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The planned and the perceived city: a comparison of cyclists' and decision-makers' views on cycling quality

Abstract

Introduction

Traffic jams, congestion and pollution demand sustainable modes of transport. To increase the appeal of cycling, bicycle-users' perceptions and needs should be acknowledged by decision-makers. However, traditional transport planning mainly focuses on quantitative, infrastructural data. To address this research gap, this study explores to what extent decision-makers are aware of cyclists' needs and perceptions. Furthermore, the study compares the assessments about cycling of decision-makers and cyclists in Leipzig, Germany.

Methods

Qualitative Interviews with 13 cyclists and similarly structured interviews with 6 experts from politics and planning were compared using qualitative content analysis. Two main topics were examined: (1) the reasons for cycling and (2) the perceived environment (built, natural and individually perceived). To integrate the spatial context, the interviewees draw sketch maps which were analyzed and compared using geo-information systems.

Results

Experts assume that main roads with cycling infrastructure are decisive for fast and safe cycling and cyclists agree with this statement. However, cyclists further refer to the positive effects of green spaces, the experience of the natural environment (e.g. fresh air) as well as the healthy and recreational effect of cycling. Cyclists prefer taking side roads and are prepared to use detours to integrate the natural environment and avoid traffic jams, noise and air pollution – these aspects were rarely acknowledged by decision-makers.

Discussion

We conclude that urban planners need to involve cyclists' perceptions more explicitly. Integrating cyclists' experiences in planning processes using sketch maps and interviews have added value, complementing quantitative approaches to enhance the understanding of cyclist behavior. The findings are essential to promote a sustainable, healthy and environmentally friendly urban development appropriate to citizens' needs.

Keywords:

Planning for cycling; cycling behavior; perceived environment; decision-makers' evaluation; cyclists' experiences

1. Introduction

Cycling is considered one of the main drivers for a shift towards an environmentally friendly, healthy, space-saving and sustainable urban mobility (Guski, 2013; Pucher & Buehler, 2017). It is not considered to be solely a mode of transportation, but also expresses personal identity (Flade, 2013; Parkin, 2012). Cycling holds benefits for personal wellbeing, health and fitness, is financially beneficial and supports a high quality of life in urban areas (Bamberg, 2012; de Sousa et al. 2014; Heinen et al., 2010; Oja et al., 2011). Meanwhile, it functions as a noise-abating and pollution-free mode of transport, holds environmental benefits for urban areas and promotes climate change mitigation goals (Ahrens et al., 2013; Parkin, 2012). Moreover, cycling is the fastest mode of urban transport for trips below 5km in Germany compared to walking, public transport and driving when considering the average speed and time needed to access the respective mode (Federal Environmental Agency, 2014).

Even though these benefits are evident, traditional urban transport planning and policy still focus very much on motorized private transport and especially consider traffic flows, traffic safety and transport infrastructure (Guski, 2013; Wilde & Klinger, 2017). The bicycle was long neglected and hardly considered in transport research and planning. However, the share of cycling trips shows a sharp rise in European cities and research published on cycling has dramatically increased over the recent decades (Pucher & Buehler, 2017). Studies have proven the necessity to consistently integrate the bicycle in the planning of transport networks, in infrastructural considerations and in the way of shaping the urban space (de Sousa et al., 2014; Koglin, 2015). Yet the question arises whether the current cycling measures developed in urban policy and planning processes are matching the users' needs - only then can the measures convince infrequent or non-cyclists to a mode shift towards cycling (Milakis & Athanasopoulos, 2014).

To address this question, it is necessary to not only focus on statistics, infrastructure data and tallies of cyclists, but to acknowledge the urban space as a "lived space" and address the "lived experience and expectations of the end-user; the active citizen as an agent of change" (Cox, 2008). As for policy and planning, experiences and perceptions of those who already cycle frequently should be investigated more deeply and integrated into decision-making (Cox, 2008; Iwinska, 2018; Milakis & Athanasopoulos, 2014). So far, research is lacking which investigates to what extent urban decision-makers are aware of the needs, the motivation and everyday experiences of cyclists. To address this research gap, the aim of this study is to investigate whether a bias or a consensus exists in the perception of cycling in urban areas between decision-makers and cyclists.

We investigate if the expert point of view differs from the cyclist-view both in reasons for cycling and perception of cycling quality. The main objective of this study is to compare the view of bicycle-users with experts in urban planning and policy regarding three main dimensions:

(1) Exploring the **reasons** for using the bicycle as a daily mode of transport
(2) Revealing how the **quality** of cycling is perceived in an urban environment and which factors influence the perceived quality
(3) Understanding the reasons behind **decisions of routes**

2. Theoretical Background

We built on a theoretical framework assuming that a paradigm shift in traditional transport planning towards a novel concept of mobility is taking place (Blechschmidt et al., 2015; Wilde et al., 2017). The rather technical-organizational approaches of traditional transport planning, which are based on modernistic planning theories with a focus on motorized car traffic, have long focused exclusively on traffic flow, traffic demand and traffic prognosis (Koglin & Rye, 2014). Cyclists and pedestrians have rarely been considered equally in planning approaches and transportation models (Aldred, 2014; Koglin & Rye, 2014; Nielsen et al., 2013). As argued by Koglin and Rye (2014), this is a result of the power relations within policy and planning about how urban space should be shared and a lack of theoretical thinking for cycling planning among planners and researchers. If the lives of planners and politicians are still based on cars and the traditional planning approaches are associated with motorized transport, the importance of the car is further consolidated (Freudendal-Pedersen, 2015). However, a shift from traditional transport planning concepts based on motorized transport towards the concept of mobility is taking place, with a strong focus on human-beings, their mobility, behavior, experiences, values and attitudes (Koglin & Rye, 2014; Schwedes, 2014; Wilde et al., 2017).

Following Wilde and Klinger (2017), our theoretical framework builds upon the assumption that it is necessary to connect a social science-related mobility understanding that focuses on the individual with traditional transport planning approaches. While traditional transportation research develops solutions for planning approaches, the lived urban space and experiences of users are rarely considered. Despite a current trend towards more public participation, the public has long been excluded from urban development processes (Koglin & Rye, 2014). Meanwhile, social science mobility research focuses on the human-being, their experiences, perceptions and behavior without taking transport planning approaches into consideration (Wilde & Klinger, 2017). Addressing this discrepancy, this research aims at contrasting a transport planning and policy understanding with the people's experiences in their lived space. We take the concept of mobility and the politics of vélomobility (Koglin & Rye, 2014), derived from Cresswell's theory of the politics of mobility (Cresswell, 2010), as a theoretical background. It is argued that these new theoretical approaches are appropriate for bicycle planning, because they consider not only the physical movement from A to B, supported by cycling infrastructure, but also the power relations in urban traffic space as well as the identities and positive representation of cycling and the experiences and everyday practices of cycling (Haustein et al., 2019; Koglin & Rye, 2014). In the following, we will discuss literature which explicitly focuses on cyclists' behavior, experiences and identities regarding cycling reasons and the quality of cycling and route-choices. This will serve as a background for our study.

2.1 Reasons for cycling

Understanding the reasons for using a specific mode of transport has been the focus of transport research for a long time and is lately gaining importance in promoting sustainable travel choices (Schoenau & Müller, 2017). One of the most widely applied theories for mobility behavior regarding bicycle use intention is the Theory of Planned Behaviour (TPB) by Ajzen (1991) (Bamberg, 2012; de Sousa et al., 2014; Fernández-Heredia et al., 2016; Forward, 2014; Ma et al., 2014; Manton et al., 2016). TPB originated as a socio-psychological theory focusing on human behavior, taking different psychological factors influencing the intention of a behavior into account (Schoenau & Müller, 2017).

According to TPB, intention is determined by:

- Subjective norm
- Attitudes towards the behavior
- Perceived behavioral control

The subjective norm defines the perceived societal pressure to act in a specific way. It describes the importance of the opinion of others, especially peer groups, towards the intended behavior and the urge to meet these expectations. Attitudes describe the way an individual evaluates his/her behavior. If a person has a positive mindset towards the behavior and evaluates its outcome as positive, the behavior is more likely to be performed - and vice versa. Attitudes can be divided into instrumental motives (the perceived benefit or disadvantage of using a specific mode, e.g. time, cost, convenience), affective motives (the experiential value of using a mode and related positive or negative emotions, e.g. positive emotions due to physical activity/health improvement) or symbolic motives (the social value of a specific mode and related emotions, e.g. high social value for choosing environmentally friendly mode of transport) (Hunecke, 2015; Steg, 2005). Attitudes have a direct impact on the intentional planning of bicycle use. The perceived behavioral control defines how far an individual perceives an action as feasible. If a behavior is assessed as difficult to perform, the intention is diminished - and the other way around (Bamberg, 2012; Hunecke, 2015). As in the context of mobility behavior, Bamberg (2012) explains the perceived behavioral control with four mobility-related determinants, which have also been proven in recent cycling research. These include the length of the route (Raustorp & Koglin, 2019), the availability of a car/bike/etc., the subjective safety of transport infrastructure and personal life circumstances (Haustein et al., 2019).

The importance of route length, the subjective safety of transport infrastructure and life circumstances were revealed in a recent study on reasons for cycling. This study stresses that the spatial distribution of home and workplace is beneficial for choosing the bicycle for commuting and that cycling-friendly built environments and transport systems enhance cycling motivation (Raustorp & Koglin, 2019). Additionally, the importance of the subjective norm was emphasized by McCarthy (2010) and Aldred (2012), showing that the way other road users perceive cyclists has an impact on the decision to cycle: other road users treating cyclists as "outsiders" who do not belong on the streets creates an anti-bicycle culture in which cyclists feel unsafe and neglected and hence refuse to cycle (Haustein et al., 2019). However, an increasing volume of cyclists can also provoke a competition and conflicts between cyclists, pedestrians and car-users. Cyclists are sometimes associated with aggressive, risky and selfish driving, which may be a result of being marginalized in transport planning (Aldred, 2014). This again draws attention to the previously discussed power relations within transport planning and their role in excluding cyclists in planning decisions and calls for a need to further integrate cycling in transport management (Nielsen et al., 2013). This study will engage with this issue and especially draw attention to the perspective of planners and politicians regarding cycling reasons, considering TPB as an appropriate theoretical framework for categorizing the reasons for cycling.

2.2 Determinants influencing cycling quality

The second objective of this study addresses perceived cycling quality. A variety of studies investigated different drivers and barriers which influence urban cycling quality (Biernat et al., 2018; de Sousa et al., 2014; Iwinska et al., 2018). Most of the studies used quantitative approaches, focus on surveys, urban/transport databases or statistics (e.g. accidents, mode share) and hardly take the subjective experience of cyclists into account (Pánek & Benediktsson, 2017; Zeile et al., 2016). However, literature on cyclists' perceptions and subjective experiences of cycling routes is increasing. Zeile et al. (2016), for example, analyzed cyclist's emotions and perceptions using wearable devices for sensing bio-physiological parameters and spatially links them to specific road sections and possible danger spots. Other studies use mapping techniques, either with online tools or drawn maps, to locate positive or negative cycling experiences supported by questionnaires or open comments from cyclists (Pánek & Benediktsson, 2017; Snizek et al., 2013). A comparison of commuter cyclist's "everyday, embodied experiences" with planners' perspectives was conducted by van Duppen and Spierings (2013), revealing differences into how trajectories and divisions of urban areas are perceived. Most of the literature on perception about cycling focuses on specific aspects which may influence cycling – e.g. danger spots, environmental perception or the built environment. As derived from Willis et al. (2015) and Götschi et al. (2017), the physical environment, shaped by policy and planning decisions, as well as individual aspects, are decisive for cycling (Figure 1). However, research which investigates cyclists' perception and evaluation of their daily route in an explorative manner using qualitative interviews and sketch mapping techniques is rare, an exception being Steffansdottir´s (2014) application of a similar approach for researching cyclists’ attitudes and experiences. Still, perception research is lacking which contrasts cyclists’ with decision-makers’ perceptions and evaluations of cycling quality in the same area using qualitative and sketch mapping approaches.

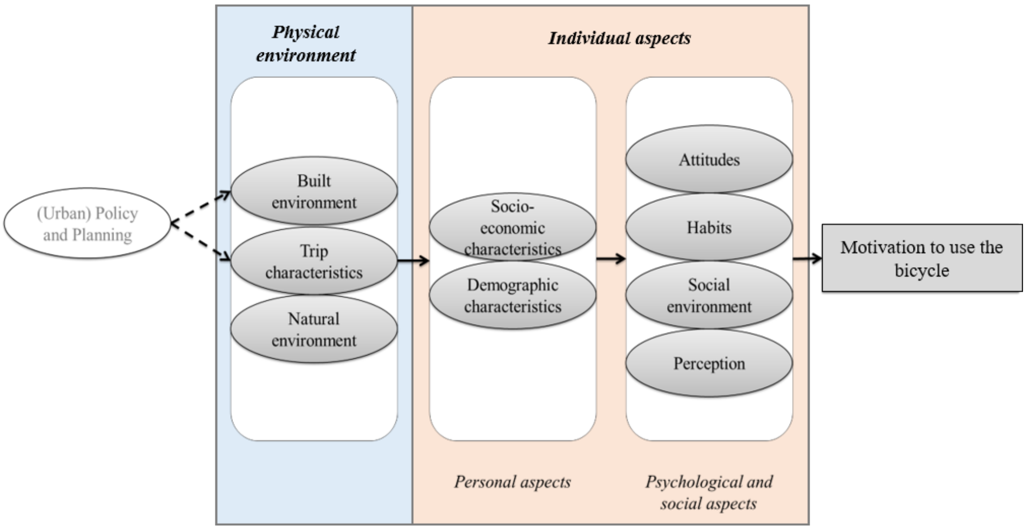

Figure 1: Conceptual model for main determinants influencing bicycle usage on the basis of current studies. Interaction of relevant influencing factors in: (1) physical environment, (2) personal aspects and (3) psychological and social aspects, which determine the possible usage of a bicycle (own illustration, based on a simplification of the concepts by Willis et al. 2015 and Götschi et al. 2017).

As a background for our study, Table 1 provides an overview of relevant factors influencing cycling quality and their type of effect, derived from a selection of literature on cycling quality. For a comprehensive literature review on determinants influencing cycling we refer to Heinen et al. (2010). Nevertheless, there is a lack of research which comprehensively explores in an open way which of these factors are most important for cyclists and which are considered as the most important by decision-makers. We will address this gap, using qualitative interviews and sketch mapping as explained in chapter 3.

Table 1: Overview of relevant influence factors on the quality of cycling, which can be perceived while cycling in the urban environment, as derived from recent literature, grouped in built environment, natural environment, personal factors and psychological and social factors

Category	*Definition/ Example*	*Effect on quality of cycling*	*Type of effect*	*Literature*
		Built environment		
Urban form, city size and accessibility	Compact city, short distances	• Shorter travel distances	*Positive*	(Caulfield et al., 2012; Heinen et al., 2010; Krizek, 2012; Ma & Dill, 2016; Nielsen et al., 2013; Skov-Petersen et al., 2018)
Cycling infrastructure/ facilities	Segregated cycling infrastructure	• Subjective safety	*Positive*	(Caulfield et al., 2012; Heinen et al., 2010; Manton et al., 2016; Skov-Petersen et al., 2018)
	On-street cycling / ”vehicular cycling”	• Subjective safety	*Negative*	(Pánek & Benediktsson, 2017)
	Separate “Copenhagen style” cycle paths	• Positive experience while cycling	*Positive*	(Snizek et al., 2013)

	Width of bicycling facility	• Increase cycling/route satisfaction	*Positive*	(Jensen, 2007)
Road conditions	Wide roads	• Subjective safety	*Positive*	(Manton et al., 2016)
	Asphalt without cracks or debris	• Satisfaction of cycling	*Positive*	(Jensen, 2007)
Frequency of pedestrians or cyclists	High cyclists and/or pedestrian volume	• Increased attention necessary	*Negative*	(Caulfield et al., 2012; Jensen, 2007)
	Social norms: cycling as a normal mode of transport	• Encouraging cycling/Feeling of belonging	*Positive*	(Haustein et al., 2019; Pooley et al., 2013)
Motorized traffic volume	Road network favoring motorized traffic	• Negative experience	*Negative*	(Pánek & Benediktsson, 2017)
	Volume and speed of motor vehicles	• Perception of safety	*Negative*	(Segadilha & Sanches, 2014)
Green spaces, Vegetation	Green areas close to cycle route (50m)	• Positive experience	*Positive*	(Caulfield et al., 2012; Snizek et al., 2013)
		• Emotional experience	*Positive*	(Pánek & Benediktsson, 2017)
		• Subjective safety (darkness)	*Negative*	(Skov-Petersen et al., 2018)
Urban blue spaces	Cycle route along the river	• Positive experience	*Positive*	(McArthur & Hong, 2019; Snizek et al., 2013)
		Natural environment		
Air pollution	Exposure to PM2.5, PM10 and PM2.5–10 while cycling on-street and on cycle tracks	• Health impacts (cardiovascular and respiratory diseases)	*Negative*	(Okokon et al., 2017; Ueberham et al., 2019)
Weather	Dry, calm, sunny and warm conditions	• Emotional experience/ Satisfaction	*Positive*	(Böcker et al., 2016; Jensen, 2007)
	Rain, cold temperatures (frozen, not cleared cycle tracks)	• Safety	*Negative*	(Bergström & Magnusson, 2003; Heinen et al., 2010)
Day/Night	Darkness / Increasing hours of darkness in winter	• Safety (Crashes/accidents)	*Negative*	(Bergström & Magnusson, 2003; Short & Caulfield, 2014)
Topography	Flat topography	• Less physical exertion	*Positive*	(Heinen et al., 2010)
		Personal factors		
Socio-economic / demographic/ personal characteristics	Gender, social class, social norm, phyical capacity, individual personal characteristics	• Perception of environment as qualitatively good for cycling depends on individual and societal characteristics		(Heinen et al. 2010; Hilgert et al., 2016; Willis et al., 2015)
		Psychological and social factors		
Subjective safety	Perception of dangerous route segments or risk while cycling	• Negative attitude towards cycling	*Negative*	(Heinen et al., 2010; Krizek, 2012; Ma et al., 2014; Manton et al., 2016; Zeile et al., 2012; Zeile et al., 2016)
Perception of aesthetics	Attractive environments and views while cycling	• Positive/ emotional experience	*Positive*	(Black & Street, 2014; Pánek & Benediktsson, 2017; Snizek et al., 2013)
Perception of noise	Traffic noise	• Health effect, wellbeing	*Negative*	(Okokon et al., 2017; Ueberham et al., 2019)
	Sounds other than traffic noise (e.g. birds chirping, people talking, wind noise)	• Satisfaction of cyclists	*Positive*	(Jensen, 2007)

2.3 Reasons for route choices

The perceived quality of cycling and specific knowledge about route characteristics is closely linked to cyclists' route choices (Ueberham et al., 2019). There are multiple factors influencing route choices and a broad selection of literature dealing with route choice theories exists. We specifically focus on cyclists' perceptions and how these affect cyclists' chosen routes. Important influence factors related to the built and planned environment are volume and speed of motor vehicles on streets as well as safety and lighting (Segadilha & Sanches, 2014). While traffic flow and infrastructure are important, evidence exists that main roads with cycling infrastructure do not necessarily attract cyclists and are sometimes even avoided by cyclists (McArthur & Hong, 2019). Research on the additional length of detours that cyclists are willing to take shows 15 – 21% additional length. However, different studies show different results depending on the calculations and contextual differences of study areas. An optimal combination of distance, time and safety is argued to be decisive for route choices (Pritchard et al. 2019). Recent research also discovered detours of about 6,4% additional length by cyclists to avoid air pollution and noise on main roads additionally to improving safety (Gössling et al., 2019). An attractive natural environment, e.g. bodies of water and green spaces along the route which reduce air and noise pollution were found to be particularly important (McArthur & Hong, 2019; Snizek et al., 2013). The natural environment and individual level determinants are important for cyclists' route-choices and call for more attention in bicycle planning and policy, considering the fact that streets with cycling infrastructure are not always decisive for route choices. Yet, hardly any research explores and compares the perspective of policy and planning practitioners on cyclist's reasons for the choice of routes with those of cyclists, even though planners are determining the characteristics of routes in urban areas. There is a need to further investigate cyclists' and decision-makers' view on cycling quality and route choices. Approaches which focus on the experiences of cyclists can be supportive to understand perceived cycling quality and cyclists' route choices. Public Participatory GIS (PPGIS), crowdsourcing and volunteered geographical information can be helpful in locating route-specific experiences and evaluations of cyclists, even allowing for combination with en-route environmental conditions through participatory sensing (Pánek & Benediktsson, 2017; Ueberham et al., 2019). Methods such as sketch mapping or qualitative interviews, as presented in the following chapter, are highly beneficial for in-depth investigations of site-specific experiences and promoting discussions about reasons for various route-choices and environmental perceptions (Boettge et al., 2017).

3. Methods

The study was carried out in the city of Leipzig in Germany. Leipzig is located in eastern Germany and counts 590 337 inhabitants (2018), with a flat topography and continental climate. Until the mid-1990s, Leipzig could be characterized as a “shrinking city”, due to many people moving to western Germany. However, since 1995 the population has grown continually, especially in the bracket of young people under 30 (Rink et al., 2012). A growing transport demand and a change in transport behavior of the citizens towards less motorized transport can be observed. Yet, the city structures have only changed slightly. Therefore, it is of interest to research transport behavior and planning in Leipzig (City of Leipzig, 2017a, 2017b).

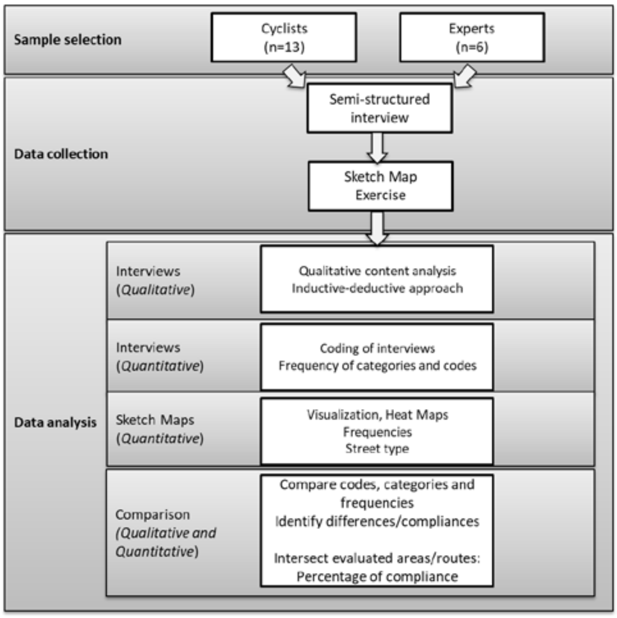

Figure 2: Research design

3.1 Research design and data collection

Due to the exploratory nature of this study, a qualitative research design was chosen, which included a mapping exercise for addressing the spatial level of the city (Figure 2). Qualitative research holds the opportunity to provide a deep understanding of individual attitudes, experiences and perceptions and is increasingly used in mobility behavior research (Lamnek & Krell, 2016; Lenzholzer et al., 2018; Mars et al., 2016). Due to its openness to unknown aspects, aspects which might have been omitted in quantitative surveys of cyclists can be revealed and compared to experts’ points of view.

We carried out semi-structured interviews with both cyclists (n=13) and policy and planning experts (n=6). The cyclists were chosen among a sample of a personal exposure study from 2017, considering an equal gender and age ratio. This offered a sample with an equal engagement towards cycling and similar cycling experiences (Ueberham et al., 2019). The experts were chosen from three fields of activity associated with Leipzig’s cycling planning: (1) municipal urban and transport planning authorities, (2) municipal politics and (3) external urban planning offices (sample characteristics are attached in the appendix). The interviews were conducted in person between November 2017 and February 2018 in Leipzig, with an average length of 56 minutes. The semi-structured interviews were similar for cyclists and experts to allow comparability. Following the structure of Przyborski and Wohlrab-Sahr (2014) and Gläser and Laudel (2009), the interview started with an open question on the perception of and reasons for cycling, followed by more detailed questions on the most influential factors for cycling quality which relate to the mapping exercise. The second half of the interview went further into detail, aiming at revealing attitudes towards cycling and bicycle planning and investigating the evaluation of cycling quality and motivation (Przyborski & Wohlrab-Sahr, 2014). We combined the qualitative interview with a sketch mapping approach.

3.2 Sketch Mapping

To understand route choices and the perceived cycling environment, a sketch map exercise was part of the interview. Sketch maps originated in mental map research but use spatially referenced maps in which participants draw specific experiences related to the urban environment (Boschmann & Cubbon, 2014). Consequently, spatial data related to qualitative survey questions can be collected.

The interviewees were given a printed map of Leipzig based on OpenStreetMap data including street names, buildings and green spaces. Therefore, it represents something recognizable (Boschmann & Cubbon, 2014). The pencil-to-paper method was used, because it gives the interviewees more confidence without the necessity of technological knowledge (Boschmann & Cubbon, 2014; Yabiku et al., 2017). Cyclists were asked to draw their typical daily route (min. 3 times a week) on the printed map and evaluate specific route sections of their drawn route as perceived positively (mark in green) or negatively (red). Experts should refer to their expert assessment and evaluate the most important route sections in the city positively (mark in green) and negatively (red). Thus, the interviewees were able to translate their spatial perception of cycling quality to a real map, which could later be used to compare experts' and cyclists' evaluations of the urban cycling environment. As presented in a similar approach by Boettge et al. (2017) or Manton et al. (2016) on cyclists' perception of stress and risk, this place-specific, hand-drawn evaluation of daily cycling routes helps the participant to discuss, reflect and point out specific cycling practices, hence providing a comprehensive understanding of the perception of routes. However, these studies did not take into account the perspective of decision-makers, which is decisive for the planning of cycling facilities.

4. Data analysis

The interviews were transcribed with the program F4 (Dr. Dresing and Pehl GmbH, Marburg, Germany) and analyzed using qualitative content analysis (QCA) (Mayring, 2007). The data analysis was guided by questions derived from our three main objectives: exploring and comparing (1) cycling reasons, (2) cycling quality and (3) route-choices.

Since there is a lack of literature which compares the perception of urban policy and planning experts with cyclists' viewpoints, the analysis was devised to allow for new and unexpected aspects, but still be closely linked to the theory presented above and any existing literature (Gläser & Laudel, 2009). We included a deductive analysis alongside the inductive analysis proposed by Mayring (2007). Following the inductive QCA procedure (Mayring 2007), we developed the main codes and some sub-codes based on the research question and our theoretical background (Figure 3).

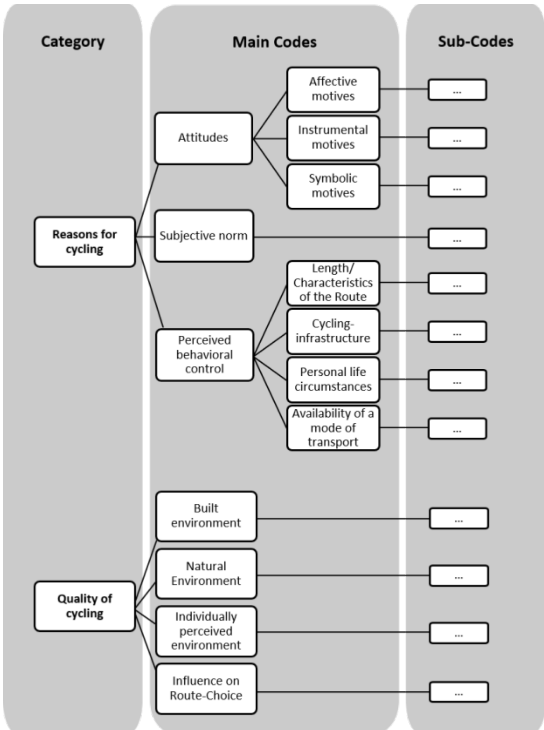

Figure 3: Categories to be analyzed and the related main codes as derived from existing literature and theories. During the data analysis process a variety of sub-codes have been defined, which will be presented in the results

In a first coding step we attached the previously developed codes to relevant text segments within the transcripts, addressing the three objectives of our research (inductive approach). During this process we also explored new aspects relevant to our research objectives. These aspects were additionally included into our coding system as sub-codes, so that the whole coding system was refined by adding these new sub-codes or by removing/revising previous sub-codes (deductive approach). After refining the coding system, we coded all transcripts again. In this step, we used our enhanced system for coding, integrating all new revealed sub-codes in the coding process. Therefore, our content analysis was based on fixed codes, but was still open to the construction of new codes

(Gläser & Laudel, 2009). The coding process resulted in a total of 24 sub-codes for the category "reasons for cycling" and 32 sub-codes for the category "quality of cycling". Subsequently, each sub-code was assigned to a related main code (Figure 3). We used descriptive analysis (using MaxQDA Version 12) to analyze and compare the codes derived from the expert and cyclist transcripts.

Each interviewee's hand drawn sketch maps were digitally scanned and imported into GIS. Using the tool "*georeferencing*", they were exactly projected onto an existing layer shapefile of the matching OpenStreetMap (OSM) basemap. Quantum-GIS (Version 2.18.14) and ArcGIS (ESRI, Version 10.5) were used to visualize and analyze the sketch maps. The tool *"heat map"* was used to visualize the amount of routes perceived in a similar way. Intersecting a 30 m buffer of the drawn routes with land-use data, we examined the urban surroundings. To refer the evaluated routes to respective street types, we used the methodological approach of Yeboah and Alvanides (2015), that uses the most defined OSM-road type tags 'primary' and 'secondary' for main roads as well as 'tertiary'(unclassified through roads with road markings, wide enough for two cars to pass safely) and 'residential' (roads with an exclusively residential purpose). Finally, we compared the streets which were evaluated by both cyclists and experts (excluding the ones which were solely evaluated by respondents from one group). Thus, matching and biased evaluations of the same streets could be identified. Using the overlay function "*weighted sum*", all heat maps (consisting of raster data) were merged and the street-sections evaluated by both groups were extracted. We compared the extracted street sections by calculating the percentages of positively and negatively evaluated point features (derived from the raster data) on each extracted street section.

Table 2: Main codes of the category "reasons for cycling" and the retrieved sub-codes, identified during the qualitative content analysis

Main code	Sub-codes
Attitudes – *Affective motives*	Fresh air; Clear mind/ mental recovery; Enjoyment of cycling; Good climatic conditions; Appreciating nature/environment; Health/ Fitness
Attitudes – *Instrumental motives*	Inadequate public transport; Inadequate circumstances for cars (traffic jam, parking space); Flexibility/ spontaneity
Attitudes – *Symbolic motives*	Environmental-friendly behavior; Identification
Subjective Norm	Cycling as a popular mode of transport; Car as a status; Dress code
Perceived behavioral control – *Availability of a mode of transport*	Bike as everyday mode of transport; No car available
Perceived behavioral control – *Length/ characteristics of the route*	Speed; Compact city; Topography
Perceived behavioral control – *Cycling Infrastructure*	Cycling infrastructure; Cycle lanes in/alongside greenspaces; Safety
Perceived behavioral control – *Personal Life circumstances*	Financial situation; Occupation as a student

5. Results

5.1 Reasons for cycling

Our qualitative content analysis revealed 24 sub-codes referring to reasons for cycling (Table 2).

5.1.1 Cyclists

The most important reason for cycling stated by cyclists was health/fitness: eleven times aspects referring to exercise, health or fitness were revealed; more often than by experts. Cycling helps to exercise the body and "*free the mind*" (P11[1]). Inadequate public and road transport (7 respondents) promotes bicycle usage, because driving is seen as too stressful and public transport as too full (P5, P11). Cycling as the most environmentally friendly option was also stated as a motivation to use the bicycle. Cycling was stated to be fast (speed) and flexible (flexibility/spontaneity) (P1, P3, P4, P8, P10, P13), associated with appreciating nature, fresh air and mental recovery (clear mind/recovery), all of which was not stated by experts. Cyclists' have a strong cycling motivation due to attitudinal aspects (Figure 4).

[1]Referring to "Participant No." (full list attached in the Appendix A)

5.1.2 Experts

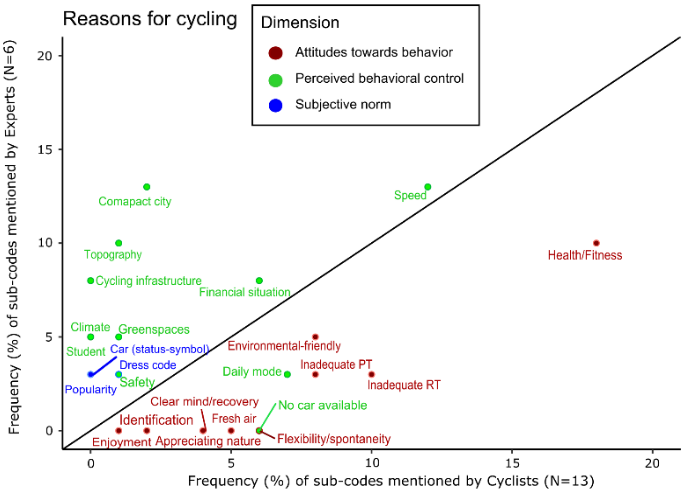

Figure 4: Comparison of identified sub-codes of cyclists (frequency of each sub-code as derived from the interview transcript divided by all cyclist sub-codes, n=104) and experts/decision-makers (frequency of each sub-code as derived from the interview transcript divided by all expert sub-codes, n=39) on reasons for bicycle usage, grouped by dimensions of the TPB (Chapter 2.1) as defined in the coding process (overview of sub-codes: Table 2). PT=Public Transport, RT= Road Transport.

The content analysis of the experts' interviews revealed a strong opinion that people in Leipzig cycle because it is the fastest mode of transport (speed), a fact which was stated by cyclists with a similar frequency (Figure 4). Road-specific aspects such as good cycling infrastructure, city-specific aspects like the flat topography, climate and short distances were stated as determinants for bicycle usage which were rarely considered by cyclists. The financial situation was taken into account by both groups, yet experts referred to it more often. Experts referred to sub-codes from the dimension of perceived behavioral control more often (Figure 4).

5.2 Aspects influencing quality of cycling

The qualitative content analysis revealed the importance of the built environment for cycling quality. Aspects at the individual level were stated more often by cyclists than experts, experts' answers referring especially to the built and natural environment. Table 3 provides an overview of all sub-codes.

Table 3: Identified sub-codes of each dimension in the category "quality of cycling" and the frequency a sub-code was mentioned by the interviewees in total (Figure 5 displays the distribution of the sub-codes of this table between cyclists and experts)

Built environment	**Number of Codes**
positive	*positive*
Good cycling infrastructure	15
Cycle racks	3
Short, fast connections	3
Quiet minor roads	3
Traffic lights (bicycle traffic lights)	2
Good road quality	1
negative	*negative*
Cars parking on cycle lanes	11
Missing cycling infrastructure	24
- Gaps in cycling network	8
- At construction sites	3
- Width of roads	5
Bad road quality	7
Traffic lights	6
Traffic volume	13
- Cyclists	5
- Cars	5
Bad traffic routing	9
- With tramway-racks	4
- At intersections	2
Missing cycle racks	2

Natural environment	**Number of Codes**
positive	*positive*
Greenspaces/ Vegetation	20
Topography	4
Weather	2
Water	1
negative	*negative*
Air pollution/ fumes	4
Rain	4
Snow/ ice	6
- Removal of snow	4
Heat	2
Night/ Darkness	1

Individual level	**Number of Codes**
positive	*positive*
Aesthetic of the environment	5
Perceiving environment/nature	5
Flexibility	4
Feeling of safety	3
Sense of community	3
Less stressful situations/ annoyance	3
negative	*negative*
Feeling of safety	14
- Related to traffic	12
- Related to social security	2
Noise	5

5.2.1 Dimension of the built environment

Cycling infrastructure is stated most often in the dimension "built environment" by both experts and cyclists. From an expert perspective, the development of the cities' cycling infrastructure is satisfactory, stating that *"the people see it, the relatively good developed bicycle network, […]"*[2] (E2[3]). Four cyclists agreed, however, bicycle traffic lights and quiet minor roads were considered by the cyclists as positive and hardly taken into account by the experts. Both experts (E1, E2, E5) and cyclists (P3, P11, P13) refer to the problems of gaps in the cycling network, saying that: "*Often cycling routes are not consistent thoughtout*" (P12) or "*an unsystematic, unreasoned [cycling] network, which has gaps here and there* [...]" (E1). Missing cycling infrastructure, tramway-tracks, traffic lights and traffic volume were most often stated in reference to safety. The missing prioritization of bicycles, resulting in e.g. cars parking on cycle lanes, was mentioned by six cyclists – only one expert refered to these issues. All in all, aspects of the built environment were considered more often by experts than cyclists (Figure 5).

5.2.2 Dimension of the natural environment

Nearly all experts (5) and cyclists (10) mentioned the positive effects of green spaces and vegetation (Figure 5), emphasizing their importance for a better feeling of safety, the improved aesthetic quality of the environment, avoidance of stressful situations/annoyance and perceiving the environment/nature. Two cyclists explained:

- "*[…] and then I enter the park and I realize, it is quiet, in front of me other cyclists, […], and then I couldn't hear anything anymore – […]. And all other cyclists just rode – it was… first of all, all these stressful situations and then I left the roads behind and the stress was gone and it was just beautiful*." (P1)
- "*It is like a meditation, that you watch the trees or the lakes and try to see some animals. There is also a different speed in parks […] I also perceive the relaxation of others*." (P8)

[2] All quotes are translated from German by the author
[3] Referring to "Expert No." (full list attached in the Appendix A)

The experts also stress the importance of greenery: Leipzig has a *"unique attribute. […] That you ride through the park or forest, rather than along main roads – […] – it brings a positive attitude to life*." (E6).

Lacking clearance of snow in winter was a negative aspect for cyclists (P1, P7, P9, P11) which was not mentioned by experts. Heat (P3, P10) and rain (P2, P8, P12) were negative weather circumstances – especially in relation to deficient consideration by other transport users. Air pollution/fumes on main roads was explicitly emphasized by three cyclists (P2, P3, P10). Only one expert mentioned them (E3).

5.2.3 Dimension of the individual level

Statements on the individual level refered to aesthetic of the environment or the positive aspects of perceiving environment/nature. Cyclists emphasized the positive effects of being aware of their environment and the weather while cycling ("*sun*", "*chill*", "*fresh air*"): cycling was associated with a "*sense of wellbeing*" (P7, P8, P10, P11). Moreover, feeling of safety and a lack of consideration by other road users was an important aspect of cycling quality (Figure 5). Three cyclists had a good feeling of safety (P7, P8, P10). However, negative associations with safety aspects were identified 12 times, seven cyclists and two experts referring to them. Five cyclists explicitly mentioned noise as negative (P2, P3, P7, P8, P10). Figure 5 gives an overview of experts' and cyclists' most used sub-codes for cycling quality.

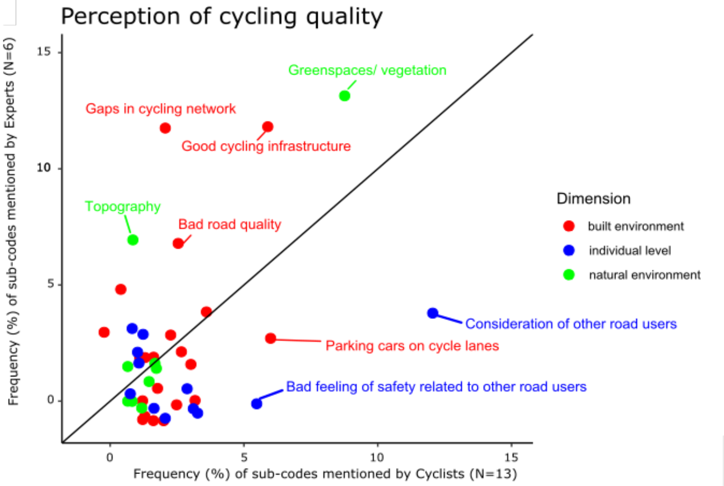

Figure 5: Perception on cycling quality, categorized by dimension (as defined in chapter 2.2) of the experts (divided by all revealed codes in the expert transcripts) and the cyclists (divided by all codes revealed in the cyclists transcripts). The codes with the highest frequencies (more than 5%, respectively) are labelled; a small random variation has been added to each point to avoid overplotting. Table 3 provides a summary of all retrieved sub-codes of "Perception of cycling quality".

5.3 Sketch Maps

The heat map of the drawn daily trips shows a concentration surrounding park areas, along the river and main roads surrounding the city centre (Figure 6).

Cyclists evaluated areas surrounding water, green space and smaller side-roads as positive. The experts, on the other hand, more often evaluated the main roads as positive. Cyclists seemed to avoid the city centre area and tended to positively rate roads connecting city districts outside the city centre. Experts appraised especially main roads, whereas the roads surrounding the city centre and to the east were considered as negative (Figure 7). When comparing the matching and non-matching positively and negatively evaluated routes of the cyclists and the experts we revealed a bias. 31% of the routes assessed by both groups were evaluated differently by the experts and the cyclists (Table 4). Out of these, only 9% were evaluated positively by the cyclists and negatively by the experts, whereas 22% were rated positively by the experts but stated to be negative routes by the cyclists (Table 4). This applies essentially to the main roads.

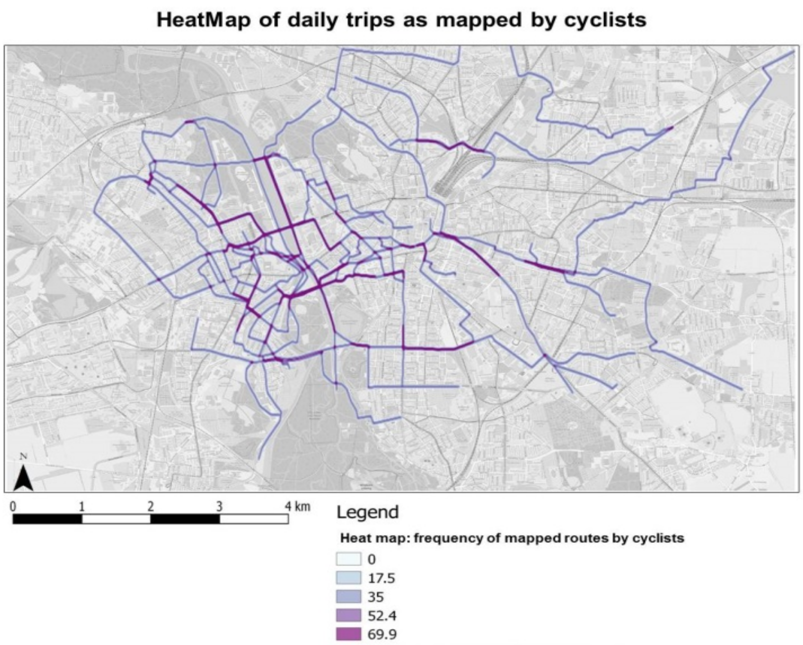

Figure 6: Heat map of all sketch mapped daily routes by cyclists (N=13) in the area of Leipzig. (Basemap: OpenStreetMap contributors)

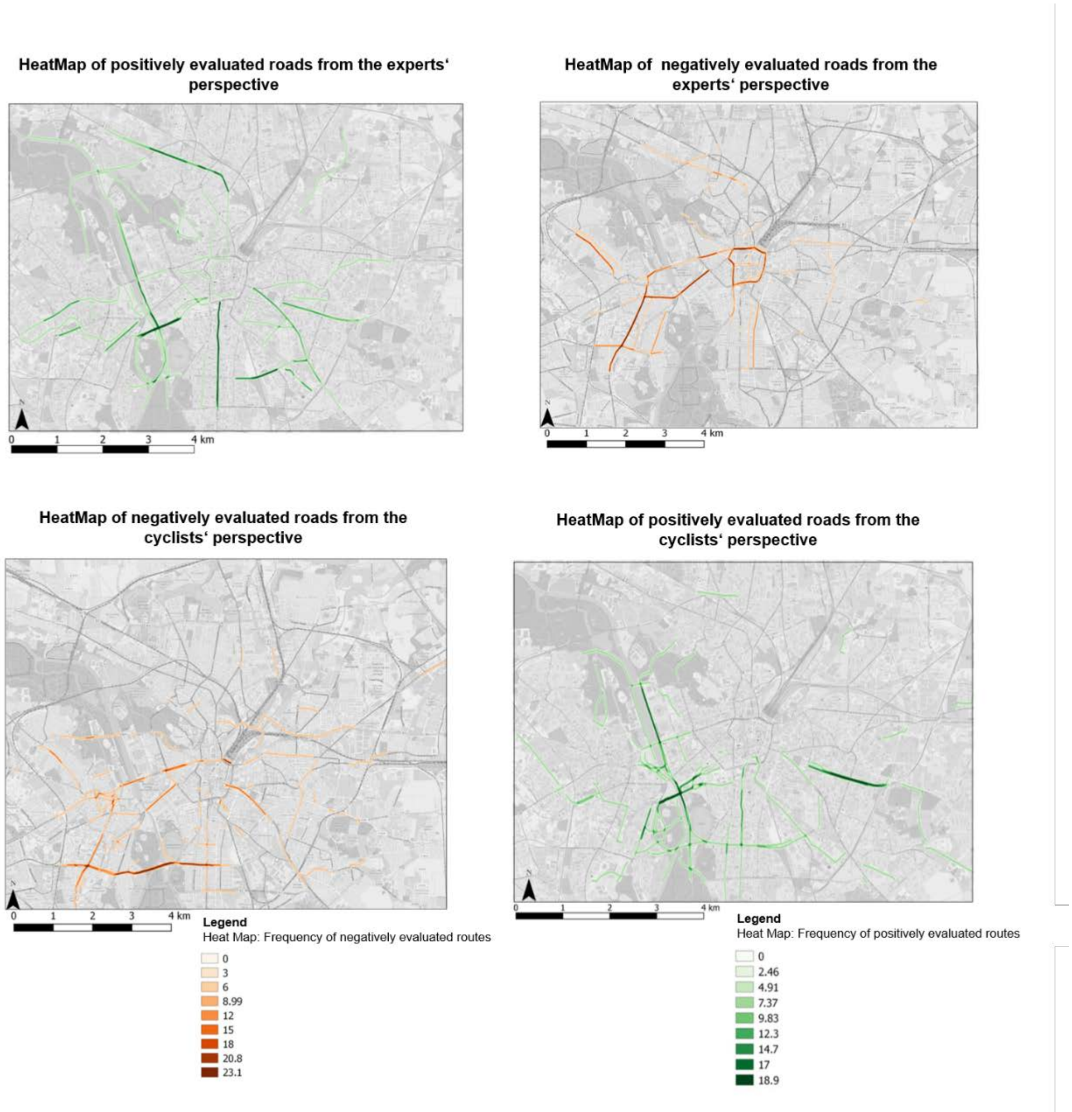

Figure 7: Heat Maps presenting the frequency of positively (above) and negatively (below) evaluated routes by the experts (left) and the cyclists (right) in Leipzig. (Basemap: OpenStreetMap contributors)

We found nearly equal consistency in positive routes (37%) and in negative routes (32%). This reveals that the cyclists' perception does differ in terms of negatively evaluated routes, however, overall a consistency was discovered in about two-thirds of the evaluated routes (Table 4). The negatively perceived routes mostly referred to 'primary' and 'secondary' defined streets and the positively rated streets were the ones classified as 'residential' and 'tertiary" (using OSM-street-type data). The positive effect of minor through-roads ('teritary') and residential streets as well as the importance of greenery for cycling quality as revealed in the qualitative content analysis becomes evident.

Table 4: Comparison of negatively or positively evaluated routes, which were evaluated by both the cyclists and the experts using the created heat maps (Fig. 7) as described in chapter 4

Cyclists (N=13)	**Experts (N=6)**	**Rasters of each evaluated route (extracted from heat maps)**	**% of all evaluated routes (cyclists and experts)**	***Matching*: % of all evaluated routes**
Positive	*Positive*	12556	**37%**	*Matching (positive)*: **37%**
Negative	*Positive*	7669	**22%**	Non-matching: **31%**
Positive	*Negative*	2947	**9%**	
Negative	*Negative*	11032	**32%**	*Matching (negative)*: **32%**

6. Discussion

In this study we have compared the reasons for daily bicycle usage and the perceived quality of cycling in frequent cyclists and decision-makers from urban politics and planning institutions. Using qualitative interviews and sketch mapping, we have given insights into different understandings of the reasons for and perceptions of cycling and put them into the spatial context. Previous studies which compared cyclists' experiences with decision-makers' opinions focused on how place and intra-urban divisions are sensed and experienced (van Duppen & Spierings, 2013) or on how "utility cycling" is negotiated using qualitative interviews (Aldred, 2014). Our study, however, attempts to provide a comprehensive understanding of cycling reasons and quality on a spatial level by means of open questions and mapping as well as comparing them with the decision-makers' perspective. Hence, the mapping exercise was not only used for mapping experiences and perceptions, as in recent studies using these tools for assessment (Manton et al., 2016; McArthur & Hong, 2019; Pánek & Benediktsson, 2017; Snizek et al., 2013), but supports the qualitative interview and discussion about cycling experiences, motivation and perceptions (Boschmann & Cubbon, 2014; Manton et al., 2016). Even though the task of evaluating routes on a map was somewhat different (the experts' evaluation was city-wide and the cyclists evaluated their everyday routes), the comparison of the overlapping evaluated routes draws attention to biases and similarities in route evaluation of the cyclists and the decision-makers. The qualitative approach of this study, using a relatively small sample of frequent cyclists and selected experts, only reflects selective opinions. We cannot draw conclusions in statistical terms, but we achieved in-depth insights into the experiences of cyclists and decision-makers, which can only be realized using qualitative approaches.

Importance of affective motives for cycling motivation

The qualitative interviews revealed attitudes as important for the intention of using a bicycle. As discussed in previous literature (de Souza et al., 2014), health benefits are the most stated reasons for cycling. Our qualitative interviews added affective motives, like the perception of nature and fresh air, as motivational factors for cycling, leading to an enhanced personal well-being of cyclists – especially in comparison with the stressful main roads. Decision-makers rarely considered these attitudinal aspects (Figure 4). They most often discuss cycling infrastructure and the built environment as motivational factors for cyclists and rarely consider the significance of attitudinal aspects (affective motivation). Even though infrastructure is crucial for safe traffic planning, attitudional aspects should also be considered when making planning decisions. Cycling policies and planning should be based on cyclists' needs. A comprehensive understanding of cycling motivation is required and further studies should investigate this aspect.

Importance of quiet side roads and aspects of the individual level

In line with other findings (Segadilha & Sanches, 2014), this study shows the high importance of quiet side roads, residential streets and green-spaces/vegetation for daily cycling routes (Figur 5 and Figure 7). Main roads were associated with rather negative traffic-related aspects. However, decision-makers focus on these when discussing cycling, even though cyclists rather use calm, residential roads and green spaces (Fiure 7). This emphasizes the need of integrating calmer (side) roads in cycle network planning, additionally to cycling infrastructure on main roads (Pucher & Buehler, 2017). Cycling infrastructure is undoubtedly important for a (perceived) safe, effective and fast journey, as mentioned by both cyclists and decision-makers. Yet, in order to successfully promote cycling, aspects of the individual level should further be acknowledged by decision-makers. As also discussed by Pánek and Benediktsson (2017), it is not only the instrumental qualities of the environment that are important for cyclists, but also the emotional experiences and the appreciation of the environment. The annoyance of noise and air pollution, the importance of personal wellbeing and the experience and aesthetic qualities of the environment while cycling are identified as crucial for cyclists, whereas decision-makers hardly refer to these aspects (chapter 5.2). This observed contradiction exposes a necessity of stronger integrating cyclists' needs and experiences in planning processes.

Approaches to integrate cyclists' experiences and perceptions

Our findings support the current discussion about integrating users' experiences in planning decisions and the need for new theories and concepts for cycling planning. Especially emotional experiences, perceptions of the environment and the evaluation of route sections must be assigned more attention in cycling planning processes and decisions to successfully promote cycling (Fathullah & Willis, 2018; Pánek & Benediktsson, 2017). A good example for integrating suggestions from cyclists in planning decisions is Copenhagen, a city where 50% of all journeys to work/education are made by bicycle (2015). Cycling planning in Copenhagen applies a participatory and collaborative process, in which cyclists can send their suggenstions electronically to decision-makers (Nielsen et al., 2013). The concept of participatory sensing (Goodchild, 2011; Kahila & Kyttä, 2009; Zeile et al., 2016), volunteered geographical information, public participatory GIS and crowdsourcing enables an easier connection between the individual and the decision-maker, for example if the data is (anonymously) collected and shared through mobile applications with planning authorities (Pánek & Benediktsson, 2017; Stojanovic et al., 2016; Ueberham et al., 2019). Especially public participatory mapping technqiues can be important for transport planning decisions, because it allows those who use cycling facilities to share their needs while on the move, which cannot be achieved solely with surveys, statistics or conventional transport engineering approaches (Pánek & Benediktsson, 2017).

7. Conclusion

We hope this research will contribute to supporting a better understanding of cyclists' needs from a planning perspective and emphasize the importance of including participatory, bottom-up planning approaches in cycling-planning decisions. Meanwhile, it may also encourage future research on cycling to more strongly take the decision-maker perspective into account and to address the power relations which still direct urban transport planning. To date, only few studies on cycling planning and decision-makers perspectives in combination with cyclists' perspectives exist (Milakis & Athanasopoulos, 2014; van Duppen & Spierings, 2013). Our study revealed differences of decision-makers and cyclists perspectives using a qualitative approach, yet further research is needed to improve our understanding of the discrepancies of planning and practice. Drawing on the theoretical background of our study and the revealed differences in decision-makers' and cyclists' perspectives, we recommend future research to further focus on the power relations in shared urban traffic space. Investigating decision-makers' evaluation of cycling quality and perspectives of cycling reasons in different cities with their respective cycling culture as well as the cyclists and the planners practices would be interesting. Secondly, for future cycling planning we emphasised the need for decision-makers to receive information from users to successfully integrate cycling measures into transportation planning, stressing the importance of sharing data about cycling experiences with decision-makers. Thirdly, the possibilities of new participatory approaches and technologies (e.g. smartphone applications or mobile sensors) to provide information from citizens to decision-makers and vice versa should be investigated further (Jiang et al., 2018). As revealed in our study, important information on e.g. health benefits or less stressfull routes with green spaces or environmental aesthetics could be provided to citizens using mobile devices or public campaigns, thus promoting bicycle usage. The needs and experiences of the traveller should be recognized and acknowledged so that urban mobility can be planned accordingly and has the potential to contribute to a healthy, sustainable and liveable urban development.

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Appendix A

Sample characteristics

Experts from policy and planning institutions

	Affiliation	Area
E1	Urban Planning office, main focus: Bicycle planning	*External planning office*
E2	Traffic and civil engineering office, main focus: bicycle planning	*City Administration*
E3	*Urban planning department*, section urban design and public space	*City Administration*
E4	Traffic and civil engineering office, main focus: planning strategies	*City Administration*
E5	Task force: Urban development and traffic *The Green Party*	*Urban Policy*
E6	SPD-fraction: Urban development, construction, traffic and environment and sports *SPD (Social democratic party)*	*Urban Policy*

Sample characteristics: Cyclists

Participant No.	gender	Age (classified)	Employment	Cycling characteristics
P1	Female	45-54	Employed	All daily routes with bicycle
P2	Male	55-64	Pensioner	Most of the time bicycle, sometimes public transport
P3	Male	25-34	Employed	All daily routes with bicycle
P4	Female	55-64	Employed	All daily routes with bicycle
P5	Female	25-34	Employed	Most of the time bicycle, car for longer journeys
P6	Male	18-24	Student	All daily routes with bicycle, in winter sometimes car
P7	Female	45-54	Employed	All daily routes with bicycle
P8	Female	35-44	Employed	All daily routes with bicycle, sometimes car-sharing
P9	Male	25-34	Employed	Most of the time bicycle, sometimes public transport
P10	Female	35-44	Employed	Most of the time bicycle, car when rain/snow
P11	Female	35-44	Employed	Most of the time bicycle, car when rain/snow
P12	Male	25-34	Employed	All daily routes with bicycle
P13	Male	55-64	Employed	All daily routes with bicycle

Appendix B

Questionnaire *(translated into English by the author)*

Cyclist interview

Introduction

1. *Phase: Openness*

General questions for introducing the topic

- In a narrative way, please tell me why do you choose the bicycle as a daily mode of transport?

- How often do you use the bicycle for daily mobility?
- What does cycling mean for you in one word?
- How do you perceive cycling in Leipzig?

2. *Phase: Specificity*

   Specific questions on perceptions

- Which aspects do you perceive as positive while daily cycling in Leipzig?
- What do you like about daily cycling in Leipzig?
- Which aspects do you perceive as negative while daily cycling in Leipzig?
- What do you dislike about daily cycling in Leipzig?

3. *Context and Relevance (Spatially)*

   Assessment of cycling quality

- What is your daily route? E.g. from home to work/sport/child care/etc. Please draw the route on the map.
- Why do you choose this route?
- Which segments of the drawn route do you perceive as positive (mark with green), negative (mark in red) or neutral (leave black)?
- Do you take detours in order to integrate positive or avoid negative aspects in your daily route? Explain. If necessary, use the map.

<u>Expert interview</u>

Introduction

1. *Phase: General Openness*

- Let us start with some general questions for the beginning. We are interested in reasons for bicycle usage. From your expertise, why do people in Leipzig use the bicycle as a daily mode of transport?
- From your perspective as a planner/politician, how do you evaluate the cycling quality for daily cycling in Leipzig?

2. *Phase: Specificity*

- From your expertise, what aspects do you think are barriers for cycling in Leipzig?
- From your expertise, which aspects are positive for cycling in Leipzig?

3. *Phase: Spatial Context*

- We specifically want to identify the barriers and drivers for cycling in Leipzig. From your expertise as a planner/politician, which areas or road sections are especially positive for cyclists/cycling quality and which are especially negative for cyclists/cycling quality? Draw on the map, use red for negative and green for positive.
- Which aspects do you think are decisive for choosing the bicycle as a mode of transport for citizens in Leipzig?