Empirically Approaching Destination Choice Set Formation

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Abstract

The discrete choice modeling framework plays a dominant role in travel demand modeling. It is particularly suitable for choices with a compact choice set, such as mode choices. However, for spatial choices such as route or destination choices, which are in general characterized by a large number of alternatives, the *choice set formation step* poses crucial and to date unsolved methodological and empirical problems. In this paper, steps towards solving these important problems are introduced. The core of this paper is a *publicly available Web-based survey tool* that enables an empirical approach to destination choice set formation and that also has potential use in collaborative efforts. A detailed analysis of the problems associated with destination choice set formation and first approaches for model estimation are included.

Keywords

shopping destination choice, choice set formation

1 Introduction

In transport research, the discrete choice modeling framework (McFadden, 1978) is often used for treating many aspects of travel behavior. Discrete choice models have proved to be productive and have thus been broadly applied in operational planning models. In this framework, decisions are modeled as a utility maximizing choice from a finite set of alternatives, the *choice set*. While the decision rules for choosing an alternative of the choice set have reached a high level of sophistication, the *formation* of the choice set still remains a major unsolved problem, in particular, for destination choice problems. As the estimated model parameters in general are very sensitive to the specification of choice sets (Schüssler, 2010; Pellegrini *et al.*, 2005) this methodological gap is crucial.

In the context of developing an agent-based destination choice model to be integrated with MATSim (MATSim-T, 2010), this paper takes empirical steps towards solving this important problem. In this first version the focus is on grocery shopping destination choices.

After presenting a brief overview of the current state of choice set formation approaches (section *Destination Choice Set Formation Procedures in Transport Research*) the general difficulties of using discrete choice models for destination choice are characterized (section *Problem*). In the section *Research Objectives and Approach*, new approaches to more empirically and conceptually well-founded destination choice set formation procedures are presented.

The section, *Survey Tool*, is the core of this paper. It describes the Web-survey tool developed to generate a fundament suitable for implementing the new approaches. The Web-survey tool is intended to be a publicly available tool for approaching destination choice set formation processes. For the time being, it is implemented for Zurich as an example. The first pre-test results are presented in the *Pre-Test* section. New avenues for discrete destination choice model estimation are identified under *Outlook* and the paper closes with the *Summary and Conclusions*.

2 Destination Choice Set Formation Procedures in Transport Research

The standard discrete choice framework is based on the concept of *homo economicus*, who is perfectly informed and equipped with unlimited cognitive abilities. Thus, the decisions of homo economicus are based on the *universal choice set*. This procedure is perfectly adequate for problems with a relatively small number of alternatives, e. g., mode or brand choice. However, for spatial choice problems, the number of available alternatives is huge, such that choice set formation becomes a crucial computational and methodological problem.

In the literature, two main strands addressing choice set formation for problems with a large number of alternatives can be identified. The models, though generally applicable to destination choice problems, have not all been applied to this context as yet. As they are essentially subject to the same basic difficulties that characterize destination choice problems they are mentioned here. These difficulties are presented in the section, *Problem*.

An overview of the different approaches of the two main strands is given in (Thill, 1992) (focused on destination choice) and in a more recent literature review (focused on spatial contexts in general) (Pagliara and Timmermans, 2009).

The models of the first strand are based on a *deterministic* specification of choice sets, where the choice sets are an exogenous input to the estimation step. Examples range from the early ad-hoc models of (Gautschi, 1981; Weisbrod *et al.*, 1984; Adler and Ben-Akiva, 1976; Miller and O'Kelly, 1983; Southworth, 1981) to the rather complex cognitive models (Chorus and Timmermans, 2009; Hannes *et al.*, 2008; Mondschein *et al.*, 2008; Arentze and Timmermans, 2004; Golledge and Timmermans, 1990) and include models of the time-geographic approach (Hägerstrand, 1970; Landau *et al.*, 1982a; Thill and Horowitz, 1997; Scott, 2006).

The second strand, which is often called the *probabilistic* approach, was founded by (Manski, 1977; Burnett and Hanson, 1979; Burnett, 1980) and integrates the choice set formation step into the estimation procedure and jointly estimates the selection of a choice set and the choice of a particular alternative of this choice set. Examples span choice set enumeration approaches (Manski, 1977; Burnett, 1980; Burnett and Hanson, 1979; Swait, 2001; Horowitz and Louviere, 1995), the competing destinations model (Fotheringham *et al.*, 2001), the random constraints model (Ben-Akiva and Boccara, 1995; Swait and Ben-Akiva, 1987), dominance attributes (Cascetta and Papola, 2009) and the constrained multinomial logit model (Martínez *et al.*, 2009).

As pointed out in the next section both strands of research are characterized by the same methodological and empirical basic set of problems.

3 Problem

3.1 Empirical Basis for Choice Set Formation

Probabilistic choice set formation models are conceptually consistent with the premise of homo economicus as choice sets are not restrained a priori by exogenous behavior-based criteria. However, the procedure is associated with combinatorial complexity, making it computationally infeasible for most practical problems. The models belonging to this second strand, that actually circumvent combinatorial complexity, e.g., (Zheng and Guo, 2008) are all in turn based on such criteria in order to restrict the choice sets and the sets of choice sets. In essence, both the deterministic and the probabilistic approach rely on exogenous behavioral information for choice set formation. This is succinctly put by (Pagliara and Timmermans, 2009): *"Even though the inclusion of latent stochastic thresholds and the simultaneous estimation of thresholds and utility functions represent an important step forward in discrete choice analysis, forecasting results still depend on the researchers' specification of the choice set."* The problem here is that to date the specification of the exogenous factors for choice set formation is rather ad hoc and more in the sense of a proof of concept. This means that both the deterministic and the probabilistic approach of choice set formation have a strong need for a more systematic and empirical investigation of the factors behind choice set formation. More generally, a deeper understanding of the spatial decision mechanisms in the context of large sets of choice alternatives is necessary in the design of productive destination choice set formation procedures.

3.2 Methodological Issues

In addition to these empirical problems, destination choice models exhibit methodological gaps.

3.2.1 Taking Into Account the Decision Horizon

Marketing research differentiates several types of consumer decision behavior, e.g., (Solomon, 2009; Kroeber-Riel and Weinberg, 2003; Foscht and Swoboda, 2007). The classification proposed by (Solomon, 2009), for example, distinguishes between *extensive problem solving, limited problem solving* and *routine response behavior*. As the names imply, the categories are characterized by a decrease in cognitive consumer involvement inter alia. This decrease is caused by lower product costs, a strong *emotional* stimulus that dominates cognition, but also by familiarity with the specific decision-making situation. During repeated extensive decisions on the same subject, approved purchasing criteria (i.e., previous knowledge) can be established that lead to limited decisions or even routine behavior.

Consequently, this means that if the investigation is limited to decisions made *immediately prior* to the purchase, there is a high probability of missing the relevant part of the decision. The accumulation of previous knowledge, i.e., the learning process as a prerequisite for the final decision, is not included in such a model. As a hypothesis to be tested in the future, it is assumed by the authors that the above cited marketing research models designed for brand choices are also relevant for shopping (and probably also leisure) destination choice models in transport research. In the authors' opinion, there is a lack of consideration for this methodological problem in discrete destination choice models in transport science.

3.2.2 Discrete Destination Choice Models: Statistical versus Behavioral Tool

A related methodological problem, lacking research, is the question about the behavioral basis of discrete destination choice models. As shown by (Tversky, 1972) decision problems with a large number of alternatives are associated with *non-compensatory* decision behavior. This means that, when facing a complex decision situation, many alternatives are eliminated by the decision-maker on the basis of a limited information search and evaluation. It follows that routine or habitual behavior is not necessarily derived from *extensive* decisions, but can also be the result of preceding decisions that were guided by heuristics.

In either case, the routine behavior is the result of preceding decisions. In other words, a sequential learning process is present. Modeling a *sequential* (potentially non-compensatory) process using a *simultaneous* utility-maximizing (i.e. compensatory) model means that discrete destination choice models are applied as a purely statistical tool and not as a behavioral model. In this context, using behavioral rules to form the choice sets is not expected to be very productive. Concluding, there is a certain lack of rules for forming choice sets, in particular, if discrete destination choice models have to be regarded as a purely statistical tool.

The above urgent and crucial problems with regard to empiricism and methodology exist for destination choice research and also for the investigation of other spatial problems such as route choice (Schüssler, 2010). The work described here is intended to provide a starting point for an empirical approach to spatial choice set formation, in particular to destination choice, and to initialize a discussion on the methodological issues described above.

4 Research Objectives and Approach

To limit the effort, this work focuses only on grocery shopping. Grocery shopping was chosen for two reasons: First, grocery shopping trips represent a substantial share of the transport demand: in Switzerland approximately 13% of all trips (Swiss Federal Statistical Office, 2006). Correct modeling of grocery trips is hence an important part of any operational transport planning tool. Second, as limited and routine decision behavior dominates in grocery shopping (Foscht and Swoboda, 2007), it serves as a good example for gaining insight into the methodological problems associated with the formation of destination choice sets.

4.1 Empirical Basis for Choice Set Formation

Ultimately relevant for shopping destination models in transport research is the information about the frequencies of visits to specific stores for specific person groups sectioned by socio-demographic attributes. Bringing these frequencies to light as a starting point for model development is one of the main goals of the development of the survey tool.

Numerous destination choice models are based on cross-sectional revealed preference data. In these models, the decision process is modeled on the basis of *one single* observed choice per person. A key hypothesis of the new model estimation approaches presented below is that grocery shopping involves a (relatively small) *set of preferred and frequently shops* (PS). If this hypothesis is true, the models based on one single observation per individual must fall short. To take their place, models where the PS plays the role of the *observed choice* must be developed. Ideas on how to specify the *choice set* for these new models are presented in the following, however, a ready-to-use model is not provided.

While the assumption, that a preferred set of grocery shopping stores per individual exists, seems almost trivial, the empirical details of this set are not. Revealing these details is one of the goals of this survey tool. It is designed to research the structure (e.g., size, spatial dimension, etc.) of the PS. Also, the question can be analyzed as to why shops are not visited by an individual, in spite of being geographically close to the stores in his or her PS.

Furthermore, the first insights into the constituting factors of the PS can be investigated. The survey tool makes it possible to investigate the influence of distance and travel time while taking trip chaining into account. As these are prominent factors in destination choice models, the results can be used to further develop, calibrate and validate existing models, in particular, the very promising time-geographic models (Hägerstrand, 1970; Landau *et al.*, 1982b) and models moving in the direction of mental map models (Chorus and Timmermans, 2009; Hannes *et al.*, 2008; Mondschein *et al.*, 2008; Arentze and Timmermans, 2004; Golledge and Timmermans, 1990).

To the authors' knowledge, the question of the location of the main area for grocery shopping of (commuting) employees has not yet been researched satisfactorily (e.g., to what extent is shopping done close to the workplace, close to the residence or somewhere in between). The findings with respect to this question can also be directly applied to time-geographic models.

4.2 Taking Into Account the Decision Horizon

It is crucial to take into account the different decision horizons of consumer decision behavior. Some of the literature in marketing research proposes a conceptualization that looks promising for destination choice modeling in transport research just as well. In addition to the set of options considered immediately prior to the choice (often termed the evoked set, consideration set or choice set), these models use additional higher-level sets that are relevant for the decision-making process (Narayana and Markin, 1975; Howard and Sheth, 1969; Crompton, 1992). (Narayana and Markin, 1975) for example, introduce the following sets: *unawareness set, awareness set, inept set, inert set* and *evoked set*. As the name implies, the awareness set consists of all options that the consumer is aware of. The awareness set is further divided into the inept set (for which the consumer has a negative evaluation), the inert set (for which the consumer has neither a positive nor a negative evaluation) and the evoked set (for which the consumer has a positive evaluation).

Even though the process of how the evoked set is derived from the awareness set is unspecified, applying this classification to discrete destination choice modeling looks promising. It can be seen as a first step towards a behavior-based destination choice set specification. The survey tool is designed to provide the first empirical information about the sets defined above.

4.3 Research Approach: Survey Tool

Summarizing, the research approach to fulfill the objectives itemized above is the development of a *publicly available Web survey tool*. As reporting on destination choices is known to be very challenging for the respondents (Thill, 1992) the tool is designed to provide consistent support of a graphical map-based survey method. The tool is implemented and parameterized for the city of Zurich as an example. It is intended to provide a means to successively approach destination choice formation. Although possible avenues for developing a new destination choice model are sketched in, the main focus at this point in time is not on model *estimation*.

5 Survey Tool

5.1 Scope

At this point, the scope of this survey tool is the workday grocery shopping trip in the city of Zurich with a purchase amount greater than 20 Swiss francs. Only persons living in Zurich are surveyed. The workday is chosen as it is assumed that on workdays, shopping destination choices are less influenced by leisure trips than on weekends. Trip chaining with respect to work trips are covered by our survey. Limiting the spatial scope to the city of Zurich increases the quality of the description of the grocery stores, which had to be collected manually in part. Moreover, the urban environment of Zurich is expected to show a denser and more uniform spatial arrangement of grocery stores than a rural environment. This is expected to reduce the (distorting) effects of location-specific geographic characteristics when investigating the fundamental decision-making mechanisms. Purchases smaller than 20 Swiss francs are excluded because buying snacks is guided by different decision-making mechanisms.

5.2 Grocery Stores

The survey includes 296 grocery stores. The focus of the study is on those grocery shopping trips, where different types of products are bought in *one single* store that provides a broad range of products. To match a stratified approach, purchases of single specific products made in, e.g., bakeries, butcher shops, kiosks and foreign specialty stores, are not included in this version of the survey tool. The respondents were also asked to add shops that were excluded by the authors.

The stores were collected in various ways, ranging from using official national registers such as (Swiss Federal Statistical Office, 2008), to online searches (via e.g. Yellow Pages) and scanning the city using *Google Street View* to bike tours through the city.

Zonal models are common in transport science. However, as the eventual goal is to estimate a disaggregate model, a disaggregate approach for data collection was used as well. This means that even for locations with multiple grocery shops within a small area, e.g., railway station areas, single shops are identified and used in the survey tool.

For the next version of the survey tool, it is planned to prepare information about additional store attributes, such as opening hours, store size, price level, parking conditions and product range. Additionally, the scope of the next version will include markets and combined multi-stage purchases in bakeries, butcheries and greengrocers etc.

5.3 Survey Design and Implementation

As depicted in Figure 3, the survey consists of five sections and an entry and exit page. It is map-based and makes extensive use of *Google Maps* and its application programming interface (API) (Google, 2010a,b). The survey language is German.

5.3.1 1. Person Details

The recorded personal attributes include age, sex, monthly household net income, household size, place of residence and workplace (if any). These attributes are prominent in destination choice models.

Employees are asked about the modes mainly used for the trip to work. Knowing this, together with the intermediate points (way points) of the trip to work provided by the respondent in the second survey section, helps to complete the routing information for the route to work in the analysis phase.

Furthermore, employees are asked for the main area visited for workday grocery shopping trips (see Figure 1) and the frequency of purchasing:

- in the proximity to the residence (15 minutes travel time away from home at the most, using the mode mainly used for the trip to work),
- in the proximity to the work location (15 minutes travel time away from home at the most, using the mode mainly used for the trip to work),
- in the area between the two areas above and close to the route to work and
- in the remaining area.

The frequencies are specified as follows: Very often (multiple times per week), Often (approx. once per week), Occasionally (several times per month but at least once per month) and Never.

This information can be applied directly and with substantial benefit to time-geographic approaches for destination choice modeling. The question is especially designed for individuals whose workplace is outside of Zurich. For individuals who work in Zurich, the answer can also be derived from the survey section *3. Frequently Visited Stores*.

5.3.2 2. Route to Work

The second section of the survey provides a map with ten markers initially placed on a line between the residence and the workplace. The respondent is asked to move the markers so that the route to work can be identified. Thereby, most of the well-known elements and functions of *Google Maps* are provided, e.g., different views (satellite, map, and terrain), zooming, showing public transport stations, etc. Knowing the route to work allows the analyst to include trip chaining for employees. This section is automatically skipped for non-employed persons.

5.3.3 3. Frequently Visited Stores

The respondents are asked to select on a map all stores that they visit at least once per month. Clicking on a marker opens a window showing a *Google Street View* panel (Google, 2010c) (see Figure 2). The respondents' identification of stores is supported by *Google Street View*, which provides a capable means to inspect the surrounding area of stores. This procedure is chosen as it obviously provides more assistance for identifying a shop than simply showing a photo, for example. In addition, this makes the survey tool more up-to-date.

5.3.4 4. Adding Stores

As it cannot be guaranteed that literally every shop in the survey area is included in the survey as yet, the respondent is asked to add any missing shops that are frequently visited by him or her. As it is expected that most respondents will not necessarily know the exact address of stores, the possibility is provided to specify the address by moving markers on the map.

5.3.5 5. Frequency of Visits, Trip Chaining and Reasons for Not Visiting a Store

In this section of the survey, the division between shops that are visited frequently and shops that are never or only seldom frequented is investigated. It is expected that including the reasons for not visiting a shop that is located geographically close to stores of the preferred set will be productive for model development.

In order to avoid producing an infeasible burden for the respondents, the set of stores that is queried (QS) has to be restricted. At this point in time, the ten shops closest to the residence and the three closest stores of every frequently visited shop are included in the QS. The QS is dynamically updated dependent on the answers of the respondent. This information is made available to the respondent through a counter that shows the number of stores to be processed. If a new frequently visited store is found while querying the QS, both the PS in this section and the QS are updated. It is planned to include stores along the work route as soon as public transport routes are provided by *Google Maps* API (Google, 2010b).

Here again, the identification of stores by the user is supported by *Google Street View*. The questions posed are as follows:

First, the respondent's awareness of the store in question is queried. This gives valuable information about the respondent's awareness set, which is an important component of the classification proposed by (Narayana and Markin, 1975). This classification is used as a starting point to model different decision-making horizons.

Second, for shops that are known to the respondent, the frequency of visits to this store is requested.

Third, if the store is visited very often, the respondents are asked about the departure site of the shopping trip and the destination after having finished the purchase. The purpose of this question is to gain further insight into trip chaining effects associated with shopping trips. If the store is never or seldom visited, the reasons for this are also requested and the following options are provided:

1. "*Unknown. I have never thought about the reasons*".
2. The product range and quality do not match the respondent's needs.
3. The store is not located close to the start, end or a change station of public transport.
4. The store does not lie en route or is too far away from the residence.
5. The store is disadvantageous with respect to value-for-money.
6. The store does not satisfy in terms of parking conditions.
7. The store does not have a nice atmosphere.
8. Further reasons given by the respondent.

It can be assumed that the stores for which option 1 is chosen have not yet been part of the decision-making process *or* that the respondent has a neutral evaluation for these stores. In other words, the respondent is aware of the stores but does not visit them frequently, but may also not have a reason not to visit these stores. As mentioned earlier, in the model of (Narayana and Markin, 1975), the set of stores for which the respondent has a neutral evaluation is called the *inert set*.

More importantly, the stores for which the respondent chooses at least one of options 2-8 constitute the *inept set* as defined in (Narayana and Markin, 1975) revealing the interesting division between stores for which the respondent obviously has a positive evaluation (PS) and the stores for which the respondent has a negative evaluation (*inept set*).

5.4 Technical Details

The survey is implemented using PHP, Java Script, HTML and SQL in combination with a mySQL database. A tab-based design is applied that enables the user to navigate back to previous questions for corrections and additions. To counter fatigue, all forms that contain follow-up questions that are dependent on preceding answers, are created dynamically. In addition, mandatory fields are colored as long as they are empty. For the few stores that cannot be accessed via *Google Street View* (underground stores at railway stations, etc.) an author-provided photo is shown instead.

Figure 1: Main area of grocery shopping trips for commuters (translated)

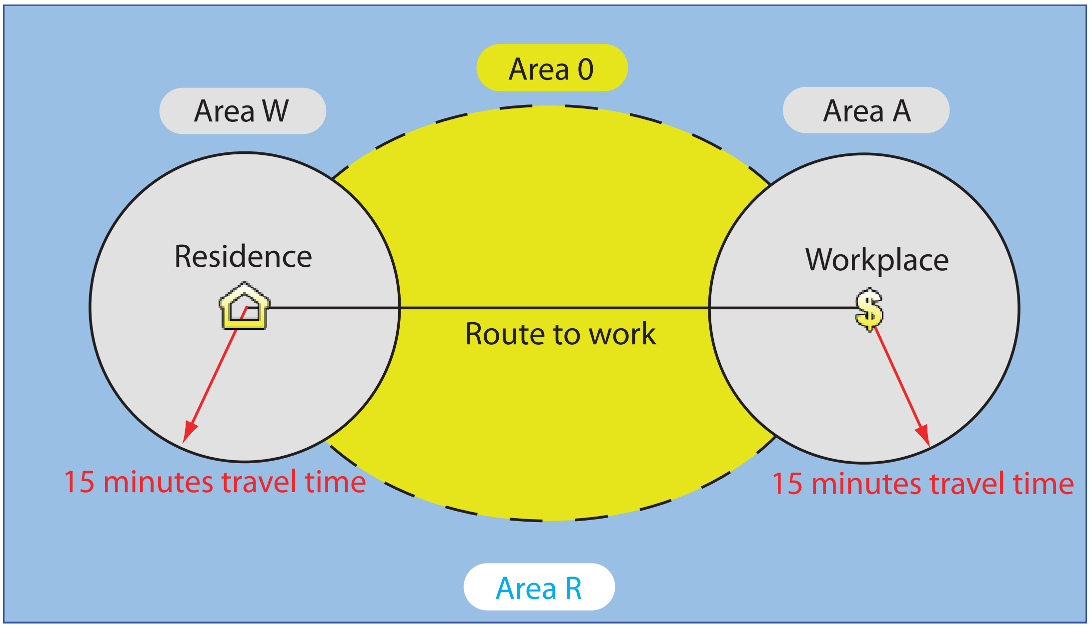


Figure 2: *Google Street View* perspective of a store site and survey questions (German)

Dhillons Quartiermarkt

Kennen Sie diesen Laden?

- (•) ja
- ( ) nein

Wie regelmässig haben Sie diesen Laden in diesem Jahr besucht?

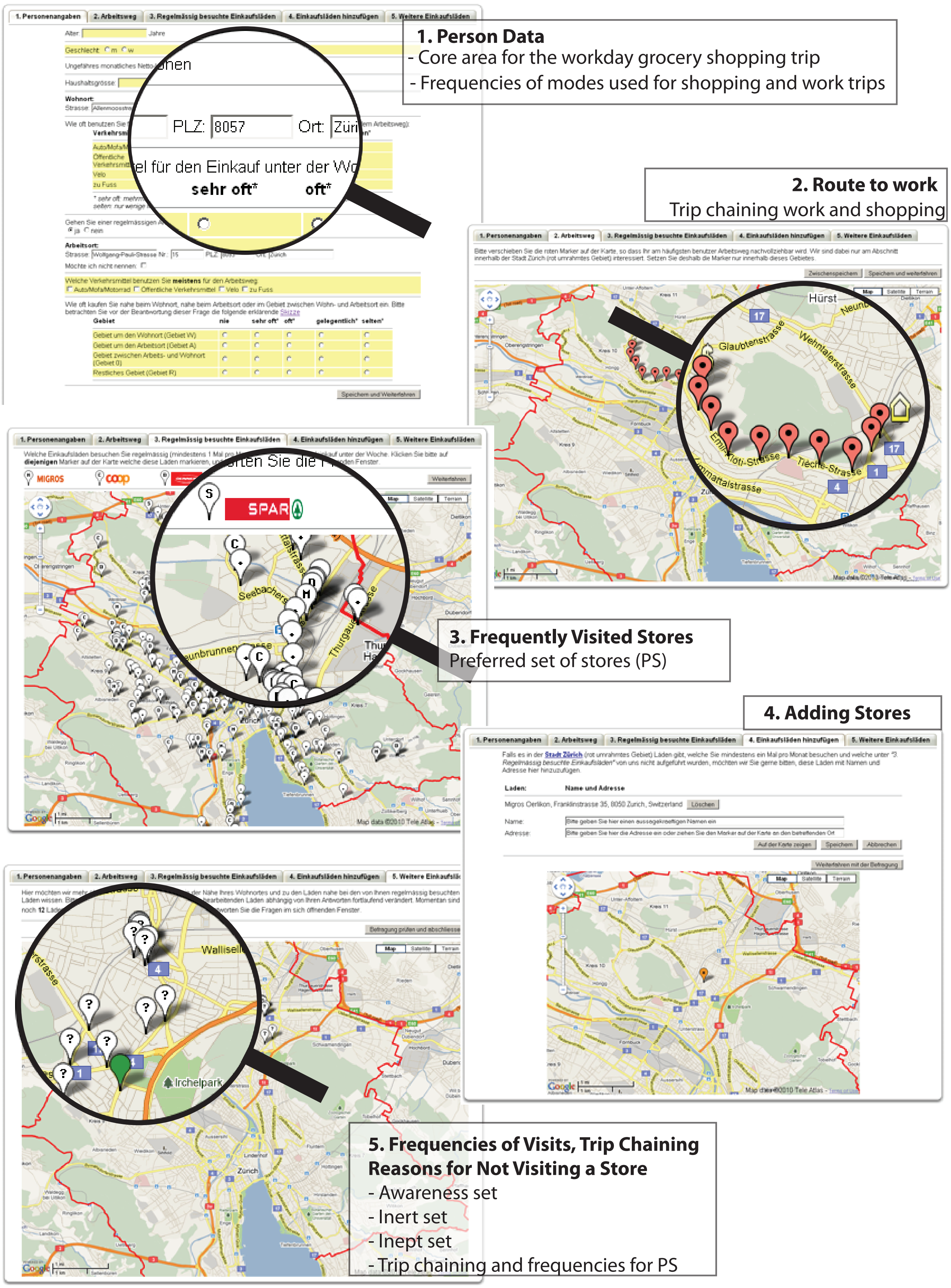
- (•) nie
- ( ) sehr oft (mehrmals pro Woche)
- ( ) oft (ca. 1 Mal pro Woche)
- ( ) gelegentlich (wenigstens 1 Mal pro Monat)
- ( ) selten (wenigstens 1 Mal pro Jahr)

Welches sind die Gründe, warum Sie diesen Laden selten oder gar nie besuchen (Mehrfachantworten möglich)

- [ ] Weiss nicht, habe ich mir noch nicht überlegt
- [ ] Mir wichtige Produkte fehlen
- [ ] Unpraktisch, weil für mich keine Umsteige- oder Endhaltstelle (Reise mit dem ÖV)
- [ ] Ist mir zu weit weg / liegt nicht an meinem Weg
- [ ] Schlechtes Preis-Leistungsverhältnis / zu teuer
- [ ] Schlechte Parkiermöglichkeiten
- [ ] Einkaufsatmosphäre gefällt mir nicht (Produktpräsentation, Platzverhältnisse, Personal etc.)
- [ ] weitere Gründe: ________

Speichern und Fenster schliessen

Figure 3: Survey Overview



6 Pre-Test

A pre-test was conducted to get some first indications for the following two questions. First, are the respondents able to efficiently navigate in the maps and locate the stores that they frequently visit? Second, is the map-based approach evaluated by the respondents as advantageous, compared to typical list-based approaches. In other words, is the intention of providing a method with game-like traits appreciated or seen as confusing? An incentive of 10 Swiss francs was offered.

To answer these questions, the following issues were evaluated.

- **Total time needed for the survey.**
- **Efficiency of reporting the frequently visited stores:** The map in this section of the survey contains the complete set of stores. The average time needed to report on the visits to a frequently visited store was measured to evaluate if this task can be accomplished with a reasonable effort.
- **Necessity for support by an interviewer**, using a scale ranging from 1 (support is not necessary and rather confusing) to 7 (support is urgently needed)
- **Convenience of the map-based approach**, using a scale from 1 (exhausting) to 7 (helpful and entertaining).
- **Fatigue in survey section 5:** The maximum number of stores for which the user is willing to report is surveyed. This will help to adjust the query set (QS) size in future versions of the survey tool.

6.1 Pre-Test Results and Conclusions

All ten pre-test participants were PhD students, with age ⌀ 31 ± 2.4 years. A second pre-test using a representative and larger sample of the Swiss population, including inexperienced computer users, is required. Timing information includes short discussions between the pre-test examiner and the respondent during the completion of the survey and is hence meant to provide first references only.

With an average total required process time of 24 ± 7 minutes, the survey represents an acceptable burden, as confirmed by the respondents. The efficiency of reporting the frequently visited stores varies significantly. The time needed to find a frequently visited store averages 50 ± 33 seconds. This indicates that at least for people who are not frequent users of *Google Maps* (e.g., elderly people) support by an interviewer needs to be taken into account. This is confirmed by the respondents although they do not see a need to be supported themselves (rating: ⊘ 3.5).

The map-based approach is rated as entertaining and helpful (rating: ⊘ 6.8 points). Having a mean at hand for scanning the residence area (or the work area) on a map to get to know additional stores was seen as an interesting feature. It was used by most of the respondents beyond the required tasks. This supports the assumption that designing surveys as informative games could strongly reduce the burden for the participants, where again support for inexperienced people must be checked. The maximum acceptable size of the QS in section 5 averages 31 stores, while the average size of the QS for the pre-test was 24 stores.

Most interestingly, indications are given for the appropriateness of model estimation approaches, taking into account the concept of dominance, e.g., the dominance attributes approach (Cascetta *et al.*, 2007; Cascetta and Papola, 2005). Although a list of reasons for not visiting a store is provided in the survey, for some stores, the respondents labored to report reasons other than "*one of my preferred stores is close by*". In all these cases, the preferred stores belonged to the largest Swiss retailers.

7 Outlook: Avenues for Model Estimation

Two perspectives on discrete destination choice modeling can be identified. According to the first perspective, discrete destination choice models are a purely statistical tool. The thresholds that define the choice sets are (optimally) set where the parameters to be estimated stabilize. However, research on this stabilization behavior of the parameters and the associated thresholds is rare. Furthermore, this approach does not reveal the behavioral base of decision-making and is expected to be computationally costly when applied in forecasting models.

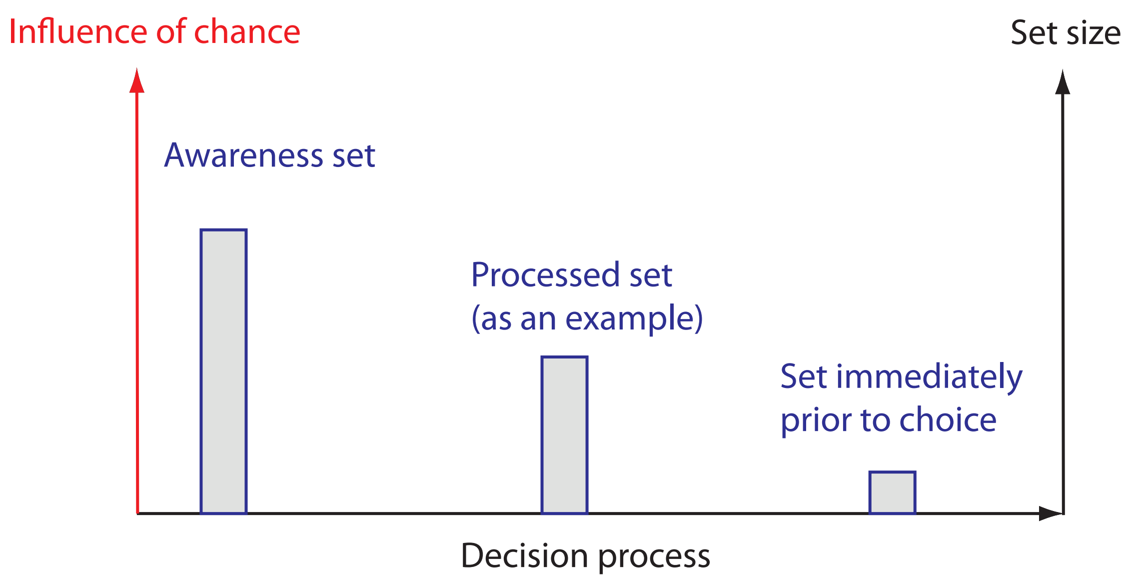
The second perspective, applied in this work, tries to approach destination choice set formation from a behavioral perspective. The overall goal is to define the choice set in such a way that it is *easy to survey* (and easy to generate in forecasting models) *and* so that it *actually plays a well-defined role* in the process of coming to and making a destination decision. Space-time prisms of time-geography, derived from travel time budgets, among others, provide an appealing approach to specify choice sets that play a role in the final decision before undertaking the respective trip. However, the specification of individual travel time budgets is subject to the same empirical and methodological problems pointed out earlier, so that searching for travel time budgets is essentially a *proxy problem* to specifying choice sets.

A different approach, inspired by mental map models, could be to use the awareness set as the choice set. The PS (preferred set of stores) plays the role of the *observed choice* in this model. For this approach, which delivers frequency data (i.e., rank data) it is potentially beneficial to apply an exploded logit model or to simulate n decisions of one person with n persons, each making one decision.

In general, the search for a set showing these characteristics is subject to the following fundamental problem (see Figure 4). The decision-making process (including preceding learning processes) can be seen as a process during which the decision-maker, starting with the awareness set and ending with the final decision, successively reduces the number of alternatives. For any non-trivial decision-making problem, the more one retrogrades in this process, the more dominant become the random influences. For example, the membership of a store in a person's awareness set can be caused by one single random visit of this person in a bar close to the store in question, whereas the reasons that a store belongs to the person's preferred set are much less random. However, the awareness set is in fact an important component of the decision-making process and, thus, means have to be developed to adequately model these random influences.

In essence, it is one of the declared goals of this work to provide a means to either successively approach a set that is easy to survey and that actually plays a well-defined role in the process or to demonstrate that such a set cannot exist.

Figure 4: Different Sets in the Decision Process and Influence of Chance. The processed set, shown as an example, is specified in (Foscht and Swoboda, 2007) as the set of stores for which the individual has gathered information.



8 Summary and Conclusions

As shown in this paper, discrete destination choice models exhibit crucial methodological gaps and a lack in terms of the empirical basis for choice set formation. In general, more reflection on the decision horizon to be modeled is necessary, i.e., the (possibly rule-based and temporally extended) learning process that precedes the final decision has to be explicitly taken into account. Furthermore, the behavioral basis of discrete destination choice models needs to be investigated. It has to be researched if they are a purely statistical tool, or if the inclusion of behavioral rules can help to achieve a productive choice set formation.

This paper introduces a Web-based *publicly available* survey tool to empirically approach destination choice set formation. The tool is map-based and uses *Google Maps* and *Google Street View* to support the respondent, where the applicability of the tool and the benefit of using a graphical map-based approach were verified in a first pre-test.

The methodological gaps and the sparse empirical basis of destination choice models are (in the opinion of the authors) responsible for a certain lack of recent progress of destination choice modeling. This paper tries to stimulate more intense research on this important topic.

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