Insights of Flexible Line Planning

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Several means of transport offer an alternative to move persons from one place to another. Whether public or private, these means need to be designed. In this study, an innovative approach is presented to design and operate a bus service considering the dynamics of an actual road network during operations.

A line planning is a set of bus lines [1]. Each line starts at an origin point, visits a set of intermediate bus stops and reaches a destination, all of that according to a time schedule. But, when an exceptional situation occurs (traffic jams, the demand at certain points raises, etc.) the service's performance is affected. This is the obvious result of planning a service for a particular situation without considering that the conditions in a network change constantly while the service is operating. In this work, a set of insights to design a so called "Flexible" Line Planning for bus services is determined. A Flexible Line Planning contains a set of temporal or permanent changes in the line planning which can decrease the effect of exceptional situations in travel times or demand. Indeed, this assumes that in the future some bus lines can change their routes during operations in order to improve the performance of the service.

To this end, a methodology to identify and apply useful permanent and/or temporal changes in line planning is proposed and tested. A well performing genetic algorithm [2] was developed for the line planning problem. The objective is always minimizing the total travel time of the passengers. The fleet size and line length of the lines are fixed and act as budget constraints from the operator side. A sensitivity analysis, based on alternative line plans for exceptional situations, led to three insights. The insights are formulated and lead to permanent changes to the line planning, thus also for the normal situation, and temporal changes that can be applied during operations.A sensitivity analysis, based on alternative line plans for exceptional situations, led to three insights. Insight 1 is about how adding nodes, splitting or joining lines, as temporal or permanent changes, are

useful in case of peak demand. Insight 2 uses alternative paths and express lines to decrease the total travel time in scenarios with some congested links. Finally, insight 3 considers second best paths during planning and operations of a bus service.

The adapted line plans, presented in this work, illustrate how a flexible line plan can be helpful to reduce the negative impact of exceptional situations.

Mandl's network [3], a benchmark network of 15 nodes, was used as a proof of concept of the methodology. Consistent and useful results were found. Currently, a real case study, based on the city of Cuenca (Ecuador), with around 300 nodes is used to determine under which conditions flexible line plans can be beneficial in realistic situations.

Références

[1] Schöbel, A. Line planning in public transportation : models and methods, OR Spectrum 34 (3), 491–510 (2011)

[2] Holland, J. H. Adaptation in natural and artificial systems : An introductory analysis with applications to biology, control, and artificial intelligence. Michigan USA : U Michigan Press (1975)

[3] Mandl, C., Evaluation and optimization of urban public transportation networks, European Journal of Operational Research 5(6), 396–404 (1979)