URBAN EUROPE

Project no. 875022

JUSTICE

Joining Urban morphology, Spatio-Temporal and socio cognitive accessibility for an Inclusive City Environment

Deliverable 3.x.5 Report on Operational Accessibility for each target group to selected places

1. Introduction

The thrust of the overall JUSTICE project comes from the need to measure accurate Public Transport (PT) accessibility not only for the overall population, but for specific situations. Indeed, with the increasing need to fight car-dependence, municipalities implement various policies to improve public transportation. However, whereas these policies are generally meant to be inclusive, the complex and multifaceted nature of accessibility could lead them to exclude some individual behaviors and widen the accessibility gaps. In addition, the most vulnerable groups remain seldom modelled and their accessibility insufficiently and often inadequately measured. In order to reveal those PT accessibility gaps, an appropriate framework taking into account not only spatiotemporal, but also social, material, and socio-cognitive constraints impairing accessibility is required. Drawing from the *capability* approach, grounded in Amartya Sen's philosophical conceptions of justice and already applied in relation with accessibility concerns[1], the JUSTICE research aims to reveal the accessibility gaps endured by those more prone to suffer from them, the most vulnerable PT users. This modelling phase follows a participative step developed in Brussels, Konya, and Strasbourg where indicators, Points of Interest (POIs) and barriers to the use of Public Transport were collectively defined.

2. Method

PT accessibility was measured in the three cities for the overall population in able-bodied, unconstrained situation (*i.e.* for *Joe Public*) as well as according to barriers pre-determined in the participatory phase. The method can be summarized as follows:

- The accessibility is calculated *via* the OpenTripPlanner (OTP) router using *A** shortest path algorithm. Although originally a router, OTP is one of the mostly used calculator amongst global scientific PT accessibility researchers, thanks to its PT-specific analyzing capacities. Indeed, the exploitation of the exhaustive PT timetables allow to provide a 1-minute grain size accessibility considering access & egress times, waiting times, as well as transfer times and transfer conditions. In addition, pedestrian paths enable to take into account walking time before, after, and between the PT trip. OTP also enables to consider transport fees but it was not the case in our study. The first version of OTP (1.4 & 1.5) was used because by contrast with OTP2, the *banning* functions are implemented, allowing to adequately take into account most of the barriers expressed in the participatory phase - the translation from barriers to constraints to model parameters is detailed below.
- The overall database consists in:
    - OpenStreetMap files, sometimes corrected thanks to municipal databases regarding the physical accessibility of public spaces or PT networks.
    - General Transit Feed Specification (GTFS) files to model the PT service and schedules. They are available in open data from STIB-MIVB in Brussels and CTS in Strasbourg. In Konya, they have been built by the municipality for the very purpose of the JUSTICE project.
    - Specific data including transit station characteristics (lifts, steps, slope, equipment, etc.) and, only in Strasbourg, street characteristics (tactile bands, narrow sidewalks, obstacles in the streets, stairs, etc.). These data were both provided by the partners and for a small part field-tested.
- A shortest path is determined according to a constraints-based accessibility model defining an origin, a destination, and a departure time or arrival time.
    - The destinations are the POIs identified in the three cities during the participatory phase. This is consistent with the fact that most constrained users had to prepare — if

[1] Pereira R., Schwanen T., Banister D.: Distributive justice and equity in transportation, Transport Reviews (2016).

not learn — their route. Hence, it appears more relevant to measure accessibility to a limited number of symbolic locations spread evenly across the urban area than to a great number of theoretical attractors (shops, jobs, etc.) like most of the accessibility studies.

- The origins are defined in a city-sensitive manner, according to the geographical and PT network differences between the cities. In Brussels, the PT network is dense, old, and well-developed (see Fig. 1). It can therefore be contended that the PT stops are spread throughout the agglomerated urban area and that most of the inhabitants live not far from a PT stop. Hence, PT stops are selected as origins from where the accessibility is measured. Conversely, in Strasbourg and Konya, the PT network is much scarcer and a substantial part of the inhabitants of these metropolitan municipalities likely live far from a PT stop. Accordingly, a grid with 200m square meshes was applied in these two cases. For each mesh where the built-up area proportion exceeds 50%, the centroid of the mesh is considered as an origin (Fig. 2). This method allows to assess accessibility for the people in the city center as well as in the outskirts.

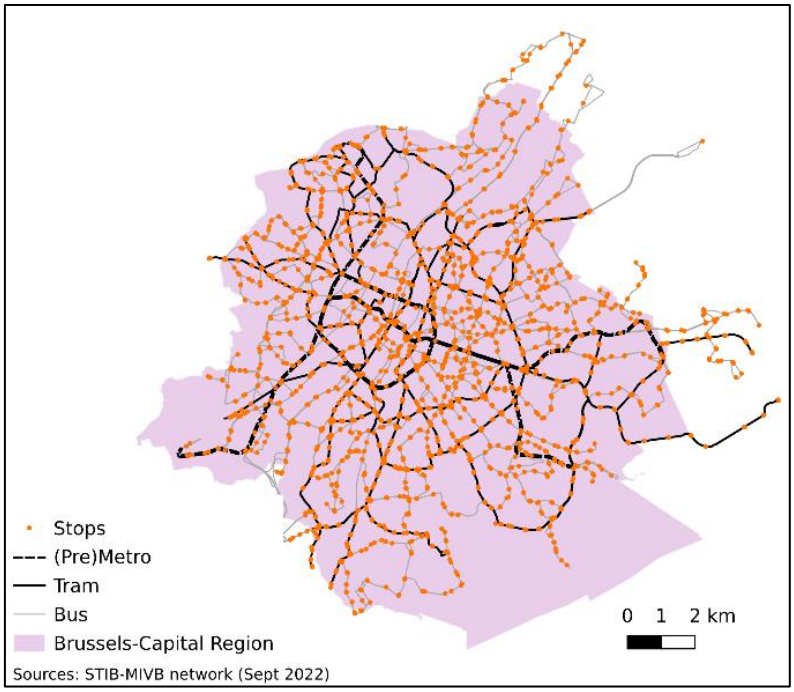

Fig. 1: The Brussels STIB-MIVB Public Transport network

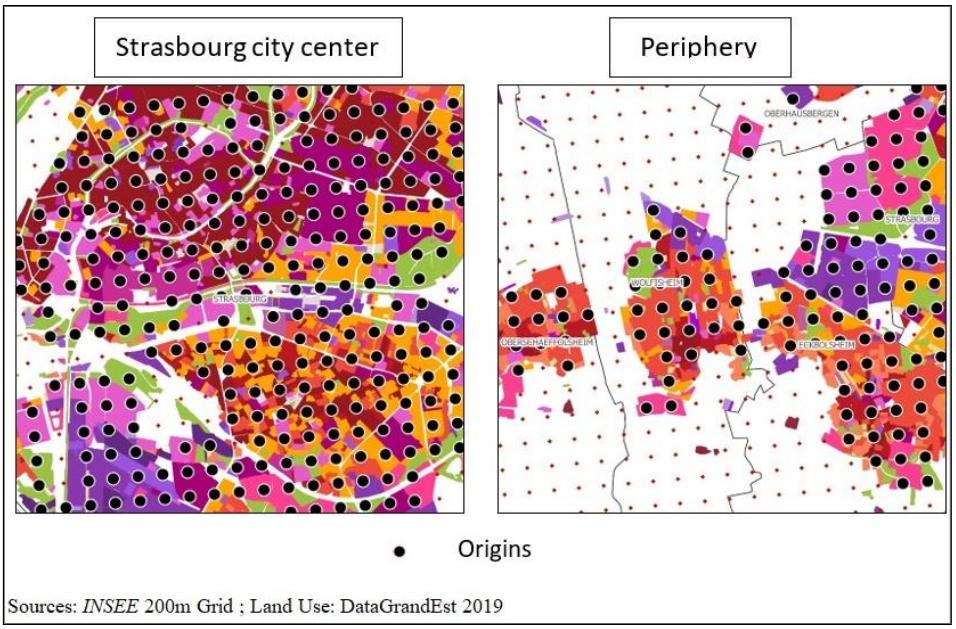

Fig. 2: The mesh centroids as origins – illustrations in Strasbourg

- Last, clockface constraints are employed to determine the shortest paths. In Strasbourg, the participatory phase has highlighted the timespan and frequency issues suffered by all the users. Accordingly, four measures were set up to take into account the heterogeneity of PT service over time. In addition, working, working atypical hours and non-working people can be concerned by these schedules:
  - Arrival at 9am in the POI on a weekday;
  - Arrival at 10am in the POI on a weekday;
  - Departure at 5pm from the POI on a weekday;
  - Arrival at 9am in the POI on a Saturday.

  In the two other cities, only the first 9am measure was provided, because the PT service consistency over time did not appear as a major issue. Besides, the calculations were based on the May 2022 timetables provided by the three PT companies. The *Joe Public* walk speed was set to 4kph.

- For each shortest path, 3 indicators are calculated, according to the participatory phase results: travel time, number of transfers, and walking distance.
- This constraints-based model is grounded in the very idea that PT users in specific situations would accept detours, longer travel times, longer walk distance, or additional transfers, in the event of a difficult crossing, a dangerous transfer, or to avoid congested streets and use wider, better-signposted roads as alternative routes. Accordingly, the barriers expressed in the participatory phase were translated into constraints such as *Route without platform-vehicle gap*, *Route avoiding the use of stairs*, *Bus aversion*, etc. Then, the adequate OTP 1.4 parameters are used to set the constraints for the shortest path calculation. Last, these "specific" accessibilities were compared with the accessibility for *Joe Public* to measure accessibility gaps (Fig. 3). This approach is consistent with the *vertical equity* rationale, tackling distributive justice issues[2].

[2] Murray A. T., Davis, R. (2001), Equity in regional service provision, Journal of Regional Science, Vol. 41, no.4, pp. 557-600

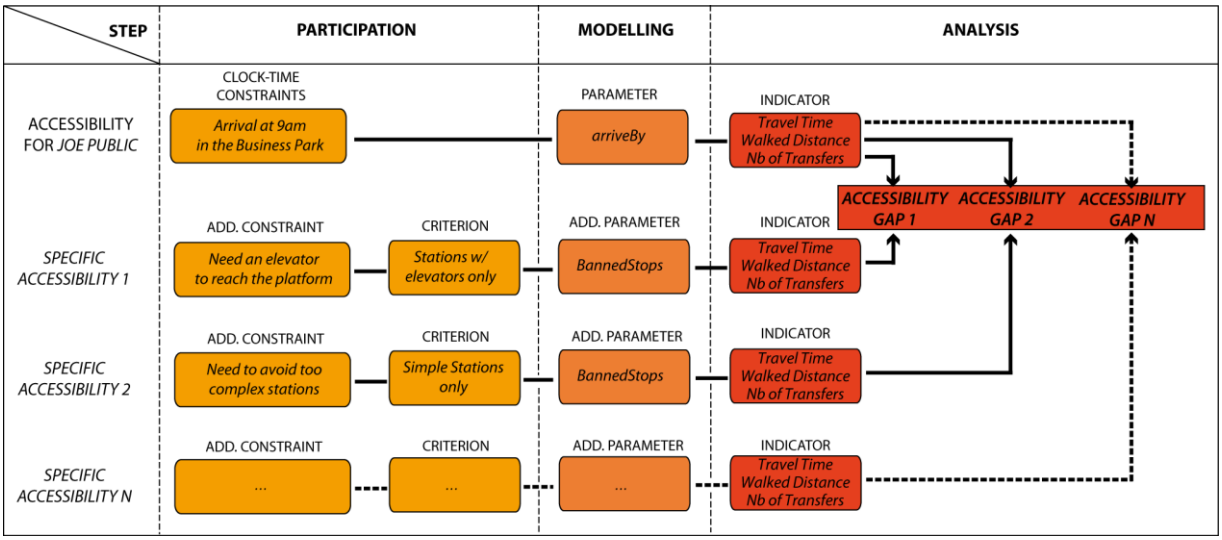

Fig. 3: The method from pre-expressed barriers to accessibility gaps

- Innovatively, the JUSTICE approach also includes the outcomes from go-along interviews. Accompanying the vulnerable PT users during their PT trips gave precious insights regarding the pre-discussed barriers they endured. It helped them to remember the barriers they had experienced on this trip, but also on other trips (the approach of the go-along interviews and subsequent focus groups is detailed on the deliverable 4.1 **Report on Participatory Survey Results**). These qualitative results were used to calibrate and refine our measurements. For instance, in Strasbourg a slow walk speed was regularly highlighted as a specific situation to deal with during a Public Transport trip. It therefore regards a lot of heterogeneous users, to such an extent that it seems difficult to set the slow walk speed value. Thanks to our *in situ* experiments, we were able to set it according to the slowest users we go with (2 kph). We also overlaid constraints in order to match the user experience as closely as possible. For instance, a profile combining the need of tactile bands, the aversion of complex stations, and the dependence to bus signage was built to render account of the high vulnerability to the absence of information and markings for some of the interviewees. On the other hand, we were struck by the autonomy of certain people. For instance, in Brussels, many individuals managed to overcome some obstacles which has led us to develop a finer gradient of constraints, more or less restrictive (e.g. size of gaps), to better represent the diversity of our target groups.
  Finally, the whole results are displayed in a web-based atlas (https://justice-project.eu/atlas/). This interactive tool allows to explore all the results by a user-friendly interface where one can select the measure settings (POI, time constraint, specific constraint, indicator) for the three cities. Several plots, figures and editable maps represent accessibility with a high responsiveness that encourages a fast but thorough exploration of the results. In addition, comparison maps are provided to better represent PT accessibility gaps. Last, the *Atlas* section offers all these functionalities in an original interface where a slider allows to compare simultaneously two maps, in an alternative visual frame to the one where a sole map represent the gaps.

3. Results

The results show that accessibility is heterogeneous according to the cities neighborhoods and to the constraints we applied on the shortest path measures. In each city, specific outcomes are highlighted. In Brussels, the physical access to the stations and the rolling stocks remains the most crucial issue. For instance, travelling in full autonomy considering a step-free route appears to be difficult, pointing out a population suffering from impactful accessibility gaps. First, a lot of stations are not compliant with this constraint, specifically out of the city center. Then, the journeys are significantly longer, with longer travel times, more transfers and longer distances walked. The tactile paving also appeared to

be an impactful constraint. As these general results substantially vary according to the POI and to the journey origin, the exploration of the results allows to pinpoint the stations, lines, sectors where the improvement of PT network inclusivity is required.

In Strasbourg, geographical features mostly prevail. Several peripheral areas suffer from an impaired accessibility to the POIs. Conversely, some POIs, including the main theater in the metropolis, are not well accessible in Public Transport. Overall, all the groups of users with walking difficulties (*e.g*. slow-speed walkers) seem particularly suffering from PT accessibility gaps. Besides, a significant part of the streets is not wheelchair-accessible according to French legal standards, impairing the wheelchair users' accessibility. The equipment of the stations (missing or malfunctioning audio beacons or tactile paving mainly) appears as a secondary issue.

In Konya, available station-level data were missing, so that an exhaustive analysis was not possible. Still, the lack of disability-compliance of the buses significantly restrain accessibility for these users to the sole tramway corridor. On the other hand, numerous bus lines all over the city provide decent accessibility, given the size of the urban area and the context. It is also to note that the slow-speed walkers experience impaired accessibility in the majority of the neighborhoods. This finding is partly explained by the difficulties to cross the main avenues for a pedestrian as well with the overall spread of the urban area.

4. Conclusion

The modelling phase provides one of the two main outcomes of the overall JUSTICE project: a set of accessibility indicators (namely travel time, number of transfers, and walk distance) allowing an appraisal of the accessibility gaps. These gaps are related to both the spatial schemes and the inclusivity of the PT network, *i.e*. its capacity to be properly used by people in specific situations. On the one hand, spatial patterns produce significant accessibility gaps, above all in Strasbourg and Konya metropolitan areas. On the other hand, accessibility gaps are also related to specific situations faced by potential PT users in the three cities. Physical constraints such as wheelchair-using or step-free routing remain today the most impairing situations, particularly in Brussels compared to the users without specificities (*Joe Public*). Then, slow-walking users also suffer from accessibility gaps. Interestingly, this constraint can be shared by a wide range of actual PT travelers: temporarily or permanently physically impaired, but also blind, visually impaired, older adults, tired, people carrying heavy loads or travelling with children, etc. Last, the equipment linked with visual impairments - tactile paving and audio beacons, was another salient concern in Strasbourg and Brussels. Of course, spatial and inclusivity issues can combine, deepening the accessibility gaps for potential specific users living in remote or underserved neighborhoods.

It is to note that these conclusions are linked with the available data. The context-sensitive differences between the three cases of study were included from the beginning, allowing to temper and interpret the raw results regarding the comparison analysis. By contrast, the heterogeneity of the available databases in each city does not allow a strict comparison of all the results. For instance, it is unknown whether Konya and Brussels have the same issues of inaccessible pavements as Strasbourg. This lack of data, that can slightly modify the analysis, will be supplemented by go-along interviews and the other qualitative methods developed in JUSTICE, in line with the mixed-method rationale advocated throughout the project.

Finally, the results are used in the last step of the JUSTICE project (see the deliverable **5.2 Report on the Recommendation Notes**). The main issues highlighted by the model outcomes are discussed with the partners (NGOs, municipalities, PT companies) and recommendations are outlined accordingly.