# Job (in)accessibility in the Parkstad region - *About the impact of transport affordability on accessibility for low-income households and the unemployed*

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**Abstract - There is increasing attention in the Netherlands in the topic of transport poverty and accessibility, with several publications discussing the need for accessibility standards to indicate injustice in the transportation system. Numerous case studies can be found where accessibility has been measured and assessed for fairness in the transport system, assuming that low-income households rely on public transport. This research reveals that up to now, the accessibility by public transport for low-income households and the unemployed is overestimated. Transport costs do not only have a diminishing effect on the accessibility by car, but also limits the accessibility by public transport. By means of the methodology 'Designing fair transportation systems' [1] it was possible to evaluate the job accessibility in the Parkstad region, a region where income on average is the lowest in the Netherlands and the unemployment rates the highest. The limited job accessibility by both car and public transport raises the question to what extent transport poverty contributes to the high unemployment rates in this region. Municipalities are recommended to use these results to further explore what the population groups suffering from transport poverty need and propose interventions to improve job accessibility for those who need this the most.**

***Keywords: Job accessibility, case-study, transport justice, sufficiency, transport affordability***

## I. Introduction

In the past few years, multiple research institutions in the Netherlands published reports on accessibility and transport poverty in the Netherlands ([2])([3]). For decades the focus of transport and planning policies has been on improving road networks to alleviate congestion and choosing the locations of facilities and jobs to ensure that they are primarily accessible by car. A car dependant society has been created where, in addition, public transport has been increasingly reduced leaving a higher risk of transport poverty. In the literature, one out of many definitions of transport poverty is 'the lack of accessibility to daily activities, which can lead to a situation where people are (involuntarily) excluded from full participation in society' ([4]). Transport poverty can also be explained as a more overarching term which includes *mobility poverty*, *accessibility poverty* and *transport affordability* ([5]).

The aforementioned reports from the PBL and Rli raise the possibility of an accessibility standard, which could enhance the structural measuring and improvement of peoples accessibility, implying policy from a sufficientarism approach, where everyone is provided with a certain standard of minimum accessibility. Case-studies found from a sufficientarism perspective were comprehensive spatial accessibility analysis which also included socio-economic target groups ([6]), ([7]) and both made use of the methodology proposed by Martens (2017). What most quantitative research in the evaluation of justice in the transport system have in common, is the use of location-based measures where travel times are being used to measure the number of amenities one can reach from a specific location. In neither of the case-studies, the travel costs are explicitly

included to determine accessibility for people with limited travel budgets. Instead, the assumption is that part of the population can't afford travelling by car and is therefore dependant on public transport. However, this is a limitation that additionally results in an inadequate perception of both car and public transport accessibility for low-income households.

This study aims to demonstrate the applicability of Martens' method with the extension of travel costs and to reveal the impact of transport affordability on the accessibility for low-income households and the unemployed. The main research question for this study is:

***To what extent can a job accessibility analysis from a sufficientarism perspective help identify transport poverty and guide municipalities in the Parkstad region in designing a more inclusive transport system for low-income households and the unemployed?***

Since various studies have elucidated that the risk of transport poverty and poor accessibility is mainly located outside major cities and in rural areas an appropriate case-study will be provided with the Parkstad region. This region shows characteristics indicative of regions with an increased risk of transport poverty due to its geographical position and the multitude of socio-economic challenges, such as high unemployment rates and a large share of low-income households, which also determined the scope on job accessibility.

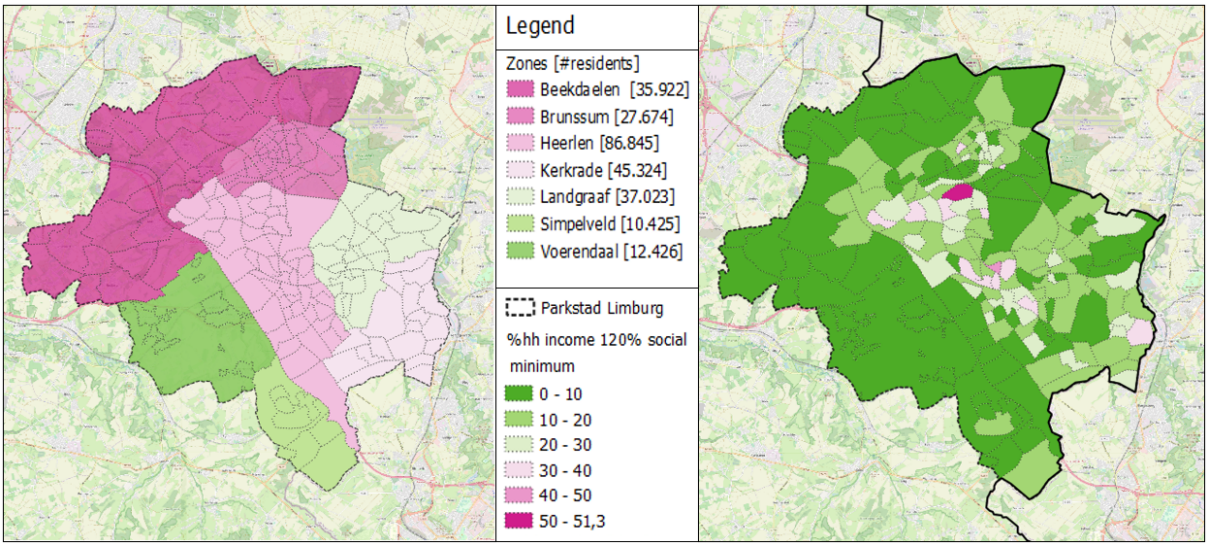


**Figure 1. The Parkstad region with the seven municipalities (left) and households living from a maximum of 120% social minimum(right).** ***(©OpenStreetMap, created with TravelTime API)***

In addition, there are other areas in the Netherlands that show a similar profile and for whom this study has added value. Along the eastern border of the Netherlands several urban areas are located where incomes are low and where there is also population decline, such as Enschede and Groningen ([8]).

In order to asses the sufficiency of the accessibility of jobs in the Parkstad region, the method proposed by Karel Martens ([1]) is applied. Because a number of steps are strongly interrelated, all steps are distributed over 4 phases. Based on this phase structure, which is shown in figure 2 the results will be presented. The final phase was realised in cooperation with several municipalities, with whom the results of the study were evaluated. As this study involves both geographical and socio-economic data, QGIS is used, because this software program allows the geographical visualisation of relevant data as well as the results. Also,

TravelTime provides a plugin for QGIS that allows the calculation of (travel) distances and travel times with all modes between given locations.

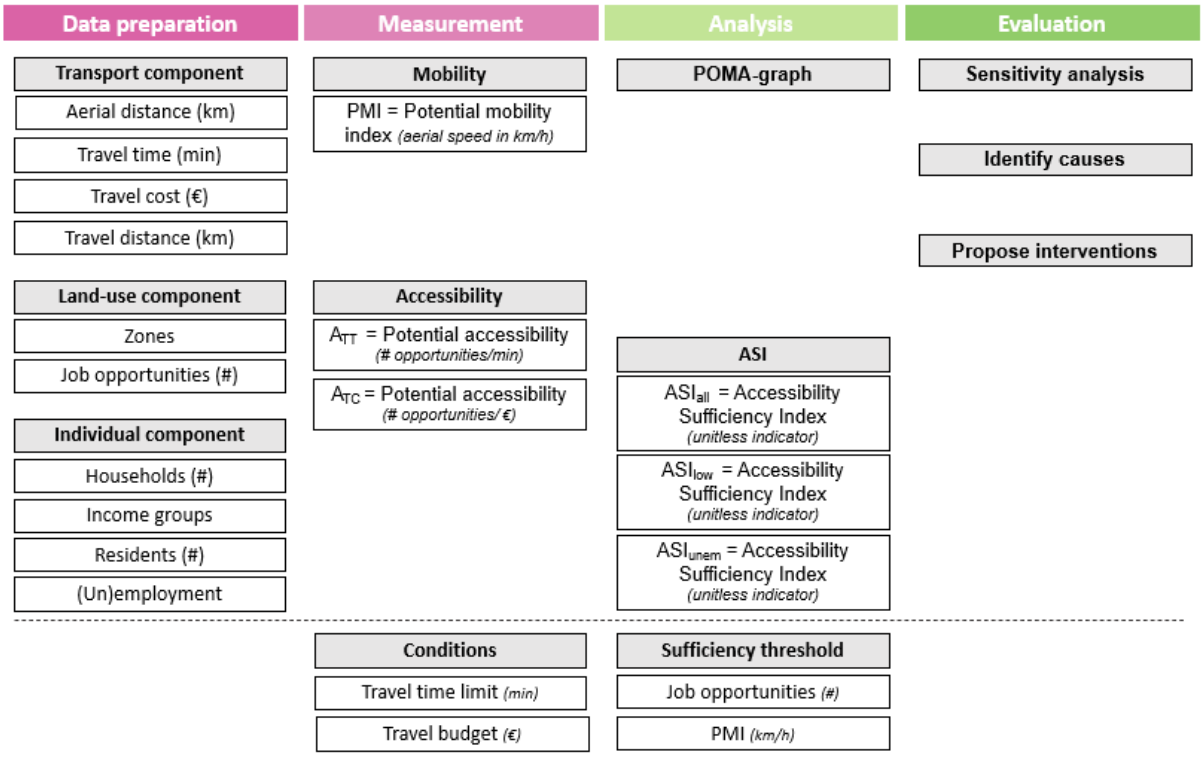


**Figure 2. Conceptual model**

## II. Analysis

This section is structured by means of the methodology 'Designing fair transportation systems' and consists of 4 phases. The subsections will elaborate on the methodology, main assumptions and the results for each of those phases.

### A. Data preparation

The QGIS model is based upon a fine-grained neighbourhood classification from the Dutch Bureau of Statistics (CBS) and allowed the region to be disaggregated in 199 zones, for which both socio-economic data as well as the number of jobs is known. With the TravelTime plugin for QGIS the matrices of the travel times, travel distances and aerial distances between all 199 neighbourhoods, by all modes are constructed.

### B. Measurement

To assess the transport network, the Potential Mobility Index (PMI) is calculated for each mode. This index is calculated by dividing the aerial distances between neighbourhoods by the travel time, thus taking into account not only the speed on the network, but also the network structure itself. The average PMI in the region to travel to all neighbourhoods by car, public transport and bicycle is 28.6, 8.4 and 14.2 km/h respectively. In other words, to cover the same aerial distance, it takes you on average more than three times as long by public transport when compared to car, and cycling allows you to travel faster than public transport. The total travel time by public transport includes the time needed to walk to bus stops and stations and transfer time.

Calculations of travel time by bicycle takes into account the height differences in the region, which can make a significant difference for travel times.

The accessibility measure chosen for the assessment of the job accessibility, is a cumulative accessibility measure. This measure allows for the estimation of the total number of jobs that can be reached within a given travel time or travel cost threshold. This measure is both easy to compute and interpret and data requirements are rather modest. The initial condition for travel time is 30 minutes, which is close to 26 minutes, the average commute time in the Netherlands and the travel time in which the complete region can be reached by car. There are a total of over 102 thousand jobs in the region, with a number of locations standing out where most jobs are located. These include the centre of Heerlen, centrally located in the region, but also a number of business parks located especially along the highway and connected ring roads. Within 30 minutes, from each neighbourhood in the region, all 102 thousand jobs are available by car. By public transport, this is more than four times less on average. Accessibility by bicycle stands out in a positive sense; with an average accessibility of over 63 thousand jobs, you can reach more in the region by bicycle than by public transport. All neighbourhoods in the region from which the residents can reach more than 50% of all jobs by public transport, live in the vicinity of business parks or the city centre of Heerlen, which are the epicentre of all jobs.

Following this analysis, the calculation of the job accessibility was repeated, only this time with a travel cost budget. The initial condition for the travel cost budget is based on statistics on what low-income households spend on transport annually [9][10]. Under the assumption that the expenditure for low-income households is equal to what they can afford, a travel budget of 3 euros per day was estimated. For car and public transport a price per kilometer was used to calculate the travel costs between all neighbourhoods (provided by Nibud and Arriva respectively).

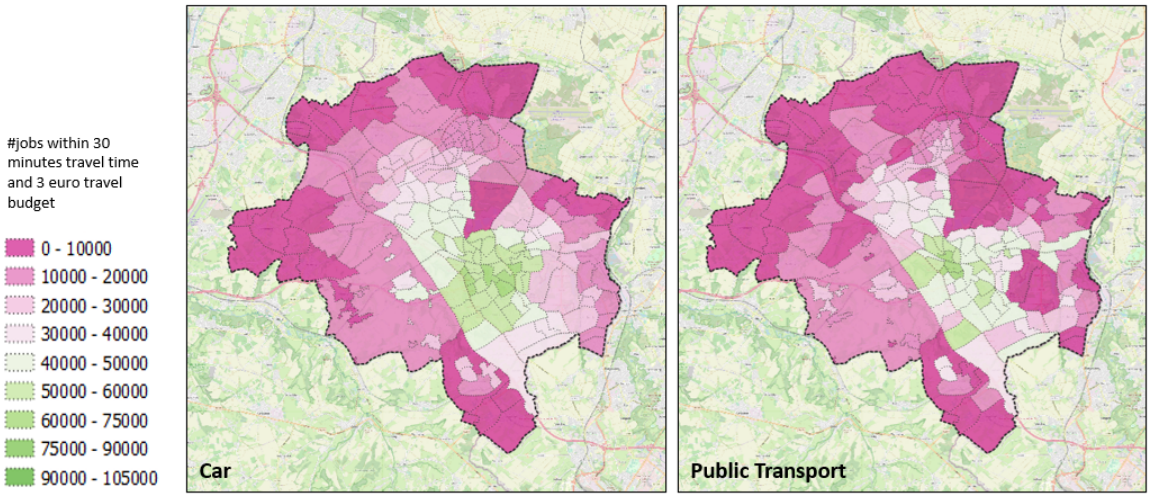


**Figure 3. Job accessibility by car (left) and by public transport (right) for low-income households.** ***(©OpenStreetMap, created with TravelTime API)***

Figure 3 shows how travel costs affect the job accessibility by car for low-income households and what accessibility by public transport is by comparison. The average job accessibility by car and public transport are not that different, but from these maps its evident that less neighbourhoods have sufficient job accessibility by public transport than by car. Including the travel costs particularly impacts job accessibility by car, which is now down by 72% compared to the analysis which included only travel times. The travel budget apparently

has no effect on job accessibility by public transport; what is within the range of 30 minutes travel time, is also within the range of a 3 euro travel budget.

### C. Analysis

The third phase is the analysis of the job accessibility, which starts with placing the values found in a so-called 'Potential Mobility and Accessibility (POMA) - framework [11], which can be found in figure 4. Each color in this graph represents a mode and each dot a neighbourhood. On the y-axis is the number of jobs one can reach from a specific neighbourhood and the x-axis shows the corresponding PMI. In this graph, two red dashed lines are added and suggest accessibility thresholds of 25% and 50% of all jobs and aid in identifying neighbourhoods below the threshold value.

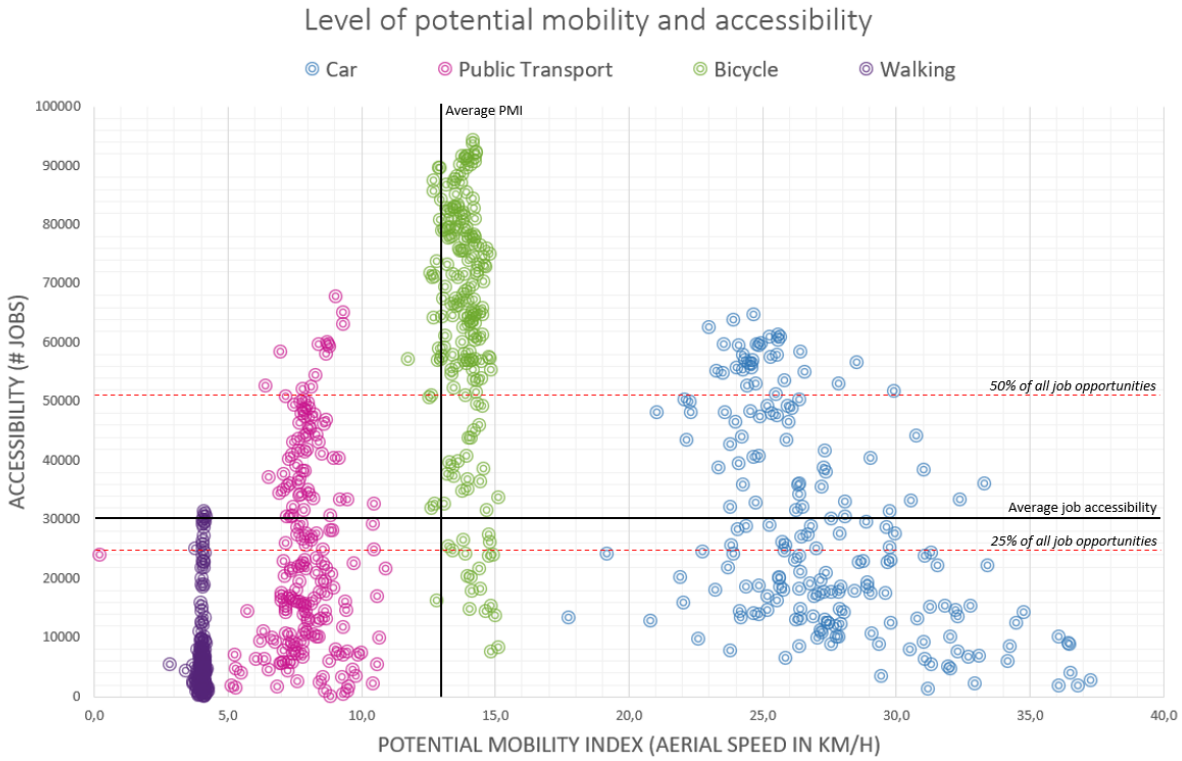


**Figure 4. Potential Mobility and Accessibility within 30 minutes travel time and 3 euro travel budget**

The methodology proposes the Accessibility Sufficiency Indicator (ASI) as an indicator to determine the severity of the accessibility for specific target groups. A neighbourhood's contribution to the overall job related transport poverty in the region can be expressed, by dividing a neighbourhood's ASI by the sum of ASI values in the overall region. Figure 5 shows these values for transport poverty by car for low income groups (left) and bicycle (right). The larger share in transport poverty by car on the east side of the region (Brunssum, Kerkrade, Landgraaf) is due to the higher share of low-income households. The figure on the right shows that most neighbourhoods are provided with sufficient job accessibility by bicycle and that mostly neighbourhoods located on the edges of the region have insufficient job accessibility by this mode due to the larger distances to job opportunities.

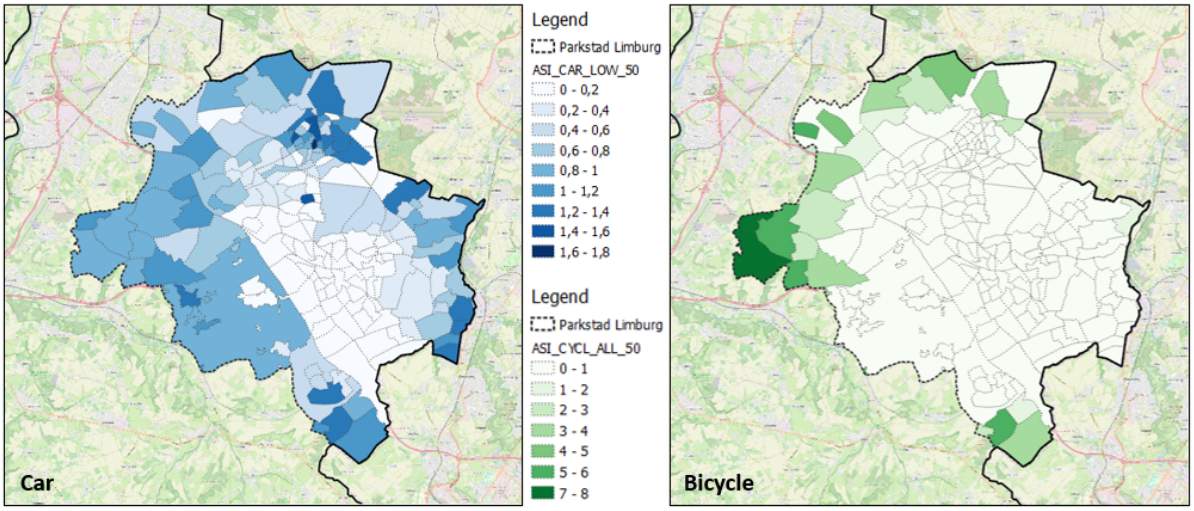


**Figure 5. The spatial pattern of the ASI by car (left) and bicycle (right) under a threshold value of 50%.** ***(©OpenStreetMap, created with TravelTime API)***

With the ASI values it is also possible to determine the share of people suffering from transport poverty, which was calculated with a sufficiency threshold value of 25%, 50% and 75%. With a threshold value of 50%, only 22% of the households with a low income have sufficient accessibility by car and 9% of the households have sufficient accessibility by public transport. For residents who are unemployed, only 20% and 8% of the people have sufficient accessibility by car and public transport respectively. For all the aforementioned target groups, over 80% has sufficient accessibility by bicycle, which emphasises on the potential of this modality, whilst at the same time exposing the poor functioning of public transport. For households with a medium or high income, the share of households with sufficient accessibility by public transport and bicycle is a little lower, but this is compensated with 100% accessibility by car.

| | THR. 25% jobs | | | THR. 50% jobs | | | THR. 75% jobs | | |
|---|---|---|---|---|---|---|---|---|---|
| | TT30+TC3 | | | TT30+TC3 | | | TT30+TC3 | | |
| Target group | PT | CAR | CYCLING | PT | CAR | CYCLING | PT | CAR | CYCLING |
| Lowest 10% | 58% | 61% | 96% | 11% | 23% | 84% | 0% | 0% | 41% |
| Low income | 55% | 57% | 94% | 9% | 22% | 82% | 0% | 0% | 39% |
| Unemployed | 53% | 53% | 93% | 8% | 20% | 81% | 0% | 0% | 37% |
| | TT30 | | | TT30 | | | TT30 | | |
| Target group | PT | CAR | CYCLING | PT | CAR | CYCLING | PT | CAR | CYCLING |
| Middle income | 51% | 100% | 91% | 6% | 100% | 79% | 0% | 100% | 36% |
| High income | 45% | 100% | 87% | 4% | 100% | 73% | 0% | 100% | 33% |

**Figure 6. The percentage of people/households with sufficient job accessibility**

## D. Evaluation

The evaluation phase consists of two steps, which are a sensitivity analysis and evaluation sessions with officials of the municipalities in the Parkstad region.

The graph in figure 7 shows the sensitivity for travel costs. For all four modes a line shows how the job opportunities increase with increasing travel budget. Travel costs are particularly limiting for accessibility by car; a budget of 6 euros showed to be sufficient to provide accessibility to all jobs for all residents by public

transport and 12 euros by car. Two dashed lines are added to show the cost sensitivity under a travel time limit of 30 minutes. The job accessibility by public transport, cycling and walking is clearly restricted by the travel time limit of 30 minutes and does not increase with increasing budget.

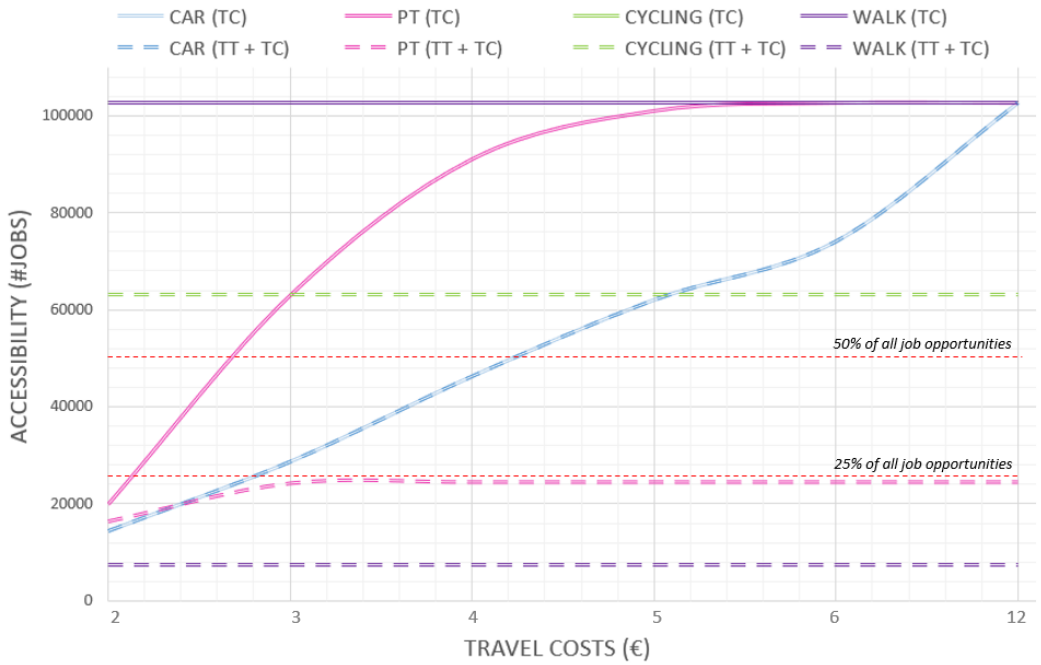


**Figure 7. Sensitivity for travel time within a 3 euro budget**

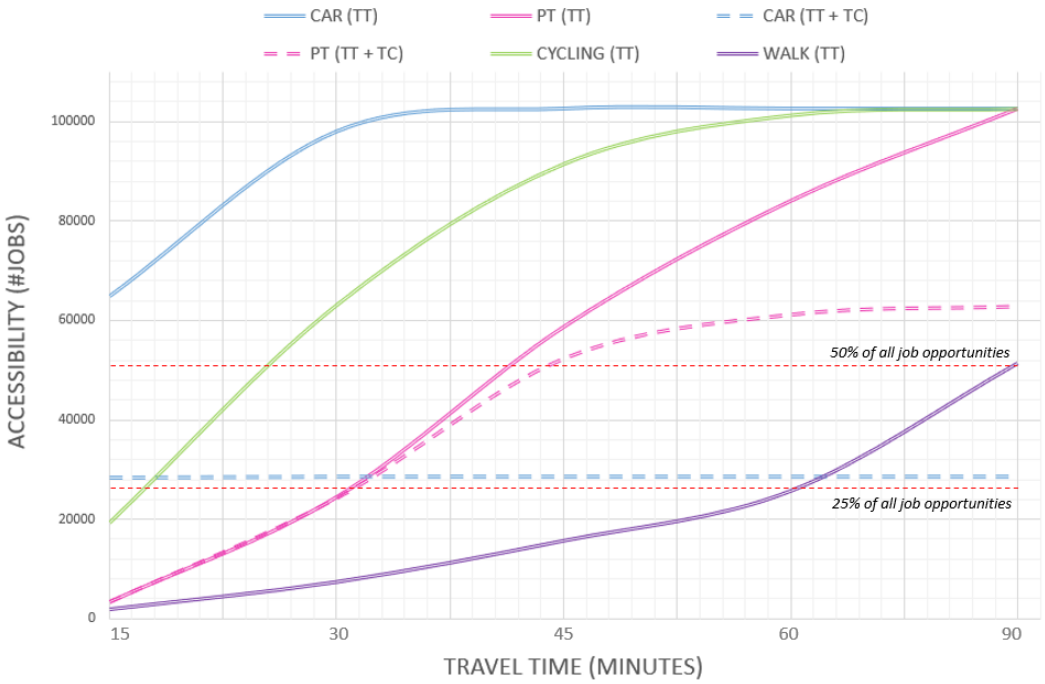


**Figure 8. Sensitivity for travel time within a 3 euro budget**

The graph in figure 8 shows the sensitivity for travel time. For all four modes a line shows how the job opportunities increase with increasing travel times. Two dashed lines are added to show how job opportunities for both car and public transport increase with increasing travel time if there is also a limitation of a travel budget of 3 euros. Accessibility by car is now limited to around 28% of jobs and 61% for public transport. So eventually, within a travel time budget of 3 euro, and 45 minute travel times, low-income households have on average a job accessibility of 61%. Mind you that these are averages and this is not correct for all low income households in this region. Further analyses showed that with a threshold value of 50%, within 45 minutes travel time and a 3 euro travel budget, up to 29% of low-income households and 31% of the unemployed still have insufficient accessibility by public transport.

In a series of interviews with officials from the municipalities of Beekdaelen, Heerlen, Kerkrade and Brunssum, the results of the study were presented and evaluated. In the municipality of Landgraaf a motion recently passed, which will soon make free public transport available to people with an income up to 140% of the social minimum. If the aim is to increase the chance of a job, only providing free public transport is probably not the solution, given the performance of public transport in this region. An important detail here is that the free pass is only valid in off peak hours, which means that it is probably not suitable for all jobs. That the potential of the bicycle was evident from the results confirmed for them that there are opportunities to further improve accessibility by bicycle and compete with car accessibility. In this discussion, the current modal split of the region was brought up, which shows a low share of travelling by bicycle for commute (13% compared to a national average of 24%, ([12])). Explanatory arguments for this are the high car accessibility and the differences in altitude in the region, which results in extra physical effort for people to travel somewhere by bicycle. E-bikes are considered a part of the solution in this regard, but these are to expensive for low-income households and the question is to what extent people also have suitable parking facilities for such an expensive bicycle. In the Parkstad region, there are already several hubs of an e-bike sharing system. Increasing the supply of these locations (also specifically on job locations) and making these e-bikes accessible for people who experience low accessibility would increase their job accessibility. Perhaps a free pass for these e-bikes sharing systems could improve job accessibility more than a free pass for public transport would.

## III. Conclusion & recommendations

The aim of the research was to demonstrate the applicability of Martens' method with the extension of transport affordability. For this purpose a threshold value for a travel cost budget was added as an additional restriction into the analysis. This study shows that it is possible to include travel costs in the calculation of (job) accessibility and thus capture the accessibility of vulnerable target groups even better. The results show that if a limited travel budget is taken into account, the accessibility by both car and public transport is restricted at some point, demonstrating how accessibility by public transport for low income households has been overestimated thus far.

In separate sessions, the results were also presented for and discussed with the municipalities involved. The results provoked in-depth discussions about the severity of the shortfall in job accessibility, its causes and possible interventions. The results of the analysis were easy to communicate and provided the municipalities with lists of neighbourhoods where job related transport poverty is high. It can therefore be concluded that this methodology can guide municipalities towards designing transport systems that include low-income households and unemployed people as well. Due to the limited scope of this research, multiple officials of municipalities even asked whether the research could be expanded to include a larger area or other amenities for different target groups to gain even more information about accessibility and transport poverty in the region.

The policymakers also saw opportunities to use these results to prioritise policy, value possible solutions (such as free public transport), identify neighbourhoods where further research would be justified and to promote

bicycling. An important note here is that, where for one target group an e-bike may be a solution, other people would be more pleased with free and improved public transport. More qualitative research, which includes involving the people affected, can also aid in understanding the results and come to useful interventions. A recent study of Krabbenborg et al. ([13]) shows that the obstacles people face to reach destinations are not only limited by travel times and costs, but for example, physical capabilities or unsafe infrastructure as well.

Previous qualitative research in Rotterdam showed that the inaccessibility of jobs can hinder people from finding or keeping employment ([14]). Since the unemployment rates are so high in this region, and the accessibility to jobs by public transport, based on both travel times and costs, is very limited it seems justified to wonder to what extent limited accessibility also directly contributes to the unemployment in this region. I would therefore recommend the municipalities to use the results and propose interventions that improve (job) accessibility for those who need this the most.

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