CONCEPTS, REFLECTIONS AND APPLICATIONS OF SOCIAL EQUITY

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APPROACHES TO ACCESSIBILITY TO PRIMARY GOODS AND SERVICES IN THE REGION OF FLANDERS, BELGIUM

Introduction

>> Mobility presents a variety of opportunities as it allows users to access locations and services, and to meet people beyond their immediate surroundings. While the concept of mobility primarily focuses on the ease of moving, accessibility delineates the actual potential to participate in out-of-home activities. As a result, accessibility is a complex concept with a multitude of foci. This complexity is presented in the first section, which explains the general concept of accessibility, how it is defined and how it is related to the notion of transport-related exclusion. This section also gives an overview of the body of literature on the measures to determine area-based as well as personal accessibility levels and points out the important contrast between the simple, easy-to-interpret methods, adopted by policy makers and the complex methods preferred by experts.

The second section clarifies how the dichotomous relationship between the urban and rural environment is reflected in transport policy that emphasizes on (especially car-based) mobility rather than on accessibility. Furthermore, the environmental and economic points of view are highlighted and the common policy strategies focused on sustainability are illustrated. Subsequently, the shortcomings in the way in which the contemporary debates concerning mobility, sustainability and the social implications of transport planning are conducted, are criticized. Finally, the last part of this section is dedicated to an extensive discussion on the ability of transport policies to, on the one hand, generate spatially as well as temporally uneven accessibility effects that give preference to certain population groups above others, and on the other hand, their ability to strive for a more equitable distribution of transport services amongst the population.

The third section proposes two methodologies for measuring transport-related social exclusion implemented in a literature-based case study in Flanders. These studies comprise the following topics: measuring transport gaps by relating the social to the transport disadvantage and measuring modal disparities by comparing accessibility by private and public transport. The former investigates in which areas the provision of the public transport system is not tailored to specific public transport needs. The latter examines the disparity in access by private and public transport in order to highlight the car dependency. Both case studies incorporate the temporal variability in provision through the private and public transport network, as the time-of-day strongly influences accessibility levels.

The complex concepts of accessibility

Defining accessibility: a widely applied yet slippery notion

Although the concept of accessibility is deeply rooted in the research domains of transport geography and planning (Neutens, 2015), the definition of accessibility greatly depends on the context, ranging from social equity studies to transport and economic expansion issues. The difficulty of finding an operational definition of accessibility is well stipulated by Gould, who says: "Accessibility […] is a slippery notion […] one of those common terms that everyone uses until faced with the problem of defining and measuring it" (Gould, 1969, p.64). According to Hanson (1995), accessibility is "the number of opportunities, also called activity sites, available within a certain distance or travel time" (Hanson, 1995, p. 4). Ingram (1971) uses the following definition: "Accessibility may loosely be defined as the inherent characteristic (or advantage) of a place with respect to overcoming some form of spatially operating source of friction (for example, time and/or distance)" (Ingram, 1971, p. 101). A third example is to be found in Morris et al. (1979): "Accessibility has generally been defined as some measure of spatial separation of human activities. Essentially it denotes the ease with which activities may be reached from a given location using a particular transportation system" (Morris et al., 1979, p. 91). In essence, accessibility refers to the relative ease by which the locations of activities – such as work, shopping or health care – can be reached from a certain location and by using a given transport system. On the one hand, it varies across space, because it is affected by where the activities or services (supply) and the people (demand) are located. On the other hand, accessibility also varies over time, because both supply and demand are time-dependent (Luo & Wang, 2003; Neutens, 2015). In sum, it can be seen as the opportunities of individuals or groups to participate in a desired activity at a desired location and at a chosen time.

In fact, accessibility is a multi-faceted concept that involves five dimensions: affordability, acceptability, accommodation, availability and geographic accessibility. These dimensions can be classified in two classes: spatial (geographic accessibility and availability) and non–spatial (affordability, acceptability and accommodation) (Penchansky & Thomas, 1981). In the spatial class, geographic accessibility can be defined as the relationship between the locations of supply and demand, taking into account the distance and the clients' transportation resources and time budget. For example, if there are no pharmacies located within walking distance of a bus stop, they can only be accessed by car-owners or people who live nearby. Availability is the second spatial dimension and concerns the relationship between the volume and type of existing services and the clients' volume and type of needs. Geographic accessibility and availability are often considered as one, and grouped under the denominators 'spatial accessibility' or 'accessibility'. In the non-spatial class, affordability is seen as the relationship between the cost of a service and the clients' income or ability to pay. Acceptability refers to the relationship between the clients attitudes about personal and practice characteristics of existing providers including sex, age, location, education, religion, etc. as well as the provider's attitude about personal characteristics of the client. A common example is found in shopping behavior. A store can be attractive for one person because the goods are low priced and of good quality, while another person can have issues with the store's hygienic condition and, as such, prefers to pay more for the same quality in another shop with higher hygienic standards. Finally, the term accommodation is understood as the relationship between the manner in which the supply resources are organized and the clients' ability to accommodate to these factors, such as the office hours of a service, and the clients' perception of their suitability. For example, the confidence that someone has to be able to get good medical care when needed. The non-spatial factors influencing the overall accessibility are often highly correlated. For example, neighborhoods with low educational attainment tend to have high unemployment rates and low income levels (not considering complex mechanisms such as upwards mobility or social and cultural capital) (Dai & Wang, 2011; Penchansky & Thomas, 1981).

Another dichotomous classification of access to services is the potential access versus the revealed (realized) access. Revealed accessibility focuses on the actual use of the service, whereas potential accessibility signifies the probable entry into the service, but does not ensure the automatic utilization of the offered services (Khan, 1992; Luo & Wang, 2003). The ability to participate in out-of-home activities is closely related to people's well-being. An example of where potential access will influence policy is the issue of the ageing of the population. To face the ageing population in Flanders in the future, it is necessary to take action at the present. Based on demographic statistics, it is possible to calculate the number of elderly people in need of a stay in a retirement home in the short and medium term. The dimensions of the services (in the example, number of available rooms in homes for the elderly) can then be adjusted in response to the potential user dimensions. This means that potential access is offered to potential users. Potential access thus means probable entry into the retirement home system. However, it does not signify the automatic occupancy of the total number of rooms made available. The actual utilization is susceptible to a lot of factors (barriers or facilitators) depending on both the service and the users, such as the quality of the rooms, the cost, other services that may expand (i.e. home based care), the retirement benefits, the family situation, etc. When the facilitators are preponderant to the barriers, the service will be utilized and realized access is achieved (Khan, 1992; Luo & Wang, 2003). While the concept of potential access is likely to be used in planning processes, the concept of realized access is often applied to evaluate existing systems.

The degree of fairness of access to these opportunities, however, is a highly complex matter. Van Wee and Geurs (2011) highlight three primary ethical theories that form the guiding principles for transportation equity: utilitarianism, egalitarianism and sufficientarianism. The utilitarianism approach states that an equitable distribution is achieved when the net benefits outweigh the costs and, therefore, is often applied to analyze and evaluate transport projects and plans (Rock et al., 2014). In other words, justice is done when the total amount of utility is maximized (Geurs & van Wee, 2004). Consequently, the distribution of these benefits is not taken into consideration. An egalitarian approach answers this shortcoming by introducing a sense of fairness by broadly stating that all people are to be treated equally. Nevertheless, this general view on justice does not consider specific needs and does not fully answer the question of who gains the benefits and who bears the costs. Sufficientarianism focuses on the degree that people can meet their particular needs sufficiently and states that priority should be given to improve the well-being below a certain threshold (Rock et al., 2014). This would, however, imply that small benefits for someone below this threshold are prioritized above benefits for larger groups, even though this choice would bring more people below that threshold. In addition, determining this threshold has proven to be a difficult task and seems practically impossible to justify. Martens et al. (2014) delineate prioritarianism as an expansion to sufficientarianism, as it states that benefits matter more the worse off the person is to whom these benefits accrue. Contrary to sufficientarianism, the concern is not absolute: large gains for well-off people can outweigh small gains for worse-off. The prioritarian approach has become an important focus of transport-related social equity studies.

Modeling accessibility: from place-based to sophisticated people-based measures

Modeling accessibility has a long history with a trend towards increasingly sophisticated measurements. More detailed accessibility analysis enables to better determine who has the strongest claim when resources are scarce and, therefore, further unravels the key role transport may play in ensuring an equitable distribution of opportunities. Based on their complexity, methods for measuring accessibility can be categorized in at least four groups. The first group consists of methods in which accessibility is measured at the level of spatial boundaries, mainly administrative districts. 'Provider to population ratio' (PPR) is the most popular method in this category and is derived from dividing the number of facilities (supply) by the number of inhabitants (potential demand) located within a zone of a particular zoning system. An important limitation of these container-based metrics is the assumption that facilities outside the predefined areal unit are inaccessible and that those within the unit are equally accessible to all people within that areal unit. As the same level of accessibility is allocated to all inhabitants of a zone, these methods do not factor in the difficulties related to the spatial distribution of both supply and demand within that zone and ignore competition between suppliers and consumers (Huff, 1963, 1964). However, these methods are often used in spatial policy decision making because such metrics are easy to calculate, do not always require GIS (Geographical Information Systems) tools and are intuitive and readily understood by policy makers (McGrail & Humphreys, 2009; Neutens, 2015). An example of PPRs used in Belgium can be found in IMPULSEO[2], a system that awards financial assistance to physicians settling in shortage areas based on the calculation of the PPR per physician zone. Nevertheless, research shows that this only offers a very crude representation of accessibility to primary health care, because physician zones cover too large geographic areas (Dewulf et al., 2013).

Methods belonging to the second group are slightly more complicated than PPRs,

[2] Koninklijk besluit tot oprichting van een Impulsfonds voor de huisartsgeneeskunde en tot vaststelling van de werkingsregels ervan, B.S., March 30, 2012

however they also produce easily interpretable values, and are easy to understand and to implement using popular off-the-shelf GIS software. Well known methods are 'travel impedance[3] to nearest provider', also called 'closest facility' function (CF) and 'average travel impedance to provider'. The advantage over PPRS is that services in other zones are also considered, however, in the CF, the competition between services is still not accounted for. Therefore, the measure is primarily useful in rural areas characterized by a low availability of services. The average-travel-impedance-to-provider method is more suitable for analysis in urban environments, as it considers all the services or a predefined maximum number of the closest services in the research area. This method introduces the competition between services into the calculations. Taking into account the demand side, however, requires more advanced models. Variations to these basic principles are applied in different case studies (Apparicio et al., 2007; Apparicio et al., 2008).

The third category comprises the more complex gravity-based and cumulative-opportunity measures that partly overcome the limitations of the methods described above. They rely on three elements: the demand or population location, the service locations such as shops, physicians, or schools, and an impedance function (travel impedance) to reduce the number of opportunities in function of the distance or effort that needs to be overcome (Delamater, 2013). They deliver a combined indicator of accessibility and availability and can provide accessibility measures for both urban and rural areas. Gravity models attempt to represent the potential interaction between any population point and all service points within a cut-off value, discounting the potential with a mode-dependent impedance decay function. To be successful, these functions need to be fine-tuned for each new study to reflect the true impedance at that point in time and space. Cumulative-opportunity measures on the other hand, integrate the impedance by excluding opportunities beyond a cut-off value. The simple gravity-based model has two main problems. First, the calculated values are not intuitive for policy makers, who prefer to think of spatial accessibility in terms of PPRS or simple distances. Second, it only models supply. There is no adjustment for demand or for the competition between services (Luo & Wang, 2003). Over the years, several enhanced methods were developed based on the gravity model. Some of these sub-types are extensively documented in literature.

The floating catchment area (FCA) family of metrics is a widely applied method and is based on gravity models. FCA metrics incorporate the interaction among supply, potential demand, and travel cost in their characterization of spatial accessibility. These metrics allow the containers to "float" as travel buffers or catchments and are based on the travel impedance from the facility and/or population locations. They also offer detailed variations within large administrative entities. Therefore, they offer a more realistic approach of accessibility than the traditional container-based regional availability measures (first category). The shape and size of the catchment area depend on the density of, and the location in the transportation network. Unlike general gravity models, the FCA metrics provide an output in a highly interpretable

3 Travel impedance or travel cost can be expressed as a distance, a time, or an amount of money and is often used to define the size of the catchment area of a population or a service. Numerous accessibility measures use the concept of catchment areas of which the size is defined by the threshold travel impedance or the maximum cost a person is willing to spend on one trip. As a consequence, the distance is often not introduced directly in the accessibility calculations. Instead, given a certain maximum time limit, a transport mode, a transportation network and speed limitations inherent to the transport mode or to the network (speed limitations), the threshold travel distance will be calculated and then used as input for the network calculations.

supply to population ratio (e.g., number of physicians per person) and was amongst others applied to calculate accessibility to primary health care (Luo, 2004; Luo & Wang, 2003). A disadvantage of the FCA method is that it does not account for the competition between services in case of overlap between service areas. This limitation is overcome by the two-step floating catchment area (2SFCA), which is a favored method for the assessment of accessibility to health care (McGrail & Humphreys, 2014). The 2SFCA was subject to further modifications, some of them tailor made solutions to a specific accessibility issue. The best known are the enhanced 2SFCA (E2SFCA) and the kernel density 2SFCA (KD2SFCA), which improve the calculations by introducing travel impedance decay functions in function of the distance to the center of the catchment area, meaning that locations near the center are more accessible than locations situated at the edges (Dai & Wang, 2011). Another example is the three-step floating catchment area (3SFCA) which also takes into account the potential competition between services to avoid an overestimation of the demand when several services are accessible from one location (Bell et al., 2013; Wan et al., 2012).

The importance of selecting the most suitable method for a given accessibility issue is illustrated by Figure 1. This figure shows the results for some of the measures described in the previous paragraphs for the accessibility assessment of pharmacies in Ghent, Belgium. It is clear that the conclusions drawn from an accessibility study strongly depend on the type of measures used.

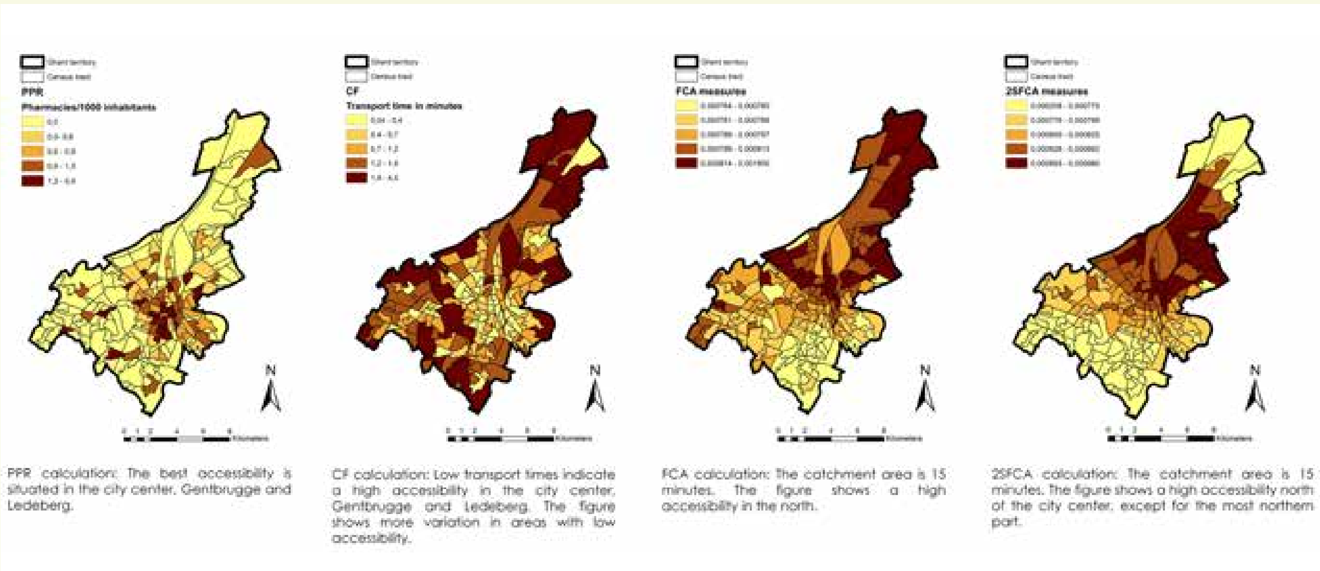


FIGURE 1

Comparison between the results of the PPR, CF, FCA and 2SFCA method for the assessment of the car accessibility to pharmacies in Ghent, Belgium

While the first three categories are predominately place-based measures, the fourth category consists of person-based measures or a combination of both. Place-based accessibility measures are particularly suited to examine changes in the proximity of services to the homes or workplaces of individuals or modifications of the transport network. All these measures tend to use the home or workplace as a static substitute for an individual. They ignore the many trips that originate from the work location (such as noon errands and childcare), other anchor points, and the multi-linked trips. Furthermore, they do not take into account accessibility limitations as a result of social inequalities caused by language, gender, financial situation, mobility, etc. or individual-based needs (Miller, 2007; Neutens, 2015). Moreover, these accessibility indicators ignore the fact that accessibility is time-dependent and that both supply and demand fluctuate over time, e.g. day and night rhythm, daily routines, travel time, public transport schedules and traffic congestions (Delafontaine et al., 2011; Neutens et al., 2010). When temporal changes are made to the service provision (e.g. by changing opening hours), spatio-temporal accessibility levels will fluctuate, which may lead to the exclusion of certain groups within the population from participating in specific activities (Casas, 2007). In fact, the actual accessibility levels will constantly fluctuate during daily or weekly cycles. These fluctuations derive in part from variations in operating hours of services and facilities as well as from the individuals' commitments or fixed activities that bind them to particular places at specific times of the day, e.g. workplace, childcare, shopping, sleeping (Schwanen & de Jong, 2008; Zandvliet & Dijst, 2006). Today's lifestyle implies that using information about the distribution of the stationary, night-time population across street addresses or zones and the implicit assumption that (adult) members of that population can access services at any time of the day, as the basis for the evaluation of changes in service provision have become increasingly problematic (Neutens et al., 2010).
People-based measures rely on the characteristics of the transportation system as well as on detailed observations of an individual's activity schedule (Neutens et al., 2010). A very recognizable situation in which spatio-time accessibility measures (STAMS) can be used to improve the individual accessibility is comprehensively narrated by Schwanen and de Jong (2008) in the article "Exploring the juggling of responsibilities with space-time accessibility analysis". In this article the story of a highly educated mother who has to reconcile fixed employment times, chauffeuring her son to childcare, and a lengthy commute via congested highways is used to explain the benefits STAMS have over the traditional space-based measures. The case study shows how STAMS allow analysts to evaluate if, and to what extent, individuals can actually benefit from proximity to services. Nonetheless, the number of empirical studies of space-time accessibility that explicitly consider the effects of open hours on opportunities is limited to date.

Recently, researchers have succeeded in introducing not only spatially related parameters, but increasingly also temporal and person-based parameters into the calculation of accessibility measures, thanks to the increased computational power of GIS and the availability of individuals activity and travel data. Instead of a measure of potential accessibility, it is now possible to determine revealed or realized accessibility for different groups of people. This leads to more accurate and realistic assessments of changes, variations or gaps in accessibility, but also implies more complex methods and results that are difficult to interpret, which is probably the main reason why most policy decisions are still based on the simple and intuitively interpretable, yet not adequately accurate PPR methods. Although policy makers have historically paid little attention to the exploration of these complex analysis methods, there has been a shift within the planning and transport fields towards a focus on measures that aspire to attain a just and equitable distribution of opportunities.

A reflection on the social aspect of transport planning

Shaping mobility: the locational paradox
Both the living environment and the location have an impact on an inhabitant's mobility. Additionally, they are strongly influenced by and at the same time have an impact on the transport mode choice. As a result, deciding on a city, town or village to settle in is one of a household's most important life choices: in between jobs, but close to friends and family; lots of child-friendly space for the kids to play outside, yet not too far from shops and services that offer the daily required commodities. Urban environments are generally known for their high built density and their elevated number of and variation in facilities within walking or biking distance. Cities bear enormous potential in making use of their efficient layout and the proximity of amenities to maximize accessibility. Consequently, they have risen as pre-eminent spaces for initiatives to counteract the overall car dominance with more sustainable

FIGURE 2
Projects Fietsschool Leuven (left, source: Mobiel 21) and Leefstraat Ghent (right, source: Lab van Troje)

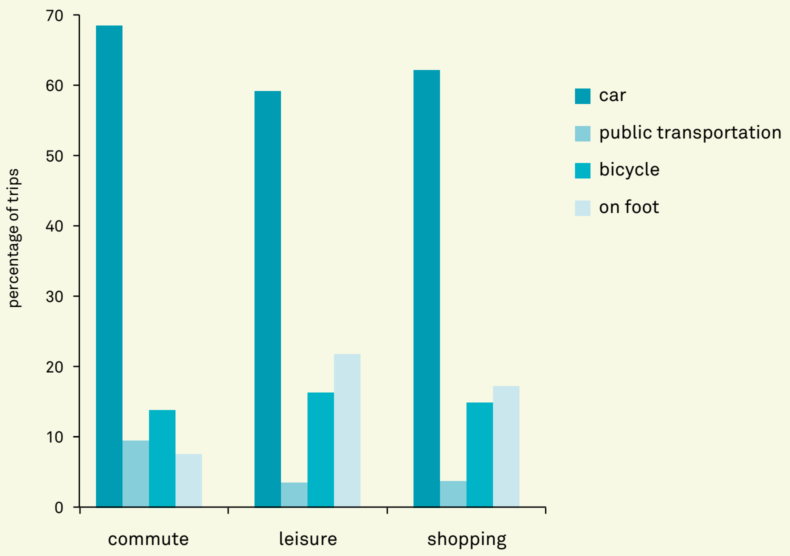
alternatives. In 2015, both Ghent and Brussels have reimagined their mobility plan to focus on phasing out cars and creating breathing space for cycling and walking. Car-free streets, hindrance of car flow between different neighborhoods and stronger restrictions in maximum drive speeds are becoming fixed values in city's mobility policies. Recent ambitions are no longer only policy-based, more often citizen initiatives and organized movements arise that aim to improve the quality of life of the street, neighborhood or city they live in. Cycling School Leuven ('Fietsschool Leuven'), for example, annually teaches over 100 adults to safely ride a bike in the city of Leuven, in the ambition to provide a satisfactory substitute to car transportation. In Ghent, volunteers of the Lab van Troje-network aid the residents of dozens of streets to temporarily convert them to car-free zones with space for greenery, cohabitation and encounters (Figure 2).

Another example is the project Elderly as Public Transport Ambassadors ('Ouderen als Openbaar vervoer-ambassadeurs') in the regions of Flanders and Brussels, where elderly people provide information to other elderly people on how to use the public transport system, in order to overcome barriers such as the complex time schedules or purchase of tickets. This type of qualitative investments contribute to putting a halt to the great migration from the city centers to suburban and rural areas that peaked in the second half of the 20th century as a result of the increased wealth and the use of the automobile.

Paradoxically to the apparent advantages of living in a city, suburban and rural areas remain the most favorable living location for households willing to trade in proximity and vivacity for tranquility and spaciousness, at the cost of car ownership and longer commute. The outer city neighborhoods and suburbs combine the vicinity of the city center's goods and services with the peace and quiet of living outside the city core. As the city's scale remains small, commutes, leisure trips and social visits are characterized by short distances, which are often still possible to bypass by bike (the emergence of the electrical bike has even further increased the radius by bike) or on foot. The accessibility to daily needs such as employment, health care or education remains relatively high, even for households with a lower mobility. However, as the distance to the city center increases, so does the transport dependency. Facilities are more distributed and thus harder to reach, and the range of options rapidly diminishes. Additionally, public transport stops that commonly radiate peripherally from the city center, become a rare characteristic in the rural fabric. Road layouts are no longer focused on pedestrians' and cyclists' safety, as sidewalks and bike lanes make way for car-oriented infrastructures that ameliorate the efficiency of travel by car. These transitions culminate in the most remote areas, frequently distinguished by ribbon development along the roads connecting city centers.

In general, mobility rather than accessibility has been the focus of transport policy since the popularization of the car (Martens et al., 2012). Due to its typical spatial structure characterized by sprawl and ribbon development, Flanders is known for its strong car dependency. Almost 70% of the commutes and around 60% of the leisure

FIGURE 3
Transport mode choice for different travel types in Flanders (De Vos, 2015)

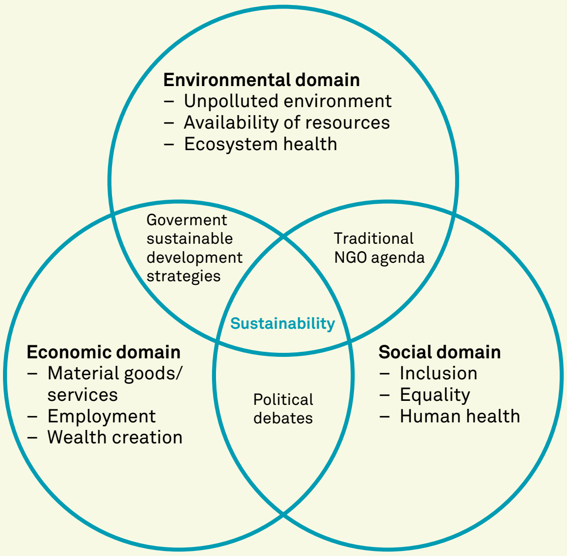


[4] Rurban as a combination of urban and rural space, distinctive for the Flemish countryside. This transition zone is considered as an important social, institutional and spatial challenge (Vanempten, 2010).

and shopping trips in Flanders are made by car (Figure 3). In the Netherlands for example, the modal share of car use lies below 50% for all type of trips and bicycle use is considerably higher (De Vos, 2015). Improving the accessibility by increasing the number of facilities in these areas is often not efficient, as insufficient inhabitants are located in the additional catchment areas. As a result, the best way to facilitate better access is by increasing the mobility, which in the Flemish rurban[4] landscape is usually realized by more travel by car. Providing adequate public transport in even more remote areas has proven to be difficult. This has largely been to the detriment of inhabitants without access to a car and disadvantaged groups (Martens et al., 2012). It remains a challenge to maximize mobility while at the same time trying to replace the dominance of private motorized transportation by alternatives that currently do not provide a comparably qualitative solution. In recent years, several projects arose in rural areas that focus on car sharing or communal taxies, yet they do not always provide solutions for people living in poverty or individuals without an adequate social network.

From an environmental and economic point of view, the dichotomy between urban and rural mobility is believed to be reflected in the degree of sustainability. Longer commutes are generally considered disadvantageous because of the externalities related to motorized transportation. These outcomes are intensified by the preference of private motorized transport over more sustainable alternative transportation modes. The increased mobility leads to a considerable strain on the environment in the form of pollution, whereas congestions or the high number of traffic accidents have an important financial impact. In Flanders, for example, fine particles diminish average life expectancy with three years (Van Zeebroeck & Nawrot, 2008). In addition, possible future problems have become the subject of debate, as global warming or exhaustion of fuel resources are considered to endanger future generations. To prevent these externalities from manifesting, policies often strive to minimize the environmental and economic effect of the growing mobility in order to enhance sustainability.

FIGURE 4
The domains of sustainable development (Reeves, 2005)



Towards equitable accessibility: transport as a social issue

As illustrated, common policy strategies focused on sustainability strive to compensate the effects related to an augmented mobility. Figure 4 indicates the functionality of governmental sustainable development strategies in the cross-section of the economic and environmental domain. There is a strong interaction between both domains, as measures aimed at increasing the economic benefits can have an inversely proportional impact on our environment. For example, making goods and services better accessible by introducing more road capacity simultaneously increases the number of cars on the road and thus the overall emission of CO_2 and fine dust. Discussions on these types of topics are a fundamental component of the daily debates, especially as it is often the economic domain fueled by political opinions that prevails. Independent on their outcome, these discussions frequently start from the recognition that the overall mobility, and more specifically car use, is increasing, and policy should aim at counteracting the economic and environmental externalities related to growth. In this respect, the debate on the realization of the shopping and recreational complex Uplace in Machelen is exemplary, in the sense that figures on the uplift of trips by automobile have played an important role for the opposition to object to the project (Boussauw & Lauwers, 2015). As of today, public as well as political support is waning rapidly as the project is considered not only an economic mishap but also a significant trigger for traffic congestion and pollution. These debates, however, fall short to the question of how the complexities of the existing and evolving society's travel behavior are incorporated into the decision process of actions that lead to this gain in mobility. Consequently, this growth should not be compensated after the decision process, but it should be countered by including a more sustainable provision to the population's complex mobility needs into the decision process. Boussauw and Vanoutrive (2015) rightfully indicate that the development of a transport system which is overall less environmentally harmful does not automatically contribute to a more just and socially substantiated configuration. This line of reasoning rises beyond the classic vision on mobility, as the social domain of sustainability is incorporated into the equation.

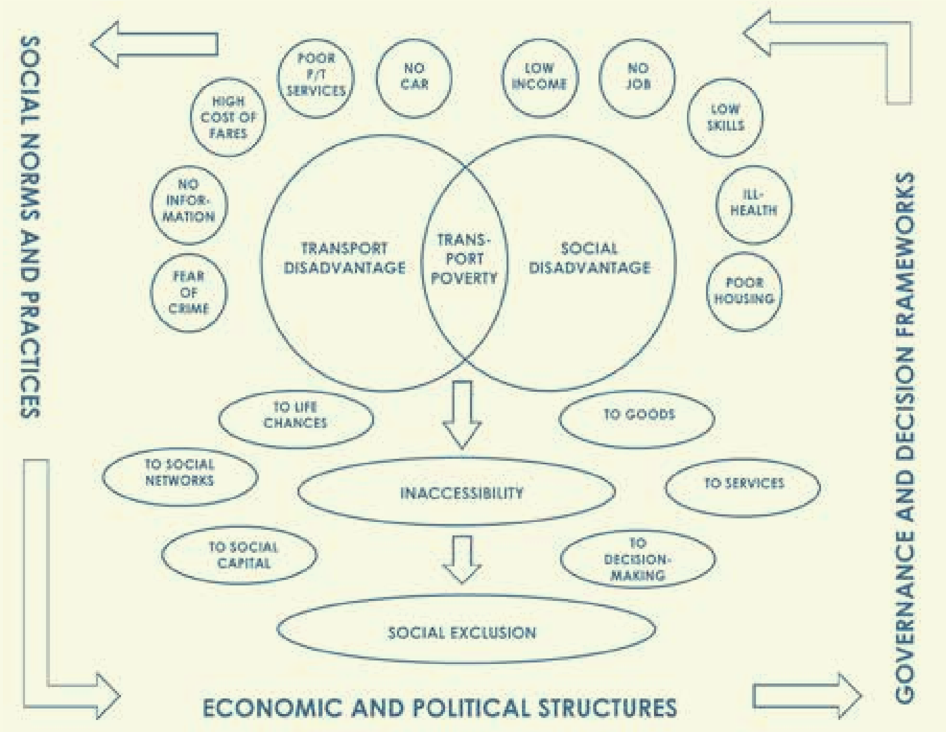
Reeves' view on sustainability also highlights the importance of exploring the social domain alongside the traditionally well-studied economic and environmental outcomes. The past two decades have witnessed a growing academic as well as policy interest in the social implications of transport planning (Boussauw & Vanoutrive, 2015; Bulkeley & Betsill, 2005; Lucas, 2012). In addition to locational substrata, a lack of mobility and, consequently, the inability to access primary needs is unmistakably related to an individual's socio-economic and demographic status. Inhabitants without a privately owned vehicle do not have access to the luxuriously dense Flemish road network, whereas low-income households might struggle to allocate a sufficient portion of their budgets for daily public transport fares. There is a wide recognition that transport policies have the ability to generate spatially as well as temporally uneven accessibility effects that give preference to certain population groups above others (Grengs, 2015). For example, increasing the road capacity is not beneficial in enabling less privileged population segments without privately owned motorized vehicles to participate in everyday activities. A more complicated illustration is the way in which improving the public transport frequencies does not necessarily benefit wheelchair users' mobility if the extra buses, trams or trains are not wheelchair accessible.

Nonetheless, policies simultaneously have the ability to strive for a more equitable distribution of transport services amongst the population. The region of Flanders, for example, has adopted a clear-cut stance towards combatting social disadvantages, as it is one of the only regions in the world where the right to basic provision of public transport is granted by law in the decree 'Personenvervoer'[5]. This right is defined as the right to basic mobility ('Basismobiliteit'[6]) and is formulated as having spatial access to a minimum level of public transport service irrespective of the location of residence. However, as this decree defines maximum distances to transport stops and minimum frequencies at these stops, it answers to social disparities in access to the public transit system (accessibility of the transit stops) rather than by that transit system (accessibility of the facilities through the transit system). It does not determine what places or services a person could reach at a given time and, as such, describes mobility rather than accessibility. Furthermore, a gain in mobility does not necessarily lead to a higher accessibility if people are unable to satisfy their primary daily needs. Recently, understanding the ways in which inadequate or lack of mobility can contribute to social disadvantage and isolation has been brought to the forefront of the transport policy agenda (Fransen, et al., 2015a). The right to basic mobility as constructed in 2001 by the Flemish government, for instance, is currently reformulated as the right to basic accessibility ('Basisbereikbaarheid'). Hence, this revision will additionally aim to guaranty access to specific location types.

5 Decreet betreffende de Organisatie van het Personenvervoer over de Weg, B.S., August 21, 2001

6 Besluit van de Vlaamse Regering betreffende de Basismobiliteit in het Vlaamse Gewest, B.S., January 23, 2003

FIGURE 5
Transport poverty as the interaction between social and transport disadvantage (Lucas, 2012)



From transport disadvantage to social exclusion

Policy concerns related to social discrepancies in mobility and accessibility have appeared and grown parallel with a wider policy interest in the causes and effects of social exclusion. Understanding the underlying factors that lead to these incitements, however, is not an easy task. The number of factors influencing both supply and demand is on the increase, as the present-day society is becoming more complex. The topic of social exclusion originated in the United Kingdom, where the Social Exclusion Unit (SEU) drafted a report on the interactions between transport and social disadvantage in the late 1990s. Since the publication of the report, researchers from around the world have built up empirical evidence of examples of transport problems that have led to various forms of social exclusion. Studies on this relationship have been conducted in Europe (Priya & Uteng, 2009), North America (Paez et al., 2010), Latin America (Delmelle & Casas, 2012), Australia (Delbosc & Currie, 2011) and Africa (Porter et al., 2012). Revealing the main drivers for social exclusion commences with the relationship between transport disadvantage and social disadvantage (Figure 5). Herein, the former corresponds with the degree of service by a transport system while the latter relates to area-based populations most in need of transport. Theoretically, transport poverty occurs on the cross-section of transport disadvantage and social disadvantage.

Nonetheless, it is difficult to determine when a person is to be considered transport poor (Fransen et al., 2015a). By definition (Lucas, 2012, p. 106), this has to do with the inability to access a 'normal' range of activity locations, but the exact meaning of such a 'normal range' remains absent, apart from it being the range of activities that is available to the majority of people in society (Levitas et al., 2007). The necessity of being able to reach certain opportunities unmistakably varies for each individual and in different societies. Having access to health care, for example, is more important to the elderly than to students, whereas the opposite may be true for education. Generally, inaccessibility takes place when the provision is not regulated to the need. Pinpointing the threshold when this discrepancy actually occurs is challenging as this depends on whether inaccessibility is conceptualized on normative or relative terms. Normative terms coincide with expectations about the minimum required level of accessibility while relative terms refer to a particular standard expressed by the accessibility level of other individuals in the same society (Paez, Scott, & Morency, 2012). Eventually, inaccessibility results in exclusion from goods, services and social contacts, which relates to social exclusion and personal isolation.

A number of projects conducted under the umbrella domain of transport-related social exclusion try to pinpoint when and where disparities between the transport and social disadvantages take place and subsequently aim to provide solutions to these gaps. For instance, the project Job within reach ('Job binnen bereik'), conducted by Mobiel 21 and Nazka Mapps aims to promote job locations (such as ports or business parks) that are hard to reach for job applicants without a privately owned vehicle. An online map application demonstrates the possibility of using alternative travel modes while at the same time promoting these locations as an appealing workplace. The first such application was commissioned by the Cycling School of Antwerp, to help people with low access to the job market to find their way to the jobs in the Port of Antwerp. There is also a wide range of academic studies that used GIS to explore the connection between social disadvantage, transport needs and transport provision. Combining both practical and theoretical research on social exclusion and transport poverty bears a large potential, as it enables researchers to cooperate with policy makers and analysts in order to pinpoint issues as accurately as possible.

Empirical evidence and case studies

Public transport deficiencies
The first section indicated the complexity of the concepts of mobility and accessibility. As our society is growing more multifaceted, so do the models that aim to simulate societal behavior in the most accurate way. Recent endeavors focus on personal mobility, changes over time and underlying, often unexplored relationships between the different actors (e.g. competition, trip chaining, etc.). On the contrary, the resulting accessibility levels are becoming harder to understand for non-professionals. This can lead to two important side effects: on the one hand, the results of our current models are hard to interpret and thus confined to 'experts', while on the other hand, results are harder to verify, and these 'experts' can project their (subjective or distorted) interpretation on the general public. Nevertheless, there is a need for more precise measures of accessibility, as they enable to incorporate indicators on the individual level. In an ideal situation, accessibility measures would take into consideration every personal aspect of an individual in order to determine

the accessibility on the most detailed level possible. The second section underlined the importance of examining the population's specific mobility needs, in order to help shape justice and equity in access to the primary amenities that are deemed necessary in the society that we live in. Herein, social disadvantages related to these particular mobility needs have a strong link with the transport disadvantages that occur because of the specific transport system's characteristics. If both aspects are not accustomed to each other, transport gaps come into existence that in turn result in the inability to access social networks, services and vital commodities. Defining where and when transport poverty materializes is a necessary step in supporting policies aimed at combatting social exclusion.

Within the internationally embedded body of literature on the social domain of transportation, much attention has been devoted to the degree of quality of alternative transport modes to car use. Various studies have examined active travel modes such as biking or walking, not only from a planning point of view (Saelens et al., 2003), but also in the domains of health care (Dewulf et al., 2012), and movement and sport science (Van Holle et al., 2012). These topics have been widely examined because of their strong correlation with benefits for physical health, and their positive impact on the quality of life in as well as livability of cities. However, these studies are mainly conducted for urban settings because they are primarily related to the built environment. In addition, not everyone is capable of active travel modes: elderly people are less likely to ride a bike or walk for longer distances, and wheelchair users are strongly dependent on public transport for greater distances. Research that focuses more on the inclusive aspect of mobility is often situated in the domain of public transport and more specifically, targets on designating individuals and areas that suffer from public transport deficiencies. People without access to private transportation are strongly disadvantaged in reaching opportunities in an auto-oriented spatial structure (Kawabata, 2009). Furthermore, improving the provision of public transport has played an important role in countering the financial, environmental and societal externalities related to car-oriented development (Glaeser et al., 2008; Lucas, 2006). From an academic point of view, two main strands of studies aimed at assessing the quality of public transport arise. A first group quantifies socio-spatial deficits in public transport by constructing and comparing two indices: one that expresses public transport needs (social disadvantages) and another that represents public transport provision (transport disadvantages). The difference between both indices is termed the 'transport gap', which acts as a proxy for an area's vulnerability to developing transport poverty (Fransen et al., 2015a). Considering accessibility by public transport is a first step, yet it does not fully consider the broader picture. An important question remains: How does access through public transport relate to the access by car? A second strategy seeks to determine the discrepancy between accessibility by private (car) and public transport, which is a measure for the degree of automobile orientation (Golub & Martens, 2014). The travel time-based ratio of accessibility compared for both transport modes is an indicator of the probability a person will choose the car as primary transport mode, as the time budget strongly affects an individual's travel mode choice. This choice is also influenced by the degree of freedom and ease associated with car use, in the sense that users are not bound to time tables, intermodal connections or service quality.

Case study: transport poverty in Flanders

This paragraph is based on the literature review and results for an ongoing study on transport poverty in Flanders, conducted by the Department of Geography, Ghent University (Fransen et al., 2015a). As illustrated, transport poverty is an important trigger for social exclusion and threatens an equitable distribution of access through the considered transport system. There are two main actors that shape this transport poverty: the particular needs for transportation and the actual transport system. Both actors and their relationship have been internationally studied. The first studies in this strand of research mainly focused on social disparities in access to the public transport system rather than by the public transport system. For example, Wu and Hine (2003) examined the impact of changes in the bus network for different social groups in Northern Ireland. In their study, they determine accessibility levels based on walking times to and waiting times at the bus stops. Similarly, Currie (2010) combines the access to the transit stop with the number of bus, tram or train arrivals per week for the city of Melbourne, Australia. While such indicators provide understandings in the identification of socio-spatial differences in access to the public transport system, they do not examine whether the system brings people to preferred locations within an acceptable travel time at the desired time of day[7]. Moreover, these indicators disregard the fact that local availability of goods and services can compensate an inadequate proximity to public transport provision. Several studies have answered these limitations by calculating end-to-end travel times by public transport. Delmelle and Casas (2012), for example, developed a multimodal approach that accounted for the travel time to as well as by the transit system, in order to assess the equity of the development of a Bus Rapid Transit (BRT) system in Cali, Colombia. However, these types of accessibility measures are static because they describe what is reachable by public transit from a specific origin at a single temporal section. They do not consider the time-based variability in accessibility levels at multiple origins, which is driven by variations in operating frequencies across the diurnal cycle and between weekdays and weekends. The most recent studies contribute to the research outlined above by additionally drawing on the latest field of modelling time-continuous, schedule-based public transport. The study by Farber et al. (2014) attempts to analyze public transit access to supermarkets in Cincinnati, Ohio, by calculating travel times at different times of the day. These types of studies indicate how schedule-dependent, public transportation can be factored into measures of accessibility analysis.

For public transport, there are several socio-demographic variables that shape the population's needs, ranging from physical and spatial to socio-economic factors. For the study area of Flanders, these indicators were determined based on previous studies (Currie, 2010; Jaramillo et al., 2012; Kamruzzaman & Hine, 2011) and in

[7] These are also the considerations that at the present day fuel the debate on the efficiency of the concept of basic mobility (*Basismobiliteit*) and the transition to the more specific concept of basic accessibility (*Basisbereikbaarheid*), as is explained in the previous section.

consultation with mobility experts as well as professionals in the social domain. They provide the most relevant information about the relative size of the socio-demographic groups that tend to depend largely on public transportation. However, supplementary and more precise indicators can further detail specific needs (e.g. information on disabilities, data on a personal level, etc.). Car ownership and income are considered to be strongly related to transport poverty, as well as the percentage of unemployment. Low degrees of car ownership and income (often characterized by a strong correlation) and high levels of unemployment are indicators for an elevated dependency on alternative modes of transportation. Additionally, age-related indicators such as the percentage of elderly and children play an important role in identifying the need for transport, as these groups seldom have access to privatized motorized vehicles or even active travel modes such as a bicycle. Amenities within walking or biking distance should also be incorporated in order to formulate the need for public transport accurately. For Flanders, the rural and suburban areas are mainly characterized by high public transport needs, because of their specific socio-demographics (e.g. higher number of elderly) and lower density of facilities. However, comparison of the calculated values to the population density indicates that the highest needs coincide with less densely populated areas (Figure 6). On the contrary, city centers and coastal areas have low public transport needs, primarily due to the high number of facilities within walking or biking distance.

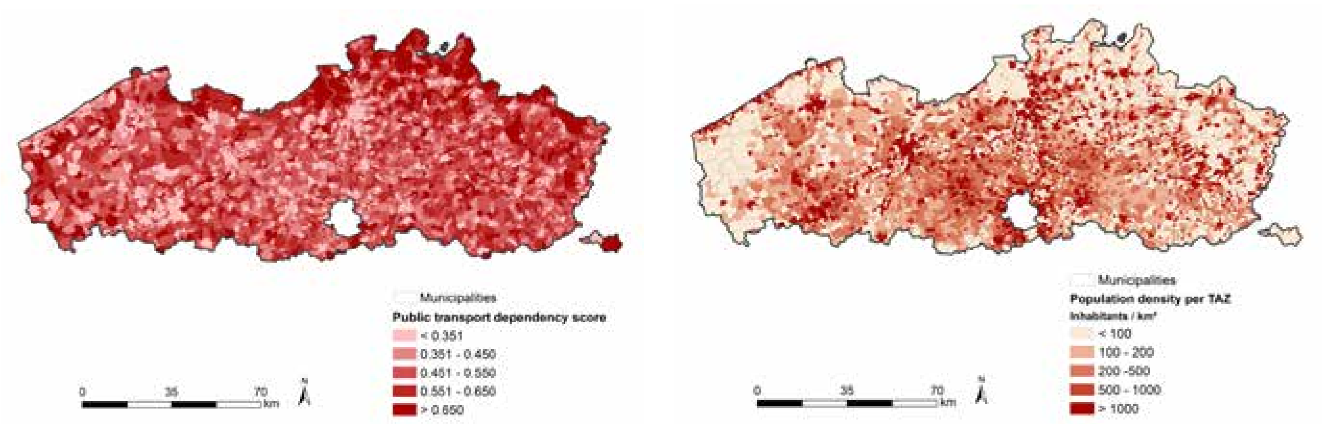


FIGURE 6
Indices of Public Transport Needs per traffic analysis zone or TAZ (a) and population density per TAZ (b) for Flanders (Fransen et al., 2015a)

The provision of public transport is complex as it is dependent on the time schedules of different types of transit systems. Recent accomplishments have indicated the benefits of integrating time schedules for bus, tram, metro and train as well as a pedestrian network into a single multimodal network (Farber et al., 2014; Hadas, 2013; Ma & Jan-Knaap, 2014). As a result, this network accounts for all components of a public transport trip: the walking time from the origin to the public transport stop through the pedestrian network, the waiting time at the public transport stop (including the time to enter or exit the vehicle), the actual travel time through the transit network (including transfers) using timetable information and the walking time from the public transport stop to the destination through the pedestrian network. The resulting network can be applied to calculate travel times to various types of destinations at different times of the day and days of the week. In Flanders, a high provision of primary facilities corresponds with areas with a good availability of public transit. This is the case for cities and along the railway tracks and bus lines running peripherally from the larger city centers. The region of Brussels is characterized by the highest values, as the city of Brussels serves as the most important public transport hub. Due to lower transit frequencies, the provision noticeably declines during off-peak hours, especially for the suburban areas (Figure 7).

Eventually, the relative values of the public transport needs and provision are compared to determine the mismatch between both indicators (Figure 8). Low values designate areas where the provision surpasses the need, which is interesting from an economic stance as service can be restricted. Additionally, from an urban policy point of view they indicate the ability to intensify the use of the transport network and, as such, accommodate more need in these areas. Low values are mostly apparent

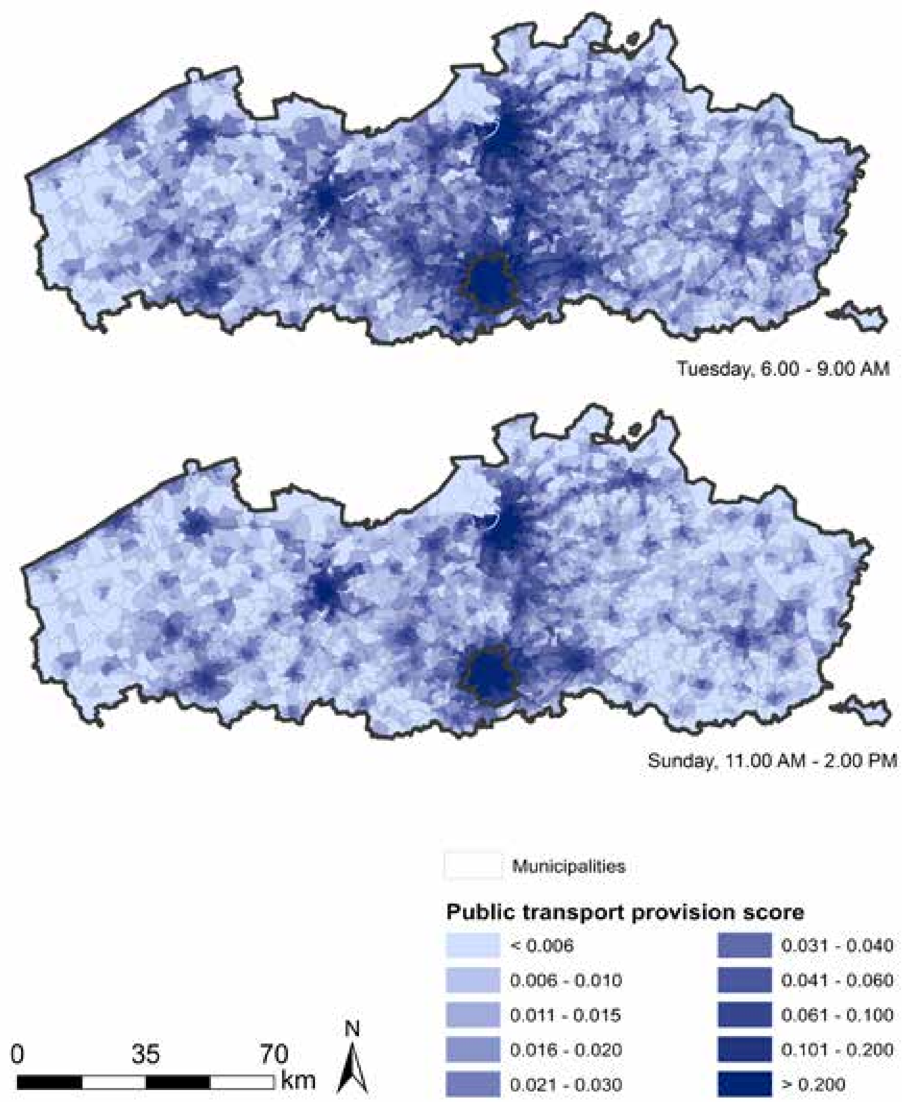
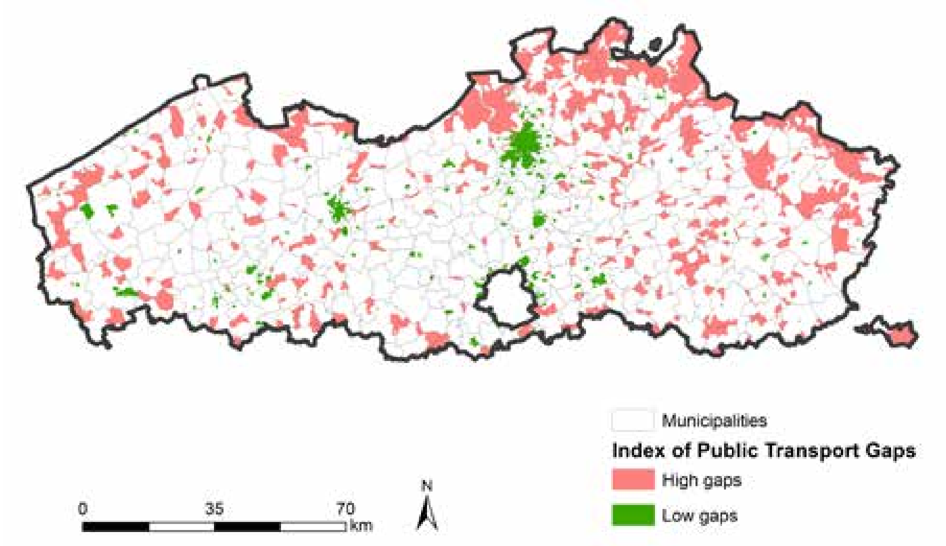


FIGURE 7
Public transport provision per traffic analysis zone for Flanders and Brussels, for various temporal sections (Fransen et al., 2015a)

in the larger city centers. The past years, several public transport companies have conducted studies to determine if and where cutbacks in service would be beneficial. It is important that possible actions are thought through, since diminishing service in public transport dependent neighborhoods would further strengthen its inhabitants' social exclusion (Fransen et al., 2015b). Higher values pinpoint areas with an overall high need for and under provision of public transport and thus assign areas in need of considerable attention in transport planning. Higher transport gaps are primarily found in the rural and suburban areas. However, the detailed scale of analysis allows to additionally highlight urban areas with high transport gaps (e.g. the city ports in Antwerp and Ghent). Furthermore, this measure offers transit agencies, policy makers or academics the possibility to examine specific transit gaps for a certain type of need in respect to the appropriately related type of provision (e.g. elderly access to physicians or access of the unemployed population to jobs).

FIGURE 8
Public transport gaps per traffic analysis zone in Flanders (Fransen et al., 2015a)



Case study: modal disparities in Flanders
This paragraph is based on the literature review and results for an ongoing study on modal disparities in job accessibility in Flanders, conducted by the Department of Geography, Ghent University (Fransen et al., 2015b). The previous case study allowed to identify public transport gaps, which proved an important tool for both policy makers and transport companies in better adjusting the provision to society's specific needs. However, this public transport provision (more precisely bus, tram and train use), is also related to car availability and dependency since both transport means compete with each other. From the viewpoint of a fair distribution of opportunities, persons with access to the dominant mode of transport (private motorized transport) will face few accessibility problems in the current society. Persons without access to a car, however, will experience insufficient levels of accessibility depending on the access provided by alternative transport modes (Martens et al, 2014). Several studies have examined the relationship between motorized private and public

transport in order to better understand travelers' attitude towards transport in general and, more specifically, perceptions of public transport service quality. Beirão and Sarsfield Cabral (2007) performed a qualitative study of travel attitudes and behaviors for public transport and car users in Porto, Portugal. A more practical example is found for Flanders, where the public transport company De Lijn aims at upgrading the public transport travel experience by providing free Wi-Fi connection on trams in several major cities.

Apart from the perception of the transport mode, the actual efficiency of the transit system also plays an important role in travel mode choice. As mentioned, comparing car-based and transit-based accessibility is an indicator of the degree of car-orientation of a certain area. Increasing the attractiveness of public transport (e.g. lower fares, improved wheelchair accessibility, etc.) benefits the ability of this means of transport to compete with private motorized transportation. On the contrary, if policies aim at facilitating car use (making it faster and cheaper), this transport mode is more likely to act as the primary mode choice. A study on the transport gaps in the Tel Aviv metropolitan area by Benenson et al. (2011) underlined the importance of adequate policy responses by estimating accessibility to employment and other land uses. Studying the modal disparity in accessibility is a key indicator to assess urban policy and urban form. Different studies have also examined the spatial disparity as an interesting framework for assessing the impact and distribution of benefits generated by transport developments. Golub and Martens (2014) assessed the rate of transport poverty for the San Francisco Bay Area by measuring the differences between public transit and automobile access for the situation before and after two proposed transportation investment programs. A major limitation in the current studies on modal disparity is that its temporal variability has received little attention. Time measures, however, are more sensitive since they incorporate constraints related to a demographic, social, economic and cultural context (Miller, 2007). The previous case study showed that the transport provision fluctuates over time, since transit is often characterized by time-specific, schedule-based travel times. The frequency and service hours can make necessary, fixed activities unreachable by public transport, which in turn adversely affects an equitable distribution of primary needs (Tribby & Zandbergen, 2012). Additionally, car-based travel is also influenced by the time of day, as congestion is stronger during peak hours.

In combination with a time-dependent, multimodal network to assess travel through public transport, a routable and time-variable network for travel by car is an important requisite in determining car accessibility on a detailed level. Historical data on travel speeds (often extracted from car GPS data) allows users to adapt the commonly applied network datasets that solely focus on the maximum travel speed for each road segment. Average travel speeds on different times of the day are linked to the road network and the dataset becomes time-dependent. As a result, travel times are based on actual average travel speeds instead of theoretical speeds, leading to distinct lower average values during peak hours. These time-dependent networks allow for the calculation and, subsequently, comparison of accessibility

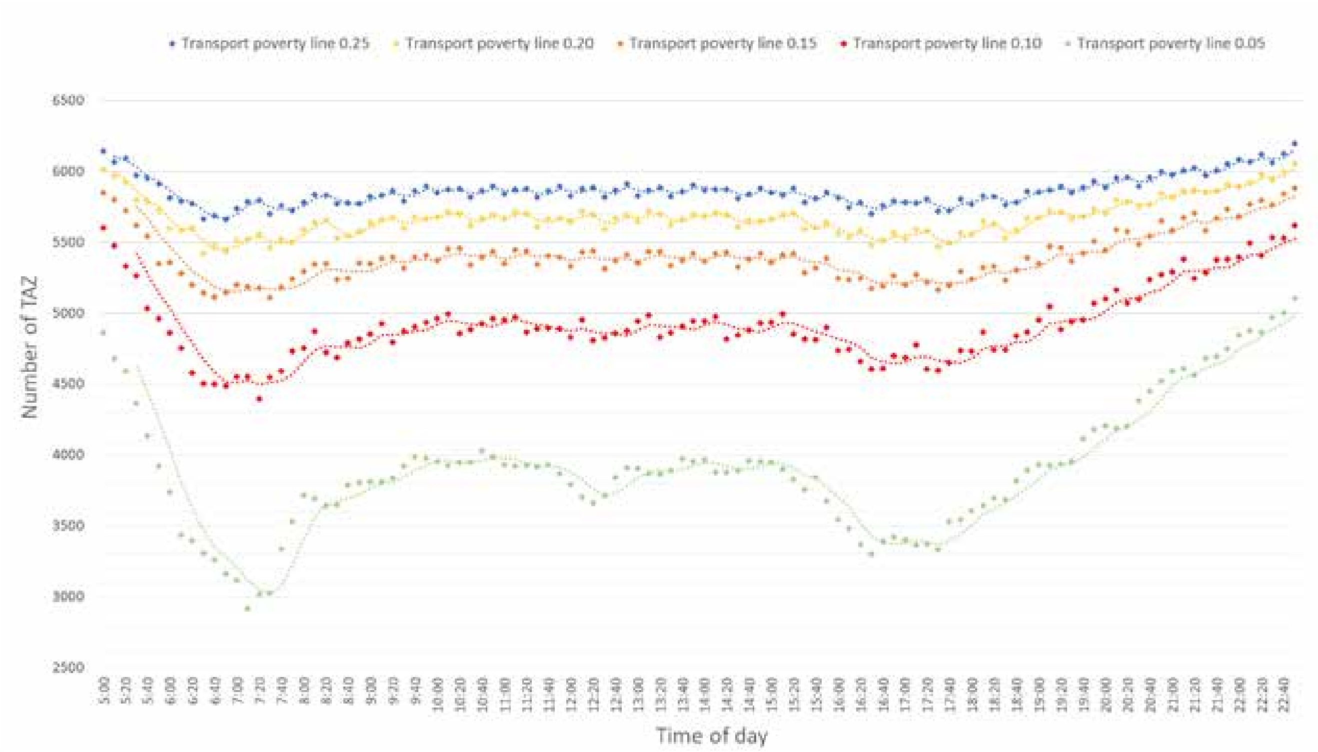


FIGURE 9
Fluctuations in the number of traffic analysis zones in Flanders under the access poverty line during the day

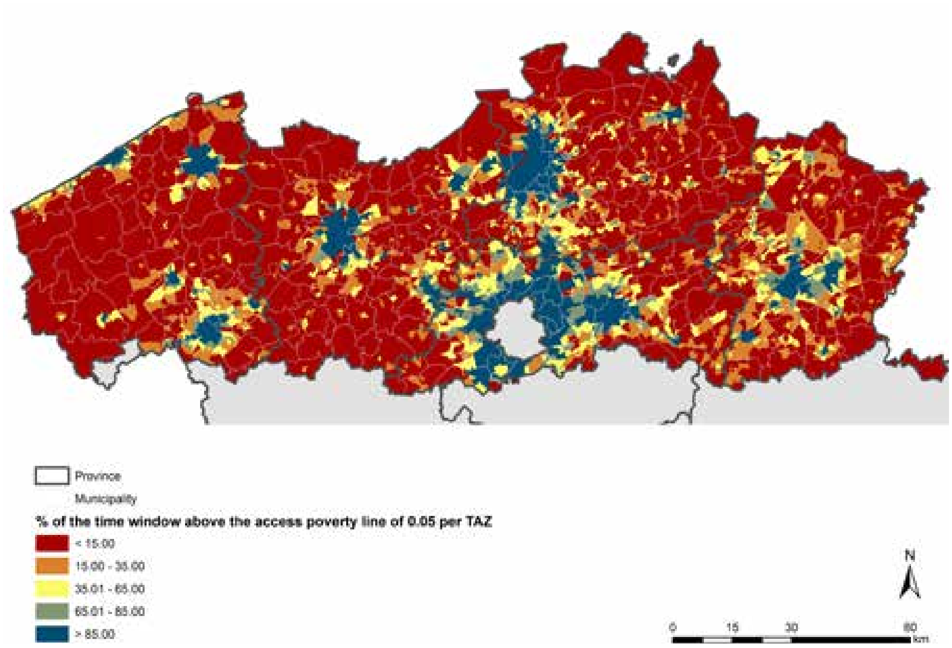
rates by both transport modes. An accessibility rate bordering 1.00 equals a more equal modal distribution. If this value exceeds 1.00, more opportunities are reachable through public transport than by car and vice versa. The maximum accepted gap in car and public transport accessibility is defined by the public transport poverty line[8], which is an explicit normative standard. For example, an access poverty line of 0.25 indicates that inhabitants who are not able to reach a number of opportunities by public transport equal to or higher than ¼ of the opportunities accessible by car are pinpointed as access impoverished. Figure 9 shows that for the strictest access poverty line of 0.25, on average almost 90% of the traffic analysis zones in Flanders is considered transport poor. For less strict values (0.15 and lower), the temporal fluctuations throughout the day become apparent. The number of public transport impoverished zones declines during peak hours, mainly due to congestion in and around city centers and higher transit frequencies. On the contrary, this number rises strongly in the early morning and late evening when public transport becomes more scarce and higher driving speeds can be reached by car. However, close to 60% of the traffic analysis zones have average values below the transport poverty line of 0.05. Policy makers should decide on the acceptable maximum gap for relative public transport access.

It is important to understand where the fluctuations are situated geographically, since this enables to determine areas with a relative high or low public transport provision on a detailed level. Figure 10 indicates the percentage of the day a zone has values above the chosen transport poverty line of 0.05. Zones with low percentages are considered as access impoverished, and this does not change strongly throughout the day. These zones are mainly located in a rural environment, characterized by

[8] Also referred to as access poverty line.

FIGURE 10

Percentage of the day the traffic analysis zones in Flanders are considered as access impoverished



a sparsely distributed transit system and a lower number of facilities in the direct vicinity. Similarly, zones with high percentages have adequate relative access through public transport for almost every time of the day. This is mostly the case for the larger urban centers, such as Ghent, Antwerp or the metropolitan area of Brussels. Values in between indicate a strong temporal variability of the relative access through public transport for this traffic analysis zone (TAZ), with higher values during peak hours and lower values during off-peak hours. Areas with a strong temporal variability are predominantly located around the zones with an overall high value peripheral from the larger city centers and in the smaller town centers. When comparing the access impoverishment to the dominant job types, a strong division is apparent. Jobs in agriculture, industry, construction and retail are mainly located in areas with a low relative job access through public transport, while jobs in services, administration, education or health care are primarily situated in areas with a high relative access to jobs.

The province of Vlaams-Brabant has the highest values, as it is located around the region of Brussels, which is a major public transport hub (especially train) and the main provider of jobs for the region of Flanders. As a result, temporal fluctuations in accessibility rates are more apparent, even for the more strict access poverty lines (Figure 11). For the access poverty line of 0.05, the rate of traffic analysis zones considered as access impoverished drop below 30% during peak hours. Performing the accessibility level on a detailed level of analysis allows researchers to determine intraregional difference. For the city of Ghent, located in the province of East-Flanders, for example, a strong disparity occurs between the city center and the port area in the north (Figure 12). These differences on the microscale are of utmost importance, as the port area is an important concentration of job opportunities that are hard to reach by public transport. As a result, a transportational

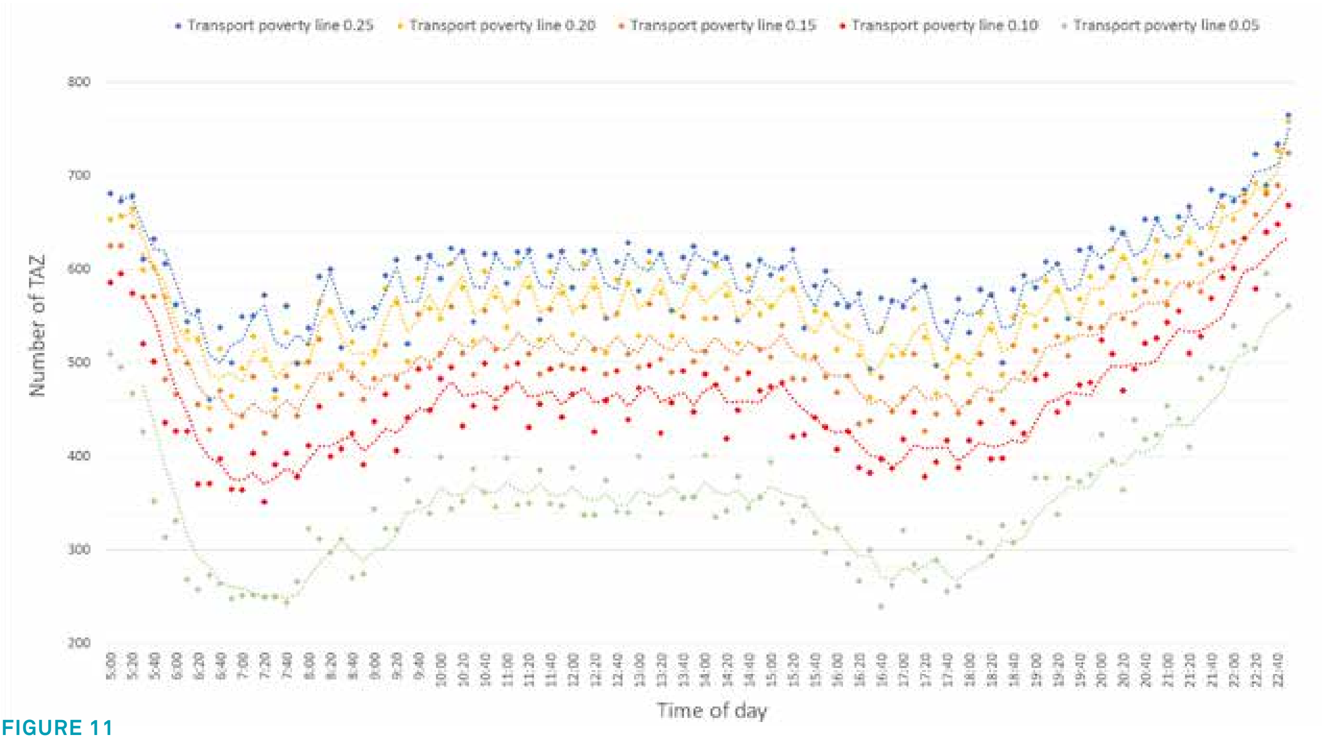


FIGURE 11

Fluctuations in the number of traffic analysis zones in the province of Vlaams-Brabant under the access poverty line during the day

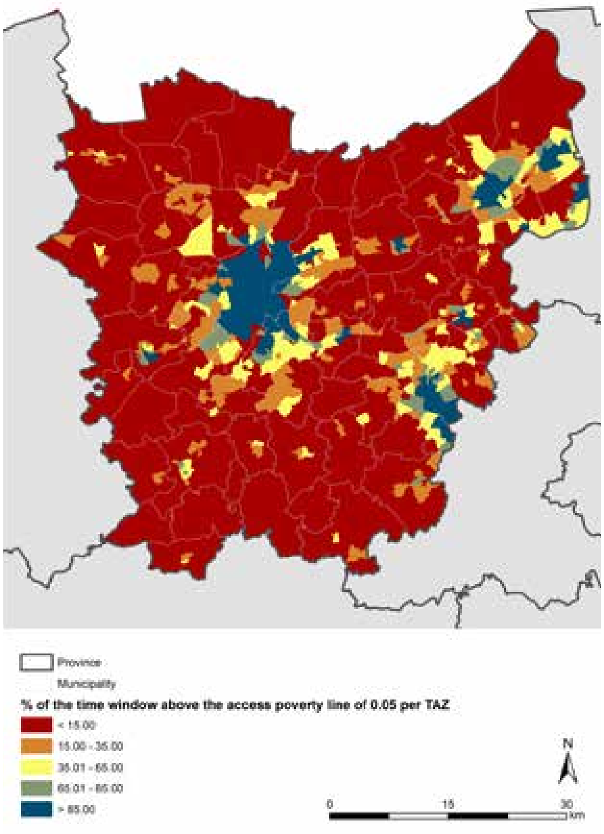


FIGURE 12

Percentage of the day the traffic analysis zones in the province of East-Flanders are considered as access impoverished (Fransen, Neutens, De Maeyer, et al., 2015)

mismatch between certain population segments dependent on public transport and possible adequate job opportunities is generated. Because of their detail of analysis, these accessibility measures provide policy support for decision-making on the local, supralocal and regional level.

Conclusion

The presented case studies provide an example of how academically based methodologies have the ability to provide policy support in the broad topic of transport-related social equity issues. They are an important first step to further unraveling the intricacy of the concept of fairness in transport. Nevertheless, as yet, they do not fully succeed in incorporating all the complexities of the modern day society. An important limitation is the fact that different people have different views on how equity in accessibility is established. Especially in the political arena, this may lead to difficulties in translating theoretical concepts and methodologies to a practical implementation. For example, the debate on redefining the concept of basic mobility to basic accessibility provides several important hurdles for policy as well as all other actors to take. 'What services or goods should be considered as necessary?', 'When are destinations to be regarded as accessible?' or 'How are specific needs incorporated in the concept of basic accessibility?' are questions that arise within this contemporary debate.

Whether or not all factors at a personal level can be included, more detailed measures construct a theoretical framework that allows policy makers to substantiate policy decisions and investigate the implications of these decisions. Depicting the transport gaps in Flanders, for example, enables highlighting the areas most in need of injections in the transport system. From a prioritarian point of view, the gaps are compared to the population density in order to better prioritize the available resources. In addition, comparison to various socio-demographic variables allows for policy makers to think about possible alternative solutions: transport gaps for a larger number of young families can be answered by providing subsidies for bicycle purchase, while elderly people living in areas with poor transport provision may benefit more from a system of communal taxis.
Policy makers should be aware that a supply of public transport matching the actual demand is a conditio sine qua non for countering the car-dominance. For example, portraying the modal disparity between private and public transport accessibility aids policy in pinpointing areas where public transport provision is lagging far behind in comparison to the provision through privatized motorized vehicles. However, a change in attitude towards car ownership is equally important and probably harder to realize as the 'average Fleming' is very attached to the individual freedom associated with car ownership. Hence, stronger efforts should be made to sensitize citizens to the negative effects on the overall quality of life and the possible uneven accessibility effects associated with the present-day dependence on individual motorized transport.

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