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European- and global urban guided transit: Green- and socio-economic fit

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Abstract

The study undertook top down research in the low axle load, low speed market space where urban rail is vulnerable to competition from rubber-tyred guided transit modes. Heavy Rail and Light Rail are well established, but Light Metro, Automated Guided Transit, Monorail, and Bus Rapid Transit are ascendant. A global database containing 98 country, city, and modal variables, underpinned a multivariate research design using factor analysis and structural equation modeling. It extracted fourteen latent variables plus a complex but rationally interpretable set of regression coefficients that describe the green- and socio-economic fit between cities and guided transit solutions. The study found that the rubber-tyred modes had positioned themselves between Heavy Metro and Light Metro plus Light Rail, and that ecological adaptation was taking place in the low axle load, low speed, urban transit market space.

Keywords: Automated; bus; fit, genetic; green; guided; heavy; light; metro; monorail; rail; rapid; technology; transit.

1. Introduction

1.1. The research context

Public urban mobility serves many needs, from basic access to job opportunities in developing countries, to an eco-friendly alternative to private cars in developed countries. Within the field of corporate citizenship, which subsumes an entity's contribution to society through its business activities, social investment, and engagement in public policy, administrators and management strategically position the guided transit mode or modes in their particular jurisdiction. In turn, affected stakeholders judge the outcome against fit with the entity's mandate, their expectations, and other significant- or topical criteria. This interaction is observable in the public domain, so the authors elected to research guided urban transit positioning and fit from that perspective.

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Thus far, modal positioning research has tended to adopt a setting-specific or bottom up approach, comparing two or three modes in particular cities or -countries. Examples are Tirachini, Hensher, et al. (2009) and Henry & Litman (2011). While such research contributes understanding in its defined setting, many pertinent considerations, such as city dimensions and -stature, the relative merits of various transit modes, their prestige and contributions, users' income and presence of alternatives, system diversity and carbon footprint, are also present in global transit settings: The latter rich array of countries and cities, each with one or more transit modes, invites global research as an extension of setting-specific research. What follows is thus an empirical study of global city- and country behaviour regarding aspects of guided urban transit, rather than a study in a defined setting to compare modes for a specific mobility task.

1.2. Guided transport genetic technologies

It is helpful to examine competitiveness of guided transport, of which guided transit is a subset, vis-à-vis other transport modes by considering their degrees-of-freedom-of-movement. Three degrees of freedom of movement (e.g. aerial- and submarine transport) offer high, spatial mobility, but at relatively high cost. Two degrees-of-freedom-of-movement (e.g. unguided surface transport) offer lower, surface mobility at lower cost. One degree-of-freedom-of-movement (e.g. guided surface transport) offers only limited, linear mobility, back and forth on a guideway, but at relatively low cost in high-volume corridors. Limited mobility impairs the comparative value of transport service, so guided transport modes must offer compensating advantages to compete successfully against modes that offer higher mobility.

Axiomatically, such compensating advantages should inhere in the technologies that differentiate guided transport from modes with more degrees-of-freedom-of-movement. A vehicle-guideway pair ensures precise location of vertical loads, and secure application of lateral loads, technologies named *Supporting* and *Guiding* by Vuchic (2007: 449). One may leverage Supporting and Guiding by combining two or many vehicles, to scale capacity as required, a technology the authors named *Coupling*. Supporting, Guiding, and Coupling are the three *genetic technologies* that uniquely distinguish guided surface transport from all other modes: The extent to which particular guided transport modes exploit their three genetic technologies is a measure of their inherent competitiveness.

1.3. Application to railway positioning

Given the name of the authors' business, their research interests are railway-centric. Steel-wheel-on-steel-rail contact mechanics develop vertical- and lateral force components, corresponding to the Supporting and Guiding genetic technologies: They enable respectively heavier axle load and higher speed than other guided transport modes. Cross-breaking Supporting and Guiding, yields four railway market spaces. Three of them are inherently competitive, exploiting two or more of rail's genetic technologies—Heavy Haul (Supporting and Coupling), High-speed Intercity (Guiding and Coupling), and Heavy Intermodal (Supporting, Guiding, and Coupling)—to demonstrate robust sustainability in competition with other transport modes in the global setting. The authors have developed grounded understanding of railway positioning in those three market spaces (Van der Meulen & Möller, 2008b). The next section, the topic of this paper, addresses the fourth market space where rail is inherently weak.

1.4. The challenge for urban rail

Human passengers do not achieve high axle load by railway standards, even in double deck vehicles. Furthermore, the comfort criteria and physical laws that relate acceleration, coasting, retardation, and