Journal of Transport Geography 35 (2014) 130–143

Contents lists available at ScienceDirect

Journal of Transport Geography

journal homepage: www.elsevier.com/locate/jtrangeo

Measuring transit oriented development: a spatial multi criteria assessment approach for the City Region Arnhem and Nijmegen

Yamini Jain Singh [a,*], Pedram Fard [a], Mark Zuidgeest [b], Mark Brussel [a], Martin van Maarseveen [a]

[a] Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands
[b] Centre for Transport Studies, Department of Civil Engineering, Faculty of Engineering and the Built Environment, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, South Africa

ARTICLE INFO

Keywords:
TOD
TOD Index
SMCA
Hot-spot analysis
Arnhem Nijmegen City Region

ABSTRACT

Transit Oriented Development (TOD) is a planning approach that can stimulate sustainable development by encouraging better land use and transport integration. Arnhem Nijmegen City Region, a regional planning body, in the Netherlands, aims to promote sustainable development in their region and control the current pattern of increased use of cars vis-à-vis transit for longer commutes. Planning for TOD can help achieve this aim. It is believed that measuring the existing levels of TOD is a prerequisite for TOD planning and that it can be done using a TOD Index proposed in this research. A TOD Index measures multiple spatial indicators and aggregates them under the SMCA framework to arrive at a comprehensive value depicting the existing levels of TOD at a location or an area. Using this TOD Index, TOD levels were measured over the entire City Region covering approx. 1000 km^2. High levels of TOD imply that the urban development's characteristics, at that location, are ripe for use of transit and these high levels, as expected, were found in the urban areas of Arnhem and Nijmegen. From the results of TOD Index measurement, using hot-spot analysis, those locations were identified that have high TOD levels but poor transit connectivity. These locations are accordingly recommended for better transit connectivity. As a part of our future work, it is intended to use the TOD Index to elevate TOD levels around existing transit nodes.

1. Introduction

Transit Oriented Development (TOD) as a planning tool integrates the land use and transport system, thereby creating lively, sustainable, pedestrian and cycling friendly areas and neighbourhoods (CTOD, 2009), while encouraging people to choose transit over cars for their long commutes. A more widely agreed description of TOD is an urban environment with high densities, mixed and diverse land uses, located within an easy walkable area around a transit stop (Calthorpe, 1993; The City of Calgary, 2004; Parker et al., 2002; Hale and Charles, 2006). But TOD planning is not and should not only be about creating development that is oriented towards transit use. It should also mean bringing transit to those locations, where the development already possesses the physical characteristics of that of a typical TOD, but without having transit connectivity at that place. This actually signifies a two-sided planning approach that ensures that necessary planning interventions are made to either make the urban development more transit oriented or to bring transit to places where the development is already transit oriented, i.e. having high densities, etc. We can also call this planning approach 'TOD Planning'.

Public investments in infrastructure such as for TOD are too often made without understanding the existing situation and possible outcomes of the plans. Renne and Wells (2005) concluded in their report on measuring TOD that there is a lack of comprehensive tools of measurement that quantify the existing levels of TOD. Measuring those levels helps in better TOD planning. This has also been highlighted by Evans and Pratt (2007) as they point out that there is a need to express the existing TOD-ness of an area in terms of a 'TOD Index'. They describe a TOD Index as a "...potential device for considering the degree to which a particular project is intrinsically oriented towards transit" (Evans and Pratt, 2007, p. 17-3). Such a TOD Index measures all the criteria of TOD and also makes different areas comparable, objectively. TOD planning can also benefit from lessons learnt from previous TOD projects. Renne and Wells (2005, p. 10), stress for example that "Without measuring the outcomes of TODs, mistakes in

* Corresponding author. Tel.: +31 (0) 619357011.
E-mail addresses: y.j.singh@utwente.nl (Y.J. Singh), fard28531@alumni.itc.nl (P. Fard), mark.zuidgeest@uct.ac.za (M. Zuidgeest), m.j.g.brussel@utwente.nl (M. Brussel), m.f.a.m.vanmaarseveen@utwente.nl (M.van Maarseveen).

http://dx.doi.org/10.1016/j.jtrangeo.2014.01.014
0966-6923/

investment strategies will continue to be repeated". The literature is rich with case studies, where TOD projects have been evaluated qualitatively or quantified by measuring the changes in transit ridership and development densities amongst others. However, a comprehensive measurement of TOD levels in form of a single index that can be used for efficient TOD planning has been missing so far. In addition to this, Schlossberg and Brown (2004, p. 2), point out that it is the "fine grained, spatially explicit types of analyses that have been lacking in TOD" efforts in spite of the fact that two corner stones of TOD, land use and transport, are both inherently spatial in nature. Hence, a number of indicators that relate to TOD need to be measured and combined into an index that can further help in making justified planning decisions, such as for location decision-making.

This paper, thus, presents an approach and a tool capable of measuring TOD levels, resulting in a TOD Index, which can be used for TOD Planning. We have used spatial analytical tools, i.e. GIS and Spatial Multiple Criteria Analysis (SMCA) to measure TOD levels. For our case study, we have chosen the City Region of Arnhem and Nijmegen, The Netherlands.

The Arnhem Nijmegen City Region in The Netherlands is the third largest of eight City Regions in the country. These City Regions have been formed to plan for urban growth at a regional level, around a few important cities. Arnhem and Nijmegen are two such important cities. West of the City Region is the main economic zone of the country, Randstad Metropolitan Region, that covers a large area and includes four of the eight City Regions of the Netherlands (Fig. 1).

Even as Randstad continues to be the main economic centre, Arnhem Nijmegen City Region (called 'City Region' hereinafter) is poised to become the second biggest economic zone in the Netherlands by 2020. Currently, the City Region consists of 20 municipalities with around 735,000 inhabitants over an area of 1000 km^2 and more than 40 percent of the population resides in its two major cities (Fig. 2).

The City Region's policy vision is centred on creating more housing and employment and providing higher levels of mobility. However, in the current scenario, cars are being increasingly used for more and longer trips rather than public transport (Rijkswaterstaat, 2010). This issue coincides with the overall mobility situation in the country, as reported in the Mobility Report for the Netherlands (KiM, 2013), where cars account for approximately three-fourths of the total vehicle-kilometres travelled in the country in 2012. To stimulate a modal shift from cars to transit, the City Region wishes to make public transport as competitive as private transport and to ensure that more and more commuters use transit for their regional travel demands. To do this, the City Region already offers an existing rail based transit service and is planning for BRT. Hence, it would benefit from knowing which areas in the region require transit connectivity. Realizing such modal shift of trips from cars to transit is one of the most difficult tasks to do anywhere in the world, however, 'Transit Oriented Development' is one of those popular and effective planning tools that can bring about the desired change as shown, for example, by Cervero and Murakami (2009) in the case of Hong Kong. The City Region also sees TOD as a powerful tool that can help make people

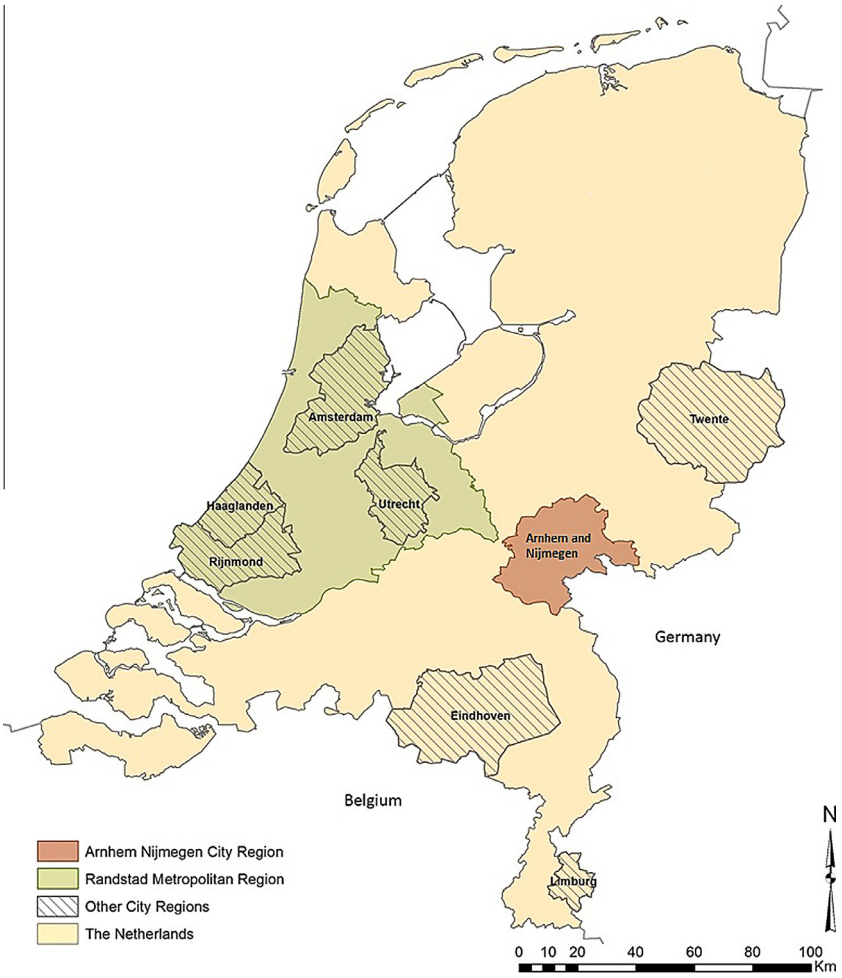

Fig. 1. Arnhem Nijmegen City Region in the Netherlands.