STABILITY AND VARIABILITY IN DESTINATION CHOICE FOR LEISURE ACTIVITIES

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ABSTRACT

Empirical research has shown that people's daily life consists of highly stable, repetitious behaviors as well as of significant sequences of variability. This does not only concern activity patterns, but also refers to travel mode and destination choice. Within travel demand modelling, destination choice is dependent on capturing the mechanisms that lead to behavioral stability or variability in order to point out the changeability of destination choices. This research addresses the modeling of destination choices of different leisure purposes by considering spatio-temporal relationships towards certain destinations by using a longitudinal data set. Three dimensions of heterogeneity are accounted for: the inter-travel-purpose, the inter-traveller and the intra-traveller-related dimension. Considering these, the developed destination choice model estimated with the six-week Mobidrive study contains a differentiation between five sub-purposes of leisure, assumes latent classes among the respondents revealing different preferences. Furthermore, the study accounts for both spatial and temporal destination choice patterns of individuals. The classes reveal destination choice behavior to be different between individuals having both stable and variable preferences and further reacting differently to accessibility and attractiveness. While it is applied to leisure travel, the proposed model including additional components is applicable to all travel purposes in an agent-based travel demand framework.

Keywords: destination choice, heterogeneity, latent classes, stability and variability

INTRODUCTION

The current state of the transport sector is expected to experience fundamental transitions, triggered by policy responses to climate change, the emergence of digital and autonomous technologies as well as by a presumed change of travellers' behaviors. The development and the adaption of a transport system enabling a high degree of mobility and to encourage both an efficient and low-emission transport system is a key challenge. A transformation, however, implies that relatively stable, highly routinized user behaviors need to be altered, in terms of the modes being used but also in terms of the distances travelled. Considerable research exists that deals with the habitualization of mode choice behavior, while less scientific debate comprise the the stability and variability of destination choices. However, to understand and assess the dynamics mentioned above, it is required to understand the mechansims of stability or the willingness to change destination choices. The paper at hand will therefore try to contribute to this debate by highlighting stability effects in leisure destination choice.

A significant part of daily life and the overall traffic volume is taken up by leisure travel. For example, the latest version of the German national household travel survey "Mobility in Germany" (2017) accounts for a share of 28 % of trips and 34 % of distance travelled (*1*). This tightly exceeds the total of commuting and business trips in both measures. Further, leisure activities are part of every everyday life not depending on age or occupation.This makes statements on the willingness to change destination choice based on socio-demographic attributes even more challenging. Thus, leisure travel is important to consider for the development of traffic volume. The importance to consider general travel indicators of leisure travel has been highlighted by several authors (*2, 3*).

Travel demand models aim at quantifying the extent to which policy interventions or technological innovations will contribute to changing travel demand. They provide the possibility of planning infrastructure by considering multiple overlaying interactions of measures and external developments. One precondition for its suitability to forecast future behavior is seen in its ability to realistically reproduce existing behavior patterns with its causalities.

Within travel demand modeling, travellers have to choose destinations for a given set of activities to locate trips appropriately in space and time. Destination choice is thus a crucial step for generating realistic model results. The sheer amount of possible locations in space for recreation (and other purposes) is very challenging to model. Therefore, strategies are needed to reduce the amount of available destinations to a manageable size. Strategies to do so include deterministic and probabilistic approaches (an overview is given by Thill, Pagliara and Timmermans (*4, 5*)). In summary, most approaches perceive spatial and time budget factors as the most fundamental determinants for destination choice.However, it does seem a bit arbitrary to apply this assumption to all destination choices alike (*6, 7*).

Another challenge is seen in the heterogeneity of the travel purposes themselves. Describing the attractiveness of a destination for a broad class of travel purposes is not without problems, if no further information is available about what exactly a person is aiming at. For example, it does make a difference for the attractiveness of a destination, if someone wants to go swimming or if that same person wants to see a friend. While this is already difficult to consider in a data set, it is proposed to restrict destinations to an "awareness-set" of locations being known to the traveller (*6*). In line with this reasoning, some strategies take into account cognitive aspects, such as familiarity with or emotional aspects towards certain locations (*7, 8*).

Either way, destination choice modelling is dependent on capturing the mechanisms that lead to behavioral stability or variability. Empirical research has shown that people's daily life consists of highly stable, repetitious behaviors as well as of significant sequences of variability (*9–11*). It has been emphasized that decision-making is not always rational in the sense that there is a systematic weighing up of pros and cons of different alternatives. Instead, even after infrastructural interventions, travellers tend to stick to routinized behaviors (*12*).

Against this backdrop, the aim of this research is to contribute to modeling destination choices by considering spatio-temporal relationships of individuals in a longitudinal perspective. We will therefore outline the importance of a non-rational perspective on destination choices in everyday leisure travel and collect destination choice model approaches being able to account for spatial and temporal patterns of destination choice on an inter- and intra-personal level. For the formulation of an own model approach, we analyze the variation of leisure destination choices based on a longitudinal travel survey. This is followed by the development of a destination choice model applicable in agent-based travel demand models (AB TDM) accounting for observed spatial and temporal stability. Hereby, heterogeneity of choices is analyzed by different latent classes of stable and variable destination choice behavior. The destination choice model is applied for leisure purposes, but conceptualized for all travel purposes. The paper concludes with recommendations for further research needs to improve the understanding and models of destination choice for long-term and short-term planning horizons.

LITERATURE REVIEW

The state of knowledge is provided for empirical research on stability and variability in travel behavior with a focus on destination choices and discusses current approaches to destination choice modeling.

Variability of travel behavior

The availability of longitudinal data has helped to reveal spatio-temporal patterns of activity and destination choice. Today, several studies are available showing that people's daily lives are characterized by recurrent activities and destinations as well as by sequences of greater variability (*9, 13*). By using multi-week survey designs it is possible to observe clusters and periodicity of activities and destinations on specific days or at specific times being previously unobserved in cross-sectional surveys (e.g. weekly soccer training, which is practiced on the same day every week). Studies suggest that up to 70% of everyday trips follow routine destination choices (*14*). Hanson and Huff (*15*) defined core stops for each individual based on their occurrence on representative days and the total frequency. They classified 65 % respectively 83 % of individuals having recreation stops or shopping stops as a core stop. These can be regarded as an anchor point in everyday life. Looking at possible combinations between purpose and destination, Schlich and Axhausen (*13*) observe only a small share of combinations occurred within the six-week survey period supporting the suggestion of routine destination choices for certain purposes.

Only a small share of destinations of about 17 % of all observed destinations within the survey are located within a radius of 1 kilometer around home locations. This share is larger when it comes to out-of-home-leisure destinations (*3*). This finding supports the assumption of travellers having a larger activity space for leisure travel. Furthermore, destination choice is linked to obligatory destinations such as the location of workplace or education institutions, as well as other highly stable activity patterns. This influences the time frames, in which other destination choices have to be accommodated, potentially leading to further stability mechanisms for destination choices that are widely assumed to be discretionary. (*14, 16*) Empirical research indicates clearly that variable behaviors are more likely to occur on weekends, whereas Fridays differ slightly to other working days (*13*). Further, there is more spatial extension on Fridays and on weekends (*14*). Especially for leisure purposes, the longitudinal perspective of the survey reveals that new destinations are visited more frequently on the weekends, indicating a higher variability (*3*).

Hanson and Huff (*9*) assume a systematic, cyclical, temporal variability of travel behavior. But it is also important to separate systematic from random effects. The literature highlights both the temporal and spatial dimension of behavior. The flexibility regarding the choice of destinations for different purposes depends on both.

Destination Choice Modelling

Looking closer at destination choice, individuals can be recognized as being driven by certain needs: supermarkets allow people to take care of their weekly grocery purchases and local recreation areas serve as places for spending leisure time. Consequently, the structure of an area is one important criteria for assessing its attractiveness. Travel demand models use attractiveness as a measure to model destination choices of people by using spatial interaction models (*17*). Generally, they combine impacts of access or distance and impacts of scale or size in relative terms (*18*).

Various models are available for destination choice, whose task is to link the attractiveness of a destination (or traffic cell) with the effort required to overcome space (resistance). Cascetta et al. (*19*) provide an overview over different destination choice models. Destination choice is more difficult to model than other choice decisions, since there is a disparately larger set of alternatives available (*6, 20, 21*)). Consequently, choice set formation is regarded as a possibility to limit the opportunities and to only consider recognised destinations of individuals. Spatial and temporal aspects are seen as key determinants in limiting possible destinations (*4, 5, 22*). But as Hanson and Huff (*23*) set the requirements to appropriately model destination choice to be "sufficiently detailed and complete to distinguish habitual from non-habitual behaviors", only using subsets of destinations might not be enough to distinguish between stable and variable patterns in destination choice.

The assumption of destination choices being not independent from each other is brought up, among others, by Tardiff (*24*) and Miller and O'Kelly (*25*). Their model approaches applied on shopping destination choice therefore include both a time dependency between choices by either integrating time-specific parameters or by exploring the influence of past choices on present choices. The latter involves the problem of missing information for the first trips and aging for the on-going survey (*25*). The results show a decreasing influence of objective attributes like accessibility and attractiveness by incorporating time dependency. The assumption of relationships being relevant for destination choices has been investigated by Puhe et al. (*26*) by using a qualitative research design. The observed stability of shopping destination choice as a result of a relationship to a specific store respectively the owner or a relationship to a brand were applied to a simulated shopping travel demand of one week and their changeability was tested in the model.

Other approaches of modeling destination choice provide a broader scope and operate on an aggregate level and are included because of their consideration of spatial and temporal dependency of destination choices. The problem of spatio-temporal correlation has been addressed by Zhang et al. (*27*) applying a Bayesian approach incorporating spatio-temporal random fields to observed destination choices of taxis. For capturing both inter and intra-segment heterogeneity in a destination choice model Mehadil Orvin and Rahman Fatmi (*28*) combined a latent class approach with continuous distributions of parameters within the classes and applied it to dockless bikesharing data to analyze the influence of spatial and infrastructural attributes of the destination zone. However, theses approaches are dependent on a large amount of aggregated data, which is difficult to receive across all travel modes. Further, the approach is missing the individual perspective and therefore hardly applicable in AB TDM.

METHOD

Based on these findings, the aim of this research is the analysis of destination choices in a longitudinal travel survey through discrete choice modelling. The resulting models thereby are aimed at being applicable in an AB TDM framework to not only understand stability and variability in destination choice but also to incorporate observed behavior in forecasting models.

In this research we limit the analysis to the frequent leisure purposes being asked in the Mobidrive study (*14*). These include *active sports*, *cultural activities*, *club meetings*, *meeting friends* and *gardening*.

Data Description

The Mobidrive survey was conducted in spring and fall 1999 and covers the population of Karlsruhe and Halle, two medium-sized cities in Germany. Respondents reported their travel behavior for six consecutive weeks enabling a deeper insight into rhythms of daily life and longitudinal dimensions of different travel related choices. The sample for the city of Karlsruhe includes geocoded locations of home, workplace and all destinations visited. Its sample size is comparatively small what leads to limitations (*29*). Not many longitudinal studies exist yet that provide the data needed for answering the research questions. To test the approach we accept potential hazards resulting from an old data set.

General travel indicators like average trip frequency, distance and duration for all purposes match with German-wide results of the German mobility panel of the same year (*3*). This can be observed even though the sample only contains an urban population. Leisure trips were reported to be more frequent, which was explained with the intensive supervision of the survey. The sample is characterized by a higher share of employees, a higher income and a more frequent car ownership than in the average population of the considered region (*13*).

The longest distances among the sub-categories of leisure were observed for cultural excursion, meeting friends and relatives and nature excursions (*3*).

Stability of destination choice can be analyzed when looking at recurring choices over time. An analysis therefore is only appropriate, when there is a certain number of observations per destination and purpose. The distribution of frequency of destinations by leisure purpose is shown in Figure 1. Based on this analysis the sub-purposes *active sports*, *disco/pub/restaurant*, *garden/cottage*, *group/club meeting* and *meeting friends* were selected for further analysis. It should be noted that having a garden plot outside someones home is quite common among the German population, at least in urban settings and among certain population segments. However, other leisure purposes may become of interest, when the length of observation increases due to observation methods reducing the burden to the respondent such as GPS tracking.

A detailed differentiation between *group/club meeting* and *active sports* could not be done by the author. We expect potential overlapping of the data sets and respective model effects as e.g. soccer training can be seen as both a *group/club meeting* or an *active sports* activity. The same applies to meeting friends, which could overlap with the purpose *disco/pub/restaurant* and it is not clear if people responded consistently or which instruction they were given.

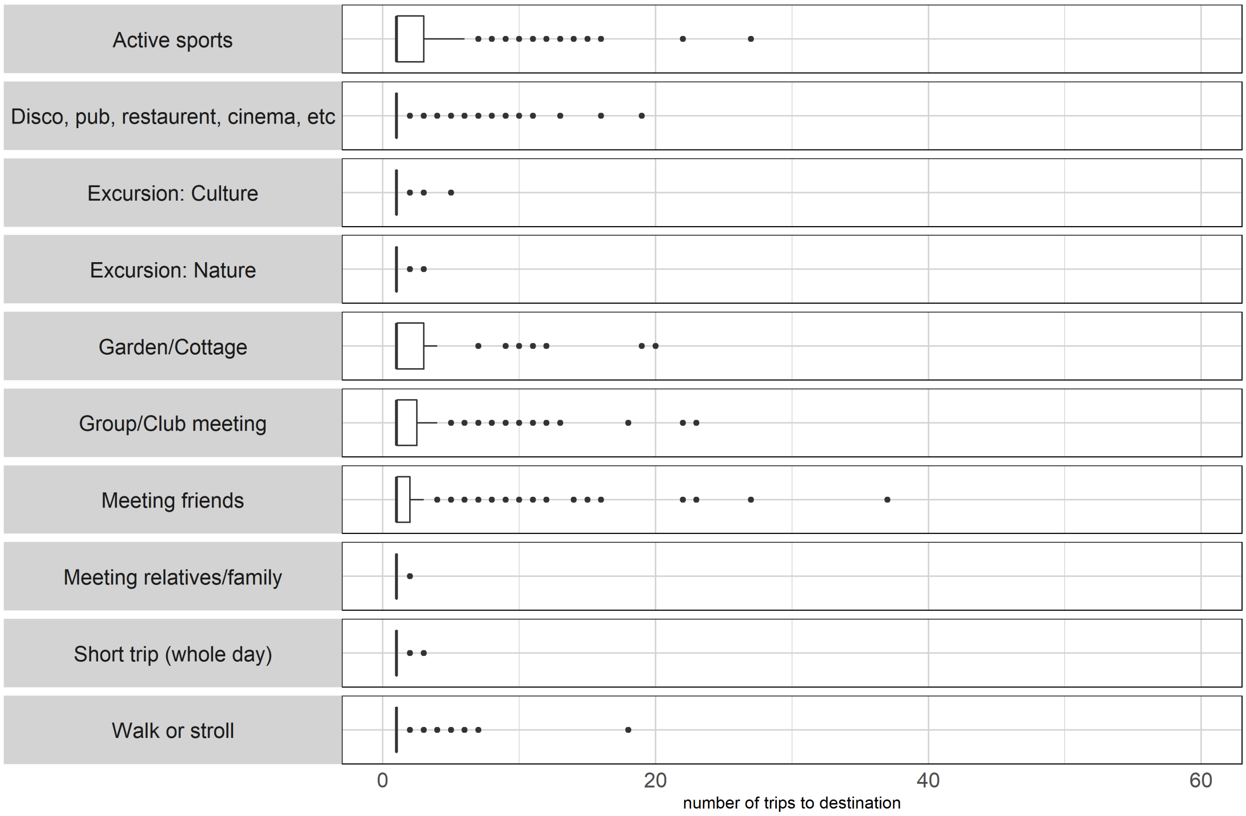

FIGURE 1 Frequency of visits of destinations by leisure trip purpose

A further important information is the distribution of visits on different destinations. Schönfelder and Axhausen (*14*) already pointed out, that only few destinations make up for a major proportion of trips. This can be further differentiated looking at the variation of destinations by sub-categories of leisure purposes (cf. Figure 2). The variation hereby captures the share of the destination most frequently visited among all trips of this purpose of a person.

The analysis reveals a higher variation for purposes like *meeting friends* and *disco/pub/restaurant*. At the other end of the scale, there are more stable purposes like *group/club meetings* and the visit of an own garden plot or cottage appear. The analysis confirms the finding of other studies described in section 3.1 that both stable and variable behaviors exists.

Model Formulation

With this expectation in mind and based on the data set described, multiple destination choice models for different leisure purposes are set up to analyze influencing factors on decision-making. The trips are restricted to the geocoded trips of the population of Karlsruhe. The data set is not limited to a certain kind of trip chain, but covers all trips or trip chains that include leisure travel. Consequently, all situations where a person chooses a location for a leisure purpose are considered. The choice set for the estimation of the destination choice model is reduced to 10 alternative destinations including the chosen alternative, a set of other destinations that have been chosen at different points in time and random destinations that have not been chosen at all. When a

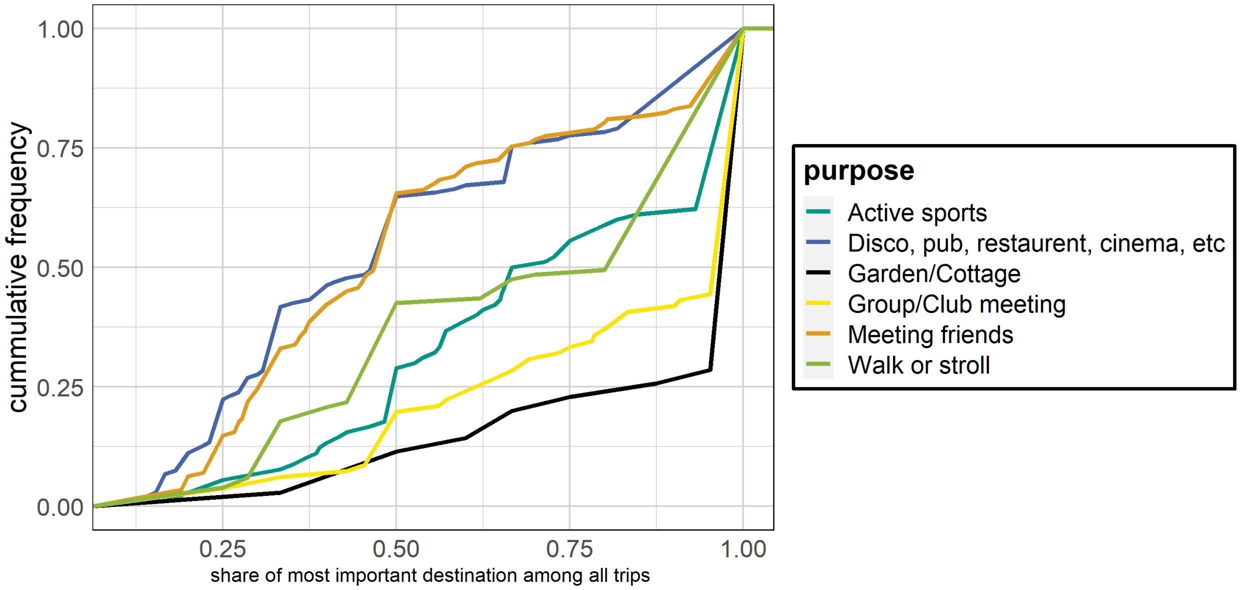

FIGURE 2 Variation of destinations by leisure trip purpose

respondent generally visits only few locations, this results in more non-visited destinations in the choice set, because the number of other destinations chosen depends on what was observed in the data. Consequently, the choice set formation is aware of the activity space for leisure purposes of an individual respondent.

The attributes are assigned both on the origin - destination level of traffic analysis zones (TAZ) and on the destination level relating to certain geocodes. The following attributes are used for the estimation:

- *acc* - a logarithmic utility of pedestrian travel time indicating a higher accessibility with higher values - assigned on TAZ level
- *attr* - a measurement of attractiveness by collecting POI relevant for the purpose and weighting number and size to a value of trip attraction (cf. Klinkhardt et al. (*30*)) - assigned on TAZ level
- *share freq* - the share of visits to this location among all visits of the decision maker for this purpose - assigned on geocode level
- *HHI weekd.* - the Herfindahl Hirschman index of a location and the decision maker for weekdays - assigned on geocode level
- *HHI dayt.* - the Herfindahl Hirschman index of a location and the decision maker for different times of the day classified in three-hour-intervals - assigned on geocode level

The Herfindahl-Hirschman-index (HHI) is a measure for variability of observations (see e.g. the explanation of Susilo and Axhausen (*31*)). The indicator is used in this case to describe the temporal variability respectively stability of visited destination over the week or over different times of the day. A high index thus reflects a high stability regarding weekdays or daytimes, whereas a high parameter shows a higher preference for temporally stable destinations. A specific club meeting only occurring at one destination and happening always at a certain day of the week can be seen as an example for a high index.

The term preference in the context of this research does not distinguish between the reasons for showing a likeliness for certain attributes of a destination. Based on the available data set the authors are not able to identify obligations regarding specific destinations or simply an affection to location or individuals at the location. Only stable and variable patterns are observed and correlation to the actual choice is worked out.

All destination choice models were estimated by using the package *Apollo* (*32*). Both a simple multinomial logit and a more complex latent class approach are chosen. The latter includes heterogeneity through a "discrete parameter variation" (*33*) in combination with a class allocation model analyzing deterministic influences of attributes on the probability. Therefore it is not observable to the analyst, whether an individual respondent falls into a specific class. That carves out certain taste classes regarding the addressed decision. For a detailed explanation of the latent class model see Greene and Hensher, Hensher et al. (*33, 34*). The latent class models are estimated by applying the starting value search to better reach the global optimum.

MODEL RESULTS AND INTERPRETATION

In a first step, different destination choice models are estimated to present general differences between the leisure purposes. General model results are comparatively good: depending on the purpose, a high proportion of heterogeneity can be explained. This is only possible as *share freq* is already known and acts like a preference for certain destinations. Nevertheless, this influence differs among the purposes. Among the more stable leisure purposes as a result of the general preference are *garden/cottage* and *meeting friends*. *Active sports* and *club meetings* are less stable. However, as the low variation (cf. Figure 2) suggests, *group/club meetings* take place at more temporal stable destinations indicated by both HHI parameter values. This counts as well for the daytime HHI of *garden/cottage* activities, pointing out to destinations being preferred that are mostly visited at a similar time of day. In general, daytime stability is of higher importance than weekday stability except for meeting friends suggesting typical regular weekdays for these activities. The accessibility is of lower importance for the choices but still has a significant influence, being highest for *acitve sports* and *club, pub, restaurant*. The measured attractiveness is only weakly significant in few cases. An overview of the MNL model results can be found in Table 1.

TABLE 1 MNL estimation results

Purpose	R^2	acc	attr	share freq	HHI weekd.	HHI dayt.
meeting friends	0.35	0.002**	0.04*	6.56**	0.59**	0.49**
club meeting	0.71	0.003*	-	5.71**	0.80*	1.13**
active sports	0.54	0.004**	-	5.69**	0.77**	0.89**
disco, restaurant	0.33	0.005**	-	6.06**	0.32*	0.88**
garden/cottage	0.89	0.003**	-	6.47**	0.34	4.59**

level of significance ** 5 % , * 10 %

The MNL model results provide average insights in the influences of destination choice for different leisure purposes. For the observation of both variable and stable choice patterns latent classes are assumed among the respondents and included in the model by applying the latent class approach with a class allocation model. As a result of the low number of individuals, a maximum of two classes can be observed in the data set.

Cultural activities in *clubs, pubs, restaurants or cinemas* are visited in different patterns by different people. The results in Table 2 reveal a more stable and a more variable class. The more stable class is characterized by being attracted by locations that are typically visited by the decision-maker. Furthermore, this class shows a preference for destinations visited with a high stability regarding both daytime and weekday. The more variable class reveals a higher preference for closer destinations and is less bound to specific destinations. Additionally, the locations are visited on different weekdays, whereas the daytime appears highly stable - even more stable than for those of the other class. The attractiveness of the location measured by the number and size of respective POI has a negative effect on being chosen, indicating a preference for locations without a cultural agglomeration and not attracting a large number of people. Regarding the size of the classes the more stable class includes about two thirds of the sample whereas a significant effect of the age on class allocation can be recognized: respondents with an age between 18 and 40 years have a substantially higher probability to be part of the more stable class.

The destination choice for *meeting friends* also contains a higher degree of inter-individual heterogeneity. Both classes are influenced to a similar degree by *share freq* whereas this does not hold for the temporal indicators: the larger class consisting of about 87 % of the sample has an additional preference for point in time related destinations regarding weekdays and daytime. This does not count for the smaller class, which prefers more temporal variable destinations for meeting friends. A second major difference can be observed in the valuation of accessibility of both classes. The temporally more variable class (LC 2) strongly prefers a better accessibility by foot. This indicates that they seem to have more friends in close proximity. In the context of the urban sample of the survey it reflects meeting friends within the same or close city districts and less in other municipalities. It exists a slightly non-significant effect of students to be more likely in this second class which can be a plausible explanation of the more geographically dense network of friends in this class. The general frequency of visiting relatives is comparatively low and the related distance is quite high, leading to the conclusion that a higher share of respondents did not grow up within the survey area. It seems relatively reasonable to argue that joined *group/club meetings*, locations for education or workplaces are geographically more oriented towards the city center than towards the neighbouring municipalities. However, it is generally more likely that friendship relations depend more on homophily than on geographical proximity (*35*). For other experiences with friendship destination choice, see e.g. Chen et al. (*36*).

Group and club meetings itself are expected to be both spatially and temporally stable due to typical locations like clubhouses, fire departments or church buildings for these activities. Still, the results do not support this assumption at first glance. The influence of *share freq* in both classes is average. The first class consisting of about three quarters of the sample has a significant preference for temporally stable destinations being visited only at certain weekdays and daytimes. The second class contrarily does prefer destinations being visited on different days of the week which can be transferred to multiple meetings a week at the same location. Further, the influence of accessibility for this class is higher than for the first class. This might indicate the fact that club meetings are often located at destinations, which are accessible to as many people as possible. However, participating in a specific club can still be driven by other rationales than accessibility ratings. The result of a general stability of destinations being only average can be interpreted as a share of respondents having different group/club meetings for different purposes (e.g. music education and volunteer youth work), but are stable in their location and relationship.

Destination choice behavior regarding *active sports* further differs inter- and intra-individually in different dimensions. There exists a major share of individuals being more variable regarding the spatial choice for doing sports while still revealing some patterns of destinations that are only visited at certain days. Daytime does seem to be less important which is contrary to the MNL results. Although, there is a smaller class of about 27 % of the sample showing a high spatial stability for doing *active sports*. The choice is further influenced by a high weekday stability of destinations. Looking at the influence of accessibility there is no substantial difference between both classes. But the attractiveness complements the existing picture of the classes: the first class prefers locations with sport facilities like gyms, pools, sports fields and parks. The second class clearly behaves in the opposite way by preferring locations without these facilities. Individual sports activities like running and cycling often take place outside the built environment, which is not covered by the attractiveness measure used here. Interestingly, the spatial and temporal stability is very high for these respondents. An example can be a weekly running appointment in a close forest.

The destination choice for *gardening* revealed problems to find a significant second class within the data set. The observed share of respondents in the second class is below 1 % leading to insignificant results. A larger sample might eventually enable more accurate insights in heterogeneity of destination choices of gardening and staying at a cottage. For this analysis the results of the MNL can be used for the interpretation. A highly stable choice behavior becomes apparent, especially regarding location and daytime. This is no surprise as most people have one specific garden or cottage for regular visits.

The results provide deeper insights into the destination choice behavior for leisure purposes, which can be used in forecasting under certain circumstances. The application of the models in AB TDM would require a previous simulation of relationships consisting of location, their general preference based on the observed frequency and the observed temporal stability for all agents and the respective travel purposes. These relationships can be observed in longitudinal travel data. The sample of the survey used in this research reaches its limits regarding sample size and number of individuals. Other survey methods like GPS tracing provide lower barriers for participating in longitudinal surveys as they significantly reduce the effort of reporting.For example, Molloy et al. (*37*) reached a sample size of more than 3,500 respondents participating eight weeks in their survey and a still considerable share participating even longer.

The observed relationships towards certain destinations can be assigned randomly or by applying estimated choice models to the agents in the simulation. Present approaches for choice set formation or travel-probability fields (cf. Beckmann et al. (*38*) or Schönfelder and Axhausen (*14*)) can help for the selection. It would still be required to account for uncertainty and enable the choice of a destination that has never been observed before as specific constraints can cause the inappropriateness of many other destinations. Thill (*4*) points out this dimension of the choice set formation by pointing out that the analyst is external to the choice process.

Further information on the reasons, commitment and alternatives for chosen specific activities and destinations can be implemented in a survey. Cullen and Godson (*39*) proposed simple questions as an addition to reported trips asking whether the respondent could have done an activity at another time or another destination.This research has also inspired a series of surveys that study the ad hoc nature of activities and respective destinations, e.g. by Doherty (*16*). Looking at the changeability of stable destination choice patterns this information is important to understand

TABLE 2 Latent class estimation results

Purpose: Disco, pub, restaurant, ...	LC 1	LC 2
share	*0.67*	*0.33*
acc	0.001**	0.058**
attr	-	-0.38**
share freq	7.92**	4.49**
HHI weekd.	0.55**	-0.32
HHI dayt.	0.69**	1.92**
Purpose: Meeting friends	LC 1	LC 2
share	*0.87*	*0.13*
acc	0.001**	0.008**
attr	-	-
share freq	6.58**	6.23**
HHI weekd.	0.82**	-
HHI dayt.	0.85**	-
Purpose: Club meeting	LC 1	LC 2
share	*0.74*	*0.26*
acc	0.001	0.038*
attr	-	-
share freq	5.72**	5.36**
HHI weekd.	1.37**	-
HHI dayt.	0.97**	1.23**
Purpose: Active sports	LC 1	LC 2
share	*0.73*	*0.27*
acc	0.007*	0.01**
attr	0.06**	-0.71**
share freq	5.43**	13.61**
HHI weekd.	0.94**	2.85*
HHI dayt.	0.78**	0.57**

level of significance ** 5 % , * 10 %

the causalities. Puhe et al. (*26*) states that "changeability is not a matter of frequency only", but depends on the type of relationship. In the case of grocery shopping, both trust in person and trust in brands result in different degrees of changeability. This perspective can also be transferred to other purposes. Imagine, for example a person having a relationship to a football club. This person would not choose a different destination, just because it is more attractive in an objective point of view. Rather, the changeability of the destination depends on the motivation of this person has to continue the relationship with that specific club (*40*). However, addressing such issues in quantitative survey designs appears relatively challenging.

CONCLUSION

This research address the modeling of destination choices by considering spatio-temporal relationships of individuals towards certain destinations with a longitudinal perspective. The state of knowledge on destination choice behavior coincidentally points out that travellers only recognise a certain number of possible destinations. Further, there exist both variable and stable patterns of choices being being dependent on the specific travel purpose, at least to a certain extend. Existing model approaches to account for spatial and temporal patterns of destination choice on an inter- and intra-personal level are collected. They agree on a further need for an extended consideration of such patterns within modelling frameworks. Mainly, three dimensions of heterogeneity occur: the inter-travel-purpose, the inter-traveller and the intra-traveller related dimension. Based on these, the developed destination choice model estimated with the six-week Mobidrive study contains a differentiation between all sub-purposes of leisure, assumes latent classes among the respondents revealing different preferences and accounts for both spatial and temporal influences on destination choices. With further model components the model is applicable in an AB TDM and provides a framework integrating more realistic destination choice patterns in travel demand forecasts.

Nevertheless, for capturing destination choice heterogeneity for a whole population, a larger sample of longitudinal destination choices is fundamental. The significant interpersonal class allocation parameters are rare for this data set and the number of observed classes is limited. Further, only an urban population is covered which still leaves open how observed patterns shape in other geographical contexts.

It should be mentioned that the presented analysis and the consecutive destination choice model framework cover only correlations. Causal mechanisms of stability and changeability are not incorporated. It is striking, that there is a relatively large number of studies available describing and measuring the extent to which everyday life patterns are stable or variable. Though, other than for mode choice behavior, there is hardly any analysis available systematically exploring the causes of stability or its changeability. It has thus remained largely unanswered which conditions favor persistent stability of destination choice behavior or under which conditions people are willing to change established habits. However, this knowledge is needed to assess the the transforming potential of new technologies, transport services or restrictive policy interventions.

In social psychology, habitual behavior is a key topic being under investigation. Although there is still disagreement about its conceptualization and measurement, literature agrees on habitual behavior following a kind of script or a rule of behavior triggered by certain cue stimuli. Thus, the behavior performed may have been originally decided intentionally, but with increasing repetition under the same (or similar) conditions, the traveller does not reconsider the reasons for action. Moreover, several studies highlight that people have persistent social relationships to people, things and places (*12, 40–42*). Following up on these aspects could be a worthwile approach to the study and modeling of changeability.

The problematic of a more stable destination choice caused by a more habitual behavior is seen its higher resistance to changes (*13, 43*). Consequently, stronger changes would be required to make up for this.

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AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and literature review: T. Woerle and M. Puhe; data preparation: T. Woerle; analysis and interpretation of results: T. Woerle, M. Puhe and P. Vortisch; draft manuscript preparation: T. Woerle. All authors reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Nobis, C. and T. Kuhnimhof, Mobilität in Deutschland- MiD: Ergebnisbericht, 2018.
2. Ettema, D. and T. Schwanen, A relational approach to analysing leisure travel. *Journal of Transport Geography*, Vol. 24, 2012, pp. 173–181.
3. Schlich, R., S. Schönfelder, S. Hanson, and K. W. Axhausen, Structures of leisure travel: temporal and spatial variability. *Transport Reviews*, Vol. 24, No. 2, 2004, pp. 219–237.
4. Thill, J.-C., Choice set formation for destination choice modelling. *Progress in human geography*, Vol. 16, No. 3, 1992, pp. 361–382.
5. Pagliara, F. and H. Timmermans, Choice set generation in spatial contexts: a review. *Transportation Letters*, Vol. 1, No. 3, 2009, pp. 181–196.
6. Miller, E. J., Agent-based activity/travel microsimulation: what's next? In *The Practice of Spatial Analysis*, Springer, 2019, pp. 119–150.
7. Arentze, T. and H. Timmermans, Representing mental maps and cognitive learning in micro-simulation models of activity-travel choice dynamics. *Transportation*, Vol. 32, No. 4, 2005, pp. 321–340.
8. Hannes, E., D. Janssens, and G. Wets, Destination choice in daily activity travel: mental map's repertoire. *Transportation research record*, Vol. 2054, No. 1, 2008, pp. 20–27.
9. Hanson, S. and J. O. Huff, Assessing day-to-day variability in complex travel patterns. *Transportation Research Record*, Vol. 891, 1981, pp. 18–24.
10. Huff, J. O. and S. Hanson, Repetition and variability in urban travel. *Geographical Analysis*, Vol. 18, No. 2, 1986, pp. 97–114.
11. Raux, C., T.-Y. Ma, and E. Cornelis, Variability in daily activity-travel patterns: the case of a one-week travel diary. *European transport research review*, Vol. 8, No. 4, 2016, pp. 1–14.
12. Gärling, T. and K. W. Axhausen, Introduction: Habitual travel choice. *Transportation*, Vol. 30, No. 1, 2003, pp. 1–11.
13. Schlich, R. and K. W. Axhausen, Habitual travel behaviour: evidence from a six-week travel diary. *Transportation*, Vol. 30, No. 1, 2003, pp. 13–36.
14. Schönfelder, S. and K. W. Axhausen, Mobidrive-Längsschnitterhebungen zum individuellen Verkehrsverhalten: Perspektiven für raum-zeitliche Analysen. *Tagungsband CORP*, Vol. 2, 2001, pp. 315–321.
15. Hanson, S. and O. J. Huff, Systematic variability in repetitious travel. *Transportation*, Vol. 15, No. 1, 1988, pp. 111–135.
16. Doherty, S. T., Should we abandon activity type analysis? Redefining activities by their salient attributes. *Transportation*, Vol. 33, No. 6, 2006, pp. 517–536.
17. Wilson, A. G., *Urban and Regional Models in Geography and Planning*. John Wiley & Sons, Ltd, 1974.
18. Haynes, K. E. and A. S. Fotheringham, Gravity and Spatial Interaction Models. *Web Book of Regional Science*, 1984.
19. Cascetta, E., F. Pagliara, and A. Papola, Alternative approaches to trip distribution modelling: a retrospective review and suggestions for combining different approaches. *Papers in regional Science*, Vol. 86, No. 4, 2007, pp. 597–620.
20. Schönfelder, S. and K. W. Axhausen, *Urban rhythms and travel behaviour: spatial and temporal phenomena of daily travel*. Routledge, 2016.

21. Timmermans, H., P. van der Waerden, M. Alves, J. Polak, S. Ellis, A. S. Harvey, S. Kurose, and R. Zandee, Spatial context and the complexity of daily travel patterns: an international comparison. *Journal of Transport Geography*, Vol. 11, No. 1, 2003, pp. 37–46.
22. Cascetta, E. and A. Papola, Dominance among alternatives in discrete choice modelling: a general framework and an application to destination choice. In *PROCEEDINGS OF ETC 2005, STRASBOURG, FRANCE 18-20 SEPTEMBER 2005-RESEARCH TO INFORM DECISION-MAKING IN TRANSPORT INNOVATIVE METHODS-SEMINAR ON CHOICE MODELLING-GENERAL*, 2005.
23. Hanson, S. and J. Huff, Classification issues in the analysis of complex travel behavior. *Transportation*, Vol. 13, No. 3, 1986, pp. 271–293.
24. Tardiff, T. J., Definition of alternatives and representation of dynamic behavior in spatial choice models. *Transportation Research Record*, , No. 723, 1979.
25. Miller, E. J. and M. E. O'Kelly, Estimating shopping destination choice models from travel diary data. *The Professional Geographer*, Vol. 35, No. 4, 1983, pp. 440–449.
26. Puhe, M., L. Briem, and P. Vortisch, Understanding social processes of shopping destination choice-An approach to model stability and variability. *Transportation Research Interdisciplinary Perspectives*, Vol. 7, 2020, p. 100183.
27. Zhang, S., X. Liu, J. Tang, S. Cheng, Y. Qi, and Y. Wang, Spatio-temporal modeling of destination choice behavior through the Bayesian hierarchical approach. *Physica A: Statistical Mechanics and its Applications*, Vol. 512, 2018, pp. 537–551.
28. Mehadil Orvin, M. and M. Rahman Fatmi, Modeling destination choice behavior of the dockless bike sharing service users. *Transportation Research Record*, Vol. 2674, No. 11, 2020, pp. 875–887.
29. Axhausen, K. W., A. Zimmermann, S. Schönfelder, G. Rindsfüser, and T. Haupt, Observing the rhythms of daily life: A six-week travel diary. *Transportation*, Vol. 29, No. 2, 2002, pp. 95–124.
30. Klinkhardt, C., T. Woerle, L. Briem, M. Heilig, M. Kagerbauer, and P. Vortisch, Using OpenStreetMap as a Data Source for Attractiveness in Travel Demand Models. *Transportation Research Record*, Vol. 2675, No. 8, 2021, pp. 294–303.
31. Susilo, Y. O. and K. W. Axhausen, Repetitions in individual daily activity–travel–location patterns: a study using the Herfindahl–Hirschman Index. *Transportation*, Vol. 41, No. 5, 2014, pp. 995–1011.
32. Hess, S. and D. Palma, Apollo: A flexible, powerful and customisable freeware package for choice model estimation and application. *Journal of choice modelling*, Vol. 32, 2019, p. 100170.
33. Greene, W. H. and D. A. Hensher, A LATENT CLASS MODEL FOR DISCRETE CHOICE ANALYSIS: CONTRASTS WITH MIXED LOGIT. *Transportation Research Part A-policy and Practice*, Vol. 37, No. 8, 2003.
34. Hensher, D. A., J. M. Rose, and W. H. Greene, *Applied Choice Analysis*, 2015.
35. McPherson, M., L. Smith-Lovin, and J. M. Cook, Birds of a feather: Homophily in social networks. *Annual review of sociology*, 2001, pp. 415–444.
36. Chen, Y., A. Frei, and H. S. Mahmassani, *Exploring activity and destination choice behavior in social networking data*, 2015.

37. Molloy, J., A. Castro, T. Götschi, B. Schoeman, C. Tchervenkov, U. Tomic, B. Hintermann, and K. W. Axhausen, The MOBIS dataset: a large GPS dataset of mobility behaviour in Switzerland. *Transportation*, 2022, pp. 1–25.
38. Beckmann, M., T. Golob, and Y. Zahavi, Travel probability fields and urban spatial structure: 1. Theory. *Environment and Planning A*, Vol. 15, No. 5, 1983, pp. 593–606.
39. Cullen, I. and V. Godson, Urban networks: the structure of activity patterns. *Progress in planning*, Vol. 4, 1975, pp. 1–96.
40. Puhe, M., J. Schippl, T. Fleischer, and P. Vortisch, Social network approach to analyze stability and variability of travel decisions. *Transportation research record*, Vol. 2675, No. 9, 2021, pp. 398–407.
41. Larsen, J., K. W. Axhausen, and J. Urry, Geographies of social networks: meetings, travel and communications. *Mobilities*, Vol. 1, No. 2, 2006, pp. 261–283.
42. Larsen, J., J. Urry, and K. W. Axhausen, Networks and tourism: Mobile social life. *Annals of tourism research*, Vol. 34, No. 1, 2007, pp. 244–262.
43. Aarts, H. and A. Dijksterhuis, The automatic activation of goal-directed behaviour: The case of travel habit. *Journal of environmental psychology*, Vol. 20, No. 1, 2000, pp. 75–82.