Measuring Disruptions’ Impacts on the Reliability of Public Transit Accessibility with High-resolution Real-time Transit Data

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# Introduction

Accessibility is the primary indicator of a public transit system’s useability. It determines passengers’ ability to reach opportunities given a fixed amount of time [CITATION NEEDED]. However, high reliability of public transit systems’ accessibility is a primary disadvantage compared to other transportation systems. Transit systems are highly dynamic and time-dependent, and their actual arrival time and accessibility can be significantly different from the scheduled time. On-time performance loss worsens the useability and user experience of transit systems, and it is one of the most important reasons why people do not favor public transit among other mobility options [CITATION NEEDED].

A major cause of unreliability is public transit systems’ vulnerability to outer disruptions, including short-term and long-term disruptions. Short-term disruptions introduce temporary disturbances usually in only a part of the system. Prominent examples are traffic jams, extreme weather, and major social events. Short-term disruptions affect accessibility primarily by influencing the on-time performance, in the form of delayed or early arrivals. Long-term disruptions have persistent impacts on the reliability of the whole system, such as the COVID-19 pandemic and schedule changes caused by budget cut. Besides the on-time performance, long-term disruptions can also change the schedule, which create more nuanced patterns of unreliability.

Some prior studies discussed public transit’s accessibility unreliability. Wessel, Allen, & Farber (2017) and Wessel & Farber (2019) assessed the unreliability of schedule-based accessibility with respect to retrospective real-time accessibility; they calculate schedule-based measure from transit schedule data and calculate retrospective real-time accessibility from historical real-time vehicle location data. They find significant unreliability in schedule-based accessibility. Nevertheless, retrospective measure assumes users know *a priori* the actual arrival time (Wessel & Farber, 2019), which is only attainable after the event happens. Therefore, retrospective accessibility cannot be realized by a user. It does not represent the actual accessibility that a user experiences during operation, and the deviation of retrospective accessibility from schedule-based accessibility cannot accurately reflect accessibility unreliability.

In this paper, we use *realizable real-time accessibility* – a space-time prism measure that can be achieved by ordinary users (Liu, Porr, & Miller, 2022). It uses both schedule and real-time data to simulate the decision-making process of users. It acknowledges users’ inability to use the actual arrival time *a priori* when planning their trips. The measure is a more accurate representation of users’ actual accessibility experience, and its deviation from schedule-based accessibility can be a good indicator for the reliability of the public transit system.

# Literature review

We review relevant literature in this section.

# Method

We present our method in this section.

## Data

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