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Exploring Spatial Behavior via Social Network Analysis: a Survey-based Approach

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Abstract

This paper investigates the spatial and social dimensions of everyday mobility using a survey-based social network analysis approach. Between November and December 2024, 1,377 residents of a small German town were surveyed about their local activities and their reasons for traveling beyond their municipality. Through activity-specific name generators, respondents listed individuals and places they interact with across five domains: shopping, errands, private visits, leisure activities, and volunteering. This method yielded over 17,000 reported relationships. The paper introduces the name generator design and outlines the categorization used for analysis. Findings show that respondents maintain a high number of relationships within their municipality, particularly in the domains of shopping, errands, and associations, where both active and motorized transport are commonly used. In contrast, relationships related to private visits and other leisure activities are more frequently located outside the municipality, with motorized transport being the predominant mode of travel. These results highlight the interplay between social belonging and mobility patterns, offering insights into the spatial behavior of everyday interactions.

Keywords: Spatial Behavior; Social Network Analysis; Name Generators, Activity Spaces

1. Introduction

The mobility sector is rapidly evolving, due to digitalization, automation, and climate goals. These changes are expected to fundamentally reshape the mobility landscape, potentially enabling new transport services and applications (Lyons, 2022; Thomopoulos and Givoni, 2015). However, beyond performance metrics, it is crucial to assess how innovations align with people's daily lives and activity spaces (Puhe et al., 2025).

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There is a longstanding tradition in mobility research of analyzing peoples' everyday lives on the basis of individual actions in time and space (Jones, 1979; Miller, 2021). Activity-based analysis is the most established approach to understanding mobility behavior. It explicitly recognizes that complex spatial, temporal, transportation and interpersonal interdependencies constrain activity participation (McNally and Rindt, 2008). Closely linked to the activity-based approach is the concept of activity spaces. An activity space describes the geographical area with which people are in direct contact to perform their activities (Horton and Reynolds, 1971; Patterson and Farber, 2015). Previous research has shown that people's activity spaces tend to be relatively stable. For example, Schönfelder and Axhausen (2010), based on various transport surveys from different geographic contexts, estimate that approximately 80% of all activities occur at the ten most frequently visited locations. This suggests that the majority of individuals' activities are concentrated in a small number of places.

However, identifying such patterns depends on the time span of data collection, as some of these places are visited regularly but only rarely. National travel surveys, such as the MiD in Germany or the Dutch National Travel Survey, are typically conducted as single-day surveys, capturing the travel behavior of a large number of participants on a specific reference day. This approach enables researchers to obtain a satisfactory overview of inter-personal differences and similarities in activity patterns, spatial behavior, and mode choice at the national level.

Though, the nature of single-day surveys limits insights into intra-personal variation, as individual mobility patterns can differ from day to day and across activity types. For example, it remains unclear whether a person visited a distant supermarket on the reference day by coincidence or as part of a regular routine. As a result, such surveys do not reveal how many individuals – e.g. within a given spatial context - typically remain within their local municipality, nor for which types of activities they do so, or do not.

Although there are a number of statistical models or Geographic Information Science approaches that allow to extrapolate the activity spaces from a small sample of activities, Patterson and Farber (2015, p. 688) note that "this does not represent locations of direct contact, but are rather best thought of as areas with which people *could* have contact."

Accordingly, several efforts have been made to collect data over extended periods of several weeks. Notable examples include the Time-Use+ survey in Switzerland (Winkler and Axhausen, 2024), the Mobidrive study (Axhausen et al., 2002), the Uppsala Household Travel Survey (UHTS) (Hanson and Huff, 1981), the Zurich Leisure Study (Schlich et al., 2003), and the Thurgau survey (Löchl et al., 2005). Among other things, these studies revealed that significant differences exist not only between but also within activity types. For example in leisure transport, it has been noted that club and group activities, as well as sports, walks, and cultural activities result in similar average distances between 4 and 7 kilometers, while the distances for private visits to family and friends are significantly higher, averaging 16 kilometers (Schönfelder and Axhausen, 2010). Buliung et al. (2008) show that social activities, such as visiting friends, are spatially less variable than sports- and recreational activities. Consequently, travel behavior scholars have emphasized that analyzing mobility patterns needs, where possible, a more disaggregated analysis of activity types (Schönfelder and Axhausen, 2010). For instance, the highly recognized MobiDrive study differentiated a total of 24 types of activities, including ten for leisure transport alone (Chalasani and Axhausen, 2004). However, this amount of possible answers can soon become very unwieldy if applied in travel diaries or GPS tracking studies.

To better understand peoples' social interaction patterns, a variety of studies from different geographical backgrounds have employed the concept of personal social networks (Carrasco et al., 2008, 2008; Frei and Axhausen, 2007; Guidon et al., 2018; Kowald and Axhausen, 2012; Parady et al., 2021; van den Berg et al., 2009). All these studies used an ego-centric approach. The ego-centric approach focuses on people's social ties from the perspective of a single individual, known as the "ego". Typically, this method identifies the ego's contacts, known as "alters," by prompting respondents to list their social network members using name generators. Name generators do not only ask "Who do you know", but aim to limit the number of potential names to a manageable list, by asking topic-specific questions (Campbell and Lee, 1991). Kim et al. (2018) provide an overview of name generators used in travel behavior research. Usually, different types of name generators are combined, e.g. it is asked with whom the ego regularly keeps in touch, with whom they had contact within a specified time frame, or who ego usually asks for help. These questions are inspired by existing name generators developed in the social sciences, such as the Burt name generator, designed to identify network members for discussing important matters; Wellman's name generator in which respondents were

asked to name the persons outside their home that they feel closest to or the Fischer name generator, developed to identify individuals who provide various types of resources or support (see Campbell and Lee, 1991 for an overview). Additionally, some name generators used in the analysis of travel behavior were tailored to elicit specific alters related to social activities, such as "people with whom ego spend leisure time" (Frei and Axhausen, 2007). While these studies have confirmed that the properties of personal social networks significantly influence social interaction patterns, they are limited to the identification of travel conducted with others.

This segment of travel is without doubt important. However, for the overall configuration of people's activity spaces, it is only one piece of the puzzle. To keep everyday life going, other aspects, such as personal care, shopping, or escorting children play an important role too. As already indicated above, our own qualitative research shows that people built social and emotional relationships not only with their family and friends but also with specific supermarkets, hairdressers, doctors, sports clubs, or volunteering organizations (Puhe et al., 2020; Puhe and Schippl, 2025).

Against this background, we would argue that to understand the complex patterning of daily life, research needs to dig deeper into the situations (and social relationships) that make up everyday life. The framework of social network analysis provides a promising approach to let respondents report about these situations and to point out which personal relationships make their activity space. Other than the name generators that have so far been used in travel behavior research, we employed specific types of questions and name generators tailored to different activity classes.

2. Survey design – using activity-specific name generators

For this study, we worked closely with the administration of Bad Schönborn, a small community in northwest Baden-Wuerttemberg, Germany. Geographically, Bad Schönborn is a small town in a regiopolitan region. The municipality has 13,342 inhabitants, is located between two larger cities (Karlsruhe and Heidelberg) to which it is well connected via autoroutes and the regional train systems. In their effort to enhance the transport conditions for residents, the municipality seeks to offer an on-demand shuttle service, which ideally, in the foreseeable future, will run autonomously within the cities' boundaries. To develop a targeted service that matches the residents' needs, more information is needed about the specific activities residents undertake within their municipality and those for which they travel elsewhere.

Therefore, the purpose of the survey was to learn more about the typical mobility patterns of the residents to find out, which service could help whom in which situation. As outlined above, the survey design needed to capture frequent and infrequent, yet regular activities to provide a comprehensive overview of the places with which respondents are in direct contact. However, extending the survey period to capture both, frequent and infrequent encounters would be costly and burdensome to respondents (Von Behren et al., 2024). Rather than asking about or tracking every single trip during a given time period, we used a survey design that asked about typical patterns, without specifying any time frame by using name generators. However, rather than asking only about relationships with other people, we also asked about relationships in different activity categories. Each name generator produced a personalised list of relationships (e.g. doctor, hairdresser, bank), followed by questions about frequency, regularity, mode- and destination choice.

The survey was conducted online, as implementing the name generators on paper was not feasible. To accommodate the city's relatively large elderly population, who may be hesitant to complete web surveys, the research team provided in-person assistance at the city hall for five full days over three weeks. Additionally, a phone number was available for respondents needing help. Both offers were well-received, especially by older people and, to a lesser extent, by those with limited German language skills. However, the questionnaire was available not only in German, but also in English, Turkish, and Romanian. The survey is structured as follows: the first part asks general travel-related questions, such as availability of modes in the household. This is followed by a second section with questions about work or education. The third section consists of activity-specific name generators. Both, the second and third section include questions about the frequency of interactions, modes and destination choice. The last section covers further socio-demographics, such as household composition. For this paper, we will concentrate on the activity-specific name generators, as used in section three of the survey.

2.1. Sample

The sample was drawn along the administrative boundaries of the municipality. All households within the municipality, of which there are 8,400, were contacted via an invitation letter, signed by the mayor of the city. With the invitation letter, each household received a personalized access code to enter the survey to make sure every household could only participate once. Using the birthday method, the household member who most recently had a birthday and was over 16 years old was asked to participate in the survey. After two weeks, a reminder was sent out to those who had not participated by then. In total, 1,377 persons participated in the survey (see Table 1), which corresponds to a 16,4% response rate. This is within the expected range for online surveys, especially given that there is a steady decline in response rates over the past decades (Jabkowski and Cichocki, 2025).

To assess the representativeness of the sample, comparisons with known population characteristics has been conducted (see Table 1). The sample shows some notable deviations from the population, particularly in terms of gender and household structure. Women are significantly underrepresented (36.5% in the sample vs. 49.2% in the population), while men are overrepresented by nearly 12 percentage points – this may be a result of the birthday method used. It seems plausible that, especially in older age cohorts, it is primarily men who feel obliged to participate or to provide information about their household. Age distribution is relatively close to the population, with only minor differences. This is particularly noteworthy for an online survey, where older age groups are often underrepresented. It appears that targeted outreach and support during the survey process helped to mitigate age-related disparities and improve representativeness. Household structure shows a marked underrepresentation of one-person households and an overrepresentation of two-person households. Car ownership and education levels cannot be fully assessed for representativeness due to missing population data, but the sample includes a broad range of educational backgrounds and subjective wealth levels. Overall, while the sample captures a diverse cross-section, the gender and household structure discrepancies suggest limited representativeness.

Table 1: Sample description

Variable	Population (%)	Sample (n=1377)	Sample (%)	Difference
Gender [1)]				
Female	49,2%	502	36,5%	-12,7%
Male	50,8%	862	62,7%	11,9%
Age [1)]				
16–29	17,7%	200	14,5%	-3,2%
30–45	26,9%	355	25,8%	-1,1%
46-60	23,3%	369	26,8%	3,5%
>60	32,1%	453	32,9%	0,8%
Education				
Not (yet) completed	n.a.	17	1,2%	n.a.
Completion of compulsory school	n.a.	78	5,7%	n.a.
Completion of secondary education	n.a.	192	13,9%	n.a.
Vocational qualifications	n.a.	479	34,8%	n.a.
Acedemic degree	n.a.	549	39,9%	n.a.
Household car ownership [2)]				
No car	8%	86	6,2%	-1,8%
One car	50%	626	45,5%	-4,5%
Two or more cars	42%	665	48,3%	6,3%
Household structure [1)]				

One-person household	34,4%	276	20%	-14,4%
Two-person household	30,4%	583	42,3%	11,9%
Three-person houshold	15,7%	226	16,4%	0,7%
Four-person household	13,6%	205	14,9%	1,3%
Five- or more person household	6,0%	68	4,9%	-1,1%

Note: population data is derived from two sources: 1) Official statistics for Bad Schönborn from the Statistical Office of the Federal State of Baden-Württemberg, and 2) Mobility in Cities – SrV (Hubrich et al., 2024) for data of the Rheintal region to which Bad Schönborn belongs.

2.2. Activity-specific name generators

The aim of using name generators was to investigate the different relationships that makeup people's everyday lives. Six activity-specific name-generators were developed: shopping, errands, three different ones for leisure activities and escorting others. Each name was followed by questions on frequencies of interactions, destination

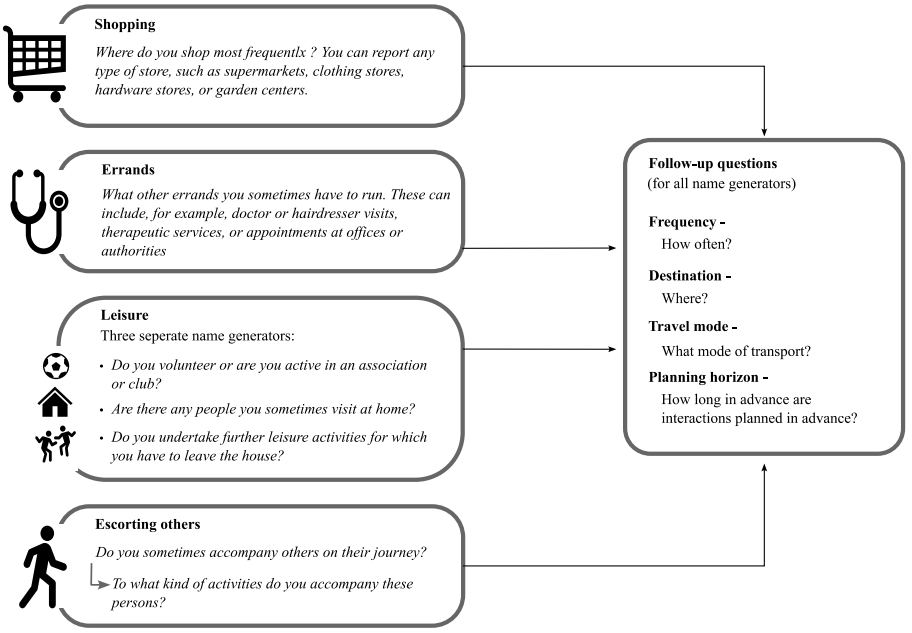

Figure 1: Overview of name generators and travel related follow-up questions

choice, modes choice as well as the planning horizon (see Figure 1).

2.3. Catagorization of name-generator entries

The name generators used open answers. As intended, entries were highly individual. At the same time, spelling mistakes could not be ruled out from the outset, making an automated categorization difficult. However, this led to a considerable interpretation effort for the research team. A more or less easy task were the name generators for shopping and errands. Here, respondents typed in typical German supermarkets (like Rewe or Aldi) as well as visits to the doctor or hairdresser. Most of them were quite easy to categorize. However, other name generators showed a much more diverse response pattern. For example, the name generator for club or voluntary activities prompted participants to mention abbreviations such as "DRK" (German Red Cross), "SG" (Sportgemeinschaft Bad Schönborn), or different spellings of an entry (e.g. volunteer fire department: "FF", 'FFW', "FH"). For private visits, family relations ("mother"

etc.) and friendship relationships ("friend 1" etc.) were used, but also real names, which had to be anonymized in the processing for data protection reasons. The most diverse picture emerged for other leisure activities. In addition to more or less common activities such as "going for a walk", "swimming" or "visiting the zoo", respondents entered highly individual activities, such as "tinkering classic cars with Bernd", "herpetology meetings" or "RC driving".

To analyze the results, we had to categorize these entries into comparable units. In doing so, we followed the categorization used by Gramsch-Calvo and Axhausen (2022). Due to the large number of different entries, we have derived subcategories. Linguistically ambiguous entries were assigned the description "Other". In some cases, an entry was made in one name generator though it would fit better to another one (e.g. visiting mother was typed in the name generator on errands). In that case, and only if it was obvious, we transmitted it to the more fitting name generator. The categorization we developed can be seen in Table 2.

Table 2: Categorization of entries

Name Generator	Categories	Subcategories
Shopping and Errands	Supermarket or stores	Discounter; supermarket; drug store, DIY and garden centre, bakers, butchers, small gorcers
	Errands	Doctor; therapy; body, health & care; administrations and organizations; finances; disposal
	Other (not clear)	Other: linguistically ambiguous
Private visits	Family or relatives	Mother, sister, brother
	Friends or acquaintances	Friends, neighbours, colleagues
	Other (not clear)	Other: linguistically ambiguous or real names
Volunteering/ Associations	Clubs or associations	(Club) and team sports; (club) or course meetings (e.g. parents council meeting)
	Volunteering or religious centers	Voluntary activities; religious centres or meetings
	Other (not clear)	Other: linguistically ambiguous
Other leisure activities	Sports (no club activities)	Individual sports (e.g. fitness centres)
	Gastronomy	Restaurants, cafés, bars, nightclubs
	Cultural institutions or events	Cultural facilities, sports, music or entertainment events, fairs
	Non-sporting recreation	Recreational activities; recreation centres; hobbies; garden plot, work on the property
	Excursions	Excursion activities; Excursion destinations
	Other (not clear)	Other: linguistically ambiguous

3. Results

The following analysis covers five of the six name generators, as the one related to 'accompanying others' is not yet ready for analysis due to the complexity of its question structure. As outlined above, the name generator for 'shopping' allowed respondents to enter up to five names, while 'errands' permitted three. For 'private visits' and 'leisure activities', ten entry fields were provided each, and 'volunteering/association' offered three. Within these limits, respondents could enter as many names as they wished. They were not required to fill in every name generator—only those relevant to their personal activities. For instance, individuals who do not volunteer or do not visit others at home were not shown the corresponding name-prompting questions, as earlier filter questions (e.g., "Do you sometimes visit other people at home?") excluded them. Thus, it was possible to provide names for one category while leaving others blank.

In total, 60 participants did not enter any names for 'shopping', 150 for 'errands', 213 for 'private visits', 767 for 'volunteering/associations', and 173 for 'other leisure activities'. Only 24 respondents left all name generators blank but completed other parts of the survey. Since the reasons for missing entries are unknown, these have been coded as "0" relationships.

Table 3 summarizes the entries made by respondents. Altogether, 17,318 relationships were reported, corresponding to an average of 12.6 relationships per participant. On average, respondents listed 3.3 relationships for

shopping, 1.9 for errands, 0.7 for associations/clubs, 3.5 for private visits, and 3.2 for other leisure activities. However, the high standard deviations in the 'private visits' and 'leisure activities' categories suggest that some individuals listed many names, while others did not provide any

Table 3: Description of name generator entries*

	Sample (n=1,733)				
	Total	*Mean*	*Std*	*Median*	*75%-quantile*
Shopping	*4529*	*3.29*	*1.461*	*3.00*	*5.00*
Errands	*2566*	*1.86*	*0.985*	*2.00*	*3.00*
Private visits	*4834*	*3.51*	*2.512*	*3.00*	*5.00*
Volunteering/ Associations	*959*	*0.70*	*0.919*	*0.00*	*1.00*
Other leisure activities	*4430*	*3.22*	*2.259*	*3.00*	*5.00*
Total	***17,318***	***12.58***			

* This overview does not entail the relationships reported for accompanying others

Figure 2 shows what respondents do in the municipality they live in, in the neighbouring communities and in other places. First of all, it becomes apperent that shopping and errands are most frequently done in Bad Schönborn, with a significant drop-off in neighbouring and other communities. Club and association activities are also primarily local, but a notable number of relationships are located in other communities. Relationships for other leisure activities show a more balanced distribution, with a substantial number being located in other communities, even slightly more than in Bad Schönborn. Private visits are the most dispersed: while many are located in Bad Schönborn, the highest number is reported in other communities, suggesting strong social ties beyond the immediate area.

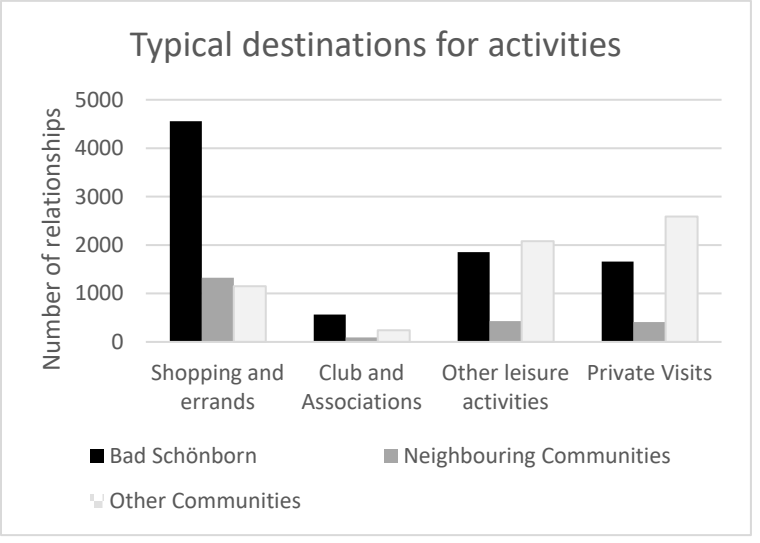

Figure 2: Typical destinations for interactions

Looking at the modal split in different spatial contexts and across different activities, we see that private motorized transport is the most dominant mode across nearly all activity classes, especially for destinations outside Bad Schönborn. Active transport is most common for local activities within Bad Schönborn, particularly for shopping and leisure. Public transport is used significantly less and if it is used, it is primarily used for destinations outside Bad Schönborn, especially for private visits and leisure activities.

Beyond this aggregated overview of activity types, the data allows for a more fine-grained analysis of the relationships. For instance, the data shows that destination choice for shopping is strongly related to the type of retail store. Supermarkets are predominantly visited within the respondents own municipality. No correlation was found

between people's workplace and place of shopping, suggesting that participants tend to shop at supermarkets in Bad Schönborn regardless of where they work. Drugstores and building supplies/ garden centres do exist in Bad Schönborn and are used, but respondents tend to purchase these products more often in other locations – 37% of relationshops with drugstores and 65% of building supply/ garden centre relationships refer to destinations outside the municipality, and another 27% of relationships with drugstores are in neighbourig communities. This may be due to a better product range offered elsewhere or the limited selection available locally. Retail beyond food—such as clothing stores and other non-food goods—is mostly accessed outside Bad Schönborn. Residents clearly prefer to leave the municipality for these purchases, with 66 % of relationships in other locations and only 12% in neighbouring communities. This suggests that the local retail offering may not sufficiently meet the needs of a broader target group. In contrast, butchers, bakeries and small grocers are well represented locally (73%).

4. Discussion

Even though we cannot provide more insight into the results yet, we can still discuss what worked well and where there is room for improvement. By assisting participants in filling out the survey, we learned which questions worked well and which were difficult to answer. Initially, we started the survey with name generators for escorting, followed by leisure activities. However, participants were skeptical about naming people without knowing the subsequent questions. Therefore, we changed the order, starting with name generators for shopping and personal errands, allowing participants to experience follow-up questions in a less critical segment. Our impression is that this ordering of questions made participants more open to reporting friends, family members, or acquaintances (they accompany on journeys or visit at home), although some were only willing to do so after being told they could use placeholders instead of real names. It is crucial to clarify this option in the instructions. But still, the comparatively high standard deviation in the categories "other leisure activities" and "errands" suggests that there is room for improvement for these questions. For the question on private visits, it might be beneficial to revert to the existing name generators introduced in section 2. However, since we were interested in the occasions when people leave their homes to visit friends, relatives, and acquaintances, rather than the emotional context of those relationships, we decided to ask directly about this. The comparatively low number of entries could have various reasons. It might be that people were reluctant to name those individuals due to privacy concerns, or it could be that some respondents have de facto only few people they visit at home. Many respondents are older, and we learned through the assistance that quite a few older respondents had not many people they can visit at home, either because there are none (anymore) or because they no longer have the physical capacity to do so.

To get more out of the name generator on other leisure activities, it could be helpful to provide participants with more specific prompts. Currently, we offer a lengthy text listing potential activities, and it can be assumed that many respondents do not read this text, especially since this name generator is placed at the end of the survey. We considered two options to address this issue in future surveys. One option is to provide a button that automatically adds common activities to the list (e.g. theater, restaurant, go for a walk). However, some respondents mentioned very specific hobbies, such as "working on my vintage car." To accommodate unique hobbies and relationships, another option is to provide specific columns for cultural relationships, sports and wellness, gastronomy, and other activities to still leave enough room for respondents to give answers in their own words. This approach might help elicit more leisure activities, including those that are done infrequently. On the other hand, it would make the survey even longer.

The follow-up questions on frequencies, destinations, modes, and planning horizon, were relatively easy for participants to understand and complete. However, some criticized the survey length, which averaged 25 minutes. Yet, the survey included many questions on household composition, socio-demographics, and attitudes toward automated driving, which could potentially be reduced in future studies.

With regards to the results, we are optimistic about eliciting interesting patterns of the respondents' travel behavior. With regards to the modal split, our results align with a large-scale survey in Germany (Mobility in Cities), which indicates a share of public transport at 10%, 55% for private motorized transport, and 34% active transport for the Rheintal region, in which Bad Schönborn is located (Hubrich et al., 2024). However, with the approach presented here, we can differentiate this share for those activities performed in Bad Schönborn compared to activities and relationships held outside of Bad Schönborn. For municipalities, this information can be crucial in helping them to

identify the mobility needs of their inhabitants that they can actually influence (as opposed to, for example, inter-county travel, which is in the responsibility of other authorities). For example, the preliminary results suggest that an automated shuttle service could potentially be attractive for those people in Bad Schönborn who do their shopping in town but are currently dependent on the car due to a lack of alternatives. However, the shuttle would need to run a very specific route and offer an interior that accommodates the transport of shopping bags.

We believe that a detailed understanding of people's daily lives, beyond aggregated activity categories, can provide insights for addressing challenges on a local level. A common method in transport studies to assess potential changes are stated choice surveys, where respondents are presented with hypothetical choice situations. However, this method has its limitations too, as the hypothetical scenarios may be very different from real-life experiences or they may be so general that the researchers do not really know what situation the respondent had in mind. One might consider whether it is feasible to replay respondents' reported situations (e.g., shopping in store 2, visiting friend 2) and inquire about potential changes. This can be done either in a qualitative or quantitative research setting. Our qualitative research revealed that starting with people's social relationships enabled respondents to imagine how a hypothetical scenario (e.g., the introduction of a shuttle service) could affect their routines and consider the possible consequences (Puhe et al., 2025).

5. Conclusion

In this paper, we have demonstrated a research methodology to observe people’s activity spaces by using name generators. So far, name generators have been applied for the study of personal social networks, primariliy in the context of social travel. By combining both research strands, we aim to better understand the spatial structures and corresponding mobility patterns of our sample.

This approach offers several advantages for analyzing intra-personal travel patterns, providing detailed information about social networks and interactions, allowing also an analysis of events that occur only randomly or infrequently. Unlike travel diaries or GPS tracking studies, which capture interactions by chance, name generators can uncover peoples’ personal relationships to people, things, and places. Respondents can specify individuals and activities beyond general categories such as "leisure," by listing their doings in their own words, i.e. their club memberships, associations, people they visit, or hobbies. The input usually only requires a single word (like friend 1), which we assume minimizes the respondent's burden.

However, we also want to highlight the drawbacks of this method. Recall bias can lead to inaccurate data as participants may forget or misreport interactions. Name generators may not capture all relevant mobility data, especially spontaneous trips, and do not provide continuous data, such as trip chains. Additionally, they are less effective in capturing detailed temporal and spatial dimensions of interactions compared to travel diaries or more technologically advanced methods like GPS tracking. However, we believe each method has unique strengths and weaknesses, and the choice depends on the specific goals and constraints of the research project.

Future analysis of the data will focus on measures to identify typical activity spaces of individuals, such as the ones described in the introduction to this paper. For doing so, we need to identify components that describe differences and similiarities between peoples’ activity spaces first.

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