).

Although smart campus initiatives may be used for a variety of purposes ranging from optimizing classroom usage to air quality monitoring, the traditional spatial components of an interactive web-based campus maps include i) searching for a POI, ii) routing, iii) street-view imagery, and iv) printing maps (PDF export). Some studies also investigate the user experience benefits of 3D campus maps (Lu, Zhou, Guo, Chen, & Pei, 2021). In addition, multi-language support is a key feature that enhances the system's accessibility. Finally, authorized login functionality allows for additional security and provide real-time updates within the system. Indoor navigation is also a distinctive feature of a campus. However, as it is a research topic in its own right, and one that may involve privacy or ethical restrictions regarding data sharing, it is not discussed within this paper. Considering the aforementioned seven components of interactive campus maps,

four universities across the United States are investigated in more detail as illustrated in Figure 1.

The three established universities rely on professional solutions for their web-based campus maps. Specifically, Harvard University's web-map is built on an ArcGIS Indoors license; Stanford University's basemap and road networks are maintained via Google Maps, and UCLA has partnered with a commercial software provider that also supports the web-mapping platform of some other universities (e.g. Trinity University, <https://map.trinity.edu/>).

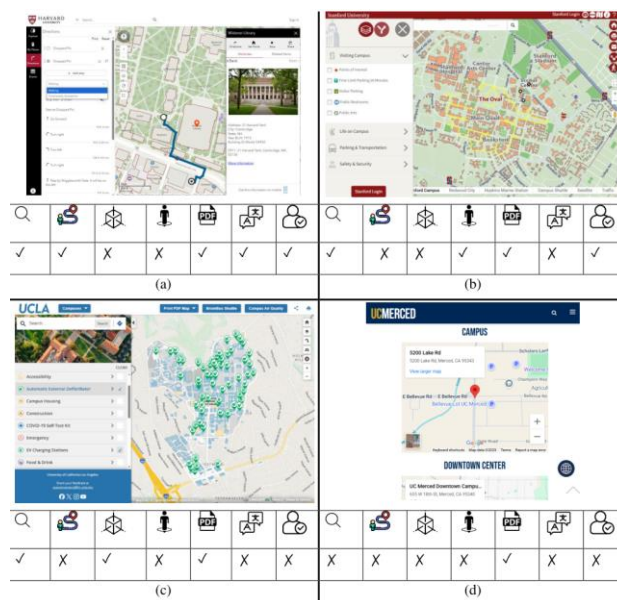


Figure 1. Different universities web-based map sites. Each university is assessed in terms of i) poi-search, ii) routing, iii) 3D support, iv) street-view, v) PDF export, vi) language support, and vii) authorized login respectively (as of 30 June 2025).

- (a) Harvard, <https://mapprod.cadm.harvard.edu/portal/apps/indoors>
- (b) Stanford, <https://campus-map.stanford.edu/>
- (c) UCLA, <https://www.maps.ucla.edu/>
- (d) UCMerced, <https://www.ucmerced.edu/maps>

Finally, as one of the youngest campus universities in the United States, UC Merced offers a notably simpler web-based mapping service compared to those of well-established institutions. This streamlined platform provides a downloadable campus map and driving directions from different highways. Albeit not recent, earlier research (Su, Slottow, & Mozes, 2000) shows that UCLA previously relied on proprietary solutions which are no longer available today. This observation highlights a key concern in long-term sustainability. Specifically, the value of open-source alternatives to proprietary solutions is highlighted, as they offer greater transparency, adaptability, and resilience against vendor discontinuation.

The second part of the literature review investigated the 20 papers retrieved from Scopus by searching the keywords: 'campus map' and 'web' keywords together as of 17 July 2025. Due to the significant evolution of web-based technologies, the focus has been limited to the nine publications published since 2015. Access was limited to the abstracts of two of these publications, as full texts required a subscription not available to the authors. First, Baek, Choi, & Kim (2024) focused on the important topic of identifying the locations of Automated External Defibrillators (AEDs) and stated that 'most campus maps did not provide AED information'. The other publication, by Maidin et al. (2021),

addressed the development of a campus website, but the provided URL in the abstract is no longer functional highlighting a change in technology, web infrastructure, or maintenance practices.

Yan & Wong (2021) presented an excellent and sophisticated campus map integrating shortest path computation in both 2D and 3D spaces, with functionality extending to indoor routing for The Hong Kong University of Science and Technology. Their work can be explored further at <https://pathadvisor.ust.hk/>. The main limitation, however, is that suggestions can only be linked to a geographical context by geolocating the issue based on its textual description, which may require additional communication between the reporter and system administrators if the reporter has opted to provide an email address. In addition, the source code of the project has not been made publicly available, making it difficult to replicate the system at another university. Heilig (2018) highlighted the importance and legal issues surrounding the development of accessible web-based interactive maps. It was found out that as the criteria list increases, it becomes difficult to satisfy them. Specifically, information about the ramps and elevators of buildings and sidewalks depicted with curb cuts and crosswalks are two issues commonly overlooked in web-based maps. The majority of other studies that focus on 3D campus relied on a proprietary ArcGIS license (Pispidikis et al., 2018; Syafuan, Husin, & Azizi, 2022). Another study on water monitoring and management relied on the proprietary Microsoft Silverlight platform, which has not been supported since 2021 (Shi, 2017).

Search log analysis had been the focus of two papers, which provide useful information to the developers of interactive campus maps, as user behaviour and interest could better be understood. Chao (2016) investigated the user search behaviour and query characteristics on the University of New Mexico (UNM)'s interactive campus map using Google Maps API. Although the author emphasized that the API was free, companies' API usage policies may change over time (Teuguia, 2025), and the website provided in the abstract is no longer accessible. Furthermore, UNM now appears to offer a similar interactive campus map powered by the same software vendor used by UCLA. Second, Tang, Tong, & Du (2014) investigated search log of almost six months of different levels (i.e. term, query, and session). Query-level investigation found out that the user traffic varied substantially on special days (e.g. national holidays or beginning of a new semester). Session level analysis identified that the users are likely to quit using the interactive map after five queries. Finally, frequent keyword analysis using the Generalized Sequential Pattern algorithm revealed that the two longest sequences returned no results, indicating the need to update the database.

3. OSRM Route Analysis

This section compares the route lengths of OSRM and a legacy database of a campus university. An analysis of the pedestrian routes revealed a 90% correlation between the two datasets as can be observed in Figure 2a. The OSRM routes (~915.9 meters) were on average almost one meter shorter than the legacy database routes (~916.7 meters). The highlighted origin-destination pair in route A reveals the incomplete data in OSRM. Specifically, the identified OSRM distance is much larger compared to the database due to a missing topological connection for the pedestrian network in OSM. The much shorter route obtained from the legacy database, and the OSRM route are illustrated in Figure 2b.

It is also important to note that the start and end points of the routes differ between the datasets. This discrepancy arises because the OSRM routes were generated using coordinates from the legacy system. These legacy points were not necessarily located directly on the OpenStreetMap (OSM) road network. As a result, OSRM performs a snapping operation, aligning the given coordinates to the nearest routable point on its network. This snapping process is the primary source of the observed mismatch in start and end locations between the two datasets.

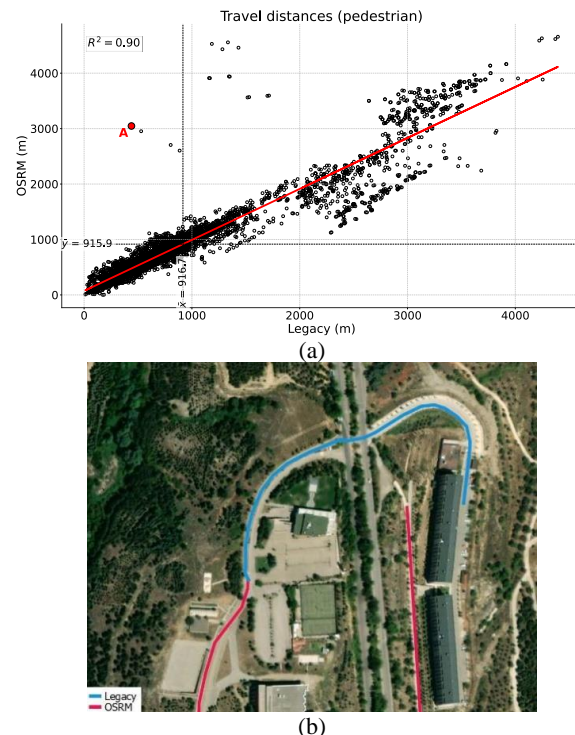
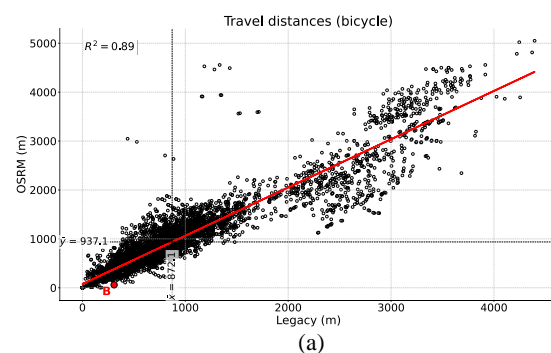


Figure 2. Pedestrian routes' distance comparison for OSRM and the legacy database (a). Route A in two datasets (b)

A similar analysis was conducted for the bicycle mode, revealing an 89% correlation between the two datasets, as illustrated in Figure 3a. However, in this case, the routes from the legacy database were, on average, nearly 7% shorter than those from OSRM. This suggests that the legacy system may have incorporated more intricate or localized details. In contrast, the OSM-based network appears to be less complete for bicycle routing. Therefore, when updating the OSM network, special attention should be given to the accuracy and presence of tags related to bicycle infrastructure. For instance, a campus administrator could quickly address this by conducting a brief on-site survey to identify missing or misclassified bicycle paths and update the OSM data accordingly.



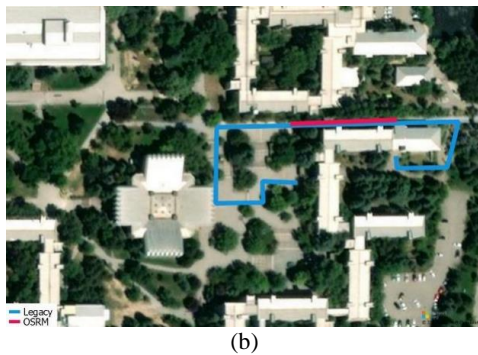


Figure 3 Bicycle routes' distance comparison for OSRM and the legacy database (a). Route B in two datasets (b)

Although the analysed paths between these units could have been obtained using the Directions API or Routes API offered by Google, it is against the Google Maps APIs Terms of Service to create a database on top of them and distribute them (Google, 2025). As of 1 July 2025, the item 10.4.c.ii states that “No creation or augmentation of data sets based on Google’s Content or Services. You will not use Google’s Content or Services to create or augment your own mapping-related dataset (or that of a third party), including a mapping or navigation dataset, business listings database, mailing list, or telemarketing list.”. Therefore, we have excluded analysis using Google’s content in this paper. Nevertheless, this statement also strongly supports the use of open-source technologies for developing web-based routing applications, as it might not be feasible for a newly established university in a developing country to allocate such a financial resource (Choi, Hwang, Kim, & Ahn, 2016). The eight benefits of relying on open-source software to implement the operational use and distribution of geo-processing services have indeed been identified for more than two decades ranging from no software costs to ease of compatibility with existing IT infrastructure (Anderson & Moreno-Sanchez, 2003).

4. Open Source Framework for Routing and Event Management in University Campuses

This paper introduces an open-source web-based framework designed to provide routing features and display campus events. The map-based framework is designed to be used by three different users: i) guests, ii) registered students and personnel, and iii) supervisor. First, guests are the public and anonymous users who can access the routing features and general campus information without logging in. Second, registered students and personnel can post events to their associated units. Specifically, universities host many student clubs, each of which organizes a wide range of events. In order to provide an organized view to these student clubs events, all such events are grouped under one location, initially determined during the setup of the system. On the other hand, registered personnel can post events associated with their units. Finally, the supervisor has administrative privileges and oversees the overall functioning of the system with full access to all information. One of the main tasks of the supervisor is the approval of registered students and personnel. Only after this approval registered students and personnel can post events. Due to its importance, the supervisor is required to log in using a 2FA (Two-Factor Authentication) mechanism to ensure an additional layer of security beyond the standard username and password.

The framework is developed entirely using open source tools and technologies. Specifically, while OSM and OSRM are the key components, the framework is composed of three main parts: i)

frontend, ii) backend, and iii) database. The technologies used in these parts are illustrated in Figure 4.

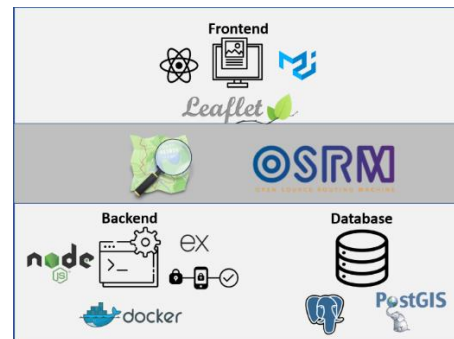


Figure 4. Open-source technologies used in the framework

The frontend architecture utilizes React.js in combination with Leaflet for interactive geospatial visualization and Material UI to ensure a responsive and accessible user interface. The backend is implemented using Node.js and Express, incorporating 2FA and *bcrypt* to enhance the security of user authentication by hashing the passwords. Docker is employed specifically for running the OSRM, enabling efficient and scalable routing services within the application without the need to sending API requests. Data storage and spatial processing are managed using PostgreSQL with PostGIS extensions, supporting efficient handling of campus units/buildings, and user-reported updates such as missing roads or buildings. Such feedback, submitted exclusively by registered users, can subsequently be utilised to update OSM.

The use-case diagram of the framework is shown in Table 1, which depicts the three types of users (guests, registered students and personnel), and their roles and capabilities. The only difference between the registered students and personnel is the location of events they post. All student posts appear in a single shared location, whereas personnel posts are displayed under their respective campus units.

	Guest	Student	Personnel	Supervisor
Routing	✓	✓	✓	✓
Display events/units	✓	✓	✓	✓
Login	✗	✓	✓	✓
2FA	✗	✗	✗	✓
Confirming registrations	✗	✗	✗	✓
Adding a new event	✗	✓	✓	✓
Adding a new unit	✗	✗	✗	✓

Table 1. Use-case diagram

The web-interface, illustrated in Figure 5, has seven panels/sections that provides interactive guidance and visualization.



Figure 5. The User Interface (UI) of the framework

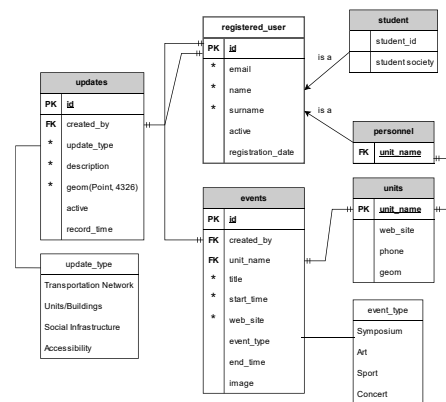


Figure 6. The Entity-Relationship (E-R) diagram of the framework

The primary functionality of the developed framework is routing, which offers users a range of options. Routing between any two points can be performed either by typing the name of the campus units or by selecting locations directly on the map as demonstrated in panel 1 of Figure 5. The source code and video tutorial for replicating the framework are available through the project's GitHub repository (for review: <https://anonymous.4open.science/r/isprs26-campus-1F77/>).

The unit name appears on the system when clicked on the start point and end point. The framework supports three routing modes: i) walking, ii) cycling, and iii) driving. These modes are readily available in OSRM, which is used to obtain the routes based on the selected mode of transportation. The distance between the selected points is also displayed. Start and end markers can be positioned interactively. Finally, two buffer zones are created to represent 5-minute and 10-minute walking distances from the location of the pedestrian icon illustrated in panel 2. These zones are based on an assumed walking speed of 1 meter per second, which accommodates a wide range of typical walking speeds for both men and women up to the age of 70 (Bohannon & Williams Andrews, 2011). The button illustrated in panel 3, clears the map and illustrates only the base OSM map. In panel 4, users can activate to view the events and the units. Once events are activated, a special icon, illustrated with label 5, displays student societies' activities. In this way, students will have an organised view of all the events organized within the university. A key feature of the framework is its bilingual support, enabling users to switch between two languages as illustrated in panel 6, which is also used to login and register to the system. Finally, panel 7 provides additional visualization by supporting street view and offering remote sensed aerial images instead of OSM as the base map.

The developed framework can be adapted to a different university campus, during which some of the following environmental parameters have to be configured:

- **Campus boundary (geojson):** Determines the boundaries of the study region. It is used for better user interaction. Specifically, routing is available only within this region, and users' selecting somewhere outside are warned.
- **Student events' location:** The latitude and longitude of the icon to be positioned that holds all student registered events.
- **Institution logo (jpg):** Institution logo is displayed on the top-left of the system.
- **Institution name:** Displayed on the title of the system.
- **Email settings:** Registered students/staff will receive an email generated via the Ethereal, which is a fake Simple Mail Transfer Protocol (SMTP) service (<https://ethereal.email/>).
- **Acceptable Email Domain:** Only registered students and staff with an institutional email address are permitted.

A relational-database approach is adopted in the framework, reflecting the foundational principles of traditional GIS systems, as illustrated in Figure 6.

The database design aimed to minimize the user input. For example, when entering event details, the web-based user interface only requires the event's start time (indicated with an asterisk in Figure 6). The end time is automatically set to five days after the start time and is therefore hidden from the user interface. After the end time, the system automatically removes the event from the display. Furthermore, the user is required to provide a description only when submitting an update –selected from one of four predefined options– to assist the supervisor in reviewing the submission. Specifically, *updates* table holds the necessary geographic information that requires an update in OSM.

5. Replicability Analysis Workshop

The replicability of a preliminary version of the framework was tested with voluntary participants on 24 May 2025. Volunteers were recruited on a first-come, first-served basis through a LinkedIn post announcing the workshop. The registration form was completed by 22 participants within a day of the post, far exceeding the initial capacity of 10, which led to the form being closed earlier than anticipated. A summary of the responses is presented in Table 2. The LinkedIn post itself received nearly 200 likes and endorsements, reflecting strong interest in the event.

Survey Item	Summary of responses		
Gender	16 male, 6 female		
Sector	Private:	13	
	Public:	7	
	Not specified:	2	
Profession	Geomatics/ Surveying	9	Academic 2
	Developer	8	City planner 2 Geographer 1
Web-based development	No: 8		
	Yes: 14		

Table 2. Registrant overview.

Among the 22 registrants, 14 confirmed their attendance with laptops; however, only seven of them participated in the workshop (Figure 7). As we did not follow up with the registrants afterward, the reasons for this discrepancy remain unclear.



Figure 7. A photograph from the workshop

The workshop began with participants downloading .osm data for randomly selected universities from OSM. Each participant then processed the data using a series of command-line tools: *osmium-cat*, *osrm-extract*, *osrm-partition*, and *osrm-customize*. The processed data was subsequently deployed into an OSRM container running within Docker. This workflow was successfully executed across both Windows 10/11 and macOS 14 platforms, demonstrating cross-platform compatibility.

The framework was configured to interact with each participant's local OSRM endpoint. Parameters, such as the university name, logo, initial map centre, and default zoom level, were customized via the .env file. Following an average installation time of approximately 90 minutes across different platforms, participants successfully generated routes between two randomly selected points and verified the results, with response times consistently under 150 milliseconds. Figure 8 presents screenshots from four of the successful implementations.

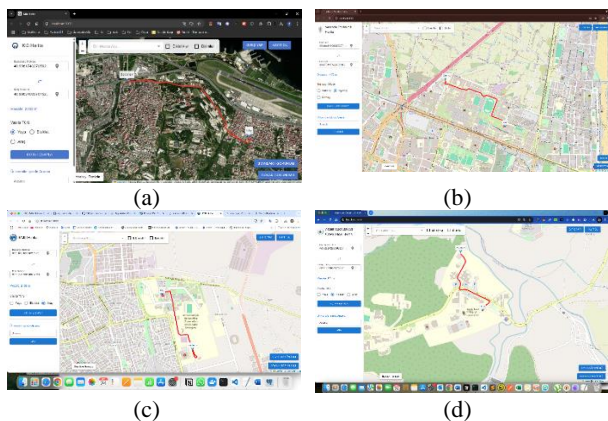


Figure 8. Different universities campuses were modelled during the replicability workshop on different operating systems.

Karadeniz Technical (a) and Valencia Politeknik Universities (b) on Windows; Karamanoğlu Mehmetbey (c) and Abant İzzet Baysal Universities on macOS.

Three main issues were encountered during the workshop. First, one participant did not have Node.js installed on their computer, which required additional time to set up the necessary software. Second, some participants lacked experience with React and Node.js integration, necessitating extra guidance and debugging when configuring connections between the server and client. Finally, the installation scripts were initially written using Windows-specific directory separators and path syntax, which led to platform incompatibilities. These issues were resolved by modifying commands and adjusting file permissions for participants using macOS. While one of the initial objectives of the workshop was to test the database connection for event and

user management, this could not be carried out due to time limitations. Consequently, the main limitation of this study lies in the fact that essential parts of the framework, including the database and event management components, were not evaluated, resulting in limited evidence for its easy replication and sustainable deployment.

Despite these technical challenges, an initial version of the framework was successfully deployed by all but one participant, owing to the container-based architecture and flexible configuration files. The only participant who was unable to complete the framework did so because Docker could not be installed. The experimental study demonstrated that the proposed framework provides a sustainable navigation infrastructure for campus environments by solely relying on open source technologies.

6. Discussion

The project has been regarded as successful by the IT Management of our university since its launch on 28 July 2025. This positive assessment is evidenced by subsequent requests to expand the system's scope, including the integration of additional points of interest such as Automated External Defibrillators (AEDs) in early September 2025 and potable water stations in February 2026. These requests encompassed both campuses of Hacettepe University, namely Sihhiye Campus and Beytepe Campus, with the latter corresponding to the cluster located in the south-west of Figure 9. While the current implementation focuses on the Beytepe campus, there is a clear expectation to extend the system to the Sihhiye campus in future developments (Figure 10c).

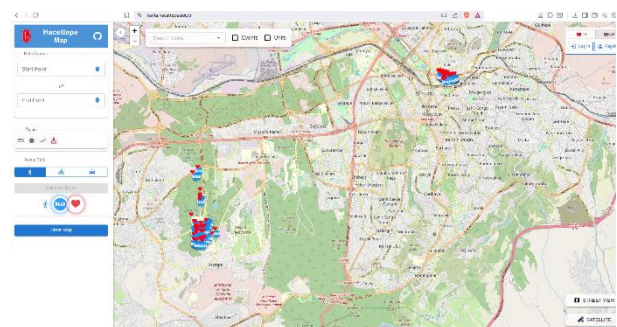


Figure 9. The POI-based extensions requested just after the launch of the project

In addition, the navigation infrastructure of the project has been deployed within the mobile application developed by the IT department, *HuMobil*, and is accessible via both the Google Play Store and the Apple App Store (Figure 10a). The distinction between the two campuses can be visually verified. It can be observed that the "Route Planner" (*Rota Planla*) displays only the units in Beytepe campus as of 19 May 2026 (Figure 10b).

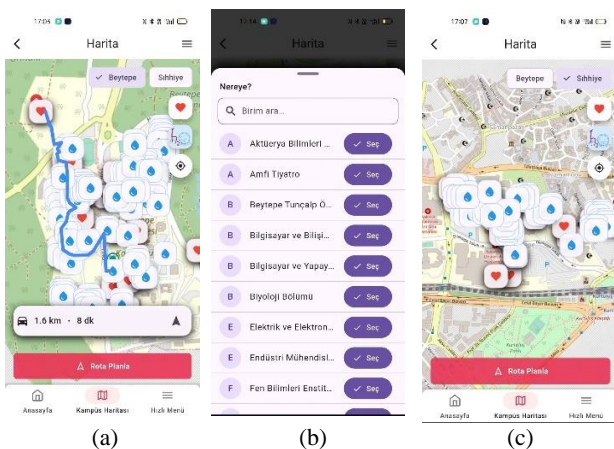


Figure 10. Route planning is currently available only for the Beytepe Campus (a), as the relevant units are implemented exclusively in this area (b). In contrast, the newly added POI layers, AEDs and potable water stations, are available for both the Beytepe and Sıhhiye campuses (c).

The development of the mobile application further validates the applicability of the proposed web-based framework, as its core components and services have been successfully integrated and deployed within the mobile environment.

7. Conclusions

Campuses are dynamic geographic environments characterised by the continuous development of new roads, pavements, and buildings. In response to these evolving needs, a web-based framework for routing and event management has been introduced. Developed as an open-source and modular platform, the framework is designed to be easily adaptable and replicable across different campus settings. With minimal customization, other institutions can deploy the system using their own spatial data, thereby supporting a wide range of use cases without the need for proprietary software or extensive technical infrastructure.

This paper presents the design and development of the *ROAMer* framework. The framework integrates a web-based routing and event-reporting system, enabling campus users to access route planning and points of interest. Its functionality and replicability were demonstrated through a proof-of-concept workshop, which also highlighted practical strategies for extending coverage and incorporating additional infrastructure data, such as AEDs and potable water stations. By combining OSM-based routing with locally curated datasets, *ROAMer* provides a flexible and scalable solution for campus navigation and event management, offering both administrators and end-users a user-friendly and adaptable tool. While the workshop involved only seven participants, this limited sample does not diminish the meaningful insights gained regarding the system's replicability and practical applicability. A follow-up replicability workshop is planned to be conducted during the 25th ISPRS Congress under the title 'Open Web-GIS for Disaster Response and Campus Routing: From Architecture to Deployment'.

Future work will focus on expanding the system's capabilities through the integration of sensor-based data (e.g., CCTV cameras, air quality monitoring sensors etc.) to support real-time monitoring. Additionally, developing a robust API support will facilitate the distribution of geographic and event-related data to third-party applications and institutional platforms, fostering interoperability and scalability. Furthermore, future efforts will

focus on obtaining user feedback and performing systematic evaluations tailored to the primary stakeholders, namely guests, registered students and personnel, and supervisors, to inform further improvements to the system. Last but not least, at the moment, the framework remains primarily an academic endeavour, and it is critical to investigate the long-term sustainability of the framework, which necessitates the involvement of other stakeholders. This might include integration with the university's IT department, ensuring not only technical support but also fostering a sense of shared responsibility and institutional ownership. The development of the mobile application by the IT department had been an important milestone in this regard.

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