UnlockedMaps: A Web-Based Map for Visualizing the Real-Time Accessibility of Urban Rail Transit Stations

Ather Sharif
asharif@cs.washington.edu
Paul G. Allen School of Computer
Science & Engineering | DUB Group,
University of Washington
Seattle, Washington, USA

Aneesha Ramesh
aneeshra@cs.washington.edu
Paul G. Allen School of Computer
Science & Engineering,
University of Washington
Seattle, Washington, USA

Qianqian Yu
qyu8@uw.edu
Applied and Computational
Mathematical Sciences,
University of Washington
Seattle, Washington, USA

Trung-Anh H. Nguyen
trunganh.nguyen@duke.edu
Department of Political Science,
Duke University
Durham, North Carolina, USA

Xuhai Xu
xuhaixu@uw.edu
The Information School | DUB Group,
University of Washington
Seattle, Washington, USA

ABSTRACT

Limited visibility into real-time accessibility in current web-based maps disenfranchises urban rail commuters who rely on functioning station elevators (e.g., wheelchair users). We shed light on the experiences of such commuters through interviews with representatives from five stakeholder groups (people with mobility disabilities, pregnant people, cyclists/stroller users/heavy-equipment carriers, disability advocates, and civic hackers). Motivated by our findings, we present UnlockedMaps—an open-data map that visualizes the real-time accessibility status (accessible, experiencing at least one elevator outage, not-accessible) of urban rail stations in six North American cities and displays nearby accessible restaurants and restrooms, assisting users in making informed decisions regarding their commute. We assessed UnlockedMaps by conducting (1) an exploratory user study, (2) controlled and "in-the-wild" longitudinal studies, and (3) follow-up interviews with our stakeholder groups. Our findings show that UnlockedMaps is a "for-us-by-us" solution that benefits all stakeholder groups, including those who do not rely on functioning elevators.

1 INTRODUCTION

According to a report by the United States Department of Commerce [2], over four million people utilized at least one form of urban rail transit in 2019 to commute to work. Among these commuters are people who can benefit from rail transit *only if* the transit stations are accessible, such as people with mobility disabilities, who constitute 13.7% of the United States population. Web-based maps are the most frequent method of map dissemination, enabling people to share data effectively and efficiently. However, for commuters who rely on the accessibility of stations (functioning elevators, in particular), no web-based map exists that assists them in making informed decisions about their commute based on the real-time elevator outage status of transit stations. Additionally, while some transit authorities communicate information on *active* elevator outages through their websites, none of them provide the data on *past* elevator outages to the public. The lack of exposure to this historical data can not only reduce public transparency into the inequities faced by disabled commuters but also potentially occlude avenues for disability advocates to drive policy changes.

To assist users in making informed decisions regarding their commute, we developed "UnlockedMaps," an open-data web-based map, to highlight the real-time accessibility of urban rail transit stations. To do so, as a preliminary step, we interviewed members of our stakeholder groups to gather insights into their commuting experiences. Our stakeholder groups were: (1) people with mobility disabilities; (2) pregnant people; (3) cyclists/stroller users/commuters with heavy equipment; (4) members of disability advocacy groups; and (5) civic hackers. Unlike existing solutions, UnlockedMaps allows users to visualize urban rail transit stations by their accessibility status (accessible with functioning elevators, accessible but experiencing an elevator outage, or not-accessible). Additionally, using UnlockedMaps, users can view accessible restaurants and restrooms in the vicinity of their desired transit stations. We recorded the elevator outages over 28 months (≈2.3 years) from 2,336 transit stations, enabling users to assess the reliability of transit stations. We made this data publicly available via an Application Programming Interface (API) for public consumption and display on the UnlockedMaps' user interface (UI), providing transparency into the history of elevator outages. UnlockedMaps is the first system to (1) display the real-time accessibility of urban rail transit stations using a web-based map; and (2) provide data on the history of transit station elevator outages in multiple cities.

2 DATA COLLECTION AND API

To collect transit stations and elevator outage data, we scraped the websites of transit authorities. Specifically, we recorded station names, longitude, latitude, wheelchair accessibility, bike rack availability, parking availability, ticket office presence, connecting service lines, and elevator outages at those stations (outage time, station information, elevator location, and advisory message). Although crowdsourcing is a plausible method of collecting data [1, 4], the websites of transit authorities served as a reliable and sufficient source for our needs. Our system automatically collects the station data quarterly (every three months) and the elevator outages data every hour for each of the six North American cities. As of the date of this writing, our automated script collected information on 1,061,375 elevator outages over the past 23 months. All our data is publicly available via two API endpoints: (1) https://api.unlockedmaps.com/v1/stations; and (2) https://api.unlockedmaps.com/v1/outages.

3 USER INTERFACE (UI)

To visualize the real-time accessibility of urban rail transit stations by their elevator outage status, we created a website[1]. Our solution was motivated by the findings from our formative study, which sought to understand the experiences of commuters who rely on functioning elevators. Our website has two main components: (1) *map page* and (2) *station page.*

3.1 Map Page

The *map page* highlights the real-time accessibility status, providing users with data filtering options and a legend for colors and icons. Our goal was to maximize the display area of the map while simultaneously providing users with prominent visibility into the filtering options and map legend. Therefore, we divided our map page into two main sections: (1) *filtering options for station-related attributes* (name, wheelchair accessibility, bike rack availability, and parking availability); and (2) *filtering options for transit authorities.* Additionally, we created our website following the guidelines on responsive web design from prior work [3], enabling users to interact with our system using various devices.

3.1.1 Filtering by Station-Related Attributes. UnlockedMaps' map page provides users with five options to filter stations by: (1) *searching/selecting the desired station*; (2) *wheelchair accessibility*; (3) *bike rack availability*; (4) *parking availability*; and (5) *transit line and authority.* Our system enables users to select multiple options for filtering data using any combination.

3.1.2 Filtering Options for Transit Authorities. Filtering options for transit authorities is a collapsible menu (collapsed by default) located at the top-left corner. When expanded, the menu displayed a list of transit lines organized by their respective transit authorities, with a checkbox next to the transit lines for easy filtering.

3.2 Station Page

The *station page* displays the information about a transit station, including elevator outage history and accessible restrooms and restaurants nearby. We displayed the recent (current and past month) elevator outage history on the *station page* to provide transparency into the reliability of transit stations. Similar to Google Maps, we implemented a "Food Nearby" section on our *station page.* We scraped the Yelp API to get the list of restaurants near a given station. As our goal was to display the *accessible* restaurants, we filtered out the restaurants to include only those that were wheelchair accessible. Additionally, we implemented a distance slider that enables users to specify a search radius for accessible restaurants, ranging from 0.5 miles to 2 miles. We used the Refuge Restrooms API to obtain the list of accessible restrooms near a given station. Similar to the Yelp API, the Refuge Restrooms API also supports filtering the results by ADA compliance.

3.3 Accessibility

To make our website accessible, we followed the WCAG 2.1 guidelines and ensured that the contrast ratio was at least 3:1 using the WebAIM Contrast Checker tool. We also included icons next to our text to assist users, such as people with Alexia[2], in comprehending the written language. Additionally, we ensured that the icons' colors were Color Vision Deficiency (CVD) friendly.

4 CONCLUSION

We developed UnlockedMaps, an open-data web-based map that displays the real-time accessibility of urban rail transit stations in six North American cities. We created UnlockedMaps to assist people who rely on functioning elevators at transit stations for their commute and to provide transparency into elevator outages. In addition to displaying real-time elevator outage statuses, UnlockedMaps offers users the ability to view accessible restaurants and restrooms near any given station and to filter the stations on the map by wheelchair accessibility, bike rack availability, parking availability, and transit lines and authorities. Our work is the first system to collect elevator outage data over almost two and a half years and make it available for public consumption via our API. We conducted formative, exploratory, and longitudinal studies with follow-up interviews with our stakeholder groups to assess the usability of UnlockedMaps. Our results show that all of our participants found UnlockedMaps user-friendly and beneficial for their needs, appreciated the transparency into the elevator outage data, and liked the central focus on accessibility, considering UnlockedMaps as a "for-us-by-us" solution.

REFERENCES

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[4] Eric Schenk and Claude Guittard. 2011. Towards a characterization of crowdsourcing practices. *Journal of Innovation Economics Management* 7, 1 (2011), 93–107.

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[1]https://unlockedmaps.com

[2]Alexia is a rare condition in which reading comprehension is nonexistent or significantly limited due to brain injury, damage, or trauma.