Simulating Social Processes – An Interdisciplinary Approach to Integrate Social Relationships into Destination Choice Modeling

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ABSTRACT

Transport systems are affected by fundamental technical and social dynamics. For planners and researchers, travel demand models are an important tool to gain insights about possible effects of these dynamics and to find appropriate ways of dealing with them. However, most state-of-the-art travel demand models underestimate the social aspects of transport choices, which we consider essential for understanding stability and variability of transport choices. Based on a qualitative interview study, the paper at hand presents an interdisciplinary approach to consider social aspects for modeling shopping destination choice. Starting point for our considerations is that people are social beings, moving around to build and maintain relationships, and that these relationships only unfold in relation to overall sociotechnical structures. The interview study provides evidence for relationships between stores and customers. Relationships can be distinguished in two dimensions. First, in terms of the meaning of a relationship: having a relationship either with the owner of a specific store or towards specific brands. Second, in terms of the nature of a relationship: if it has either randomly or actively been established. Both dimensions are represented in a first modeling approach. The results show that the more seldom relationships to owners of a store or to distinct stores can be modeled easily, while the more typical relationships to brands require further research.

Keywords: Agent-based Modeling, Social Networks, Shopping Daily Needs, Destination Choice

INTRODUCTION

Discussions about the increasing heterogeneity of transport offers, such as sharing services, intermodal information systems, or autonomous vehicles, often convey the impression that the introduction of such services will also considerably change today's transport behavior. And indeed, an increasing number of experts is convinced that large-scale changes of the transport system will become much more likely, mainly due to sociotechnical dynamics and/or broader societal megatrends (Puhe & Schippl, 2014; Truffer, Schippl, & Fleischer, 2017). Central to this understanding is that behavior changes are not only induced by technological developments, but also by social and political factors. Changes can be enabled, for example, by mobility-on-demand services. However, users are no passive by-standers in this process; they will shape such a service in line with their routines, expectations, and configurations of daily life. Core of this thought is that innovations do not affect the process of change from the outside, but from within (Shove, 2010). We therefore argue that a more in-depth understanding of the determinants of stability and changeability of transport behavior is required to anticipate the dimension of change and to identify entry points for governance.

These dimensions of change are also increasingly reflected in transport demand models. They are an important element for transport planning and central for assessing the impact of distinct measures and developments. By definition, models are a simplification of reality. For transport demand models, this simplification consists of a reality which is constructed from objective attributes of the built environment, the socio-demographic structure of the study area and performance characteristics of available mobility options. Agents are traditionally framed as perfectly informed utility maximizers, whose choices are only restricted by financial, spatial, and temporal constraints (Profillidis & Botzoris, 2018). Against this background, destination and mode choice behavior is assumed to be rather flexible in time and space. In this understanding, changes in parameter values – as, e.g., induced by new transport offers – trigger behavior changes quasi from the outside. However, such an approach does not recognize that individuals are likely to show rather stable travel behaviors, a well-known fact in travel behavior research (Hanson, 1980; Hilgert, Behren, Eisenmann, & Vortisch, 2018). More recently, a number of modeling frameworks have been developed to simulate stable transport choices. So far, though, approaches are rather mechanistic by modeling some kind of inertia, i.e., a mode or a destination chosen on one day receives a reward in utility for the following days. This simple method is already capable of replicating measured stability pretty well, but it does not really model the causality behind (Mallig & Vortisch, 2017a, 2017b).

However, sociotechnical transitions entail many uncertainties, in particular with regard to the behavioral implications. We cannot measure precisely how users will actually adapt to new services and in which situations or how social change will affect future technologies. Uncertainties constitute a burden to traditional transport demand models, since they are optimized for analyzing and quantifying well-known cause-effect relations, which have been measured beforehand (Schippl & Fleischer, 2012). Typically, simulation studies present different scenarios entailing

assumptions about the extent to which new services are available. But beyond assumptions about technical or service level performances, scenarios are often peppered with many uncertainties about interrelated societal developments and corresponding effects on the demand side. Assumptions about how new technologies could affect consumer patterns, labor markets, or family life, or the other way round, are widely missing. Since these dynamics are interwoven and influencing developments within the transport system, we argue that studies ignoring this interrelationship fall short in outlining how new technologies diffuse into society and to what extent they could transform the transport system in general and user practices in particular. To understand and anticipate how specific technologies or societal developments contribute to solving existing challenges or to what extent they may contradict potential solutions, more coherent assumptions are needed that address the conditions under which travel behavior remains stable and to what extent it is variable.

Aim of this paper is to present an approach to incorporate social processes into an existing travel demand modeling framework. In a first approximation to this, we will focus on food shopping as a transport purpose. As a first step, we will illustrate that broader societal transitions are likely to happen that cannot be described by technological innovations alone, but encompass the way people live or want to live their life. Based on findings from a qualitative research study conducted in Karlsruhe, Germany, we will then outline distinct forms of relationships between different kinds of supermarkets and their customers. Given a good understanding of the mechanisms of relationships between customers and stores, we will then present a first approach to technically model the observed phenomena.

BACKGROUND: FOOD SHOPPING IN GERMANY

Shopping is deeply interwoven with everyday life. Together with private businesses, it accounts for one third of all trips in Germany (Nobis & Kuhnimhof, 2018) and is thus particularly relevant for transport planning and scientific analysis. The food retail landscape in Germany is heterogeneous, with a typically high density of large hypermarkets, supermarkets, discounters, convenience stores, independent grocery retailers, organic supermarkets, and open markets in urban environments. However, only five large companies hold a market share of around 70 percent of the total food trade. Over the last years, food retail in Germany experienced increasing revenues that almost all types of stores have benefited from, especially larger supermarkets and organic supermarkets. Only small independent grocery retailers are increasingly losing relevance (statista, 2019).

Looking at the demand side, a common explanation for distinct shopping patterns relates to attributes of the specific supermarket, such as price, service, proximity, or product range, which vary between the different store types. In this understanding, people make rational choices based on their financial or time resources, but as in the case of modeling frameworks, it underestimates how consumers follow established routines that are embedded in social contexts. Transition research explicitly conceptualizes how the deep structures and corresponding consumer patterns of the food retail market appeared to be quite stable for a long time, with a clear orientation towards

rationalization, efficiency, and uniformity. In their book on changes in food consumption, Spaargaren, Oosterveer, and Loeber (2012) outline how everyday routines "are transformed under the growing influence of food safety incidents, food security crises, public protest against food-related technological innovations, and debates about the globalization of food production and consumption" (xvii). Additionally, it has not yet been fully understood to what extent mobile shopping transforms present food shopping practices.

Against this backdrop, it becomes clear that medium- to long-term transformations are influenced by a variety of societal and technological developments. These developments influence transport decisions (e.g., in which kind of supermarket to shop), but are currently lying outside transport model boundaries. However, attempts to model shopping destination choice, e.g., by including attractiveness, do not come close to the complexity of sociotechnical transitions. It is uncertain if future consumption patterns (and thus destination choices) will be characterized by uniformity, as the constant market consolidation suggest, or if (or to what extent) societal and environmental concerns, animal welfare, and health issues continue to play a key role and transform today's preferences and thus destination choices.

EVIDENCE FROM QUALITATIVE RESEARCH

In the following, we will present insights from a qualitative research study, set up to better understand social processes of mobility choices. We assume that people have relationships with different retail stores or chains which restrict or at least determine destination choice options. In this perspective, the decision about where to shop is not only determined by spatial settings, mobility options, or financial considerations, it is also triggered by more or less changeable assumptions about what is necessary and desirable for living a "normal" life (Urry, 2003, 2007). We argue that considering relationships provides a promising approach for modeling stable destination choices. Concurrently, the concept allows for a systematic analysis of how relationships might change in the light of sociotechnical transitions.

Evidence for the existence of relationships between customers and retailers is drawn from an interview study conducted in autumn/winter 2018. As qualitative research is not common in combination with simulation studies, we think it is appropriate to say a few words about the character of qualitative research. Qualitative research is not set out to be representative, but is particularly suited to analyze the meanings people attribute to their actions and to understand contextual factors that accompany distinct situations. Through discussions with participants, the researcher is able to understand what facilitates and what constrains behavior change (Clifton & Handy, 2001). A prominent example of how qualitative research can enrich transport studies is the HATS technique, widely acknowledged as a milestone in the field of activity-based travel analysis (Jones, Dix, Clarke, & Heggie, 1985). In their paper on qualitative methods in travel behavior research, Clifton and Handy (2001) described how the research group of the Transport Studies Unit in Oxford began their examination with a qualitative interview study with a small sample of participants in order to test different theoretical assumptions. Results were used to develop a

quantitative study, which finally resulted in the development of the first Household Activity-Travel Simulator (HATS).

Study design and data collection

Main purpose of the study at hand was to examine the web of social relationships people sustain in their daily lives and how that relates to transport choices. The data was gathered through a qualitative Social Network Analysis approach in 27 cases in Karlsruhe, Germany (Hollstein, 2011). In order to be able to focus on social processes of mobility choices, the spatial factors of the respondents' living environments had to be similar. All respondents live in the same inner-urban district, characterized by social diversity and abundant opportunities for food shopping. Each case consisted of two in-depth face-to-face interviews and the completion of a one-week travel diary. The first interview addressed the social network of the respondent (including individuals, objects, and places). The second interview addressed the different practices connected to keeping relationships alive. The sample includes young adults with (n=13) and without (n=14) children, based on the assumption that both groups differ in their freedom of choice and in respect to the social obligations imposed upon them by others and society as a whole. Our interviews revolved around different sorts of relationships, for example, relationships people have with other individuals such as family members or friends, but also around their reasons for choosing specific supermarkets or joining particular sports clubs. As we refer to transport for food shopping in this paper, we focus our analysis on this purpose in the following.

Different types of relationships between customers and stores

The vast majority of interview participants report on a relatively stable portfolio of stores, where they shop for their everyday needs. For some, this portfolio includes only two stores of the same type, while others report of sophisticated and dispersed compositions of several different store types.

> *"Usually we go to either Kaufland or Real [both large hypermarkets]. Depending on who has the better offers. But we always go by car and when we have time, we go together."* [Cleaning lady, two children]

> *"We always go to Edeka [supermarket]. I haven't seen another supermarket in a long time. What we do less often, for special things, we go to Füllhorn [organic store] here, if we need some special groceries."* [Researcher, no children]

For many, the composition of this portfolio is by no means arbitrary. According to Everts and Jackson (2009), different types of stores represent different meanings and in particular different trust relations. The authors distinguish between two sorts of trust relations: a) trust relations fostered by face-to-face interactions, e.g., with the shop owner of a small independent store and b) relations based on trust in specific brands, predominantly fostered by larger supermarkets. In line with this, most participants had a precise idea of which products to buy from which store.

> *"Well, at Edeka [supermarket] I am definitely once a week. Kaufland, Real [both large hypermarkets] usually changes weekly, because they're further away and I just look for what I need more urgently. If I need cornflakes, I go to Real, if I fancy muffins, I go to Kaufland."* [Nursery school teacher, no children]

> *"Today we needed very special things, which are available at Edeka [supermarket] and not at Nahkauf [other supermarket], where we usually go more often"* [Geriatric nurse, three children]

Due to the high market consolidation in Germany, it is possible to maintain relationships based on trust in brands at varying locations (at least when excluding temporal and spatial constraints for now), since it is possible to receive exactly the same products at different branch stores. Most retail companies in Germany provide a substantial range of private labels to increase customer loyalty. In 2018, the market share of private labels in the total turnover was stated to be around 40% (statista, 2019). The following quote exemplifies the loyalty to particular products, for which the respondent interrupted his tram-ride:

> "*I took the tram that day, got off, and went shopping. We just needed special things that are only available at Alnatura [organic supermarket]. And that's why I got off there"* [Geriatric nurse, three children]

As indicated by Everts and Jackson (2009), there is another type of trust relations that makes people shop at specific stores: trust in persons. Compared with trust in brands, trust in persons has been losing relevance over the past decades. However, some respondents had a somewhat strong relationship with the shopkeeper of an independent organic store. Interestingly, regular customers refer to the store by the first name of the shop owner, which underlines the relationship they have with this particular person.

> *"Well, Holger [the shop owner] is like a grandpa to a lot of people around here. And you have to go there regularly. And we often go there, too."* [Art student, two children]

> *"Well, I always go to the market on Saturdays. And I get the rest from Holger."* [Teacher, no children]

However, there are also respondents who do not have particular relationships, neither to specific brands or products, nor to persons.

> *"So I don't have a plan; honestly, I buy when it's necessary or also when I feel like doing something."* [Nursery school teacher, one child]

We assume that the different sorts of trust relations determine transport choices, especially regarding the travelers' freedom of destination choice, in distinct ways. In case of trust relations between shopkeeper and customer, the specific location of the store is fixed. For relationships based on trust in brands, the freedom of destination choice is more flexible, since the relationship can be maintained at different branch shops at varying locations. People who do not have

relationships, neither with persons nor with products, are more flexible in their destination choice. Figure 1 illustrates the anticipated freedom of destination choice for distinct trust relations.

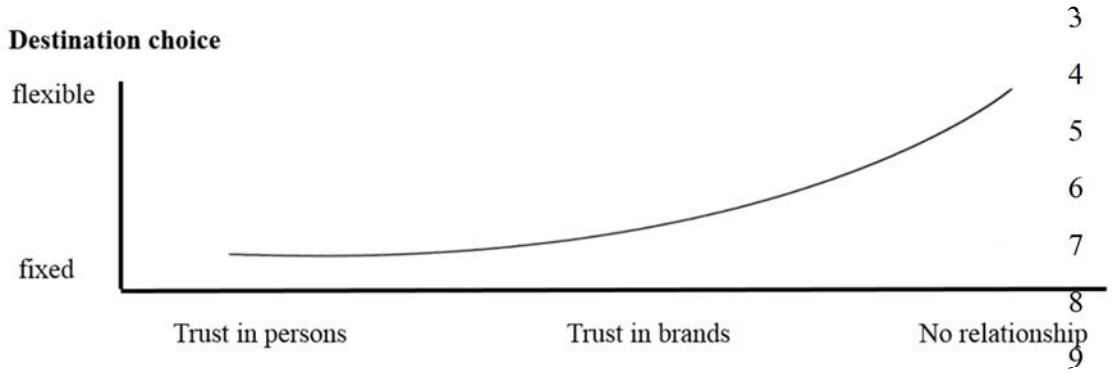

Figure 1: Anticipated freedom of destination choice for distinct trust relations

Our analysis provides evidence for the validity of trust relations between consumers and stores. Central to transportation research is that social relations are more or less strong connections, which are constituted by periodic encounters. We have argued that conceptualizing choice as a relational rather than an individual phenomenon provides a solid causal explanation for empirically measured stable destination choices. Though the main question in this paper is how the notion of relations with its strong focus on stability can also be used to analyze changes. Therefore, it seems appropriate to distinguish between the different times at which changes take effect. Taking a medium-to-long-term perspective, Everts and Jackson (2009) outlined in their paper how the introduction of self-service shops and the demise of the corner store replaced the trust in persons with trust in brands. Similarly, structural changes – such as the growing importance of societal and environmental concerns among certain social groups – could lead today, little by little, to an increase in people who trust in persons rather than brands.

However, since socio-structural changes are characterized by various interdependent factors, it is beyond the scope of this paper to sketch out complete scenarios, considering potential sociotechnical dynamics. Nevertheless, relationships vary not only over time; they also unfold their impact in a short-term perspective. Based on our results, we assume to find a fruitful approximation for what will happen if large-scale changes occur in the reasons that led to the formation and maintenance of the relationship.

Shopping – for some people it's a habit, for others a routine

As a result of our analysis, we can distinguish two modi of how relationships come into peoples' lives. The majority of participants practice a habitualized relationship with certain stores or branches. They head for the same set of stores, almost as being on "autopilot" and based on good experience. This line of reasoning is well-known in psychology-oriented transportation research that defines habitual behavior as a behavior that establishes without active deliberation (Gärling & Axhausen, 2003). Not surprisingly, the majority of respondents has mentioned the proximity to their place of residence as the main reason for choosing certain stores. The respective

relationships have developed almost randomly, in the sense that they were not intentionally established.

> *"You know, I often go to Nahkauf [supermarket]. Sometimes, when I need something special, I go to Edeka [another supermarket] because it is bigger, but normally I just don't go there, because we always walk in the other direction in the morning."* [Housewife, four children]

Common means to model choice by taking into account the generalized costs to the destination zone come close to this sort of relationship. The other mode for establishing a relationship is different though and can be defined as routinized. Some of the respondents literally cultivate their relationship with certain stores or branches, meaning they deliberately prefer one store to the other. In which supermarket they shop affects their social belonging and identity. This line of reasoning refers to social science-based research and defines routinized behavior as shared patterns of behavior within a social context (Tomlinson & McMeekin, 2018). For maintaining routinized relationships, people are willing (and able) to undertake longer journeys and accept higher costs and effort. Shopping patterns in this mode are only partly influenced by external stimuli upon which travelers react, but by conscious deliberation about what is the expected behavior for themselves and people like them.

> *"I buy groceries at Holger's and at the market. When I'm in the city center, my favorite is Füllhorn [organic supermarket]. It used to be Alnatura [other organic supermarket], but somehow I learned that Füllhorn is even more ecological and somehow cooler."* [Business consultant, one child]

Implications for behavior change

The principle that recurrent behaviors have been established holds true for both types of relationships. The reasons, though, and thus their implication for fostering behavior change, is different. Psychology-oriented transport research has shown that transport habits are a type of tacit knowledge that has been proved appropriate in certain situations. Thus, habits are relatively easy to maintain, they have proved to be efficient and are often backed by an additional normative support (that, e.g., shopping in a nearby supermarket allows for other activities considered more relevant). Verplanken and Wood (2006) have shown that people who are in the habit of, e.g., shopping in a certain grocery store, experience a biased perception of information on alternatives and do not actively search for new options. Therefore, successful habit change interventions involve disrupting the cues that lead to automatic behaviors, e.g., by substantially changing circumstances to reach a certain destination. In the case of food shopping, we consider it likely that habitualized relationships with specific stores are maintained as long as spatial-infrastructural factors are kept similar. In case of changing context factors, though, we assume that shopping destination choice follows a similar justification, namely that the store has to be reached as easily and effectively as before. The type of store plays a minor role for the decision-making process.

Relationships that we define as routinized are based on a different reasoning. Routinized relationships with certain stores or chains result from active deliberation. Such relationships are of great importance for the people, both for their self-concept and their social status. As indicated above, food, its origin and quality, cooking and eating together, are increasingly important for large parts of the well-educated middle class and are used as a means of social distinction (Reckwitz, 2018). Eating as a deliberately performed practice transforms shopping into an equally well-considered choice. It becomes more important to obtain beef from a certain butcher or to be able to offer the olives from a certain market stall, since they lack in taste elsewhere. Where to receive food from becomes an essential aspect of daily life then. Therefore, we assume that in the case of changing spatial-infrastructural conditions, people who practice a routinized relationship will more actively hold on to this relationship, even if this implies higher costs and effort, or replace it by a relationship which expresses a similar meaning (see

Nature of relationship

Meaning of relationship	**Routine** *Relationship fits social status*	**Habit** *Relationship has proved efficient*
"Trust in persons" *(destination choice is fixed to one destination)*	Stick to a relationship (up to a time or financial threshold) or search for alternative relationship expressing a similar meaning	A relationship is substituted by an alternative that is as comfortable and effective as the former one
"Trust in brands" *(destination choice is fixed to a limited number of destinations)*		
"No trust relation" *(destination choice is flexible)*	x	x

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Table 1: Choice options in the light of spatial-infrastructural changes for different sorts of relationships

Meaning of relationship	Nature of relationship: Routine *Relationship fits social status*	Nature of relationship: Habit *Relationship has proved efficient*
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"Trust in brands" *(destination choice is fixed to a limited number of destinations)*		
"No trust relation" *(destination choice is flexible)*	x	x

SIMULATION STUDY

In the following, we will present an approach to model the behavioral implications outlined above. To assess the impact of the distinction made, a hypothetical scenario of a car ban is used. The scenarios presented are capable of taking into account short-term changes of the spatial-infrastructural environment as depicted in Table 1, but do not yet aim to reflect upon the interrelated sociotechnical dynamics inherent in medium- to long-term changes. However, it seems to be a promising approach to make reliable assumptions about stable and variable behaviors in a given future setting.

To assess the effects of habitualization vs. routinization in a travel demand model, an existing model is employed. For the study, mobiTopp, an agent-based travel demand model, for the region of Stuttgart is used. Stuttgart is one of several German cities where the concentration of fine particulate matter has reached harmful levels. To reduce emissions, a partial ban for diesel cars in different parts of the city has been discussed at the political, legal, and public level. The discussion does not seem arbitrary, since other European cities, such as Oslo or Madrid, have already done so and banned cars from their city centers. We take this discussion as a basis for our hypothetical scenario of banning all cars from the inner city ("Talkessel") of Stuttgart. The effects of habitualization vs. routinization are analyzed by evaluating three cases: The first one uses the original destination choice model, the second one defines portfolios for fixed destinations (*trust in persons*), whereas the third one defines portfolios for a limited number of destinations (*trust in brands*). All portfolios are applied for the activity type "shopping daily needs" only.

The mobiTopp model

mobiTopp (Mallig, Kagerbauer, & Vortisch, 2013; Mallig & Vortisch, 2017b) is an agent-based travel demand model that models every person, household, and car of the study area. People

are modeled as agents who make decisions autonomously, individually, and situation-dependent, based on the current situation or the interaction with other agents. In mobiTopp, every agent has an assigned activity program for a whole week. While agents carry out their activity programs, they decide where an activity will take place and which mode to use. Both decisions, destination choice and mode choice, are based on discrete choice models.

mobiTopp consists of two stages: initialization (long-term model) and simulation (short-term model). During initialization, the long-term decisions of agents and households are defined. This includes population synthesis, generating all agents and households based on structural data. During this stage, locations for fixed activities (home, work, and education), the ownership of private cars and transit passes, and the activity programs for each agent are modeled. The simulation of travel demand during the simulation stage is based on these long-term decisions. In this stage, the travel behavior of all agents is simulated simultaneously. All agents are simulated over one week, applying the destination and mode choice models sequentially for each trip of an agent. The destination choice model is based on traffic analysis zones. The default mode choice model supports five modes: *walking*, *cycling*, *public transport*, *car as driver*, and *car as passenger*.

During destination choice, two types of activities are distinguished: activities at fixed locations (work, education, and at home) and flexible locations (e.g., leisure and shopping). Activities with fixed locations have predefined locations modeled in the initialization stage. Due to this, no destination choice is made for such activities during the simulation stage. For activities with flexible locations, a discrete choice model is used to select a zone as destination. The default implementation takes into account the travel time and travel cost from the current location to the potential destination, together with the travel time and travel cost from the potential destination to the next fixed location (e.g., to the workplace or back home) (Mallig & Vortisch, 2017b). A repeatability mechanism is applied to model simple stability aspects. On this basis, agents decide whether to select one of the already used destinations or to try out a new one. This can be interpreted as habitualized behavior, as the agent builds up a portfolio of destinations for each activity type during the simulation.

Input Data

As described earlier, food shopping portfolios of agents are identified by aggregating the results of a mobiTopp simulation with the original destination choice model. Results can directly be aggregated to generate portfolios for *trust in persons* scenarios. However, modeling portfolios for *trust in brands* scenarios requires defining and assigning store types to zones first. For this case, portfolios are made up of all zones labeled with store types used in the results of the original model. E.g., if an agents' portfolio consisted of a discounter and a hypermarket in the original model, all zones containing discounters and hypermarkets are part of this agents' individual choice set.

The model employs an attractivity measure for all zones which is based on the sales area of all stores of this zone. Different data sources were used to calculate attractivity. For the city of Stuttgart, a list of stores is used containing the name, classification, sales area, and other attributes.

For the surrounding area, the list contains nearly the same information but is not as complete as for the inner city. Different kinds of stores tend to be underrepresented. To compensate this, sales areas on community-level were added to zones lacking information about the specific stores. Zones did not contain any information about the store types before.

We therefore classified the stores based on the given data into the seven categories: discount store, supermarket, organic store, drug store, marketplace, hypermarket, and other grocery stores. As the list of stores lacks information outside of the city of Stuttgart, we used open street map to fill the gaps where possible. Afterward, zones were labeled with store types according to the stores inside a zone.

Scenarios

mobiTopp is designed in a modular way allowing to replace or extend existing models with other approaches. One way to integrate a more routinized behavior as indicated above is to extend or replace the destination choice model. The destination choice model consists of two parts: First, the choice set of possible destinations is calculated. Second, one destination is selected from the choice set considering various attributes of the person and the destination. Both parts can influence behavior. For the first part, available destination options could be limited to a given portfolio for each agent. For the second part, attributes for choosing the destination can be modified, e.g., by increasing costs. Both parts are altered for this simulation study.

In step one; we use the previously calculated portfolios as choice sets to model *trust in persons* and *trust in brands*. Step two is used to identify the potential effects of a spatial infrastructure change, a car ban from the city center, by extremely increasing the costs. The simulations use 1% of the population. As mentioned earlier, not all people behave routinized. Therefore, only 30% of the agents use a portfolio based on *trust in persons* or *trust in brands* to model routinization. The remaining 70% behave habitualized by using the original model. Since our approach does not draw upon quantitative data, we assumed this as an appropriate share to start with.

Discussion

Both, the modifications of the destination choice model and the car ban are hypothetical changes to measure the effects or sensitivity of the model. The sensitivity is measured by comparing the destination portfolios of all agents (Hanson, 1980).

Altering the destination choice model to a *trust in persons* model shows that the effects are quite low. Nearly no agent changes the set of destinations when comparing with the original model. However, introducing a *trust in brands* model has a stronger impact on the model. Subsequently, many agents change their set of destinations. One explanation for this could be that the portfolios of about 50% of the agents in the *trust in persons* model contain only one destination. Limiting their freedom of destination choice substantially reduces their freedom of choice. Additionally, the portfolios consist of destinations selected based on the original probabilities. In contrast, for the *trust in brands* model the number of zones includes all zones containing the same store types as

used in the original model. The set of destinations is thus not only based on the probability to choose a zone but on attributes not considered to calculate the probability before. The resulting portfolio might contain the likeliest zone and many other zones, but not the likeliest zones in terms of the original model. This has a much greater effect on the probabilities used to select a destination since further destinations become available.

Changing the spatial-infrastructural setting by introducing a car ban has a huge effect on the original model. About 26% of the agents change their set of destinations compared to the original model without the infrastructural change. Using a *trust in persons* model reduces the effect to 18%. Not surprisingly, this correlates to the number of agents configured to behave routinized. Applying the *trust in brands* model reveals an increased number of agents changing their set of destinations compared to the scenario without the car ban. As this is a counter-intuitive result – introducing stability induces instability – we researched the causes of this effect and see this as a result of the input data. The classification of shops in the inner city is based on a broader data set, resulting in a more complete and diverse classification of zones according to store types compared to the surrounding area. Agents sticking to a specific store type are, therefore, more affected by a ban of cars, if the store type is significantly more available in the city of Stuttgart.

The results of the scenarios show that the stability aspects of *trust in persons* can quite easily be integrated into a travel demand model by using a rule-based approach. The number of agents choosing a destination out of their portfolio can be configured using a single parameter. The stability aspects of *trust in brands* are much more challenging. While the *trust in persons* approach does not change behavior without any spatial-infrastructural changes, the *trust in brands* model does so in a considerable way, indicating that the *trust in brands* model needs more information and parameters to be calibrated correctly.

CONCLUSIONS AND OUTLOOK

The paper at hand argues that societal dynamics in different areas of daily life are significant for understanding developments within the transport sector. So far, though, societal dynamics are treated as a black box in transport demand modeling. Therefore the aim of this paper is to present a first approximation to open up the boundaries of modeling frameworks towards broader sociotechnical transitions. Our approach is made explicit by focusing on food shopping habits and routines. The basic idea behind our approach is that people are social beings, moving around to build and maintain relationships with people and objects, and that these relationships only unfold to a certain degree of stability and in relation to overall sociotechnical structures.

The qualitative interview study is employed to underline the validity of people maintaining relationships with grocery stores or chains, which triggers periodic encounters and thus explains more or less stable shopping destination choices. Relationships are based on distinct trust relations, which in turn have an impact on the freedom of shopping destination choices. While relationships fostered by trust in brands allow for a slightly more flexible destination choice, trust in persons is space-specific. Additionally, two modi of repetitive behaviors are distinguished to assess the

dimension of change triggered by interventions, such as a ban of cars. Apparently, the majority of respondents have habitualized relationships with grocery stores or chains. This means that they have been established randomly, often due to the proximity between home and destination. However, other respondents maintain a cultivated relationship, which we define as routinized, indicating that the relationship has been deliberately chosen, often expressing someone's identity or social belonging. We argue that in the light of recurring food scandals or increasing public resistance against food-related technological innovations, routinized relationships could potentially increase. In this perspective, decisions about where to shop and how to get there are by no means arbitrary, but triggered by changing assumptions about what is necessary to live a "normal" life. We assume that spatial-infrastructural changes would imply a different adjustment behavior than those that maintain habitualized relationships.

Furthermore, we presented a first approximation to model the observed phenomena. In order to show that the differentiation between routinization and habitualization is of relevance for understanding stability and change of transport choices, we presented six scenarios of how shopping destination choice transforms (or remains the same) under a potential ban of cars of the inner city center. Our studies show that modeling stability as *trust in persons* can be integrated in a simple way. The model output does not change that much compared to the original model in the base scenario, while the stability under a potential ban of cars can be directly controlled. Integrating a simple *trust in brands* relationship has much more influence on the destination choice. The simulation study shows that the taken approach currently behaves counter-intuitive by decreasing stability. Nevertheless, the implementation for both models is built in a modular way, allowing the replacement of the current versions with other ones.

However, our study reveals that the portfolio of relationships with stores seldom consists of a strict separation between either *trust in persons* or *trust in brands*. The majority of those sustaining a *trust in persons* relationship additionally sustain relationships with certain stores – and thus *trust in brands*. The same applies for the distinction made between habitualized and routinized relationships. The portfolio often consists of both, relationships that are important to the people and those that have a more incidental character. Therefore, we need to quantify our results in a next step to make reliable assumptions about how different trust relations, routines, and habits are distributed within given portfolios. Additionally, further research is required to find out to what extent socio-demographic characteristics have an effect on individuals' propensity for the different trust relations and on the sustainment of either habitualized or routinized relationships. Literature reveals that education rather than income provides a suitable parameter.

However, it is central to our argumentation that models assessing technological innovations in a technology biased way are running the risk of misinterpreting the impact and consequences of sociotechnical changes. By respecting the interplay between structural changes and individual behaviors, models could assist in managing dynamics and help to avoid undesired outcomes. We therefore argue that model structures have to be created which go beyond their typical application in transport planning to provide answers to the immense dynamics currently

taking place. Social relations function as a sort of intermediate level between broader sociotechnical developments and individual mobility and life choices. Yet, there remain several tasks for future work: first, this paper focuses on food shopping only. Other activities, such as family life, social engagement, or new work environments are accompanied by social obligations of a rather different nature than food shopping. Looking at social networks as a whole and their implications for transport choices promises to provide useful information on people's motivation, inertia, and willingness to do things differently than today. Thus, the conceptualization of relationships presented in this paper can only be a first glimpse. It remains an open task to structure social life in general as networked, for transportation research, and within modeling frameworks.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Maike Puhe, Lars Briem, Peter Vortisch; data collection: Maike Puhe; analysis and interpretation of results: Maike Puhe, Lars Briem; draft manuscript preparation: Maike Puhe, Lars Briem. All authors reviewed the results and approved the final version of the manuscript.

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