IN SEARCH OF THE PUBLIC TRANSPORT USERS: TOWARDS PUBLIC TRANSPORT POTENTIAL MAPS

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Contents

Samenvatting

Op zoek naar de Openbaar Vervoergebruikers: Naar Openbaar Vervoer Potentiekaarten

Gericht op de praktijk, presenteert dit paper de resultaten van een eenvoudige benadering om potentiële gebruikers van openbaar vervoer te identificeren met behulp van op GIS gebaseerde openbaar vervoer potentiekaarten. Deze kaarten staan toe om potentële klanten van het openbaar vervoer te lokaliseren. Met behulp van deze kaarten kunnen openbaar vervoerbedrijven de inzet van beschikbare middelen voor marketing optimaliseren. Ter illustratie wordt ee benadering toegepast in de gemeente Roermond. Een eenvoudig logistisch regressiemodel is geschat aan de hand van gegevens van een beperkt aantal 6-positie postcode gebieden. Met het model is voor alle postcode gebieden in Roermond de potentiële vraag naar openbaar vervoer berekend. De voorpsellingen zijn gerelateerd aan het huidige openbaar vervoernetwerk.

Summary

In search of the Public Transport Users: Towards Public Transportation Potential Maps

Targeted at practitioners, this paper reports the results of a simple approach to identifying potential customers of public transport using GIS-based public transport potential maps. These maps allow one to locate the most likely customers of public transport. Using these maps, public transport companies can optimise their available budget for marketing their services. Also urban planners can benefit of this approach. The approach is illustrated in the City of Roermond, the Netherlands. A basic logistic regression model is estimated with data of a limited amount of postal code areas. In addition, the model is used to predict the public transport potential for all postal code areas. The predicted potentials are compared with the current public transport system of Roermond.

1. Introduction

Public transport in The Netherlands, like in many other western countries, is facing decreasing market shares and decreasing budgets. This development urges public transport companies to become more active in developing their market [e.g., 1]. The companies have to find their potential customers and examine their needs [2]. For many public transport companies, this market-oriented focus is a new way of operating and doing business. In the past, public transport was primarily driven by social consideration and equality. This implied that public transport was serving as many people as possible and that costs were not relevant. This resulted mostly into long routes with many bus stops. Nowadays, many public transport companies have been privatized and have to reduce costs and increase benefits to survive. Important for the management of the companies in this context is to know who are the (potential) customers, where are they located and how can (potential) customers be reached. Most previous studies focus on the 'Who'-question. Different market segments have been defined and different promotion activities have been carried out to reach these segments [e.g., 3]. Other studies focus on the length of public transport lines in comparison with costs [2, 4] Limited attention has been paid to the 'Where'-question.

This paper presents a first attempt how the 'Where'-question can be addressed, keeping in mind that the methodology should be easy to implement. The aim of the study discussed in this paper is to construct '*Public Transport Potential Maps*' that represent the potential market for public transport in a particular area (neighbourhood, city, region) for both public transport companies and local authorities. These potential maps are based on a model that describes the relationship between public transport use and relevant area characteristics. These maps will provide insight into the potential use of public transport in the various areas of a city or region without having to conduct an extensive and expensive data collection. The current study is a follow up of the study carried out by Berenos *et al* [5] who provided a general framework for creating potential public transport demand per area, based on area characteristics. The area characteristics are used to define market segments for which a travel pattern is generated based on general travel statistics. Our study relates area characteristics directly to travel behaviour in that area.

The remaining of the paper is organised as follows. First, attention is paid to the way monitoring is carried out in the context of public transport. Next, the adopted research approach is outlined. This section is followed by a short description of the data collection and the model estimation. To illustrate the suggested approach, in section 5, an application of the use of potential maps is presented. The paper ends with a discussion and some suggestions for future research.

2. Monitoring public transport

Monitoring in public transport give planners and decision makers relevant information concerning the use and the efficiency of the public transport system. A monitoring system mostly deals with the *actual* use of public transport. It can be used to administer the number of passengers at bus stops and in busses, the distance travelled, and the evaluation of the public transport system. Passengers' counts and interviews at bus stops or in buses are used to examine the use and valuation of bus stops or bus lines. The Dutch Ministry of Transport introduced in 2001 the Public Transport Monitor System (PTMS). This system monitors progress in the public transport market and provides results on performance [1]. The information generated with the PTMS can assist planners to evaluate the effects of policy measures. The system gives insights into the performance of the public transport system based on mobility data, regional statistics, and passengers' valuation and importance scores.

A monitor system can also be used to look for the *potential* use of public transport. Based on socio-demographic, economic and geographic characteristics of people the potential use of public transport can be estimated. Berenos *et al* [5] presented a framework for market segmentation in public transport based on area potential per market segment. The area potential gives the existing market segments per zone, which is based on income, car availability, number of residents, and the surface of the zone. The general level of mobility and the modal split per type of market segment is extracted from the Dutch Travel Panel Data (CBS, 2000).

Sugiki *et al* [6] developed a potential traffic demand model that was used to generate future demand predictions of potential traffic per household. The probability of the potential traffic demand generation was calculated with a binary logit model. The model contained only two household characteristics: householder age and household type, and the service rate of public transport in a zone (services/hour).

Recently, Zhou *et al* [3] presented an approach to identify market shares of public transport. They adopted the following approach to find out who uses public transport, why are they using public transport, where are they living, and how do they use public transport. First they identified market segments based on three attitudinal factors that cover ‘value of time’, ‘schedule constrains’, and ‘sensitivity to privacy and comfort’. They defined 8 market segments: Intrepid amblers, Solo ramblers, Outgoing multi-taskers, Tense trekkers, Brave runabouts, Shy cruisers, Diligent chargers, and Rigid flyers. Next, they assign specified market segments to areas based on the population characteristics of market areas and a structural equation model. With a two-level nested logit model the modal split for each market segment and geographic market area was calculated. Finally, they calculate the market share of public transport per market area. The market shares are not directly related to area characteristics.

It appears that most studies mainly focus on the use of public transport and not on the potentials of public transport per area. If studies pay attention to potentials, the data collection is extensive and expensive. Also the level of spatial detail is not very high as might be expected in the case bus stops are involved.

3. Research approach

The study has to provide the answers on the following three research questions:

a. Where is the potential demand for public transport located?
b. Is this potential demand related to characteristics of areas?
c. How can this potential demand easily be presented to planners and policy makers?

To get insight into the relationship between public transport use and area characteristics, data were collected in Roermond, a medium sized city in the South of The Netherlands. The data collection consisted of two parts.

First, a questionnaire was designed to collect the travel behaviour of households in Roermond. The level of detail of information led to the choice for a home-based questionnaire. In the questionnaire, all home-based trips of the household were administered for various transport modes: walk, bike, car, and public transport; trip purpose: work, study, and other; time of the day: in rush hours, outside rush hours; and travel distance: 5 kilometre or less, and more than 5 kilometre (Figure 1). Because of simplicity and time pressure, the questionnaire was focused on a specific day of the week. Tuesday was selected as being a representative day of the week.

PART 2. HOME-BASED BUS TRIPS

8a. How many home based bus trips per distance class did your household made on Tuesday 28th October?
(**NB**. a trip with more than 1 person is equal to multiple trips)

………. Trips from home shorter than 5 kilometres

………. Trips from home equal and larger than 5 kilometres

8b. How many home-based bus trips did you make in rush hour and how many outside rush hour?
(**NB**. a trip with more than 1 person is equal to multiple trips)

………. Trips from home during rush hours (7:00 – 9:00 and 16:00 – 18:00)

………. Trips from home outside rush hours

8c. How many home based bus trips did you make for the trip purposes work, education and other?
(**NB**. a trip with more than 1 person is equal to multiple trips)

………. Trips from home for work

………. Trips from home for study

………. Trips from home for other purpose

Figure 1: Part of the questionnaire

Secondly, data were collected from 6-position postal code areas. The area characteristics can be divided into two groups: socio-economic and physical (Figure 2). The socio-economic characteristics (age, income, life style, and car ownership) are related to individuals and households in the zone while the physical characteristics (dwelling type, travel time, bus stops, and bus frequency) are related to the zone itself. In the Netherlands several standard databases are available that contain area characteristics. These datasets are easily accessible. One of these databases is provided by Bridgis, a data collection company in The Netherlands (www.bridgis.nl). This company provides a large set of data at the level of 6-position postal code areas. Table 1 gives an overview of available data that might be interesting for this research.

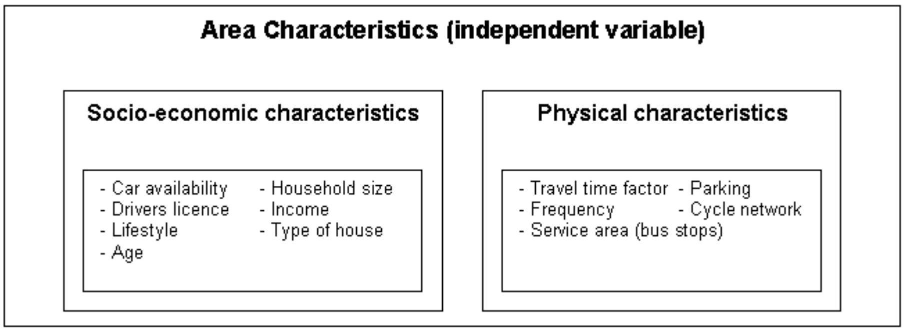

Figure 2: Socio-economic and physical characteristics of areas

Because of the availability of area related data, the study has been carried out in the city of Roermond. For an efficient distribution of the questionnaires, a limited number of postal code areas were selected (Figure 3). The selection was based on three area characteristics: car ownership, distance of areas to nearest bus stop, and location in relation to the centre of Roermond. Roermond consists of more than 1600 6-position postal code areas. The selection made it possible to gather sufficient information of all types of postal code zones.

Table 1: Standard available area characteristics

Variable	**Specification**	**Classes**
Dwellings	Number of dwellings per postal code area	Number
Own/rent	Percentage of own/rented dwellings per postal code area	5 classes exclusive unknown
Dwelling type	Dominant dwelling type per postal code area	14 classes exclusive unknown
Household	Number of household per postal code area	Number
Persons	Number of persons per postal code area	Number
Prosperity	Prosperity based on income and type of dwelling	6 classes exclusive unknown
Car availability	Car availability per postal code area	9 classes exclusive unknown
Lifestyle	Dominant lifestyle per postcode	12 classes exclusive unknown

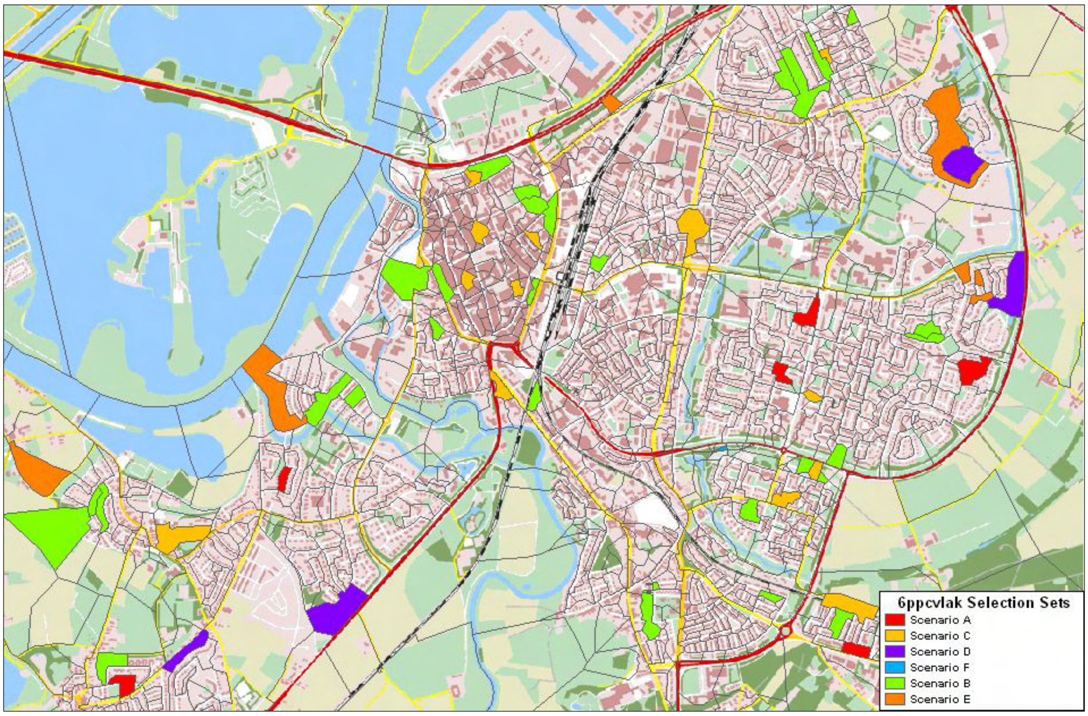

Figure 3: Selected postal code areas

4. Data and analyses

Approximately 1450 questionnaires were distributed across households in Roermond. In total 427 questionnaires were returned, without reminders, which makes a response rate of 29.4 percent (Figure 4). It appears that not all received questionnaire could be used for the suggested analyses. The questionnaires of 330 respondents contained both the origin of the respondent (the postal code) and their travel behaviour. Figure 5 shows the distribution of response across Roermond. The Figure shows that the response is spatially distributed across the city of Roermond.

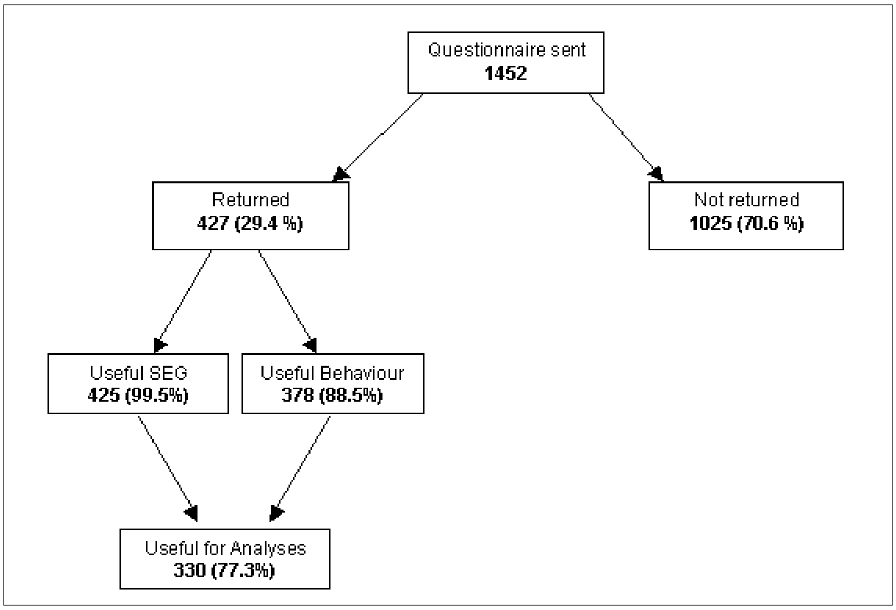

Figure 4: Overview of response

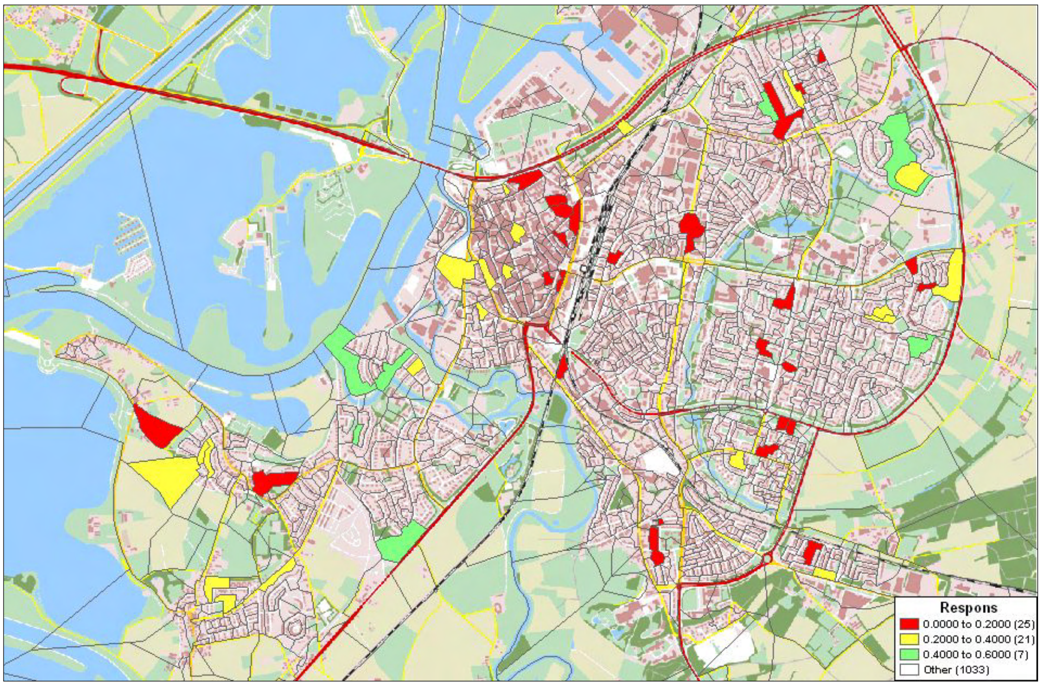

Figure 5: Response per postal code area

Table 2: Characteristics of the households

1.1 Characteristics	*Levels*	*Absolute*	*Percentage*
Household size	1 person	94	22.1
	2 persons	204	48.0
	More than 2 persons	127	29.9
Household type	Single person household	94	22.1
	Two person household	231	54.4
	Single person with children	16	3.8
	Two person with children	84	19.8
Household activity	Only work activity	119	28.0
	Only study activity	2	0.5
	Only other activity	131	30.8
	Combined activities	173	40.7
Number of cars	No cars	53	12.5
	1 car	248	58.4
	2 or more cars	124	29.1
Number of drivers licenses	No drivers license	31	7.3
	1 drivers license	133	31.3
	2 or more drivers licenses	261	61.4
Number of public transport carts	No PT-card	264	62.4
	1 PT-card	103	24.3
	2 or more PT-carts	56	13.3

Some more details of the households that take part in the questionnaire are presented in Table 2. It appears that most families consist of two or more family members and do not have children. The majority of the households have at least one car, one driver license and no public transport card. The data for the model analysis were organized as follows. The selected respondents (330) made in total 1324 trips of which 17 were bus trips. To describe the relation between the use of the bus and the available area characteristics a logistic regression model was estimated. The area characteristics used in this model are described in Table 3. The individual trips were aggregated to the postal code areas, generating per postal code area the number of bus trips and non-bus trips. The individual trips covered in total 65 postal code areas. Attributes related to these postal code areas were used to explain the mode choice behaviour.

Table 3: Investigated area characteristics

Variable	**Levels**	**Coding**
Use of bus in a postal code zone (dependent variable)	1. Yes 2. No	1 0
Availability of bus stop within 350 meters of the postal code zone	1. Yes 2. No	1 -1
Travel time factor, travel time bus divided by travel time car	1. Less than or equal to 2.5 2. Greater than 2.5	1 -1
Distance from postal code zone to railway station	1. Less than or equal to 1000 meter 2. Greater than 1000 meter	1 -1
Car availability per household per postal code zone	1. 1 or more cars available 2. Less than 1 car available	1 -1
Drivers licenses per household per postal code zone	1. 1 or more license available 2. Less than 1 license available	1 -1
Average income per household per postal code zone	1. High income level 2. Low income level	1 -1
Percentage of rented houses per postal code zone	1. Less than or equal to 50 percent 2. More than 50 percent	1 -1
Percentage of old and young people per postal code zone	1. Less than 25 percent old/young 2. More than 25 percent old/young	1 -1

Table 4 presents the estimation results of the logistics regression analyses. It appears that most parameters are in anticipated direction. The availability of bus stops, a travel time factor less than 2.5, a distance greater than 100 meter from the railway station, the availability of less than 1 drivers license, a high percentage of rented houses, a low income level, and a high percentage of old and young people increase the probability of bus use in a postal code zone. The influence of car availability is unexpected. The parameter indicates that the availability of more than one car increases the probability of bus use in a zone.

Table 4: Logistics Regression model for bus use

Model Bus	Parameters	Standard deviation	Significance
Constant	-5.568	0.311	0.000
Availability of bus stops	0.994	0.207	0.000
Travel time factor	0.452	0.139	0.001
Distance to railway station	-1.351	0.191	0.000
Car availability	1.160	0.214	0.000
Drivers license availability	-1.146	0.184	0.000
Percentage of rented houses	-0.934	0.149	0.000
Average income level	-0.430	0.145	0.003
Percentage old/young	-0.554	0.114	0.000
Percentage correct predicted	97.5		

5. The use of potential maps

To illustrate the use of public transport potential maps, in this section an example is worked out. First, for all 6-positions postal code areas the probability of public transport is calculated based on the characteristics of the areas. The dark coloured areas (red) have a small probability while the light coloured areas (green) have a large probability of bus use (Figure 6).

Secondly, The current network of public transport with the bus lines and bus stops is put on the generated public transport potential map (Figure 7).

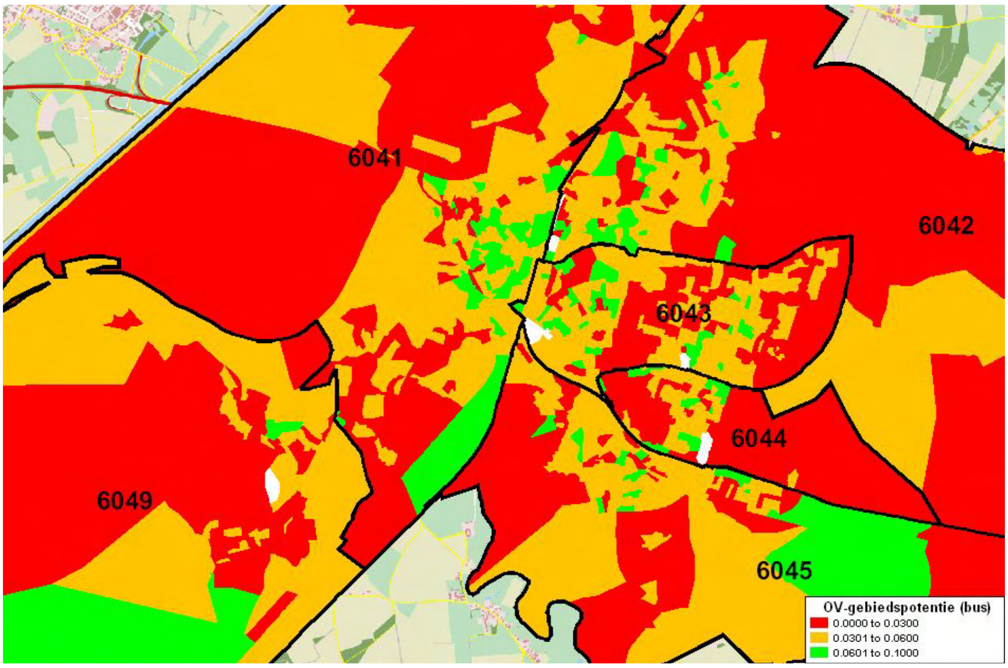

Figure 6: Example of public transport potential map based on bus share model

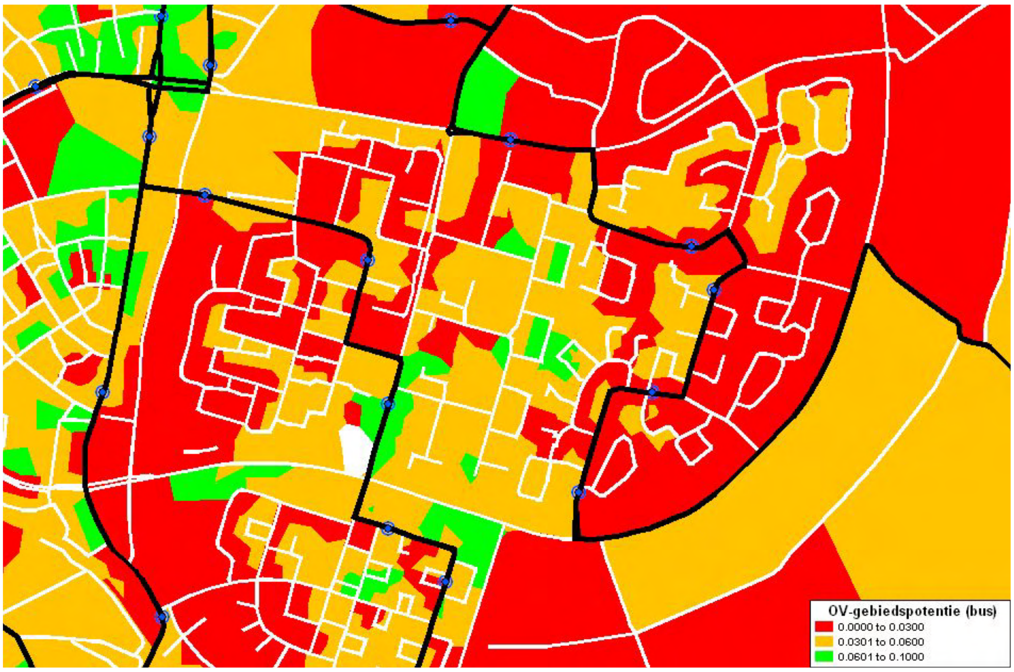

Figure 7: Public transport potential map and current public transport system

Next, the service area of the current public transport system is generated by a simple buffer analysis (Figure 8). A buffer size of 300 meter around a bus stop was used. The map shows that most of the potential demand for public transport is covered by the current public transport system. One small high potential area is not covered by the system. On the other hand, many low potential areas are covered. From the point of view of exploitation this is not good. Now, public transport planners can redesign the system or urban planners can redesign the problem areas.

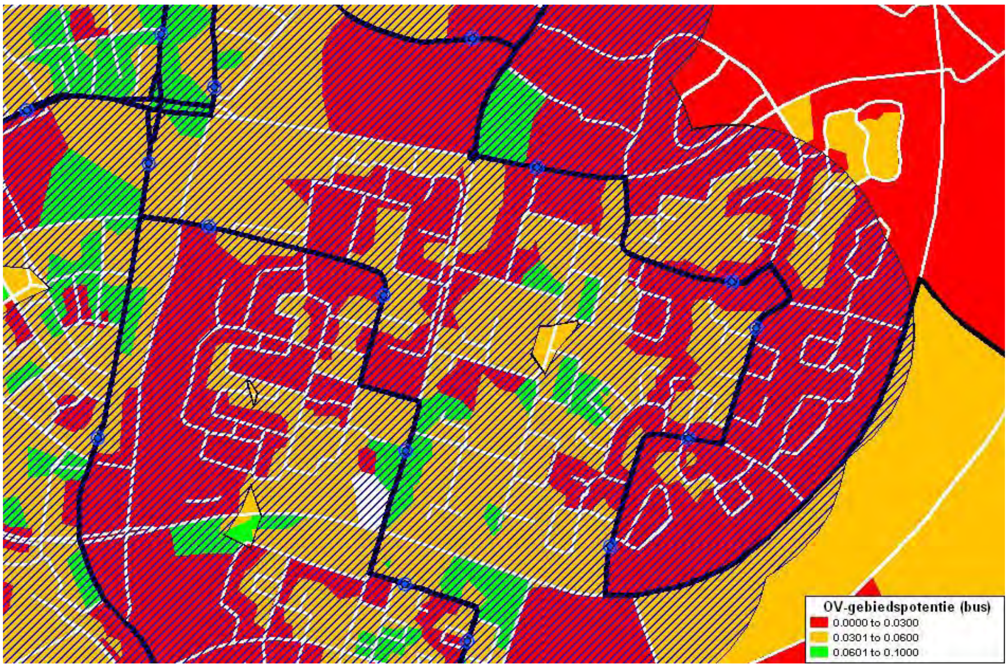

Figure 8: Public transport potential map and service areas

6. Conclusions and future research

This paper advocates that a public transport potential map might be an adequate tool for public transport companies to redesign their routes and to design their spatial marketing programmes. Also urban planners can use the maps to redesign areas in favour of public transport use. The potentials are calculated using a logistic regression model that contains eight different area characteristics. These area characteristics are standard available and can easily be accessed by planners. Together with different GIS-tools potential maps can be easily created, updated, analyzed and presented.

The first attempt is based on a limited number of bus trips per postal code area. We plan to collect more data in more postal code zones and during more days per week. We also plan to investigate other specifications of area characteristics in more detail. At the end the approach will be implemented in a decision support system for public transport companies and urban planners.

Acknowledgement

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