KSK COLLEGE OF ENGINEERING AND TECHNOLOGY

DEVLOPEMENT PART1

1. Introduction

City bus transportation is a public transportation option that is commonly used in many countries as it supports the growing transportation demand and takes into account affordability for passengers [1]. Thus, having qualified bus services becomes a key factor for smart life in a city. In this case, before enhancing the service quality, we need to understand the current quality of service (QoS) of bus transportation, then improve it point by point. The QoS of city bus transportation is generally measured by user surveys: e.g., Wethyavivorn and Sukwattanakorn [2], Ueasangkomsate [3], Chan et al. [4], Page and Yue [5], and Goyal et al. [6]. These studies found that the common issues are accessibility, availability, reliability, security, and comfortability. As to research from Thailand, the authors of [2,3] stated that passengers in particular areas of Bangkok had serious concerns about the physical facilities and service reliability. The results of [3] were reported to the government to help it plan policies for enhancing the efficiency of public buses. The relevant works are reviewed in Section 2 and summarized in Table 1.

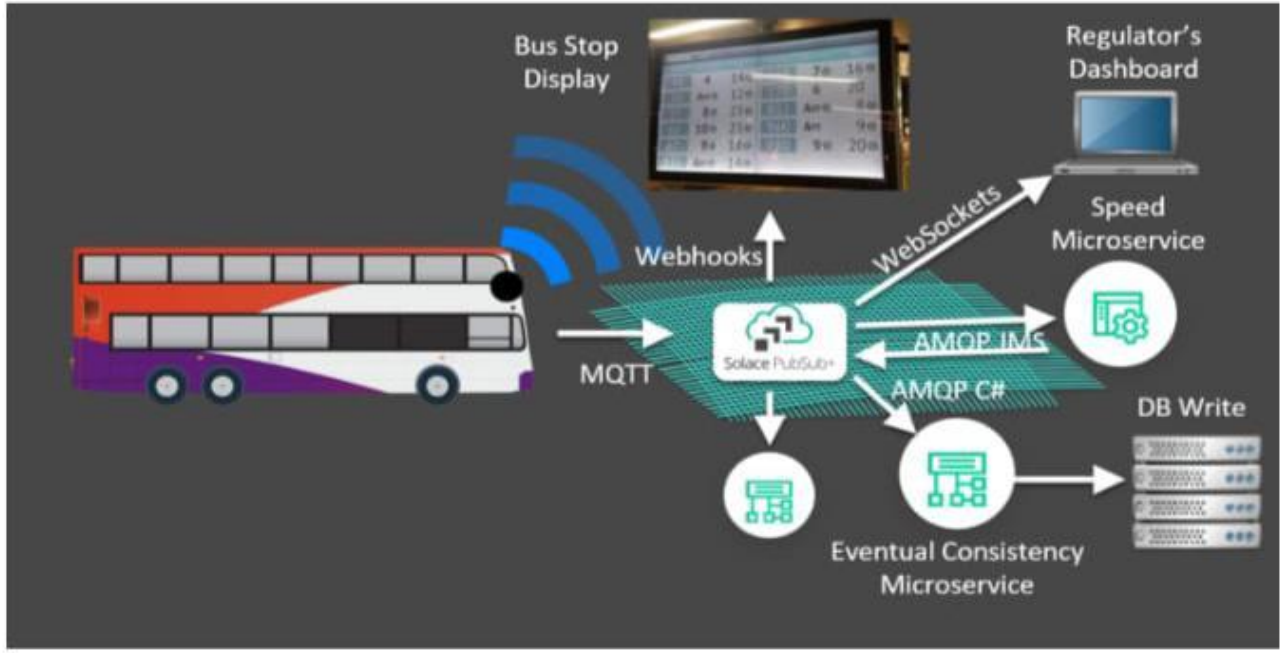
3. Materials and Methods

As seen from the review in Section 2 and the summary in Table 1, there is a high possibility of using GPS data to measure the QoS of city bus transportation. Some aspects, such as travel time, transfer time, number of transfers, waiting time, road conditions, and time periods, were analyzed by GPS technology [7,8,9]. In addition, many criteria, such as accessibility, availability, reliability, comfort, safety, customer satisfaction, customer loyalty, bus frequency, precise schedules, responsiveness, assurance, etc., were evaluated by the survey method [2,3,4,5,6]. Based on previous studies, our work aims to further support the concept of using GPS data for measuring the QoS of city bus transportation. In our work, due to the datasets available and some issues raised in [2,3], the criteria of reliability, accessibility, and availability are underlined in terms of complete trips (QoS–1), on-path driving (QoS–2), and on-schedule operation (QoS–3).

To achieve our objectives, QoS–1, 2, and 3 were evaluated by step-by-step processing of the input data; our overall work is displayed in Figure 1. There are four main steps: input, preprocessing, scoring, and output.

First, the input datasets are (1) bus GPS transactions containing bus identifiers, route numbers, coordinates, speeds, and timestamps; (2) bus route polylines, which are sequence sets of coordinates of fixed route paths; and (3) bus schedule containing conditions of each bus route path. Details are given in Section 3.2.


Traffic Management
Hybrid Cloud + Legacy
Security, Monitoring, Smart lamp posts
Waste Management
Analytics and Optimization
Transportation Management
Imports/Exports
Energy Usage & Utilities
Health and Emergency Services
solace


Bus Stop
Display
Regulator's
Dashboard
Webhooks
WebSockets
Speed
Microservice
MQTT
Solace PubSub+
AMQP IMS
AMQP C#
DB Write
Eventual Consistency
Microservice

2. Literature Review

This section studies the uses of GPS technology for transportation and the QoS of bus transportation in several works, which are summarized in Table 1. In addition, the technique of GPS coordinates, which is used to analyze spatial data, is reviewed.

2.1. The Uses of GPS Technology for Transportation

GPS technology has been used in the transportation domain for decades [8]. Shen and Stopher [8] found that there were many attempts to use GPS technology in addition to traditional survey methods, for example, to monitor travel behavior changes, route choice, residential selection, etc. Based on the coordinates data gathered from smartphones and GPS devices, they analyzed spatial data to assess trips, travel time, activities, etc. This work also summarized the processing steps of GPS data: preprocessing, trip identification, mode detection, purpose imputation, and analytical results. GPS data analytics can give insight into public transportation, as studied by Mazloumi et al. [7]. This work used GPS transactions from buses in Melbourne, Australia to determine the travel time variability. The standard deviation of travel time was explored with a period of four hours per day. Since a high value leads to poor performance in transportation, they found that the factors of section length (km), number of signalized intersections per km, and number of stops per km contributed to the increase in this value; while off-peak time and industrial area provided a lower value. This result can assist bus operators with planning their bus schedules so that the arrival time corresponds to the actual situation. In addition, working with other data helps to gather more useful results—for example, Gschwendar et al. using smart card and GPS data [9]. The analytics of using smart cards as payment for bus services resulted in data on travel time, transfer time, number of transfers, and waiting time as well as the passenger demands. Based on the analytical results of these

Due to these issues, data analytics on GPS data and other datasets is mainly employed to determine the QoS scores. In this case, our method provides four phases, input, preprocessing, scoring, and output, as depicted in Figure 1. Input data are the GPS transaction of buses, the polyline of every bus route, and the schedule conditions of all bus routes. To work with GPS data, the techniques of GPS coordinates rounding is adopted at the preprocessing phase. Then, bus trips and metadata are calculated in order to measure three QoS scoring functions. Our work resulted in the QoS score of each bus route for the three months of the last quarter of 2021, and found that there was room for improvement in the sustainability of bus transportation services.

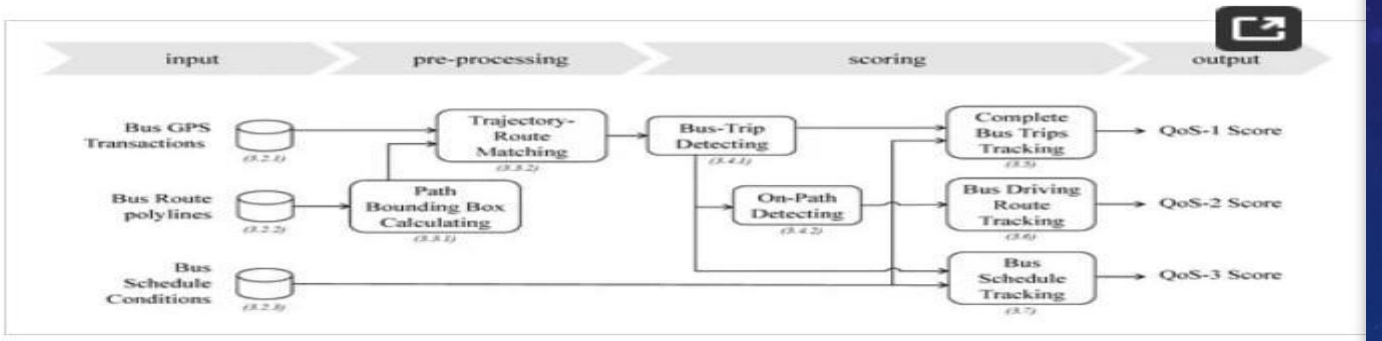


Figure 1. Our overall approach. The details of each module are described by the number of subsections in parentheses.