Travel Behaviour and Society 16 (2019) 235–240

Contents lists available at ScienceDirect

Travel Behaviour and Society

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

Improvement of public transport services for non-cycling travelers

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ARTICLE INFO

Keywords:
Public transport
Service quality
Satisfaction with travel
Well-being

ABSTRACT

In this paper, we argue that the current focus on cycling must not neglect the need to improve public transport services for the large number of people who do not want to or are unable to cycle. An attractive public transport service is currently therefore the most important component of a sustainable transportation system. The question we address is what measures are needed to improve public transport to make people who do not cycle satisfied with the services such that their well-being increases. Based on research studies of satisfaction with public transport, measures at three levels of public transport services (use, access/egress, and overall) are identified and discussed.

1. Introduction

Current motorized travel by private automobiles is not environmentally sustainable (Van Wee, 2012). It also reinforces sedentary lifestyles (Handy, 2014). Cycling is in contrast sustainable and increases physical exercise. A report analyzing cycling in Sweden (Transport Analysis, 2015) shows that Swedes cycle on average 5.3 million kilometers per day which is a decline of 16 percent since the mid-1990s. Cycling has increased in major cities driven by a general increase in travel due to the population growth. Outside of these major cities, where formerly most bicycle trips were made, cycling is almost halved. A desirable trend in Sweden paralleled in several other countries is therefore that cities increase investments in infrastructure for cycling (referred to as an active travel mode) (see, e.g., *The cycle program for Malmö city* 2012–2019 retrieved at www.malmo.se). Implementing safe and convenient cycle routes has become one of the main development tasks in many cities (e.g., Copenhagen, Munich, Utrecht, and Tokyo) and bicycle master plans are today important elements of urban strategies (Lowry et al., 2016). In fact, converting today's traditional cities to become bicycle-friendly is considered to be one of the principal goals of development plans (Zayed, 2016).

Transport policies and planning that increase cycling are also justified by research showing that satisfaction with active travel (including also walking) is higher than travel by car or public transport (Abou-Zeid and Ben-Akiva, 2011; De Vos et al., 2013; Haustein and Nielsen, 2016; Lancée et al., 2017). In addition, other research (Friman et al., 2017a,b,c; Morris and Guerra, 2015; Olsson et al., 2013) shows that active travel more than motorized travel increases general well-being which is a more important outcome measure than satisfaction with travel.[1]

A drawback is that public enthusiasm for in particular cycling and its promotion by municipalities detract attention from some known limitations associated with this mode that cannot be fully abated by technical means and improved infrastructure. One serious limitation is that cycling to and from work excludes significant segments of commuters because of distance or travel time, precipitation and strong winds, and in some countries hours of daylight, hot or low temperatures (Liu et al., 2017). Another limitation is that older people due to physical frailty do not want to cycle (Forsyth et al., 2009). Still another limitation is that people for various reasons are unlikely to use a bicycle for some types of trips (e.g., grocery shopping, social visits) other than work trips even though travel distance or time is not too long.

We thus recognize that cycling is never an option for a large number of people, and for others it is only an option under certain conditions. In fact, public transport is currently the most important component of a sustainable transportation system.[2] In this paper our argument is therefore that cycling (and sometimes also walking) needs to be supplemented by accessible attractive public transport services. We pursue this aim through a narrative review (Hammersley, 2001) in which studies reviewed are seen as contributing to a map of the research area.

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[1] We will be using the term "well-being" to refer to both psychological and somatic well-being. The term "satisfaction" is reserved for the positive evaluation of travel. Since research has found that well-being is positively influenced by satisfaction with travel (Ettema et al., 2010), this measure may also be a useful criterion.

[2] At least until accessibility by walking and cycling is substantially increased by changes in land use (Van Wee and Handy, 2014.)

https://doi.org/10.1016/j.tbs.2018.03.004
Received 29 September 2017; Received in revised form 19 February 2018; Accepted 14 March 2018
Available online 17 March 2018

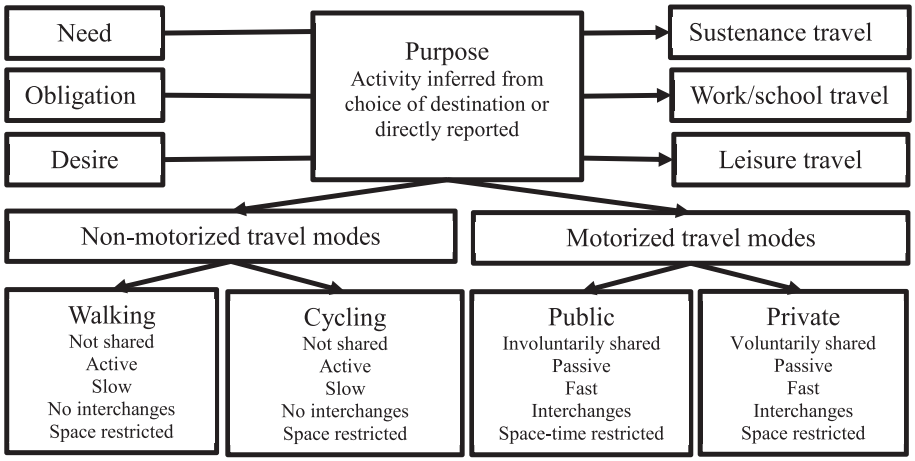

Fig. 1. A classification of travel features (adapted from Gärling et al., 2018).

Thus, our aim is not to synthesize evidence but to draw out the contributions of a range of studies for an understanding of what constitutes accessible and attractive public transport services. The challenging question we address last is how in the foreseeable future public transport should be improved to make travelers become satisfied with the services provided such that their well-being increases.

2. Research on public transport

2.1. Comparing features of public transport to features of other modes

A classification of travel features is a useful starting point for an understanding of the determinants of choices of motorized versus non-motorized travel and public versus private motorized travel. Fig. 1 is a classification proposed by Gärling et al. (2018). It highlights that purpose of travel (inferred from observations of destination choice or self-reports) is a basic feature of all travel (Axhausen, 2007). Purposes frequently identified include need, obligation, or desire to engage in some activity at the destination, usually in transport planning referred to as work, sustenance, or leisure activities (Vilhelmson, 2007). Non-motorized travel options include walking and cycling. Motorized travel modes are private or public. The purpose of travel influences choice of motorized or non-motorized travel in conjunction with other travel features (bundled as travel options) including shared or not, active or passive, slow or fast, having interchanges or not, and restricted in space/time or not.

Access is a factor that should be added to the classification in Fig. 1. Infrastructure for walking, cycling, driving, and public transport is an overarching and dominant factor influencing access. Another factor that varies with mode is access to shared vehicles. An increasing trend in many cities is shared bike systems (e.g., the Cyclocity program, www.cyclocity.com) that enable people to cycle whenever needed and without the costs and responsibilities associated with owning a bike (Shaheen et al., 2010). The flexibility of bike sharing systems makes it especially suitable for short distances and one-way trips (Bachand-Marleau et al., 2012). This holds in particular for bike sharing systems without docking stations, as recently introduced in many Chinese cities (e.g., Mobike, www.mobike.com, and Ofo, www.ofo.so). Shared motorized vehicles are provided in public transport designed for a general public. This includes buses, coaches, light and heavy rail, trams and ferries. Other shared motorized vehicles are provided by carpools and taxi services. Recent private initiatives are Car2Go, DriveNow, and Zipcar where people share the costs of owning and driving the car. The provision of fleets of shared autonomous vehicles is another development that is likely to make radical changes to the transportation system (Fagnant and Kockelman, 2014).

An important contribution to satisfaction with travel is engagement in solitary activities and desired social interaction during travel (Clayton et al., 2017; Ettema et al., 2012). Cycling does not provide these activities to the same extent as the other modes do. Social interaction in public transport may however also have negative effects if it is not voluntary.

Walking and cycling are generally referred to as active travel modes requiring more physical activity than passive motorized travel. The recent introduction of e-bikes, allowing cyclists to exert less physical activity, is a hybrid form of active and motorized travel (Langford et al., 2017). Some also identify public transport as a hybrid form of active mode due to the fact that access and egress is either walking or cycling (Besser and Dannenberg, 2005; Rissel et al., 2012; Sener et al., 2016). Active travel is associated with a number of health benefits such as reduced prevalence of diabetes (Saunders et al., 2013), a lower Body Mass Index and percentage body fat (Flint et al., 2014). Higher physical activity is observed for public transport users than car users (Waygood et al., 2015). However, there is a large variation in physical activity among users of motorized travel modes because some engage in compensatory physical activity. Therefore, higher physical activity is associated with higher incomes, flexible work schedules, shorter work hours, and mixed land uses (Chakrabarti and Shin, 2017). The positive health benefits of public transport use per se are therefore debatable (Ermagun and Levinson, 2017).

Speed or travel time is an important determinant of mode choice. Walking and cycling are both referred to as slow modes due to their limited speed. However, cycling in congested urban streets is sometimes faster than motorized travel. The increasing use of e-bikes has also resulted in both longer travel distances and higher speeds (Cherry and Cervero, 2007; Langford et al., 2017). Speed and travel time are identified barriers for car users to switch to public transport (Eriksson et al., 2008). It may be partly due to the fact that car users tend to underestimate travel times (van Exel and Rietveld, 2010).

Multimodality is a feature of all motorized travel (Axhausen, 2007). Walking to and from the bus/train or the car park is a frequent example. Another frequent example is public transport journeys having linked stages consisting of interchanges that result in waiting times when changing from bus to train or from one bus route/train line to another (Friman, 2010).

Another difference is the degree to which different modes are restricting travel in space and time. Cycling and walking are limited by weather and distance (Böcker et al., 2013). At the same time, walking and cycling are experienced by users as unrestricted (Aldred, 2013). Also, car travel is subject to space–time restrictions (e.g., lack of parking space, car-free zones, congestion) but is likewise perceived to provide a sense of freedom (Steg, 2005). Public transport is restricted by timetables and routing, although the restriction is more severe in rural than in urban areas with larger supplies.

In summary, public transport is a service that is shared by the general public, gives access to many activities although frequently fewer than other modes, and in urban areas is generally slower than car travel but, at least for longer distances, faster than cycling and walking. At shorter distances, it competes with cycling and walking and at longer distances with car use. If the ultimate policy goal of a sustainable transport system is well-being (Stanley and Stanley, 2007; Ettema et al., 2010), public transport does not offer the same levels of satisfaction and general well-being as other active modes do. This leaves non-cyclist worse off, and many will most likely choose to travel by car. Improving public transport in terms of well-being outputs is therefore important and in a subsequent section we identify measures for how this should be achieved.

2.2. Public transport's current market shares

How successful has public transport been to date? Current market shares for public transport (motor coaches, buses, trolley buses and trains) in the EU are equivalent to 16–17% of the total passenger travel (Eurostat, 2012). Nevertheless, despite a low share, it is still a relatively high market share compared to public transport in other markets. As a comparison, the market share in the United States is 5% according to the American Community Survey data 2006–2010 (Rapino and Field, 2012). An explanation for the European development and its difference to other countries is a continuous quality improvement since the 1950s when the car made its entry in many cities. Politicians and public transport companies in the EU have continued to invest in a reliable, accessible, comfortable, safe, and flexible public transport (Mees, 2010; Newman and Kenworthy, 1999; Pucher and Kurth, 1995). Other factors contributing to this positive development include economic (e.g. low employment, high taxes, high automobile costs, and public transport subsidies), demographic (population growth), and land-use (high-density cities) factors (e.g., Albalate and Bel, 2010; Buehler and Pucher, 2012).

By compiling statistics for Europe, Friman and Gärling (2017) show that the majority of public transport journeys (56%) are made by bus although the shares for different types of public transport varies in the member states with five countries (Austria, Croatia, Czech Republic, France, and Germany) having a higher share of urban rail than buses. Friman and Gärling (2017) also show that in member states offering metro systems (in 16 of the 28 member states), these attracts a significant share of the number of public transport trips. In Austria, France, and Spain, for instance, trips by metro make up over one quarter of all trips.

Major user groups of public transport are women, students, and households without access to cars (Eurobarometer, 2011). Buehler and Pucher (2012), as well as Davis et al. (2012), have noted a slight increase during recent years in use among young men. This is supported by research showing a downward trend in car use in this group (Aretun and Nordbakke, 2014; Sivak and Schoettle, 2012). In some European countries (e.g., Germany) public transport use by people with access to cars has been increasing (Buehler and Pucher, 2012).

2.3. Satisfaction with public transport

Satisfaction is known to be valuable for understanding customers' experiences (Oliver, 2010), and it is an important predictor of future customer behavior (Fornell, 1992). Customer satisfaction, therefore, highlights and explains the link between the products and services offered by a company and customers' well-being. Measurements of satisfaction have for these reasons become central in evaluating quality of public transport (Friman and Gärling, 2001; Gärling et al., 2018). Ettema et al. (2010) coined the term travel satisfaction, as consisting of both experienced affect during and a cognitive evaluation of a single trip, a typical recurring trip (such as a commute by bus), or the travel context in general. Travel satisfaction has also been found to indirectly influence overall emotional well-being as well as life satisfaction (Friman et al., 2017a,b,c; De Vos, 2017; Martin et al., 2014), and is thus a determinant of general well-being.

Redman et al. (2013) noted an important distinction between quality features of public transport that directly refer to users' experience (perceived features) and features that can be measured without involvement of users (physical features). Monitoring and measuring physical features (e.g., frequency, speed, or reliability) gives an overview and indication of whether the service is reliable and if it performs as planned. It may thus give information of the service that can be used to benchmark public transport services and guide decisions about additional investments. However, an evaluation of physical features does not provide information about how the system is experienced (for a similar discussion, see Grönroos, 1984) and thus how satisfied users are. Redman et al. (2013) therefore emphasized the importance of investigating how users experience physical features.

Apart from measuring satisfaction related to physical features, attention also needs to be directed towards perceived features that cannot be measured in a straightforward way (e.g., comfort, convenience, and aesthetics). This requires measurements by different methods that engage users. Methods include onboard interviews with paper-and-pencil questionnaires (Barabino and Deiana, 2013), national surveys (Fellesson and Friman, 2008), retrospective self-reports of satisfaction with trips (Ettema et al., 2011; Friman et al., 2013), and observations of choice and repeated choice using smart card data (Kurauchi et al., 2014). Technical developments have furthermore contributed to new innovative tools for measuring and tracking experiences. An example is apps downloaded on travelers' smartphones (Friman et al., 2017a,b,c; Susilo et al., 2017).

Service development should however not only focus on current users and their experiences. Also, non-users should be investigated to obtain information about what is required to make public transport an attractive alternative. This becomes especially important when car use is restricted and active modes are not an alternative. Examining non-users' views of public transport is difficult if they have no knowledge or previous experiences of the service. This was confirmed in a study among car commuters (Eriksson et al., 2008) showing that many car users did not know how public transport should be improved to be more attractive. Work-commuters by car were asked to state reasons that would make them reduce car use when commuting to and from work. One question was "What would make you use public transport more often?" and it was possible to choose three reasons from a list of 15 including "Nothing/not relevant or possible". Participants could also add additional reasons themselves. The results showed that of those who responded, 76% stated that increased frequency of service, shorter travel time (including a direct bus service), and lower public transport fares could be reasons for increasing their public transport use. Similar results have been obtained in other studies (e.g. Kingham et al., 2001). Another difficulty is that car users may have an unwarranted negative attitude towards public transport. One way to change non-users' attitude towards public transport services is to increase their knowledge by making them use the services (e.g. Pedersen et al., 2011).

It is important to recognize that non-users are not a homogenous group and that travel behavior change is dependent on intrinsic motivation (Friman et al., 2017a,b,c). When different user segments have different needs and are motivated by different factors, they should be treated in different ways. This has important implications for designing public transport services and promotional strategies that best serve the needs of each user segment. The review presented by Friman et al. (2017a,b,c) indicate that transport policies and marketing strategies which aim to promote public transport or active modes need to include interventions relating to processes (e.g., consciousness raising or skill improvements) and stages of motivational change. This implies that different interventions should be directed to people that have no intention of changing their behavior compared to people that have started to think about changing their behavior in the near future.

Table 1
Proposed measures to improve public transport related to different stages.

Stage	Measure related to
Satisfaction and well-being related to use	Quality features Critical factors Segmentation/target groups
Satisfaction and well-being related to access and egress travel	Waiting facilities Attractive routes Wayfinding/intuitive use Safety Cleanliness Stimulate walking and cycling Dedicated services for users with physical limitations
Overall satisfaction and general well-being	Infrastructure Design of vehicles Pricing Collaboration in city planning Focus on social exclusion and vulnerable groups

3. Future public transport

How should public transport be improved in the future such that people become satisfied with the services provided? Thinking about what future public transport should look like first requires specifying goals of improvement. From an operational, financial and management point of view, a goal may be to attract ridership to generate revenues and reduce road congestion. An alternative goal would be to increase users' well-being. These goals are not necessarily aligned. For instance, catering for the needs of current car commuters may lead to measures that make public transport less accessible for low-income captive users by offering, for example, better equipped carriages at a higher price.

In what follows we discuss implications for future public transport developments departing from the goal to optimize users' general well-being. Based on research on satisfaction with public transport as well as research relating public transport use to general well-being, we identify several measures in need of being attended in transport planning. These measures are summarized in Table 1. The measures are related to use of public transport, access and egress travel, and the overall trip experience.

Policies may draw on many studies that have identified service factors that are critical for well-being while being on board of public transport vehicles (e.g., Fellesson and Friman, 2008; Redman et al., 2013). It is also important to distinguish between user groups. Satisfaction by commuters will likely differ from satisfaction by recreational travelers. Additional dimensions on which satisfaction differs include age, gender, and whether traveling alone or in company with someone (Beirão and Cabral, 2007; Ettema et al., 2012; St-Louis et al., 2014).

The quality of access and egress travel, including waiting facilities, are important for well-being during the whole trip. A recent study by Abenoza et al. (2017) revealed that factors such as station design and design of public transport stops has an effect on satisfaction with the trip, but these aspects have received limited attention. In particular ease of wayfinding, safety, and cleanliness seem crucial. A recommendation to managers is to make the service intuitive, meaningful, and easy to use (Pareigis et al., 2012). Presenting information in a way that reduces uncertainty is also essential (Dziekan and Dicke-Ogenia, 2010). One concrete example of how this can be done is the route map for bus services in Karlstad (a medium-sized Swedish city), which is inspired by metro maps (see www.karlstad.se/Karlstadsbuss/Tidtabellerkartor/).

Access and egress travel may involve walking, cycling, or car travel as driver or passenger. Since walking and cycling invariably are found to lead to higher travel satisfaction (Olsson et al., 2013), it makes sense to implement policies that promote choice of walking and cycling in access and egress travel. While the median access distance in the Netherlands by cycling is 1.8 km and by walking 550 m (Krygsman and Dijst, 2001), a relevant observation is that that travelers accept twice as long distances to high quality public transport than to regular public transport (Brand et al., 2017). Other effective measures include location of public transport stops in residential areas as well as safe and attractive routes to and from these. An abundant research literature is available as to what requirements such routes should meet (e.g., Schlossberg and Brown, 2004; Sun et al., 2017). For instance, avoiding interaction with other transport modes is an important factor. In addition, in the case of access and egress cycling, provision of safe parking options with fast connections to public transport platforms is a key factor (Yang et al., 2015). Given that private bicycles are not available for egress travel, bike share systems at the alighting station would offer attractive active transport options beyond walking distance. The public transport bicycle program launched by Dutch railways is a good example of the potential of such systems (www.ns.nl/en/door-to-door/ov-fiets).

A specific user group to consider is those with physical limitations, such as elderly or impaired people, who may have difficulty walking or cycling to/from stations, but also to maneuver in stations or getting on/off public transport vehicles (Chiatti et al., 2017; Susilo and Cats, 2014). Dedicated services will be needed to make travel by public transport easier and more satisfactory for these user groups.

Satisfaction with travel is a domain-specific form of satisfaction (Ettema et al., 2010). As such it will influence overall satisfaction (Schimmack, 2008). For instance, a long and crowded daily public transport trip may significantly in the longer-term impact on overall satisfaction with travel due to repeated negative experiences. Long travel times by public transport also negatively affect time and energy remaining for important activities such as family time, hobbies and social interaction, also reducing general well-being. A key example is the overcrowded metro system in Beijing, where waiting times in subway stations amount to more than one hour, leading to exceptional commute durations (Mao et al., 2016). This is likely to add to negative effects on general well-being for people who already suffer from time pressure in their lives (Gärling et al., 2016, 2014).

Measures addressing overlong commutes involve improvement of infrastructure, allowing for higher speeds and increasing capacity to reduce waiting times. An alternative approach to abate the negative effects would be to design public transport vehicles such that they allow travelers to spend their travel time productively (Jain and Lyons, 2008), thereby saving work time spent in the workplace. Long commute distances are often related to housing market limitations that do not allow workers to live close to their work place. For instance, housing in central areas of cities, that host large concentrations of jobs, has become increasingly expensive, pushing workers away to suburban locations with long commute durations. While not easy to achieve, housing market policies could have considerable impact on commute durations of in particular low income workers and thereby on their general well-being.

Third, and more generally, it is essential to increase general well-being by a public transport service offering access to activities such as work, education, recreation, sport, cultural events, and social visits. This effect will be strongest for those relying on public transport because they have not access to a car or are physically not able to cycle. For those groups, having no or limited access to public transport improvements renders them at the risk of social exclusion (e.g., Currie et al., 2010; Lucas, 2012). The implication is that policy should, in addition to large groups of frequent travelers such as commuters, focus on these particular vulnerable groups. Important policy objectives would be to ensure that relevant destinations for these groups (e.g. schools, medical centers) are well-served by public transport and that areas where they reside in higher numbers are well served. In general, access to public transport among these groups is a key objective. This also includes pricing, since high fares may be a reason for some to not

use public transport. Experiments with free public transport for specific student groups in Hasselt, Belgium (De Witte et al., 2006) showed how free use can contribute to users' increased understanding of the public transport services and a positive evaluation of the city.

4. Summary and conclusions

In this paper, we argue that a sustainable transportation system needs to include an accessible public transport service of high quality. A sustainable transportation system cannot solely depend on walking and cycling due to its exclusion of different user groups and impeding factors such as, for instance, weather or travel purpose. A sustainable transportation system should furthermore integrate public transport, walking, and cycling, to foster seamless, multimodal mobility, and to increase the overall attractiveness of public transport also for cyclists who sometimes will need to use public transport.

A classification system was presented to identify important features of public transport and other modes. It is concluded that public transport can be shared by many, give access to daily activities, and made faster than other travel modes if given priority. This led to the question of what measures are needed in order to develop an attractive public transport service in the future that appeals to many user segments, including current non-users. Although the market share is relatively high in Europe, the public transport sector has set out the ambitious aim of doubling the market share of public transport worldwide by 2025 (UITP, 2014). Although currently limited to Europe this may motivate similar attempts on other continents. A neglected issue is however the specification of an overarching goal of improvement.

Since travel is crucial to the lives of a large majority of citizens and is an integral part of day-to-day human experience, we argue that the improvement of future public transport should increase users' general well-being. Based on current research on satisfaction with public transport as well as research relating public transport use directly to general well-being, we have identified several measures in need of being attended in transport planning. Yet, there is no one-fits-all solution, and measures therefore need to be customized by user segment as well as by travel context. This is a task that transportation planners at local levels must face.

Acknowledgement

Financial support was obtained through Grant #2014-05335 from the Swedish Governmental Agency for Innovation Systems.

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