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BUS STOP ATTRACTIVENESS SCORING USING SMART CARD DATA

PROJECT PROPOSAL

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1 Introduction

Public transport is an essential component of daily life, which is why continuous efforts are made to make it more sustainable, accessible, and affordable. Despite these efforts, many cities struggle with people preferring private to public transportation, causing variety of problems.

Recent advancements in data collection, especially with Automatic Fare Collection (AFC) systems and Smart Card Data (SCD), have been a key factor to analyse and understand passenger behaviour to optimise public transportation. Smart card transactions reveal when and where passengers board or alight buses, offering insights into travel patterns and network dynamics.

This study aims to develop a **Bus Stop Attractiveness Scoring (BSAS)** framework using smart card data, encompassing multiple bus lines. Unlike optimisation-based works that focus on improving route planning and network efficiency, this approach prioritises human-oriented understanding of service accessibility by analysing how and why people choose specific bus stops. By doing so, it aims to provide personalised, data-driven suggestions for passengers to help them make more informed travel decisions and improve their public transport experience.

2 Literature Survey

Earlier studies on public transport optimisation [1], [2], [3] emphasised algorithmic efficiency in route planning using Dijkstra-based methods, fuzzy accessibility measures, or transfer-minimisation strategies. While these approaches were effective in improving network performance, they largely treated passengers as static objects rather than active decision-makers. Most existing studies therefore focused on route-level optimisation or network-wide accessibility, overlooking how individual stops influence passengers' travel choices.

More recent work, such as Luo et al. [4], introduced joint passenger flow prediction models to understand multimodal travel interactions. This study showed the potential of using large-scale Automatic Fare Collection (AFC) data for uncovering hidden mobility patterns.

However, the literature remains limited when it comes to analysing bus stop attractiveness from a passenger perspective. This study addresses that gap by evaluating the passenger preferences based on smart card data, using measurable factors such as boarding frequency, temporal patterns, and inter-line connectivity. Ultimately, the focus shifts from *"How to make a route more optimal?"* to *"Which stop suits a passenger's needs the most?"*, offering a user-oriented perspective that supports personalised travel recommendations.

3 Methodology

3.1 Data Source

The dataset provided by Luo et al. [4] consists of smart card records covering the Haidian District of Beijing, ranges between the dates 07/03/2016–13/03/2016, includes 45 bus lines with 128 bus stations and 4 metro lines with 13 metro stations. Some of the important fields of these records are the following:

Type	Variable	Description	Value
Metrosystem	GRANT_ID	Grant card ID	10000 – 99999999
	ENTRY_TIME	Entry station time	2016/03/07 00:00:00 – 2016/03/13 23:59:59
	DEAL_TIME	Deal time	2016/03/07 00:00:00 – 2016/03/13 23:59:59
	LINE_CODE	Line code	4, 6, 9, 10
	ENTRY_NUM	Entry station number	1 – 13
	EXIT_NUM	Exit station number	1 – 13
	ENTRY_STATION	Entry station name	–
	EXIT_STATION	Exit station name	–
Bus system	BUSDATA_ID	Bus card ID	18... (11 digits total)
	DEAL_TIME	Deal time	2016/03/07 00:00:00 – 2016/03/13 23:59:59
	UP_TIME	Update time	2016/03/07 00:00:00 – 2016/03/13 23:59:59
	LINE_CODE	Line code	114, 121, ... (45 lines total)
	VEHICLE_CODE	Vehicle code	–
	ON_STATION	Getting on station number	1 – 128
	OFF_STATION	Getting off station number	1 – 128

3.2 Data Preprocessing

- **Filtering and Cleaning**: Remove records with missing or inconsistent data.
- **Multi-line Transfer Trips**: Identify sequential trips with the same-card to detect transfer behaviour between the lines.
- **Day-Level Aggregation**: Combine multiple bus and metro lines to find daily routines.
- **Stop-Level Aggregation**: Calculate the total number of boardings, unique passengers, and lines passing per stop.

3.3 Bus Stop Attractiveness Scoring (BSAS) Framework

The **Attractiveness Score (AS)** for each bus stop S_i is computed as a weighted aggregation of three key metrics derived from the Smart Card Data according to the methodology mentioned above:

$$AS_i = w_1 \cdot N_{boardings_i} + w_2 \cdot LineDiversity_i + w_3 \cdot TransferFrequency_i$$

Where:

- $N_{boardings}$: Number of boardings at S_i
- $LineDiversity$: Number of unique bus lines serving at S_i
- $TransferFrequency$: Frequency of transfers occurring at S_i
- w_1, w_2, w_3: Weight coefficients to be calculated

4 References

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