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Participatory evaluation of regional light rail scenarios: A Flemish case on sustainable mobility and land-use

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ABSTRACT

Rail transit is generally acknowledged as an alternative transport mode in contributing towards sustainable mobility. In addition to minimising negative externalities, rail transit has sustainable land-use opportunities to integrate transport- and spatial planning. The objective of this paper is to determine the impact of integrative light rail scenarios and their ability to curtail private vehicle driven urban sprawl in the Flemish rhombus.

The paper proposes three light rail scenarios: an infrastructural scenario; tramification scenario; and spatial rail scenario, each covering a specific landscape structure to reorganise the dispersed spatial environment in Flanders in the long-term. We used the participatory multi-actor multi-criteria analysis (MAMCA) which incorporates the objectives of all involved stakeholders to assess the impact of the scenarios.

The infrastructural alternative scenario gained most support among the involved stakeholders, on the grounds of improved multimodality, enhanced user amenities, reduced implementation costs, moderated greenhouse gas emissions and mitigated infrastructural barrier effects.

Despite the merits of the infrastructural scenario in terms of stakeholder objectives, few possibilities are included to elaborate upon sustainable land-use development. In response to the low performance of this assessment criterion, catalyst measures are discussed to support the implementation.

1. Introduction

Traffic congestion is one of the most significant cumulative drawbacks of motorised mobility, generating negative externalities such as vehicle loss hours, restricted accessibility, wasted fuel and driver frustration. Rail transit is generally considered to be an imperative alternative to reduce traffic congestion (Rodier et al., 1998; Siu, 2007; Litman, 2007; de Grange et al., 2012; Vuk, 2005; Strokes et al., 2008) and, as such, is acknowledged to contribute to sustainable mobility (Siu, 2007; Tang and Lo, 2008; Chang-fu and Yuan, 2011; Israel and Cohen-Blankshtain, 2010; Diesendorf, 2000). To establish a sustainable mobility system, transport modes should adhere to objectives that are socially acceptable (ensuring traffic safety and protecting health), ecologically justified (decreasing

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fuel consumption and greenhouse gas emissions) and economically feasible (accessible and efficient) in order to serve the societal needs of today and in the future (Vermote et al., 2013a).

Considering the significance of curtailing collision hazards at the level of road-rail crossings (Rudin-Brown et al., 2012; Lenné et al., 2011), rail transit generally corresponds to a higher degree of traffic safety than motorised vehicles (de Jong and Declercq, 2012; Wenxing and Shuai, 2012). Pollutant gas emitted by rail transit is per passenger kilometre proportionally lower than from motorised vehicles (Uherek et al., 2010; Burchill et al., 2011). The energy consumption level of rail transit systems equates to only a small segment of the fuel combusted in the road transport sector (Eurostat, 2013; Cooper et al., 2001). Rail transit emits averagely 60.2 g CO_2 per passenger kilometre, while petrol- and diesel-fuelled passenger vehicles account for 130.9 and 124.2 g CO_2 per passenger kilometre respectively (Santos et al., 2010). In general, railway noise emissions cause less annoyance than road traffic noise (Sandrock et al., 2008; Öhrström and Skanberg, 1996). The extent to which mobility systems provide access to goods, services and activities is traditionally considered from a motorised road user's point of view (Vermote et al., 2013a), since physical movements are commonly measured in terms of travel speed, vehicle loss hours and level of service ratings (Litman, 2012). On the other hand, accessibility-based approaches consider the option values of mobility modes in a broader context of optimal opportunities, such as efficient spatial planning to minimise travel distance, area walkability, transit service frequency and telecommunication technologies as substitutes for travel (Ratner and Goetz, 2013; Litman, 2012; Geurs, 2006).

As well as enhancing the sustainability performance of the mobility mode, rail transit contains sustainable land-use opportunities by integrating transport and spatial planning. Integrated planning strategies such as Transit Oriented development (TOD) combine employment, retail, activity site and public service developments at a walkable distance from railway stations, served by frequent public transportation (Calthrope, 1993; CTOD, 2013; Knowles, 2012). The densification in these new land-use projects restrains abundant automotive dependent behaviour, stimulates walking and cycling activities and enhances intermodal mobility. As such, motorised vehicle facilities adjacent to the rail stations are superseded by a built environment in favour of pedestrian squares, cycling lanes and bicycle parking. Timetables of the mass rail transit lines are aligned with connecting bus- and tramlines to ensure intermodal transfers. The availability of bike sharing and car sharing facilities stimulates community-based mobility, while reducing individual expenses of travel modes such as purchase and maintenance costs.

The majority of contributions in the existing literature addresses spatial integrative projects such as TOD's to reshape the urban structure of existing urban railway stations (Loo et al., 2010; Sung and Oh, 2011) or to elaborate on the densification of circumjacent network extensions (Ratner and Goetz, 2013; Olaru et al., 2011; Mathur and Ferrell, 2013). However, few studies determine the potential of transit-based spatial planning scenarios to restructure land-use developments and travel behaviour in densely populated suburbanised areas with a strongly dispersed spatial configuration. The Organising Rhizomic Development along a Regional pilot network in Flanders (ORDERin' F project) assesses the merits of a complementary regional light rail transit (LRT) system to connect the urban centres with the peripheral areas and to reorganise the density of the suburbanised spatial structure in Flanders in the long-term. Proceeding from this analysis, the current paper provides on a comprehensive impact assessment of prospective regional light rail scenarios in Flanders.

Section 2 conveys geographical and mobility determinants for the Flemish case. Next, a participatory assessment methodology is proposed to assess the impact of alternative light rail scenarios (Section 3), which is applied for the specific case of Klein Brabant (Section 4). Section 5 discusses the merits and drawbacks of each scenario, which are related to future research perspectives, to support prospective operationalisation of a specific alternative. Section 6 concludes the paper.

2. The Flemish rhombus

Flanders, the northern region of Belgium, is characterised by dispersed spatial planning and ribbon development. The initial morphology of discrete communities along secondary roads progressed, during the last decades, to suburbanised peripheral areas with diffused residential, commercial, industrial and leisure functions. About half of the population dwells in the strongly conurbanised central area vernacularly known as the Flemish Rhombus, which had an average population density of 855 p/km^2 in 2010. The rhombus interconnects the metropolitan areas of Brussels, Antwerp, Ghent and Leuven and encompasses significant urban areas such as Mechelen, Sint-Niklaas, Aalst and Dendermonde (see Fig. 1).

The road network in the Flemish rhombus suffers particularly from stern traffic congestion. About 67% of all Belgian vehicle loss hours occur in Flanders, where the regional roads in the agglomerations of Brussels and Antwerp are most severely affected. Prospective vehicle-loss-hours are projected to increase with 36% for the entire Flemish region between 2007 and 2020, with an increase of 60% and 41% for Brussels and Antwerp respectively (Maerivoet and Yperman, 2008). Hence, complementary competitive public transport modes are imperative to restore the modal split.

Like most European countries, Belgium developed a heavy rail system in the second half of the 19th century, which triggered early industrialisation. The dense rail network subsequently served as a cornerstone for the country's occupation and liberation in both World Wars. However, severe network damage and incremental competition from motorised vehicles forced rail transit activities into decline in the middle of the 20th century. The post-war remarshaled network configuration had significant repercussions on the quality of current connections and transit services. While regional links were abolished or replaced by more flexible bus lines, the inter-urban connections were developed into a high performance rail network. Nevertheless, decades of urban sprawl, typified by additional built belts along centripetal road patterns and increasing traffic congestion, led to the Flemish