Dynamic Decision Making System for Public Transport Routes

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ABSTRACT

This paper presents a formal model of a decision making system for public transport routes. The approach focuses on (1) environmental and societal sustainability aspects of green software engineering, (2) spatial planning and optimisation for smarter sustainable cities, and (3) user satisfaction with this information system for the various contexts of passenger, driver and overall system view.

KEYWORDS

Decision Making, Modelling, Public Transport, Spatial Planning, Sustainability

INTRODUCTION

Transport systems are major emitters of greenhouse gases, which means that environmental sustainability of any transport is a crucial issue. Another issue is the lack of a systematic approach to the modelling and implementation of public transport systems, especially for the decision making in a dynamically changing environment. Finally, there are problems with the human interfaces to public transport systems, which do not encourage, and many do not allow, comfortable and simple interaction with the system.

One of the powerful drivers for sustainable transportation is public transport. The more people who share the one means of transport, the less the cost and damage to the environment. However, there are many specific problems and challenges, which can make the use of public transport inaccessible and inconvenient for potential new passengers and inflexible for elderly people and those with disabilities. Some of these issues, which we have considered in our system for dynamic decision making for public transport routes, are explained further in this paper.

A key factor which our dynamic decision making system enables is flexibility, both in time and in positioning of stops. With existing public transport systems, passengers may be required to wait indefinitely for the next bus/train/tram, and any time longer than 20 minutes is perceived as being too long. Also, if the public transport vehicle is not following the timetable, e.g. is running late due to disruption, delays, congestion, then passengers may miss their onward connections and be late for work. If passengers know in real time where the next public transport vehicle is, or can plan better in advance, they can meet the vehicle and destinations on time.

Passengers who may live a long way away from the nearest public transport route, or the connecting multimodal options may have long walking distances to their nearest stop/station. This may be a problem especially for people with disabilities, or the elderly, and these people may not travel regularly (i.e., every day) by public transport, so requesting a permanent stop outside their home...

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would be inappropriate. Finally, from the transport providers’ perspectives, it could be considered wasteful to provide coverage of routes which do not have any passengers, particularly late at night or early in the morning. Such services would incur higher costs for the transport company, and further emission of greenhouse gases.

To deal these problems, a green software solution is required (Hilty and Aebischer, 2015; Easterbrook, 2010). Software systems can contribute to the overall sustainability of the public transport system and to decreasing power consumption.

A factor which could make any software solution questionable might be if the bus were to be empty (idle drive) which could happen for some parts of any route during some times of the day. Here quick and obvious options such as cancelling the bus, are not always the best solutions, and a systematic approach is needed to deal with these problems. A crucial question here also is, how to model these ideas in such a way that

- is applicable to any kind of transport system; and
- allows extensions for the special cases of transport systems having different flexibility in their operation possibilities; and
- covers modelling of exceptions (problems with the traffic due to some disruptions).

In this paper, we present our model and explain our system for making public transport sustainable through the use of various definitions, examples and scenarios. Our methodology was introduced in (Spichkova & Hamilton, 2015), and in the current work we extend the model and also discuss the latest version of the system prototype, recently implemented at the School of Computer Science and IT at RMIT University.

The aim of our work is to provide smart solutions for sustainable outcomes, so that a transport system becomes a part of a ‘smart city’, cf. (Ercoskun, 2011; Nam & Pardo, 2011). We conform with the desire to develop sustainable software and systems, i.e., such software and systems that “meet the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). The sustainability of software and systems development becomes increasingly important every year for many reasons, including expanding the software usage as well as growing demand for building further applications based on it.

The three pillars of sustainability, namely the economy, society, and environment need are not balanced, and to deal with this problem, a “green software” solution is required, cf. also (Hilty and Aebischer, 2015; Easterbrook, 2010). We also work within the classification of green software according to the Green Software Engineering project where the aim is to apply “green” principles to “software products, software development processes and their underlying software process models”, (GreenSoft, 2009). However, we mainly focus not on the green development process, but on the development of software and systems that can have a positive impact on the environment and human beings.

The main idea behind our approach is to identify whether a bus, tram, or train would normally be empty during the day/night for some parts of particular routes. It could be empty for some cases if the timetable were denser or if the route were extended to outlying districts. We aim to have these parts of the route provided as optional choices in the timetable, during these hours. This would imply both lower costs for the transport company with less emission of greenhouse gases, as well as enabling the transport system to be more attractive for actual and potential passengers due its flexibility. To make this idea realistic, a proper model of the system is essential.

We present our vision of a decision support system for the drivers of public transport. Our dynamic decision making system for public transport routes enables dynamic timetables, which are influenced by passengers in real time. For this case drivers need additional assistance from the system to avoid manual analysis to decide which parts of the route should be served/skipped in each particular case.
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