Large-scale Planning Tool for Mobility Hubs – Data Requirements and Open Data Availability

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Abstract. Mobility hubs can contribute to a user-friendly and sustainable mobility by facilitating the use of public transport and shared services. Despite their potential, the planning of such hubs is often hampered by inefficiencies, as planning is done on a case-by-case basis. This is further complicated by data limitations and the lack of appropriate planning tools. Therefore, we are developing a comprehensive and open data-based planning tool for mobility hubs that includes all essential planning steps. In order to assess the availability of the required data for the implementation of such a tool, we defined a methodology and applied it to the selected open data sources. This paper presents a preliminary concept for mobility hub location planning, delineates the required data, and finally summarizes the results of the data quality assessment.

Keywords. mobility hubs, decision support system, open data

1. Introduction

A growing trend in urban areas is the shift towards shared mobility and on-demand services (Machado et al. 2018). In rural areas, however, traditional forms of mobility dominate, with up to 70% of trips being made by cars (Nobis & Kuhnimhof 2018). The main barriers to public transport in these regions are a lack of information and missing services for the first and last mile and during off-peak hours (Rehme et al. 2023). Mobility hubs, which consolidate various mobility services in one location, usually near of a public transport stop, promote intermodal mobility and can reduce dependence on private transport (Frank et al. 2021). Despite their benefits, they are rare in rural areas. Planning of mobility hubs is complex, requiring decisions

about appropriate locations, type and number of mobility and other services, infrastructure, and consideration of budget constraints (Frank et al. 2021).

To support mobility and urban planners in the large-scale deployment of mobility hubs, we are developing an open data-based planning tool that integrates location planning and hub configuration. This paper explores the feasibility of the planning tool and presents its rough concept as well as an assessment of selected open data sources. It is structured into an introduction, a short literature review, the concept of the planning tool, an assessment of the data quality, and finally a conclusion and further work.

2.　Literature Review

The literature identifies two dominant methods for location planning of mobility services: accessibility measurement and optimization-based planning models (Frank et al. 2021). Geurs and Van Wee (2004) define accessibility as how land use and transportation systems allow individuals or groups to reach destinations using various transportation modes. Optimization-based planning models provide structured decision support for the location choice of mobility hubs (Frank et al. 2021). Despite the advantages of such integrated approaches, they are rarely applied in practice due to their complexity, so that hubs are often designed on a case-by-case basis (Möller et al. 2018). In the literature, different typologies and recommendations for the equipment of mobility hubs are presented (Roukouni et al. 2023). However, most of the methods and typologies mentioned above have been developed and applied mainly in urban regions. This may reflect poor data availability in rural areas.

Data quality plays a critical role in information systems and decision-making processes. The Open Knowledge Foundation (2023) defines open data as data that can be freely used, modified, and shared by anyone for any purpose. Data quality, according to DIN EN ISO 9000:2015-11, refers to how well data meets specific requirements. Various dimensions of data quality are discussed in the literature, with accuracy, validity, completeness, and timeliness, among others, identified as core aspects (DIN EN ISO 19157, Sebastian-Coleman, 2013, Klinkhardt 2021). Depending on the use case, the relevance of the quality dimensions may vary. Klinkhardt (2021) provides a comprehensive synthesis of quality standards for geographic databases with a particular emphasis on completeness and thematic accuracy for geoinformation. In order to measure data quality, it is necessary to define requirements for the data and tools to monitor the extent to which the data meet these requirements (Sebastian-Coleman, 2013).

3. Concept of the Planning Tool

3.1. Method

The first step in mobility hub planning is the evaluation and ranking of potential locations. These are initially all existing public transport stops. The planning approach focuses on the rural regions of Germany, including small towns, medium-sized towns and central cities. Through a literature review, relevant factors for assessing the potential of a location were identified, such as the number of points of interest in the catchment area, the potential demand (derived from the number of passengers, population density), and the frequency of public transport. In addition, mobility hub projects were analyzed and expert interviews were conducted to validate the planning factors. The most frequently mentioned factors were integrated into the planning concept and the required data inputs were derived.

3.2. Partial Concept and the required Data

Figure 1 summarizes the work flow for the location planning including the required data inputs. The goal of this planning step is to provide the planner with an overview of the potential sites including relevant information and a site ranking based on the total potential per stop. The total potential value per stop can be determined on the basis of only one influencing factor, e.g. passenger numbers, or on the basis of several factors, which can be additionally weighted by the planner. Based on the total potential values of the stops, the planner can select the most suitable public transport stops and then proceed to the individual planning, i.e. configuration of the mobility hub.

The individual planning is based on a mobility service recommendation matrix and a potential number of users per mobility service.
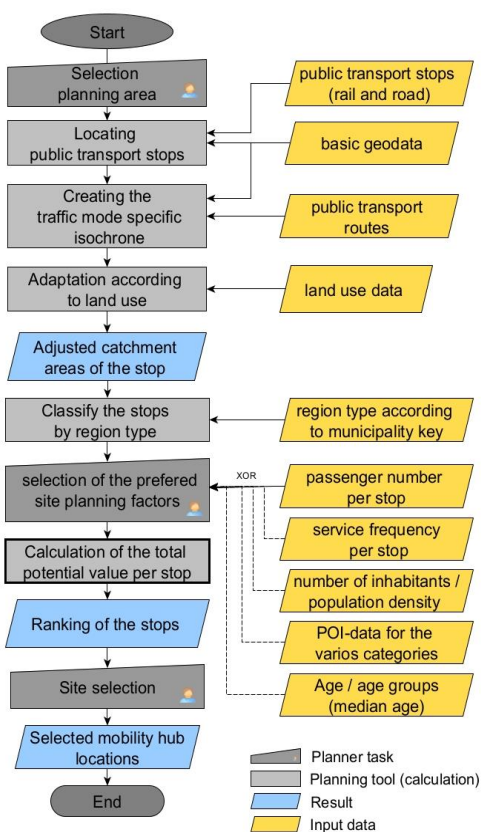

Figure 1. Concept of the location planning.

4.   Data Quality Assessment

The quality assessment of the available data sources is based on the relevant quality criteria for data, see chapter 2. Particularly relevant for the use case and therefore included in the evaluation were the criteria availability as open data, suitability of the data format, and transferability (scalability) of the data sources to all of Germany. These were assessed as exclusion criteria with a "Yes" or "No" answer. Data sources were researched using an unstructured internet research and suitable ones were selected based on the above criteria. Additional criteria – Completeness and Accuracy (thematical and positional) - were rated on a scale from 0 to 2 (0 - low fulfilment degree, 1 - medium fulfilment degree, 2 - high fulfilment degree) in terms of meeting the planning tool-specific requirements. Furthermore, the criterion complete-ness was weighted with a factor of 0.7 and the criterion accuracy with a factor of 0.3, because inaccurate information (e.g. minor deviations of the location) is generally less critical for the expected planning results than completely missing information. In the next step, the selected sources were evaluated using the above scale. For this purpose, data were qualitatively assessed by the research team.

Table 1 shows an excerpt of the data source assessment and its results.

Type of data	Assessed Source	Exclusion criteria	Comple-teness	Accuracy	Usability score
Basic geodata (roads, traffic routes, etc.)	Open Street Map (OSM)	Yes	2	1	1.7
Federal state and munici-pal borders, etc.	State survey-ing offices	Yes	2	2	2
Land use data	OSM	Yes	1	2	1.3
Regional rail transit stops	OSM	Yes	2	1	1.7
Points of interest (POI)	OSM	Yes	2	2	2
Population density	Eurostat	Yes	2	2	2

Table 1. Assessment of the suitable open data sources. Legend: 0 = low fulfilment degree, 1 = medium fulfilment degree, 2= high fulfilment degree.

The sum of the weighted criteria gives the total usability score. The score of the OSM data refers to the data format "point", which was considered sufficient information for the implementation of the concept. The data quality assessment found that open data sources exist for most of the required data and that they meet the minimum requirements. The overall usability scores vary between medium and high levels of fulfillment of the criteria by the datasets. This means that the available open data are of sufficiently good quality and can be used for the planning tool. The only missing data is the number of passengers. This can be estimated based on population density or completely replaced by other influencing factors, see chapter 3.2.

5. Conclusion and further work

The feasibility of a large-scale open-data planning tool for mobility hubs was confirmed for the location planning step. The next step is to finalize the concept for single hub configuration and to collect the necessary data. To configure a mobility hub, the number of potential users per mobility service in the catchment area has to be estimated. The required data for this, such as the intention of the users to use the different mobility services, will be collected through a survey, as it is not available as open data at the required level of detail. The validation of the collected data will be performed at a prototypical mobility hub in a rural region. Finally, the concept will be implemented as a web application.

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