Determination of Potentials for Drivers and Passengers of Integrated Ridesharing Services in Rural Areas

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Abstract

In 2013, a service which combines ridesharing with public transportation was launched in three test regions in Northern Hesse (Germany) called "Mobilfalt". Since the launch of the service, it was observable that many citizens are willing to use it as passengers while it was only possible to recruit a small number of drivers.
This paper describes the development of a potential model based on a household survey which was conducted in the test regions. Since the survey is representative, the extrapolated data can be used to draw conclusions about the population of the test regions. The model can be used to determine the quantity and characterization of potential drivers as well as passengers. The potential intensity was determined based on four categories: dependency on public transportation, awareness of "Mobilfalt", experience of riding with somebody and giving somebody a ride as well as attitudes and personality features. With the objective of gaining more private drivers, the results of this potential model are used to develop "Mobilfalt" further.

Keywords: mobility as a service; public transport; rural areas, ridesharing; potential analysis

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1. Introduction

Public transportation in German rural areas is confronted with an ongoing demographic change with a declining and aging population. Especially the decline of school children leads to decreasing revenues while the costs stay the same. (Sommer et al. 2016)

To tackle these problems, the transport association of Northern Hesse (Nordhessischer Verkehrsverbund) launched a service called "Mobilfalt" in 2013. The objective is to improve public transport by integrating ridesharing into the existing public transportation between villages and the next local centre. Thereby, the accessibility to regional public transportation and to centralized facilities such as doctors and public authorities has improved. Currently (as of 2017), Mobilfalt is operating in three regions in Northern Hesse, Germany (Witzenhausen, Großalmerode and Sontra/Nentershausen/Herleshausen, see Fig. 1). (Sommer and Schmitt 2013,)
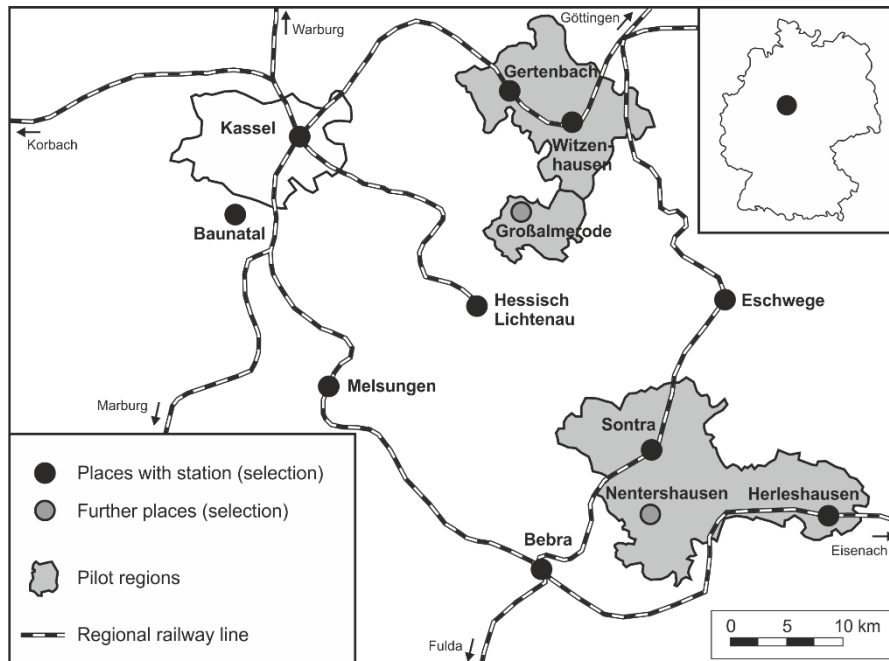

Figure 1: The three Mobilfalt regions as of 2017, Source: Harz and Sommer 2016

Mobilfalt works on demand. It complements existing bus timetables of villages with additional rides to increase the frequency of public transportation to an hourly service. Mobilfalt operates between 5 a.m. and midnight from Monday till Saturday and between 8 a.m. and midnight on Sundays. Without Mobilfalt, most villages would only have access to public transportation until 7 p.m. on a workday and no access at the weekend. Rides begin and end at the stops of the local public transportation. They usually connect the next local centre with villages nearby. These rides are only executed if there is demand. Citizens can book them online or via phone up to one hour in advance. (Sommer and Schmitt 2015)

Rides can be executed by private drivers. Drivers can enter their rides into the Mobilfalt-system in advance either online or by telephone. They can choose whether they want to offer single or reoccurring rides. If a private offer matches with a booking of a passenger, the driver receives an inquiry for this ride via text message or mail. He or she can confirm or refuse the ride. If the ride is confirmed, the driver and the passenger receive the necessary information within 30 minutes before the ride. In case no private driver is found or the driver refuses the request, the ride will be executed by a taxi. The passenger pays a fee of one to two euros for the ride regardless whether the ride is executed by a private driver or a taxi. The private driver will receive 0.30 € per kilometre as a compensation.

To participate, citizens need to register beforehand. This can be done also online or by telephone. Drivers need to confirm their identity with a driver's license. (Kepper et al. 2014)

Since Mobilfalt has been launched, the number of passengers grew continuously, and it is widely used by them. For many citizens depending on public transport, it became a crucial part of their travel behaviour. On the downside, most rides are not executed by private drivers but by taxis. The number of matchings remained low

since it was not successful to recruit an adequate number of active drivers. In contrast to the passengers, drivers have no personal gain apart from the compensation of 0.30 € per kilometre.

This is one of the reasons why the research project "GetMobil" was launched in 2015. Its objective is to analyse success factors and obstacles of shared and linked traffic services. Mobilfalt serves as a kind of "laboratory" in which results of GetMobil like measures can be implemented and evaluated in a practise-oriented environment. During the project it became apparent, that especially the understanding of the behaviour of drivers must be considered. The research project is funded by the German Federal Ministry of Education and Research (BMBF).

2. Empirical basis: household survey

Large parts of the results of the ongoing project "GetMobil" are based on a household survey which was conducted in May 2016 in two of the three test regions. The aim of the survey was to evaluate the travel behaviour of the citizens in the corresponding municipalities of Mobilfalt. The focus lay on the experience of riding with somebody and giving somebody a ride. With regards to its content, the household survey was divided into the following parts:

- sociodemographic information about all household members,
- experience with hitching and taking other people for a ride, use of car, public transportation, internet and smartphone,
- location and accessibility of typical points of interest,
- knowledge and use of different ridesharing services, including Mobilfalt,
- all trips and activities of a day,
- attitudes towards car use, public transportation and ridesharing services based on a questionnaire by Hunecke and Haustein (2007) with usage of a five-level Likert scale,
- personality features with usage of a five-level Likert scale.

Altogether, 1017 citizens from 805 different households were interviewed by phone. The response rate was 14 %. The sample showed differences compared against the composition of the population in the four municipalities. Especially children aged 14 to 17 were underrepresented whereas older people aged over 65 were overrepresented. This bias was corrected with an extrapolation on the total population (14 years or older) based on age, sex and household size. Additionally, several mobility parameters were analysed in comparison with the German National Travel Survey (MiD). It showed that the mean number of trips, which was derived from the household survey, is lower than the reference value from MiD. It can be suggested that this effect occurs due to a bias regarding highly mobile people. These people have an above average number of trips per day and it is difficult to reach them via phone.

3. Determination of the potential for passengers and drivers

An important question for further development of Mobilfalt was, how many citizens have a potential to engage in Mobilfalt either as a driver or a passenger. During the scientific monitoring of Mobilfalt in the implementation period, the number of potential users was determined in the following way: All citizens in the pilot region aged 14 or older are regarded as potential passengers, excluding citizens in the principal towns of Sontra and Witzenhausen. Potential drivers are all citizens in the pilot region who own a private car. This determination of the number of potential users can be seen as the upper boundary. It is highly unlikely to reach this potential. Therefore, a more realistic approach for the potential determination was needed to enable a distinction of potential passengers and drivers within the target group.

3.1. Potential attributes

Based on the household survey, the following categories were defined to determine the potential:

Transit captivity

One speaks of transit captivity when a person is restricted on using public transport because of objective or subjective constraints (Wermuth 1980). The main indicator is a missing access to a private car. For longer distances, which cannot be covered by walking or cycling, public transport is the only option. The missing access to a private car can have multiple reasons:

- no private car in the household
- missing driver's licence
- health restrictions

The transit captivity is an individual characteristic which does not consider that other people in the household may have access to a car. In that case, a person may have the possibility to ride with a member of the household. However, persons who have no access to a private car in the household do not have this possibility. Therefore, the dependency on public transportation was divided into three groups:

A) not dependent on public transportation
B) captive respectively public transport or receiving a ride: missing individual access to a private car but access of other members in the household to a private car exists
C) purely captive respectively public transport: missing access to a private car in the household

Mobilfalt is an alternative as well as a supplement for the existing public transport and therefore highly important for the mobility of captive transit riders. The passenger potential of this group is therefore above average.

Awareness of Mobilfalt

As already mentioned, the survey included items regarding the knowledge and use of different ridesharing services including Mobilfalt. It can be assumed that citizens who know Mobilfalt have an above average potential to engage either as a passenger or as a driver. The knowledge of Mobilfalt is divided into two groups:

A) Mobilfalt is not known
B) Mobilfalt is known

Experience as a ridesharing passenger

It can be assumed that citizens who are experienced in driving with people from other households, have a higher probability of engaging as a passenger at Mobilfalt. This level of experience is derived from parts of the survey, in which the participants were asked how often they ride with people from other households and which category of people this includes. Participants were considered experienced if they ride at least once a week with people from other households. Furthermore, it was assumed that people are more experienced if they ride together with unfamiliar persons. The experience as a passenger is divided into the following groups:

A) no experience
B) experience in riding with neighbours, friends or colleagues
C) experience in riding with unfamiliar people

Experience as a ridesharing driver

Similar to the level of experience as a passenger, the experience as a driver was determined by asking the participants how often they give members of other households a ride. The level of experience is determined analogously to the previous segment with the following groups:

A) no experience
B) experience in giving neighbours, friends or colleagues a ride
C) experience in giving unfamiliar people a ride

Attitudes and personality features of passengers regarding ridesharing

It can be assumed that the attitudes towards the use of a personal car, public transport and ridesharing services as well as personality features have an influence on the use of ridesharing and are therefore important for the determination of the potential for Mobilfalt. Attitudes and personality features were surveyed with a five-level Likert scale. The questions were included in the survey by a project partner for their behavioural research and were not specifically intended for this potential model. For the passenger's potential, it was assumed, that a positive attitude towards ridesharing and trust in people have a positive impact. Therefore, the following questions were chosen from the question set:

- "I think that ridesharing services are a current trend."
- "I am convinced that most people have good intentions."

An agreement to these questions is regarded as conducive for the potential use of Mobilfalt. The response was divided into three groups:

A)   negative response for both questions
B)   different response for both questions or questions have not been answered
C)   positive response for both questions

Attitudes and personality features of drivers regarding ridesharing

For the drivers it was assumed, that a positive attitude towards ridesharing as well as public transport has a positive impact. The aspect of public transport was included, because Mobilfalt complements the existing public transport with ridesharing. In addition, it was assumed that the openness and habits of drivers have an impact. Therefore, the following questions were analysed:

- "I think that ridesharing services are a current trend."
- "I appreciate driving the car because I can decide for myself with whom I can ride together"
- "I think that taking trains and busses is a current trend."
- "I see myself as someone who is open-minded about new things."
- "I am convinced that most people have good intentions."
- "I feel comfortable if everything goes in its usual manner."

The larger number of relevant items makes it necessary to reduce the complexity. This was done with the help of a principal component analysis (PCA). The result were two PCA-factors which describe around 44 % of the variance of the input items. The Kaiser-Meyer-Olkin Test showed, that the quality of the sample was rather low. Nevertheless, the results were used for the potential model but it was considered, that the reliability of this attribute is affected by this.

The two determined factors can be described in terms of content. Factor 1 combines the items regarding the status of public transport and ridesharing services as well as the confidence in other people. Factor 2 describes the need for routine and privacy regarding driving a car. Both factors are normalised, meaning that the mean value is set to zero. Factor 1 has a positive effect regarding ridesharing whereas factor 2 has negative effect. A positive response towards ridesharing means for factor 1 positive values and for factor 2 negative values. The response towards ridesharing from the input questions is divided into groups in the following way:

A)   negative response for both PCA-factors
B)   negative response for factor 1 and positive response for factor 2
C)   neutral response for both factors
D)   positive response for factor 2 and negative response for factor 1
E)   positive response for both factors

3.2. Potential model

The model to determine each citizen's potential as a driver or a passenger is based on the described attributes. The challenge was to transform these attributes into a metrical scale to calculate an individual potential score for every citizen asked. The objectivity of these attributes shows great differences. The dependency on public transport and the awareness of Mobilfalt are rather objective whereas the experience in riding with somebody, giving rides to other people and especially the attitudes and personality features are rather subjective. Furthermore, especially these two attributes are based on several assumptions by the researcher. Therefore, fuzziness is taken into account in the model design.

For the model, the feature characteristics were transformed into metrical variables, which have values between 0 (no effect on the potential) and 1 (maximum effect on the potential). The manifestations of the attributes are summarised in table 1.

Table 1: Attribution of metric values to the potential attributes.

group	category	A)	B)	C)	D)	E)
passengers	P1: Transit captivity	0	0.75	1	-	-
	P2: Awareness of Mobilfalt	0	1	-	-	-
	P3: Experience as a ridesharing passenger	0	0.5	1	-	-
	P4: Attitudes and personality features	0	0.5	1	-	-
drivers	D2: Awareness of Mobilfalt	0	1	-	-	-
	D3: Experience as a ridesharing driver	0	0.5	1	-	-
	D4: Attitudes and personality features	0	0.33	0.5	0.67	1

The influence of each attribute on the total potential is controlled by an individual weighting factor w. The weighting factors were determined in such a way, that the extent of objectivity and reliability of each attribute is considered. With growing objectivity, an attribute has more influence on the total potential (see Fig. 2).
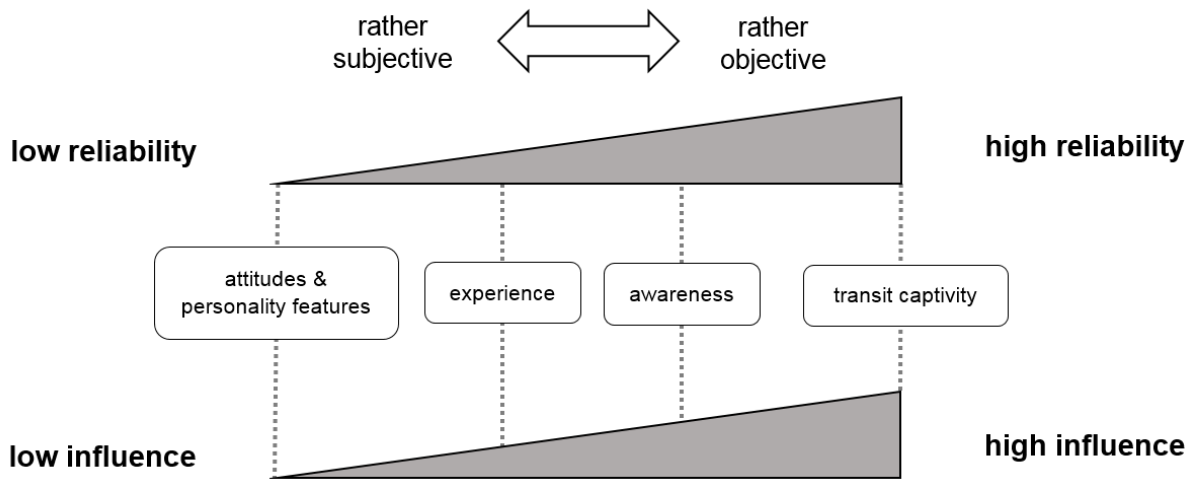

Figure 2: Classification of the attributes regarding objectivity and reliability, Source: Harz and Sommer 2016

The total potentials for passengers s_P and for drivers s_D were determined as followed:

$$s_P = 100 \cdot \begin{pmatrix} w_{P1} \\ w_{P2} \\ w_{P3} \\ w_{P4} \end{pmatrix} \cdot \begin{pmatrix} P1 \\ P2 \\ P3 \\ P4 \end{pmatrix} = 100 \cdot \begin{pmatrix} 0.4 \\ 0.3 \\ 0.2 \\ 0.1 \end{pmatrix} \cdot \begin{pmatrix} P1 \\ P2 \\ P3 \\ P4 \end{pmatrix} \tag{1}$$

$$s_D = 100 \cdot \begin{pmatrix} w_{D2} \\ w_{D3} \\ w_{D4} \end{pmatrix} \cdot \begin{pmatrix} D2 \\ D3 \\ D4 \end{pmatrix} = 100 \cdot \begin{pmatrix} 0.5 \\ 0.35 \\ 0.15 \end{pmatrix} \cdot \begin{pmatrix} D2 \\ D3 \\ D4 \end{pmatrix} \tag{2}$$

$$\sum_{i=1}^{i=4} w_{Pi} = \sum_{i=2}^{i=4} w_{Di} = 1$$

The potential score s is a value between 0 (no potential) and 100 (maximum potential). For further analyses, the potential was aggregated into four potential groups:

$s < 10$:   no potential
$10 \leq s < 40$:   low potential
$40 \leq s < 70$:   medium potential
$70 \leq s$:   high potential

A sensitivity analysis was performed for the weighting factor values to evaluate if alterations lead to changes of attribution to the four potential groups. Thereby no major changes in attribution were observed.

4. Results

4.1. Passenger potential

The potential groups for passengers are distributed among the target population for Mobilfalt as follows:

- No potential: 39 %
- Low potential: 34 %
- Medium potential: 21 %
- High potential: 6 %

In total, only 6 % of the target population (918 people) have a high potential. More than a third of all people has no and another third has a low potential to engage as a passenger.

An allocation of the potential groups in sociodemographic stages of life (based on Jäger 1989) shows notable differences (see Fig. 3). With growing potential, the shares of school children, trainees and students as well as single elderly people over 75 years of age increase. On the other hand, the shares of adults under the age of 65 and elderly people in multi-person-households decrease. The allocation into age groups shows, that the shares of people who are 30 to 64 years old decrease while the shares of people who are under 30 years old increase. No significant differences were found between women and men. When analysing occupational categories, it is observable that with growing potential the shares of employees decrease whereas the shares of students increase. The allocation into the highest educational achievement shows that especially the shares of people with higher education are above average in the group "high potential".

With growing potential, the shares of people who use the internet daily or never increase. There are no differences between the potential groups regarding the possession of smartphones.

The travel behaviour of the potential groups shows, that while there are no significant differences regarding the mean number of trips per day, there are large differences regarding the modal split. With increasing potential, the shares of trips which were travelled as a driver by car decrease notably, whereas the shares of other modes, especially travelling as a passenger by car and public transport, increase. This shows that people with a dependency on public transportation have by definition a high potential as a passenger.

4.2. Driver potential

Regarding the drivers, the target population of Mobilfalt can be divided into the following potential groups:

- No potential: 40 %
- Low potential: 29 %
- Medium potential: 18 %
- High potential: 14 %

Overall 14 % of the target population (around 3,400 people) have a high potential to engage as a driver with Mobilfalt. However, more than two third of the population have no or merely a low potential.

The allocation of the potential groups into sociodemographic stages of life shows that with growing potential the shares of adults under the age of 65 increase (see Fig. 3). 81 % of the group with medium and 77 % of the group with high potential are adults. The allocation into age groups shows that with growing potential the share of the age group of 30 to 49 increases, whereas the shares of younger and older people decrease. Also, the driver potential groups show no significant differences between women and men. The allocation into occupational categories shows that the share of employees grows with increasing potential, whereas the share of retirees decreases.

Furthermore, the share of people with higher education grows with increasing potential, whereas the share with people with a lower education decreases.

The use of the internet differs distinctly among the potential groups. In the group of people with a high potential, 75 % of them use the internet daily, whereas only 6 % never use it. However, in the group with no potential, only 53 % of people use the internet daily and 27 % never use it. Also, the rate of possession of smartphones differs. In the group with a high potential, 78 % of people own a smartphone, whereas in the group with no potential only 56 % of people own a smartphone.

The travel behaviour of potential drivers shows that people with a high potential travel more trips per day than the other potential groups. Furthermore, there are minor differences regarding the modal split. With growing potential, the use of the car as a driver increases slightly and the use of the car as a passenger decreases.
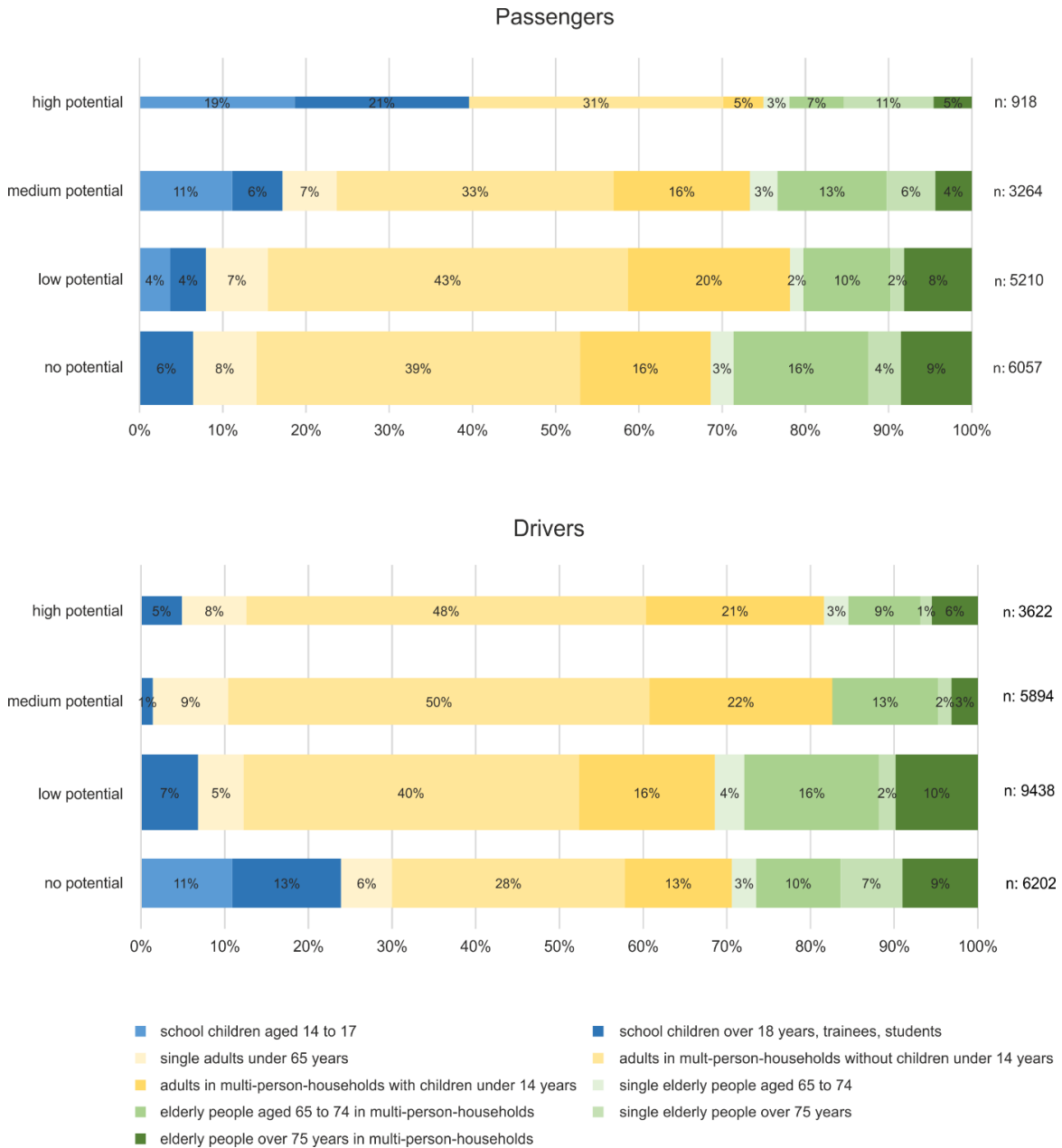

Figure 3: Allocation of the potential groups into sociodemographic stages of life of passengers and drivers, Source: Harz and Sommer 2016

5. Conclusion

A requirement for the potential model was to distinguish and characterize the potential groups. The results should support further development of Mobilfalt and adjust communications targeting potential drivers and passengers. The results describe the state of the potentials at the time the house hold survey was conducted. The composition of the potential groups is not fixed. An extension of marketing measures can lead to a higher awareness of Mobilfalt and therefore changes the size and composition of the potential groups. The results should not be seen as exact values but rather as an orientation because of the number of assumptions which are part of the model.

5.1. Exploration of the passenger's potential

The results of the potential analysis for passengers correspond with the costumer group which was targeted since the beginning of Mobilfalt. As expected, the target group mainly consists of younger people between 14 and 30 and older people over 65 years with no or restricted access to a car. These people are mostly captive transit riders and therefore also dependent on Mobilfalt. Since the number of passengers grows continuously, there is no urgent need to invest a lot of effort into gaining new costumers. The transport association presents Mobilfalt in schools and at public festivities. These activities should be pursued but there is no need to extend public relations to attract new passengers because Mobifalt is already widely used by them.

5.2. Exploration of the driver's potential

A more urgent task is to attract more active drivers. With the help of the potential analysis, the target group can be characterized more precisely.

It is shown that the target group mainly consists of adults aged between 30 and 65. These individuals usually live in a multi-person household, are often employed and tend to have a higher education. It also shows that the target group lives more often in the outer districts of Witzenhausen and Sontra than in the principal towns. The target group is open to new media in an above-average manner: both the frequency of internet use and the proportion of ownership of a smartphone are above-average. In addition, people with a high potential are characterised by a higher number of trips per day compared to people with a lower potential. The target group has a high affinity for cars and is sceptical towards public transport.

In order to increase the number of active drivers, all marketing instruments - product, pricing, distribution and communication policies - should be oriented towards the drivers with high potential.
It should be considered that the target group does not often have much time for additional activities, regarding the high amount of families and employees. Therefore, it must be possible to offer rides quickly and easily. Regarding the target group's car-oriented mobility, more attention must be paid to the car driver's viewpoint as well as their current situation. This concerns on the one hand the system itself which has been aimed at costumers with a high affinity for using public transport and a good knowledge of the stops and routes of the Mobilfalt lines until now.

On the other hand, the booking system should support the driver considerably better by demanding a minimum of knowledge of the system and by automatically allocating driver and passenger trips. Similar to navigation systems, it should also be possible to enter a ride with a start and target address without knowing the location of the next Mobilfalt stop. The high affinity for new media within the target group also makes it necessary to expand electronic distribution channels like (mobile) websites.

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