Accessibility and potential mobility as a guide for policy action

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Samenvatting

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In het afgelopen decennium is steeds meer belangstelling ontstaan voor het evalueren van transportbeleid en investeringen vanuit het perspectief van bereikbaarheid. De verschuiving van mobiliteit als belangrijkste performance-indicator naar bereikbaarheid is gebaseerd op het argument dat het uiteindelijke doel van het transportnetwerk is om reizigers te voorzien van toegang tot gewenste bestemmingen. Traditionele performance-indicatoren vanuit mobiliteitsperspectief, zoals het level-of-service criterium, beschrijven weliswaar belangrijke kwaliteiten van het transportnetwerk, maar bieden uiteindelijk geen inzicht in hetgeen daadwerkelijk belangrijk is voor de gebruikers van dat transportsysteem. Daarom heeft het bereikbaarheidsperspectief aan belang gewonnen en wordt bereikbaarheid door velen beschouwd als de enige goede performance-indicator om de toestand van het transport- (en landgebruik)systeem te beoordelen.

Deze verschuiving van de evaluatie van transportsystemen vanuit mobiliteitsperspectief naar bereikbaarheidsperspectief roept twee belangrijke vragen op. De eerste heeft betrekking op de relatie tussen het transportsysteem en bereikbaarheid. Het niveau van bereikbaarheid in een bepaalde buurt of gebied wordt bepaald door zowel het transportsysteem als het landgebruik. Het gebruik van bereikbaarheid als performance-indicator vangt beide aspecten. Dat betekent tegelijkertijd dat lage niveaus van bereikbaarheid in een bepaalde buurt of gebied zowel het gevolg kunnen zijn van een slecht presterend transportsysteem, als van een lage dichtheid van gewilde bestemmingen. Bereikbaarheidsmaten maken niet direct duidelijk waar ingrepen in het transportsysteem nodig zijn. Daarom is een meer alomvattende aanpak nodig om de performance van het transport-landgebruiksysteem te beoordelen, die zowel bereikbaarheid als mobiliteit omvat.

In deze paper presenteer ik een framework om de bereikbaarheid die wordt geleverd door een transport-landgebruiksysteem en de potentiële mobiliteit die wordt geleverd door het transportsysteem gelijktijdig te beoordelen. Dit zogenaamde 'POMA-framework' (POtential Mobility and Accessibility framework) biedt een nieuwe benadering om 'het' transportprobleem in de moderne samenleving te identificeren. Ook kan het worden gebruikt om gebieden te identificeren die geschikt zijn voor stedelijke ontwikkeling of voor transformatie. Het biedt aldus een framework dat als basis kan dienen voor transportplanning en ruimtelijke planning. In tegenstelling tot traditionele benaderingen van transportplanning focust het daarbij niet op de kwaliteit van het transportnetwerk als zodanig, maar op het uiteindelijke doel van een transportnetwerk: om mensen in staat te stellen te participeren in activiteiten buitenshuis. Het biedt daarmee, anders dan de grote hoeveelheid literatuur over bereikbaarheidsmaten, een duidelijk raamwerk om te bepalen wanneer een ingreep in het transportnetwerk nodig is en wanneer het onwaarschijnlijk is dat een dergelijke ingreep de gewenste resultaten oplevert.

1. Introduction

Over the past decade, there has been an increasing interest in the evaluation of transport policies and investments from the perspective of accessibility. The shift away from mobility as the prime performance indicator towards accessibility has been based on the argument that the goal of the transport network is ultimately to provide travelers with access to desired destinations. Traditional mobility-centered performance indicators, like the level-of-service criterion, do describe important qualities of the transport network, but ultimately do not provide insight into what is really important for the users of that transport system. Hence, the accessibility paradigm has gained in importance and accessibility is now by many considered as the only proper performance criterion to assess the state of the transport (and land use) system.

This shift from mobility-centered to accessibility-centered evaluation of transport systems raises two important questions. The first is related to the relationship between the transport system and accessibility. The level of accessibility in a particular neighborhood or area is determined by both the transport system and the land use pattern. The use of accessibility as a performance indicator captures both these aspects. The assessing of accessibility levels across a metropolitan region or country will inevitably capture both aspects. Low accessibility levels in a particular neighborhood or area may well be the result of a poorly performing transport system, as of a low density of desirable destinations. As a result, accessibility measures do not directly clarify where interventions in the transport system are called for. Hence, a more comprehensive approach to assess the performance of the transport-land use system in its relation is necessary, capturing both accessibility and mobility. The aim of the paper is to develop such a comprehensive approach.

The paper is organized as follows. Following this introduction, Section 2 provides a brief description of the shift towards an accessibility-centered approach of assessment. I then discuss the drawback of accessibility indicators (Section 3). Section 4 defines a novel indicator to assess the quality of the transport network. Then, in section 5, I present the comprehensive approach for assessing the performance of the transport-land use system. Section 6 and 7 discuss the application of the framework within the context of transportation planning and urban planning, respectively. I end with a brief conclusion (Section 8).

2. The shift from mobility to accessibility

Mainstream transportation planning has been criticized for at least four decades for its focus on potential mobility rather than accessibility ((Wachs and Kumagai 1973); (Black and Conroy 1977); (Morris, Dumble et al. 1979)). Roughly, the argument reads as follows. People are not interested in travel per se, i.e. in mobility, but in accessing places where they can fulfill needs and wants. While improved mobility can imply improved accessibility, the later does not necessarily follow from the former. For instance, if land uses are dispersed over a large area, high levels of mobility do not necessarily equate with high levels of accessibility. And, the other way around, it is argued that areas with poor mobility, such as congested urban centers, do not necessarily provide poor levels of accessibility, precisely because of the high density of various types of land uses in a small area. From these simple observations, it is argued that mainstream transportation planning directs the attention to the wrong problems: it seeks to improve mobility where accessibility is already high, ignores areas with low accessibility but high mobility, and fails to acknowledge the potentially detrimental impacts of improved mobility on accessibility in the long-term. Furthermore, the argument goes, accessibility cannot only be improved through interventions in the transport system, but also through interventions in the land use system as well as in the way services are provided (dispersed versus concentrated, attention for opening times).

A large body of literature has emerged over the past decade addressing issues of accessibility. This includes a large number of empirical studies analyzing accessibility in particular regions across the world, as well as papers developing and comparing various accessibility measures. Depending on the perspective and the type of accessibility measure that is applied, these studies reach different conclusions regarding the accessibility that is provided by transport-land use systems. More importantly, few papers explicitly define the possible policy consequences of the 'observed' patterns of accessibility. Even papers that attempt to describe what an accessibility-centered transportation planning may actually look like (notably (Curtis 2008); (Curtis and Scheurer 2010); (Geurs, van Wee et al. 2006); (Páez, Scott et al. 2012); (Ross 2000); (Schoon, Mcdonald et al. 1999); (Vigar 1999; Straatemeier 2008); (Vold 2005)) tend to fall short of providing clear and systematic directions for action. Each of these papers only describes a few possible steps of transportation planning for accessibility; none presents a full-fledged set of rules that could replace the prescriptions of mainstream transportation planning.

3. The drawback of accessibility indicators

The advantage of accessibility as a key performance indicator is also its disadvantage. Accessibility indicators (however defined) encompasses several characteristics of the transport-land use system in one indicator. By doing so, they can provide a comprehensive assessment of the accessibility 'service' received by citizens and business. However, at the same time, by integrating several aspects of the transport-land use system into one indicator, the indicator also conceals particular features of that system. In particular, accessibility indicators do not to allow transportation or urban planners to identify *why* accessibility levels are low or high in a particular area. Accessibility indicators leave underdetermined where transport systems *respectively* urban planning have succeeded in providing high levels of service, and where they have (as yet) failed to do so. Because of this, accessibility indicators do not provide a guide for action, as they leave undetermined (a) the way in which a particular situation could be improved; and (b) the organization that should take prime responsibility for improving that situation. This is so, because low accessibility indices may as well be the result of poor transport systems, as of a low density of desirable destinations in a particular area. The other way around also holds true: high accessibility indices do not necessarily imply a well-functioning transport system or an destination-rich urban structure.

The way forward is not to replace accessibility indicators as a key performance measure to analyze transport-land use systems, but rather to complement accessibility indicators with an indicator that only addresses one of the components of the system: the transport component or the land use component. In this paper, I present an indicator for the transport component and then develop a framework that enables the *simultaneous* assessment of transport-land use systems based on an accessibility indicator and an indicator for the quality of the transport system only.

In the next section, I will briefly outline an approach to assess the quality of the transport system. This results in a clearly defined indicator. In contrast, I will not define an accessibility indicator. While such a (set of) indicator(s) is crucial for the framework presented below, the exact definition of an indicator is of less importance. For now, it is sufficient to point out that some kind of geographical accessibility indicator probably best matches the reasoning underlying the framework. Infrastructure-based accessibility measures as well as utitlity-based measures are probably less suited for the effort (see (Martens and Golub 2012) for a more elaborate discussion).

4. Assessing the quality of the transport system

There is a vast body of literature on the assessment of the quality of transport systems, understood here, in line with mainstream transportation planning, as the contribution of the system to the mobility of people (and goods).[1] The most common indicator that is used in mainstream transportation planning is the level-of-service indicator, which indicates the level of congestion on (road) links ((Martens 2006)). In the literature, this indicator is generally presented as an indicator of mobility[2] or, more precise, potential mobility. Mobility or potential mobility is defined in the literature as 'the ease with which a person can move through space' ((Martens 2012)). However, on a closer look, it becomes clear that the level-of-service criterion does not provide an accurate indicator of the ease of movement. The level-of-service indicator actually only provides an assessment of the speed of travel enabled by the transport network, but it does not provide an assessment of the structure of the transport network. This structure is as crucial as travel speeds in determining the 'the ease with which a person can move through space' ((Levinson and Krizek 2008)). A network that consists of a large set of congested transport links may well make it more easy to cover distances than a network consisting of few-free flowing transport links. Hence, in order to assess the quality of the transport system in terms of its contribution to the potential mobility of people (and goods), we need to have a more comprehensive indicator.

Both (Gutierrez, Monzon et al. 1998) and Martens ((Martens 2007)) have developed such an indicator independently. The measure developed by Martens is most suitable for our purposes and could be best described as the 'potential mobility index' (PMI). The PMI is defined as the quotient of, on the one hand, the aerial distance ('as the crow flies') between an origin and all destinations in the study-area, and, on the other hand, the travel time on the transport network between that origin and all destinations in the study-area. In equation:

$$\text{PMI(TAZi-n)} = \frac{\text{D(TAZi-n)}}{\text{T(TAZi-n)}}$$

[1] These indicators are different from indicators that assess e.g., the quality of the road surface.
[2] In the literature, the word mobility is often used interchangeably to refer to the actual movement of people (i.e. the actual distances travelled) and to potential mobility (i.e, the ability of people to travel). I reserve the word mobility for only the former instance.

where PMI(TAZi-n) is the average aerial speed between transport activity zone i and all other transport activity zones; D(TAZi-n) is the aerial distance between zone i and all other zones; and T(TAZi-n) is the travel time on the transport network between zone i and all other zones. Theoretically, the measure could also be applied at a lower aggregate level than that of transport activity zones, in line with the work of Benenson et al. ((Benenson, Martens et al. 2011)).

The main advantage of the PMI measure is that it captures the impact of both the structure of the transport network and the speed on the various links on the network. The measure has significant advantages over the level-of-service criterion. A simple example can explain this. In case an area does not have its own entrance point to a highway, but is linked to the highway through a secondary road with low traffic volumes, the average speed on the transport network may be relatively high. If the level-of-service index is used as an assessment criterion, travelers do not experience any 'transport problem' on this secondary link. However, since drivers will have to make a detour to reach the highway, the actual potential mobility level of this area may be relatively low. The PMI measure provides a more appropriate assessment of the quality of the transport network provided to such an area, as it links travel time to the lowest possible distance (the aerial distance). Network inefficiencies are thus revealed by the PMI measure. Another advantage of the PMI measure, lies in the fact that it enables the direct comparison of areas irrespective of their location in the study area. For instance, the PMI of a peripheral area can be identical to that of an area in the center. This stands in sharp contrast to the outcomes when using a typical (geographical) accessibility indicator to assess the quality of the transport-land use system, as such an indicator will inevitably show large differences in accessibility between center and periphery.

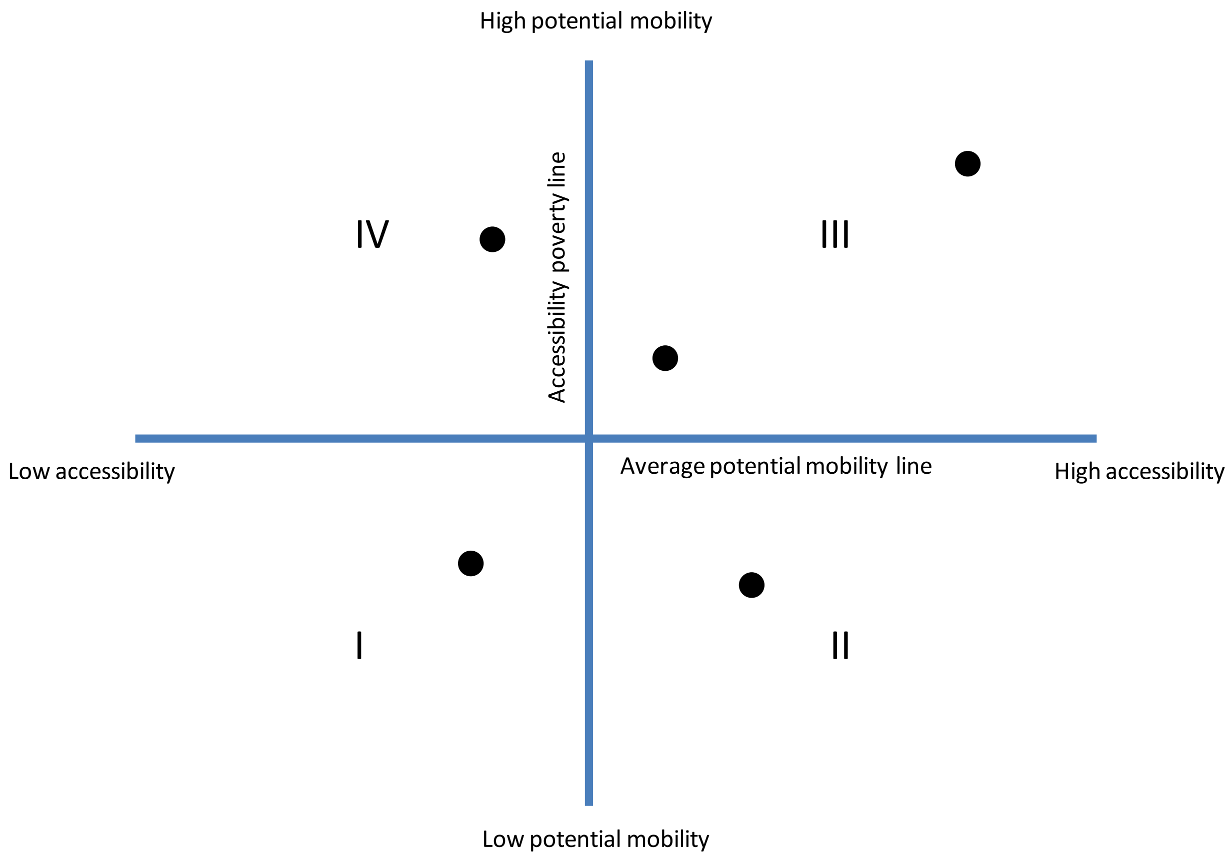
Note that the PMI can be measured separately for each transport mode or for different times of the day to account for congestion or variation in public transport schedules. Since people differ fundamentally in their ability to make use of different types of transport modes, an explicit distinction by area (neighborhood or transport activity zone) *and* mode availability (typically car versus public transport) is called for.

5. Potential mobility and accessibility

As discussed, the PMI measure is not intended to replace an accessibility index, but rather to complement it. The goal here is not to develop some sort of multi-criteria analysis, but rather to develop a framework that can help transportation planners, urban planners and decision-makers to understand the strengths and weaknesses of their regional or national transport-land use system. This so-called 'POMA-framework' (POtential Mobility and Accessibility framework) is meant to serve as a key source of information to guide future action. For this purpose, we juxtapose accessibility and potential mobility on a set of axes. The vertical axis represents the PMI, the horizontal axis represents accessibility (Figure 1). Both axes represent a continuum from a low level of potential mobility or accessibility to high level of potential mobility or accessibility. This simple coordinate system enables the placement of each neighborhood (or transport activity zone) in a particular region or country vis-à-vis both axes.

In order to adequately use the coordinate system of the axes, it is necessary to remember that both potential mobility and accessibility depend strongly on a person's ability to make use of the set of available transport modes (car, bicycle, walking, public transport). Depending on the qualities of the transport system, having access to only a subset of the available transport modes may significantly reduce a person's potential mobility and accessibility. Since in current societies, especially access to a car provides high levels of potential mobility and accessibility, it is important for an adequate assessment of the quality of the transport-land use system, to make a distinction between persons with access to a car and persons who lack such access and can only use the public transport system. This distinction does not capture the full variety in terms of the available modal set observed among persons, but it does address the most important distinction in current modern societies. Hence, the coordinate system should be used to position area-mode combinations, as both the location of a neighborhood in the region or country and mode availability will determine the 'service' a person receives from the transport-land use system. Each point thus represents a group of people that are identical in terms of their residential location (at the level of a six-digit postal code, a neighborhood, or a transport activity zone, depending on available data) and the available set of transport modes.

Figure 1. The POMA-framework in which area-mode combinations are positioned in a coordinate system defined by accessibility and potential mobility. Each point refers to a particular area-mode combination, i.e. a group of persons with identical characteristics in terms of location and mode availability.



For reasons of clarity, the axes are presented as intersecting in the middle. By doing so, the coordinate system creates a plane of four distinct quadrants (Fig. 1). This distinction in four quadrants is very productive for a better understanding of the qualities of the transport-land use system in a particular region or country and for the delineation of the roles of transportation and urban planners, as we will argue below.

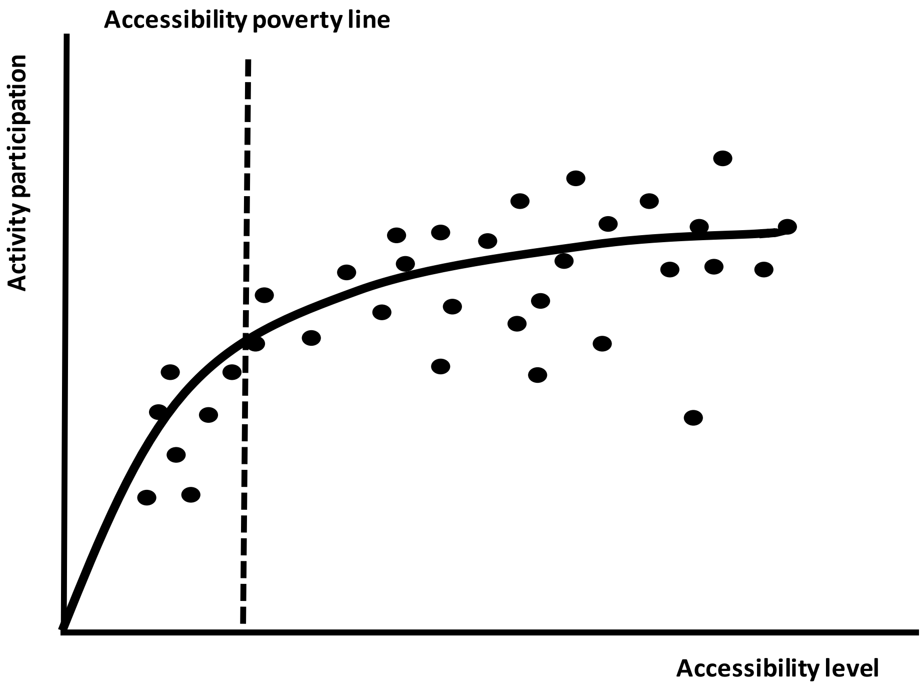
The reasoning behind the exact placement of the axes is as follows. As discussed above, the potential mobility index provides a systematic score of the quality of the transport system for each area-mode combination. From the complete set of these scores it is possible to extract an average PMI value (i.e., an average across both modes of transport). This average can be seen as the benchmark for potential mobility. Area-mode combinations that fall below the average are less well served by the transport system than the 'average' area-mode combination. These below-average areas in principle deserve the attention of the transportation planner, as the transport system for this area-mode combination is of sub-standard quality. Obviously, if such an area-mode combination primarily contains natural areas, a below average potential mobility may well be a desirable state.

The positioning of the center of the accessibility axis requires somewhat more explanation. It requires a brief discussion of the relationship between accessibility and activity participation. As argued before, transport services are important because they provide access to desired destination and thus ultimately enable (non-virtual) out-of-home activity participation. It may be hypothesized that the level of accessibility and the intensity of activity participation are correlated. All else being equal, it may be assumed that with increasing levels of accessibility, a person's level of participation in out-of-home activities will go up. The relation will be a concave one, as the impact of one unit of additional accessibility in a situation of high accessibility will have little influence on activity participation. Furthermore, it may be assumed that there is no direct relation between accessibility levels and activity participation intensity, as people highly differ in their need or desire to participate in out-of-home activities. For a given level of accessibility, we may thus well observe persons with high and low intensity of activity participation (Fig. 2).

The relation between accessibility level and activity participation intensity will be stronger for lower levels of accessibility. At a certain point, it can be hypothesized, accessibility levels are so low, that it directly limits a person's possibility to participate in activities. These limitations may be incidental, as when a disruption of the transport system instantaneously reduces a person's accessibility. It may, however, also take a structural character and limit activity participation in a systematic way, as when public transport services are cut and people without alternative means of transport find themselves 'stuck' in former accessible places. In this case, people experience transport poverty or transport-related social exclusion: the accessibility level has decreased to such an extent that people are no longer able to fully participate in the activities deemed normal for society ((Lucas 2012); (Bastiaanssen, Martens et al. 2013)). Empirically, it will not be easy to exactly draw this line. Conceptually, however, it is possible to define it. It is this line (or point) that is used to demarcate the central point on the accessibility axis in Fig. 1.

The POMA-framework enables a systematic assessment of the accessibility provided by the existing or future land use-transport system and the contribution of the transport system in delivering that accessibility. The framework is relevant for transportation planning, as it can be used to systematically identify transport problems as well as the need for intervention in (i.e., improvement of) the transport system. As I will discuss below, it can also be used for land use planning. In what follows, I will briefly discuss possible applications of the POMA-framework for both types of planning.

Figure 2. Relation between accessibility level and activity participation. Each point represents an area-mode combination.



6. The POMA-framework and transportation planning

The POMA-framework as defined above enables the positioning of area-mode combinations in four different quadrants. The framework can be used for assessing both person accessibility and place accessibility (see (Pirie 1979); (Kwan 1999); (Miller 2007) for more elaborate discussions). Person accessibility is an attribute of a person: a person has accessibility (or not) to a certain set of locations. Place accessibility, in turn, is an attribute of an (activity) location: a location is accessible (or inaccessible) for a certain set of people or from a certain set of other locations (see also (Martens 2012)). From the perspective of transportation planning, both are important: people need to have access to destinations in order to participate in activities (as the accessibility 'paradigm' underscored). Likewise, businesses and services need to be accessible in order to function properly. The use of the framework in assessing both types of accessibility will be discussion in the following sub-sections.

6.1 Assessing person accessibility

As already mentioned, the POMA-framework enables the positioning of area-mode combinations in four different quadrant (Fig. 1). Each quadrant represents a distinct performance level of the transport-land use system.

The area-mode combinations located in the bottom-left quadrant (quadrant I) are experiencing both a low level of potential mobility and accessibility. For these area-mode combinations, the transport-land use system provides an *insufficient* quality-of-service. After all, in line with the accessibility-centered approach to transportation, the ultimate goal of transportation planning is to provide accessibility so people can reach destinations and participate in out-of-home activities. If the 'accessibility poverty line' is drawn at a proper level, persons belonging to these area-mode combinations are likely to experience (severe) problems in accessing destinations and to experience structural transport-related social exclusion. Furthermore, the transport system is at least in part responsible for this sub-standard quality-of-service. This certainly holds true for the area-mode combinations that are located toward the bottom of the quadrant. These area-mode combinations thus deserve the highest priority in transport planning. Investments in transport infrastructure or new transport policies should first of all address the situation of the people living in area-mode combinations in this quadrant. Probably most area-mode combinations belonging to this quadrant will consist of transit-dependent population groups living in outer-urban, suburban and peri-urban locations. Note that also car-owning population groups living in peri-urban areas may belong to this category, for instance if increasing congestion on the road network leads to decreasing levels of potential mobility.

The bottom-right quadrant (quadrant II) represents area-mode combinations that are in a less-deprived situation. These area-mode combinations experience a below-average potential mobility level, but a sufficient level of accessibility. That is, these area-mode combinations receive adequate accessibility *in spite of* a relatively poor quality of the transport system. While the transport system is thus of sub-standard quality for these area-mode combinations (certainly if such a combination is positioned further towards the bottom of the quadrant), there is no direct reason to improve the transport system for here. This is so, because the *ultimate* goal of transportation planning is to provide sufficient accessibility levels for all. This goal has been achieved for these area-mode combinations. At the same time, if no area-mode combinations are located in the quadrant I, transportation investments serving these area-mode combinations may well bring a substantial increase in accessibility and thus in the quality of life of the persons belonging to these area-mode combinations. Typically, inner-city car-users may be positioned in this quadrant, as congestion tends to lead to sub-standard potential mobility, but land use patterns (destination density) tend to more than compensate this poor level potential mobility.

Area-mode combinations that are positioned in the upper-right quadrant (quadrant III) receive both a sufficient level of accessibility (above the 'accessibility poverty line') and an above-average potential mobility as provided by the relevant transport sub-system. The farther to the right and to the top an area-mode combination is positioned, the higher the quality-of-service provided by the transport-land use system. If the accessibility poverty line is set high enough (i.e., a person with an accessibility level above the poverty line does not experience problems to participate in the activities normal for a society due to failing levels of accessibility), these area-mode combination receive a sufficient quality-of-service. Transportation and land use planners have both separately and jointly succeeded to provide an adequate quality-of-service. The joint aim of both transportation and land use planners (and possibly also of planners responsible for service delivery) would be to guarantee that all area-mode combinations move towards this quadrant. The other way around also holds true: as long as some area-mode combinations are positioned in other quadrants, this quadrant deserves the least priority for investment in the transport system (as the potential mobility level is already above average). Typically, most car-owning population groups living in outer urban and suburban locations will fall in this quadrant. In cities and regions with high quality public transport systems, the same may hold true for many of the transit-dependent groups, possibly even for a substantial share of the locations in the metropolitan area.

Area-mode combinations positioned in the upper-left quadrant (quadrant IV) probably provide the most challenging situation. These combinations are well served by the transport network, but still lack sufficient accessibility levels. This situation is typical for truly peripheral regions that have lost employment and services due to a restructuring of the economy and economies of scale and scope. Transport investments are likely to be ineffective in such situations, as the lack of accessibility is not the result of a failing transport system. This certainly holds for area-mode combinations positioned in the upper part of the quadrant. In many cases, the (road) transport system will already provide free-flowing conditions and a reasonable network, so that improvements in potential mobility can only be achieved by introducing a fundamentally better or improved transport mode (like high speed rail). Such an improvement, however, is likely to be out of reach for a substantial part of the population in these peripheral areas, for reasons of costs. The poor level of accessibility experienced in these area-mode combinations thus seems to be a challenge for urban planning, economic policy, and service delivery policy, rather than for transportation planning.

The POMA-framework thus provides a clear guide for identifying transport problems in person accessibility. Where in the traditional mobility-centered framework transport problems are typically defined in terms of congestion (directly resulting from the use of the level-of-service as a performance indicator), the POMA-framework leads to a fundamentally other perspective of the transportation problem. The framework not only directs the attention away from infrastructure elements (road links, train connections), which is inevitable in any accessibility-centered assessment framework. It also clearly defines which areas experience accessibility problems and which areas do not. Following the POMA-framework, the most urgent transport problems are experienced by only those area-mode combinations that experience *both* sub-standard accessibility *and* sub-standard potential mobility.

Note that additional analyses remain necessary to set transport investment priorities. This is so, not only because the area-mode combinations in the left-bottom quadrant will not all experience accessibility problems to the same extent (i.e., they may be closer or farther away from the origin of the coordinate system of the two axes), but especially because the area-mode combinations will differ in terms of the size of the population they represent. Large population groups deserve priority over small population groups, ceteris paribus. But it is by no means clear how the size of the group should be weighed against the strength of the deprivation. Furthermore, person accessibility is difficult to capture with one accessibility measure and it may be preferably to assess the positioning of area-mode combinations using different measures of accessibility (e.g., separately for accessibility to employment and to medical services, or separately for different spatial scales) than seeking to integrate the multi-faceted phenomenon of accessibility in one overarching indicator. This will certainly complicate the evaluative exercise, but at the same time it is not unlikely that clear and repeating patterns will be revealed that do enable priority setting with relative ease.

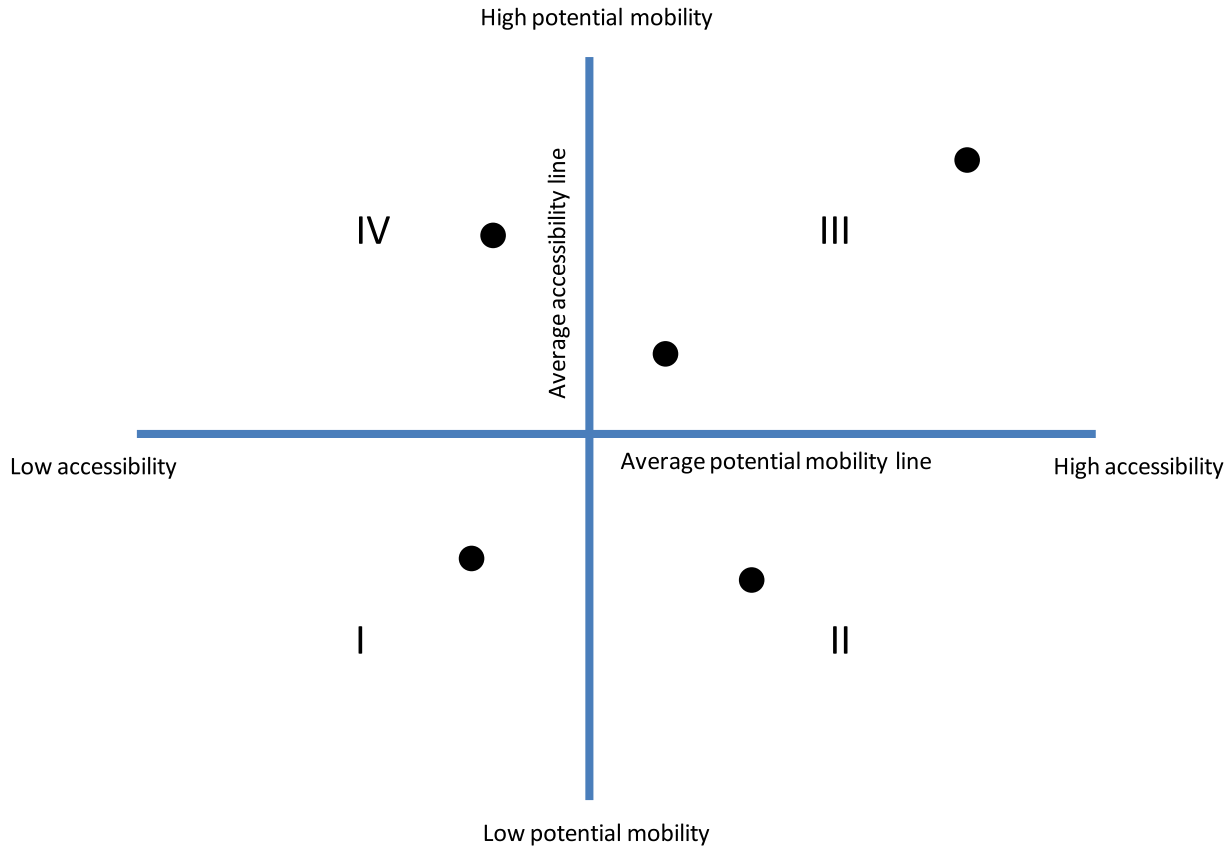
6.2 Assessing place accessibility

The use of the POMA-framework for the assessment of the transport problems experienced by businesses and services is somewhat different from the assessment of the transport problems experienced by residents. That is so, because businesses and services cannot be distinguished in terms of the relevant transport modes. Businesses and services typically prefer to be served well by all transport modes, even though they may differ in the importance they give to different types of modes. It does not follow, however, that a measure integrating accessibility by different transport modes into one indicator is the preferred option to assess the transport problems experienced by businesses and services. After all, place accessibility is the mirror image of person accessibility: businesses and services feature as the destinations persons would like to access. Full participation of persons in society requires access to these destinations. This role of businesses and services cannot be ignored in assessing place accessibility and thus an explicit accessibility analysis by transport mode is called for. Obviously, depending on the type of business or service, a different importance could be attached to poor levels of accessibility.

Like for person accessibility, the analysis of place accessibility can be carried out at the level of six-digit postal code areas, neighborhoods, or transport activity zones, depending on available data. It also could be carried out separately for services of particular importance, such as hospitals, educational facilities, or leisure facilities. There is, however, one key difference for in the POMA-framework for place accessibility. In contrast to person accessibility, there is no obvious demarcation point to distinguish poor accessibility from sufficient accessibility. First, in contrast to persons, businesses and services tend to adjust their location if accessibility drops below an acceptable level – or they will simply have to close shop. Second, what is a sufficient level of accessibility highly depends on the type of business and service and the extent to which people have a choice to access a particular business of service. Hence, it is not possible to define the 'accessibility poverty line' in the same way as for person accessibility. Yet, a comparable strategy could be adopted as has been done to set the center point for potential mobility: a distinction could be made between area-mode combinations (now filled with areas that contain business and/or services) above and below the average accessibility line (as defined in the number of people that have access to a service or business).

Based on this redefinition of the four quadrants, it is again possible to analyze the position of area-mode combinations for services and businesses (Fig. 3). Like in the case for person accessibility, those combinations positioned in the first quadrant are characterized by sub-standard accessibility and sub-standard potential mobility. These combinations therefore experience the most pressing transport problem. Like in the case of person accessibility, it is likely that especially areas poorly served by public transport, like suburban industrial estates or urban edge hospitals are located here. If these combinations represent key destinations (like hospitals) or a large number of opportunities (as e.g. measured in number of jobs), than these area-mode combination seem to be the most deserving of attention within the framework of transportation planning.

Figure 3. The POMA-framework for the assessment of the accessibility of residences and businesses. Each point refers to a particular area-mode combination, i.e. a set of businesses and services with identical characteristics in terms of location and mode.



7. The POMA-framework and urban planning

The POMA-framework cannot only be used to identify transport problems. It can also be used to identify areas suitable for urban development or urban transformation. For reasons of clarity, a distinction can be made regarding the planning of residential areas (possibly mixed with local services) and areas that primarily are intended for business and services.

In the former case, areas for (re)development can be classified in a simple way using the POMA-framework. For this purpose, the center point of accessibility is defined by the accessibility poverty line. In case an area provides sufficient accessibility by both car and public transport (i.e., both area-mode combinations are positioned in quadrant II or III), such an area is well-suited for the development of new residential areas, irrespective of the level of potential mobility provided by each mode. At the same time, an area that also provides an above-average level of potential mobility may be expected to be more robust if circumstances change (e.g., an increase in congestion). In case area provides insufficient accessibility by both car and public transport (quadrant I and IV), residential development in such an area is only advisable if they are matched with substantial investments in potential mobility (i.e., in the transport system). Note that these investments are likely to deliver limited improvement in accessibility, if an area is located in quadrant IV (unless other spatial developments are expected to take place at the same time). In case an area is characterized by sufficient car-based accessibility but sub-standard public transport accessibility (the typical case in most urban regions in the developed world), residential development is only advisable if such an investment is paralleled by investments in public transport. When no alternatives are available, such a development could also be acceptable if it serves population groups that tend to have full access to a car (one car per adult), i.e. higher income groups. Note, however, that such a decision de facto limits the possibility of e.g. older children to independently participate in activities out of the home.

In the case of the planning of areas dominated by businesses or services, a largely comparable approach applies. In this case, the center point of accessibility is defined by the average level of accessibility of all area-mode combinations. Areas with (well) above-average accessibility for both transport modes are typically suitable for development. from this set of possibilities, areas with a higher level of potential mobility for both transport modes are to be preferred, for reasons of robustness over time. Areas with (well) below-average accessibility levels for both transport modes are to be avoided, unless they are positioned in the left-bottom quadrant (quadrant I) and spatial development is paralleled with substantial improvements in both transport sub-systems. Investments in quadrant IV are again to be avoided, unless system-wide changes in the transport system are foreseen that fundamentally change the relationship between potential mobility and accessibility.

The planning of areas for businesses and services could also benefit from a careful analysis of the results of the POMA-framework for existing residential areas. Especially in case of a cluster of residential areas is located, for both car and public transport, in quadrant IV, investments in businesses and services may well be called for.

8. Conclusion

In this paper, I have presented a framework to simultaneously assess the accessibility provided by a transport-land use system and the potential mobility provided by the transport system. This framework provides a novel approach to identify the 'transport problems' in modern societies. It thus provides a framework that could serve as the basis for transportation planning and urban planning. In contrast to traditional approaches to transportation planning, it does not focus on the quality of the transportation network as such, but on the ultimate goal of a transport network: to enable people to participate in out-of-home activities. In contrast to the vast body of literature on accessibility measures, it provides a clear framework to determine when an intervention in the transport network is called for and when such an intervention is unlikely to deliver results.

The framework obviously is in need of further development. Most importantly, no explicit (set of) accessibility measure(s) has been described. Since different accessibility measures lead to different 'observed' accessibility landscapes, the careful selection of the set of measures to be used in the POMA-framework is not a simple matter. However, this challenge does not undermine the possible relevance of the framework presented here.

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