Framing the Third Cycling Century

Bridging the Gap between Research and Practice

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Prefaces

Harry Lehmann
General Director Division, German Environment Agency (UBA)

More than 200 years after its invention, the bicycle is enjoying a new renaissance. We experienced this development vividly when we celebrated the bicentennial with the International Cycling Conference 2017 (ICC 2017) in Mannheim last year. People from all over the world from the realms of both science and practice were part of a mosaic made up of a great variety of topics, characters and discourses. There was a strong impression of being part of a genuine transformation. The bicycle has always been more than simply a means of transport. In the decades following the arrival of mass motorization, it was mainly framed as a means of transport for the poor, on the one hand, and, on the other, as a means of expression for a small group of environmental activists. Now, the bicycle is attaining a very positive image: as a worldwide symbol for freedom, for personal and economic empowerment, and for a healthy and green lifestyle.

For the German Environment Agency (UBA), it is crucial that cycling is seen as one of the most environmentally friendly means of transport. The more cyclists there are on the streets instead of motorized vehicles, the less air pollution, congestion, and noise we have to suffer in our cities. In many cities, we are even witnessing that the bicycle is beginning to change the whole urban structure. This often starts with citizens demanding a better and safer cycling environment, and there are a lot of examples worldwide where their efforts have stimulated development. The great success of the Ciclovías in Bogotá, the capital of Colombia, illustrates how an activist movement can become an official policy. Closing of roads for motorized traffic on Sundays already started there in 1974, and has attracted more and more cyclists and pedestrians. In France, the great success of the Parlons Vélo campaign by the cycling federation FUB has brought forward the discussion on the establishment of a National Cycling Plan.

According to the Danish architect Jan Gehl, cities that are attractive for pedestrians and cyclists provide a much better quality of life than cities that are designed for cars. Pictures of the redesigned Seine promenade in Paris – without cars and full of walking and cycling people – have become powerful icons of change in urban planning. For Germany, the UBA has developed a vision for a Tomorrow's City which promotes environmentally friendly mobility, low noise, green spaces, compact housing and mixed-use districts (UBA 2017). In it, we emphasize the importance of integrated planning and a bundle of effective measures to make cities fit for the major challenges they are already facing and for the even greater challenges they will face in the coming decades. In our concept "Tomorrow's Cities", car dependency is no longer an issue.

One of the important measures in this vision is the promotion of active mobility. The international experts at the ICC 2017 showed that concepts for promoting cycling and walking do in fact differ from

country to country and city to city. Although the positive impacts of active mobility on health and the environment are basically the same, the way to effectively achieve the common goal of making cycling and walking safer and more attractive varies widely. This fact makes it all the more important that we share experience at an international level on the different problems of active mobility and their solutions.

Learning from others is essential if we are to achieve progress in our own countries. Good examples like Amsterdam, Utrecht or Copenhagen may well have changed a lot more than theoretical thoughts alone would have done. However, as a scientific agency, the UBA is also very aware of the importance of research. Research is not only necessary for progress, welfare and an open society. Environmental protection would also not work without precise scientific knowledge of the complexities of problems like climate change or the health impacts of pollutants. Ironically, although research and practice are in fact two sides of a coin, they are often positioned on different sides of a gap. This publication continues a process initiated in September 2017, when the ICC brought together researchers and practitioners. Like the conference, it aims to build bridges between the two sides. Most of the researchers and practitioners presented here were already part of the conference. We have selected significant and current topics to ensure a good basis for the bridging process. Building a bridge is a difficult task and requires a lot of expertise. For this publication, competent experts reflect on the articles of the researchers and practitioners and on how to reconcile them. This “matching” approach will contribute to the discussion on how best to bridge the gap between researchers and practitioners. And, most importantly, the triad of researcher, practitioner and commentator provides new findings and new thoughts on the complex relationship of research and practice in the cycling sector.

Peter Cox
University of Chester, Chair of Scientists for Cycling

Building sustainable mobility futures requires that we integrate cycling into the fabric of urban mobility as a primary mode of travel. The International Cycling Conference in Mannheim that prompted this collection demonstrated not only the breadth of expertise available to do this, but the lively interface between academia and policy. As chair of the Scientists for Cycling Network on behalf of the European Cyclists' Federation (ECF), it is an honour to be invited to comment on the relationship between academia and policy.

How do we understand the space between the drivers of academic research and the necessarily messy world of policy-making and practical implementation? How do we bridge the gap between competing domains of knowledge about cycling? Should we bridge that gap?

While emphasis from politicians and commercial interest is often put on the need to make research valuable beyond the university, scholars rightly fear too close an identification with the politics of decision making. It is proper that there should be a divide between competing interests and that academic research maintains its independence, able to set its own research agendas and to identify questions for itself. In this way, academic studies on cycling act as a critical friend to policy: by maintaining distance they are able to proffer proper critique.

On the other hand, policy and implementation (at its best) is often openly and honestly aware of limitations in knowledge and understanding, and desires a better information base that can be supplied by evidence. Thus it requires particular sets of information from academia and academic study can provide a service function. Advocacy is also essential here to point to those gaps in knowledge and to the available evidence to fill them

There is necessarily a tension between these two roles for academic study (service and critical friend), and both roles inform the relationship between academia and policy-making. To bridge gaps is to acknowledge not only the actual (and necessary) separation of functions, but also to provide a means to travel between the different roles and domains. The bridges in this case are conferences such as the ICC and networks such as Scientists for Cycling. These networks and events provide essential spaces where all parties can meet and share their knowledge and ideas.

The papers in this collection show that rigorous academic studies can provide independent analysis and evaluation of existing interventions and obvious recommendations for future actions. Academic studies on cycling are now firmly established as an important and legitimate activity across a number of disciplines. But there is also another layer to the relationship between academia and cycling, and that is in the support that academics can give to the work

of expert groups such as ECF. This extends to those whose work does not actually study cycling. Scientists for Cycling welcomes not only those engaged in cycling studies but who desire to lend their expertise, in whatever area of study they work, to ECF's work for change. Broadening the scope of contributions allows us to identify the questions not asked, to spot and to solve problems of which we might currently be unaware. This collection not only highlights the best of current research but begins to point towards where research can go in the future.

1

Introduction

1.1 How to approach bridging the gap: A reader's guide

Katherina Grafl
German Environment Agency (UBA)

Since the days of the Greek thinker Aristotle, philosophers have continuously reflected on the relationship between science and practice. All of them have drawn a line between theory and action. For a long time, theory was imagined as hovering above practice at a great elevation, like some wise old man sitting alone on high, brooding contemplatively about the essence of the world.

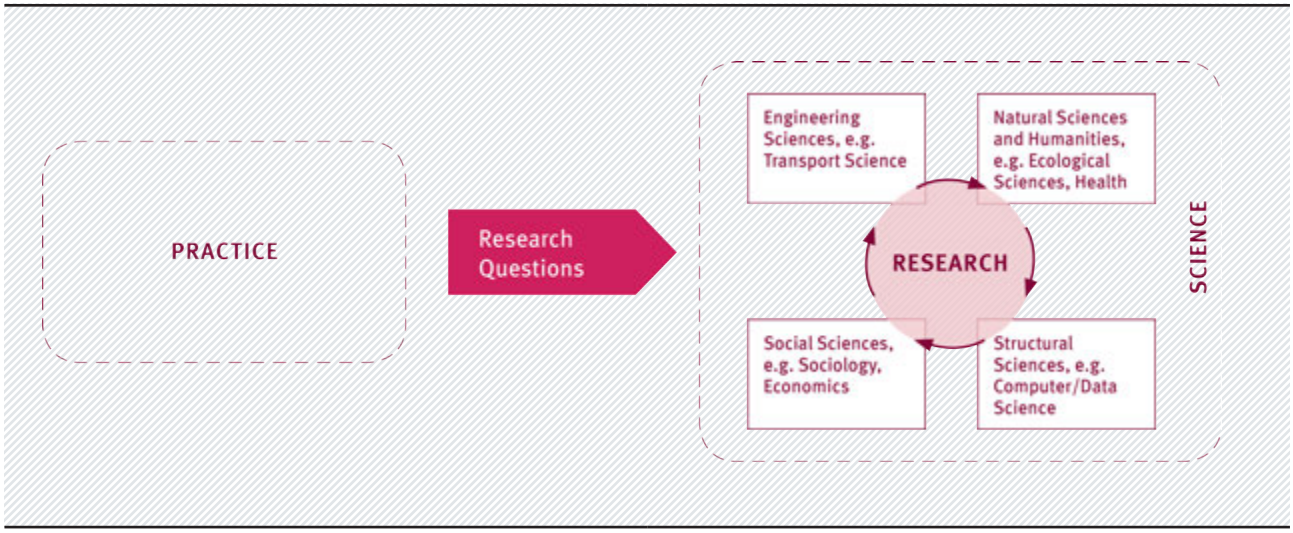
But times have changed since then. The old 'ivory tower' has progressively crumbled, shaken by a crisis of its own self-perception (see Discussion Note). Many modern scientists prefer to call themselves researchers. Even if the two terms are often used interchangeably, they are not synonymous. But there is no generally accepted differential definition of 'scientist' and 'researcher'. It depends very much on the individual or professional self-perception; very often also on the particular scientific background. Some scientists or researchers choose one of the two terms very intentionally, others without reflecting too much on the potential difference. So each classification needs to start with some very basic considerations. In this publication, a simple construct is used to ensure some degree of consistent wording. However, our external authors were free to use their own terms.

Research is conducted to answer a specific question. This could be disciplinary or interdisciplinary by nature. The term science is used here more generally and covers, for example, the different disciplines. The relationship between research and science could be described as follows: research contributes to science because it is essentially a method of gaining knowledge. In this sense, research is closer to practice because it picks up on questions arising from practice and transfers the results to science (see figure below). They do still overlap, however, and this definition is of course limited to some extent.

In the context of cycling as a subject area with concrete research questions, this publication focuses on research as a counterpart of practice. There is no 'cycling science' as such. Instead, a lot of different disciplines are engaged in all kinds of research

Figure 1

A differentiation of research and science



Source: Own illustration, UBA

questions. Cycling touches a range of disciplines from economics to psychology as well as applied research.

At first glance, current cycling research already seems very application-oriented. Many studies on topics like safety, preferences of cyclists or usage of digital possibilities offer a direct benefit for practitioners. Public research funds are often linked to the applicability of the expected results. This in itself might suggest that the gap does not exist anymore. But it does. And it is the everyday experience of a scientific authority like the German Environment Agency (UBA), whose mission is to give scientific advice to practice and at the same time to provide new research. There is a lot of knowledge already available, but it needs to reach the target group – and that means much more than simply publishing it. Here, the gap between research and practice is still very much in existence.

Before proceeding further, we need to reflect on the basic character of the researcher-practitioner gap and on how to bridge it. First of all, to bridge a gap means "to connect two things or to make the difference between them smaller".[1] Researchers and practitioners form at least two distinct groups in which information is circulated. Of course, each group is subdivided a great deal further; for example, practitioners might be politicians, administration employees or consultants. But that is not the point.

The more distinctive aspect is the existence of two communities in which the way information is shared is different. Scientific discourse has a certain degree of inherent exclusivity because a lot of conditions have to be fulfilled before one can take part in it. Basic knowledge of paradigms, terminology, methods and theories are all as necessary as being up-to-date regarding the state of knowledge. Even if many practitioners in administration or consultancy studied at the same universities as researchers and attended the same courses, they still lack two essential resources to be able to participate in the research community: time and access. The time factor is easy to explain. Whereas following and contributing to scientific discourse is the exclusive focus of researchers' work, the main duties of practitioners are diverse. For example, they may have to do basically administrative work.

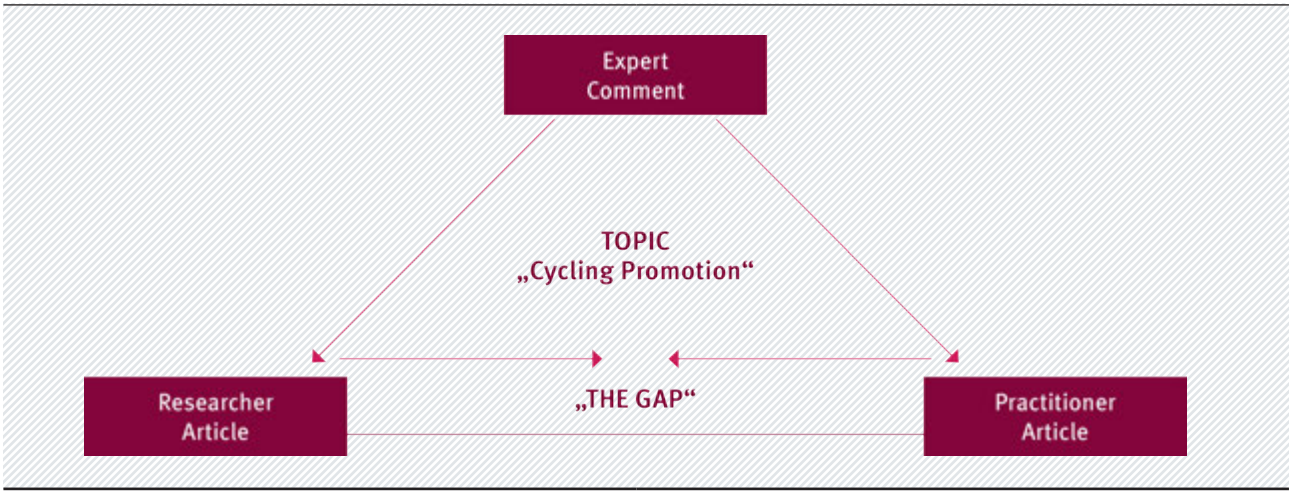
Time also determines the access factor because networking also requires time. It takes time to build a network and time to maintain it. Attending conferences and collective work on publications play an important role for integration into the scientific community. The barriers to taking part in these processes are much higher for practitioners than for scientists. As a result, practitioners who are participating in scientific discourse are very often doing so on their own initiative and in addition to the burden of their main employment.

Therefore, if we are to succeed in bridging the gap, we will need other approaches than merely waiting for the goodwill of practitioners and researchers. There are several conceivable options, most of which involve third parties acting as agents. Agents could take over the task of mediating between the two groups. This could be, for example, through the bundling and dissemination of information. Or they could promote the networking of practitioners and scientists by targeting networking meetings and conferences. It is the UBA's mission to act as such an agent. As a scientific authority, it advises politicians and informs the public based on the latest research findings. This publication is intended to be a bridge-builder, using a new approach. The International Cycling Conference 2017 in Mannheim, Germany, marked a kick-off.[2] 300 researchers and practitioners met for three days and exchanged views on current developments in active mobility. It was a good beginning, although a synthesis of topics was only partly successful. This publication continues the approach pursued there and enhances it through innovative elements like the 'matching' and the 'triad' approaches.

1 Cambridge Dictionary: https://dictionary.cambridge.org/de/worterbuch/englisch/bridge-a-the-gap (accessed 14.04.2018)
2 More information about the ICC at: www.uba.de/en/icc2017 and in our information brochure: https://www.umweltbundesamt.de/sites/default/files/medien/1968/dokumente/170911_international_cycling_conference_2017_broschuere_final.pdf

Figure 2

The triad of bridging the gap



Source: Own illustration, UBA

For some of the eight topics covered, a practitioner article and a researcher article are matched. For other topics, only one author makes a contribution. What all topics have in common is that they are discussed and commented by an expert. In other words, a 'triad' (see figure above) of researcher, practitioner and commentator is formed. The contents of the articles are independent of each other, as is usually the case. Our intention is to search for possibilities of bridging the gap. At the end of each topic, reflective conclusions are drawn about the chances and difficulties regarding that specific topic. These findings are particularly important for the interpretation of the bridging approach.

Starting with the very youngest cyclists, in Chapter 2.1, "Cycling in every period of life", *Hannah Eberhardt* and *Anna Gering* deal with the practical questions of parents-to-be and young parents as to whether cycling is possible before and after birth. *Karin Markvica* and *Christian Rudloff* focus on slightly older children and analyse the preferences of parents regarding tricycles. *Henrike Rau* is the expert who comments on the articles.

"Safety" is not only a vital topic for cyclists but also for Chapter 2.2. In their case study of Cape Town in South Africa, *Marianne Vanderschuren* and *Jennifer Louisa Baufeldt* show the challenges of providing and implementing a safe cycling infrastructure in a developing world context. *Carmen Hagemeister* and *Maike von Harten* look into the preferences of cyclists for a particular infrastructure type in Germany and their underlying reasons. The expert comment is provided by *John Parkin*.

The second focus on safety deals with "Electric bikes and safety" in a research article by *Tina Gehlert* on accident analysis (Chapter 2.3). A practical comment is provided by *Ceri Woolsgrove*.

When promoting cycling, policies play an important role. The first contribution to "Policies for promoting cycling" (Chapter 2.4) is an article by *Suzana Leite Nogueira* and *José Evaldo Gonçalo* about the implementation of the CicloviaSP programme in São Paulo, Brazil. *Julia Gerlach*, *Susan Hübner* and *Thomas Böhmer* adopt the research perspective and analyse the current state of impact evaluation of cycling measures in German cities. The bridging comment is provided by *Parvesh Sharawat* and *Anvita Arora*.

"Strategies to boost cycling" (Chapter 2.5) form the subject matter of the practice article by *Tilman Bracher* and *Sebastian Bührmann*. *Peter Cox* and *Heike Bunte* add another point of view with their research article on social practices and their importance for promoting cycling. *Holger Haubold* discusses the two contributions.

One upcoming topic with great potential is "Planning with GPS data" (Chapter 2.6). *Giuseppe Liguori* and his co-authors take a look at the usage of crowd-sourced data from the European Cycling

Challenge in Bologna and Rome, Italy. *Sven Lißner* and *Angela Francke* contribute their expertise in the research comment.

"Health and active mobility" (Chapter 2.7) was a major focus of the International Cycling Conference and is well represented here as well. *Elise Schabus* compares different European initiatives on active mobility. *Esther Anaya Boig* reflects on the practical dimension of this topic.

Cargo bikes (Chapter 2.8) have experienced a renaissance in recent years. They can be used in many different ways, for example for city cleaning in Hamburg, Germany, as *Britta Peters* describes in her article. *Sophia Becker* and *Clemens Rudolf* focus on the status quo of bike sharing in Germany. The general oversight is provided by *Karl Reiter*.

The "International Mosaic" was a highlight and, at the same time, provided a frame for the conference. With their views and experiences, six international experts from five continents raised the discussion to a comprehensive level. Like a mosaic, together their stories and perceptions formed a bigger picture. In Chapter 1.4, *Manfred Neun* and *Heike Bunte* clarify the structure of this picture and explore some important contexts.

Manfred Neun also contributes here with a reflection on framing in cycling research and practice.

Discussion note: The 'Ivory Tower' and its crisis

In the past, the 'ivory tower' was a symbol of the escapism and, at the same time, the beauty of science. Beyond the question of whether the term ivory tower was ever appropriate, today it can definitely no longer apply to many disciplines. Various shocks have severely damaged the imaginary tower of science. Very current and very present in the news, of course, is the discussion of 'alternative facts'. This discussion may seem absurd, but it clearly shows the emergence of an anti-science movement that is directed against the basic principle of transparent and comprehensible knowledge acquisition. Peter Strohschneider, president of the German Research Foundation, made a noteworthy speech about science in the age of populism (Strohschneider 2017). He says that science should not confuse the methodological reliability of scientific knowledge with anything like absolute certainty, and should know that research must indeed inform social and political discourses, but cannot take their place. Science needs a certain distance both to political power and to itself, since constant questioning is one of the basic requirements of a responsible science. He also talks about the scientific misconduct that has led to some major science scandals worldwide. For articles in prestigious journals, results have been exaggerated or prominent cases of plagiarism have become known. This behaviour of isolated individuals has shaken the integrity of science as a whole. It has raised the question of whether such misconduct was promoted by certain disincentives in the scientific community. Citation indexes as a scientific status symbol, on the basis of which research funds are awarded, are pushing researchers to increasingly frequent and increasingly sensationalist publications. Far too often, quality suffers and the freedom of science is adversely affected because only popular topics are researched. Although this is regularly discussed and criticized, so far no solution has been found for it. Science therefore continues to find itself in troubled waters and must continue to fight for its self-image and its freedom.

Strohschneider, Peter (2017): Über Wissenschaft in Zeiten des Populismus", Speech of DFG-President Peter Strohschneider at the ceremony of the DFG at 4th July 2017 in Halle (Saale); http://www.dfg.de/download/pdf/dfg_im_profil/reden_stellungnahmen/2017/170704_rede_strohschneider_festveranstaltung.pdf (accessed 14.08.2018)

1.2 Framing sustainable mobility in practice and research – and rethinking 'Reverse Innovation' in the case of Active Mobility

Manfred Neun
Honorary President European Cyclists' Federation (ECF)

Just how rich and valuable cultural diversity can be is something we learned at the International Cycling Conference (ICC). But to fully understand the value of what we experienced there, let us start with 'Reverse Innovation' (UBA/GIZ 2017). When I first encountered this term, I was not convinced – my encounter with term and concept was in the wrong frame. But when I experienced the particular kind of global learning and exchange evinced through the novel ICC format of the International Cycling Mosaic, I started to analyse both in context.

'Reverse Innovation' respects best practice examples from all over the world that contribute to sustainable development in urban transport, and we can see that well working systems – not just technical solutions or blue prints – are respected in their cultural context without needing to know the entire cultural frame. So we are not just talking about widening the frame for human needs, we are also widening the frame to make (urban and mobility) systems work – environmentally, economically and socially – and, even better, we also know that we are not starting from scratch. We already have a good head start in terms of best practice that already works and is appreciated by people. And we already have a good head start in terms of framing – as already explained at the ICC (Neun 2017, p. 17–18), from the frames we use make the world we perceive (Tversky and Kaneman, 1981) through to the increasing importance of political framing (Wehling 2016).

More advice for practitioners and researchers about the direction of sustainable urban development was forthcoming from Steffen Lehmann (2015), who reminded us that we "should remember that cities were never intended to be completed. Any city is inherently evolutionary, in constant transformation, and much in its character lies in the complexity and diversity of its urban spaces". Examples for this can be found in the UBA initiative Tomorrow's Cities (UBA 2017). When we analysed cycling friendly cities that are globally well-know, we always found that Active Mobility – which is mostly walking and cycling – was prioritized over all other modes of transport, followed by public transport (Neun 2018).

Thus, when we rethink 'Reverse Innovation' and the necessary respect for human-sized solutions, for diversity of cultures, for prioritisation of Active Mobility,

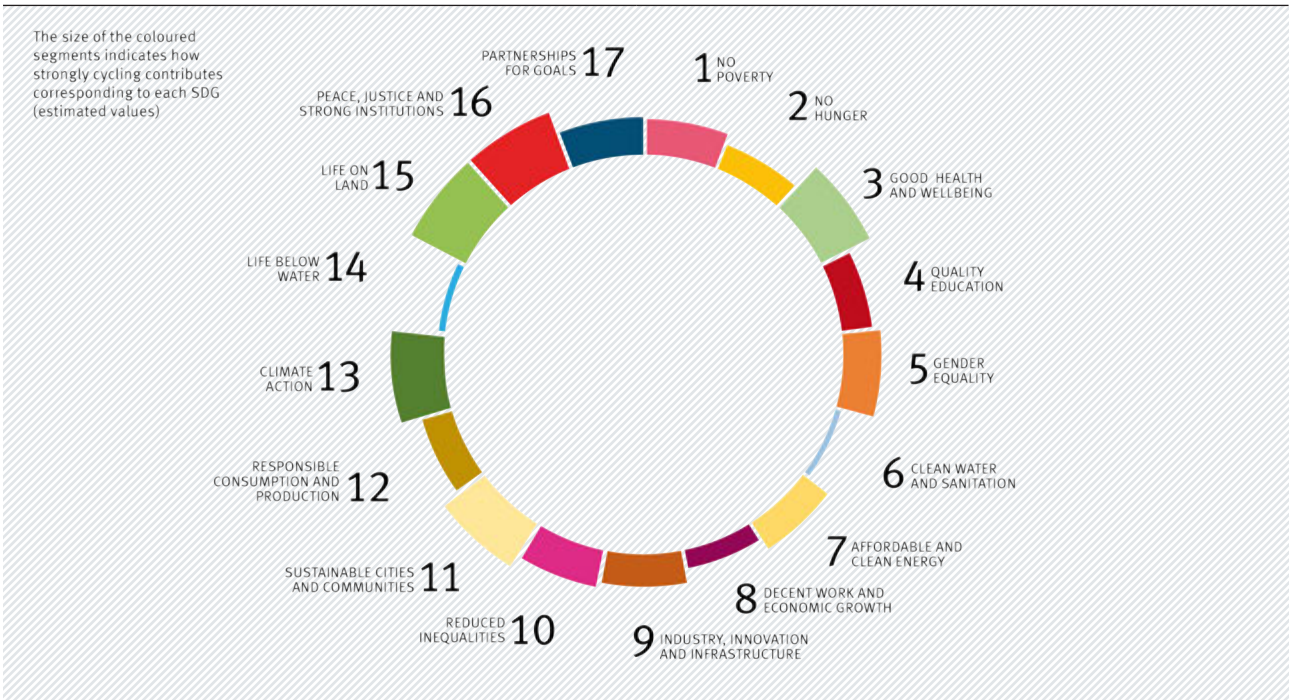
Active Mobility Agenda (AMA)

How these benefits for the entire cycling world from the Active Mobility Agenda (AMA) can be seen is demonstrated in this holistic approach with nine key-benefit categories.

The AMA was already used to evaluate the European cycling economic benefits (Neun and Haubold, 2016), and the evaluation of the contributions of cycling to the United Nations Sustainable Development Goals (SDGs) was also based on the AMA.

Figure 2

Cycling contributes to the UN Sustainable Development Goals.



As a promising perspective for researchers and practitioners, let us visualise these contributions of Active Mobility in a ring graph – as used in the NDC Explorer for countries' contributions to UN SDGs (Dzebo 2017). In the same way, we can outline the contributions as estimated ones. But a schematic representation like this can give us a very good idea of how future evaluations can be derived.

Furthermore, all these SDGs are perfect fields for the kind of collaboration between researchers and practitioners that we called for at the ICC (Gerike 2017, p. 17–18).

Source: Own illustration, Neun

and for systemic rather than merely partial working towards solutions, we can derive a valuable catalogue of questions for practitioners and researchers:

- Are we widening our frames?
- Are we achieving systemic thinking?
- Are we consistently prioritising Active Mobility solutions?
- Are we respecting cultural diversity?
- And are we – all in all – unleashing the full potential of 'Reverse Innovations'?

With these questions to guide us, we can work for people and sustainable cities. And we can achieve (a) a consequent use of the benefits of cycling as shown in the Active Mobility Agenda (AMA) for other fields in research and practice, for example a wider framing for the energy and transport transition (Schindler et al. 2009; WBGU 2011) ("Energie-, Verkehrswende"). (b) And we can also achieve a much better understanding, why people long for social cities, where they feel save and sound, a much better understanding of why people long for social cities where they feel safe and sound, where they are embedded in their "own culture", and where they can acknowledge their roots and appreciate the direction in which they are going. It is the exact opposite of what we can see all over the world, as fears grow ever faster in societies and we find ourselves facing terrible consequences. But it is not all the crises that are producing these fears – it is fears that are producing the crises, for example, when national leaders fight for supremacy of their "better culture" in competition with other cultures. The current endeavour to make things "great again" is born of fear and egocentrism in a period of history when what is really needed is global-cosmopolitan thinking in order to achieve sustainable cultures for all the inhabitants of our planet.

In this sense, the Cycling Mosaic was a great example of global-cosmopolitan contributions respecting each other and learning from each other, while maintaining overall esteem for diversity. And in this context, cycling and the sheer diversity of cycling cultures can be seen a great contribution towards providing people with orientation, helping them to feel secure in their diverse habits, to feel comfortable in practising active mobility, in being active and in open interaction with other people. Public spaces where people can meet each other reduce fear and provide a sense of social safety, as can been seen from developments in cities that have promoted and increased cycling like Bogota, Copenhagen and others.

In addition to these social benefits, we are also aware of the environmental and economic benefits that go towards achieving the "triple win" for sustainable development. And again, Active Mobility plays a central role.

Firstly, these SDGs or "Global Goals" are of immense value for telling us that all countries on earth are developing countries, and that reducing non-sustainable behaviour does not automatically create sustainable results. Sustainability must be generated from the bottom up. We know that cycling contributes to almost all of the 17 SDGs – a much greater contribution than you might expect if you only take the obvious impacts into account. For research and practice this effectively widens the frames for unleashing the higher potentials of active modes of mobility.

All these benefits underline how essential it is that we prioritise active mobility over other modes of transport, particularly with regard to the human rights aspect, the impact of cultural diversity, and also the positive effects of systemic interaction as described in Fusion Mobility (Neun 2018).

We therefore assert that cycling and walking must be at the heart of any meaningful sustainable mobility scenario. And, clearly, Active Mobility and Sustainability must be experienced as transformative values. This is the rich perspective that emerged from the 200-year anniversary of the bicycle celebrations.

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1.3 Framing for cycling practitioners and researchers

Manfred Neun
Honorary President European Cyclists' Federation (ECF)

Mark Carney, Governor of the Bank of England, issued a wake-up call earlier in 2017 when he underlined "both the growing trend for businesses to consider the impact of climate change on their operations, and for institutional investors to demand better information from them" (2017). And he got a strong response – the global Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) has just announced this as official policy. For some, this may well have been an economic earthquake; for others, it was simply an acknowledgement of reality for sustainable decision-making.

The real consequence is that a new frame has been set, one which changes the world immediately. It doesn't matter whether Mark Carney was acting as a researcher or as a practitioner; he simply used his power to set a new framework. And he acted with others by analysing evidence, urgency and potential consequences. Let's take this as an example of the power of transformative framing.

The frames we use make the world we perceive (Tversky and Kaneman, 1981). We all use frames – in our thinking, our daily life, in business, in research – and there is a growing recognition of the importance of political framing (Wehling 2016). In cycling advocacy and related research we practiced it explicitly when we changed our frame from NMT (non-motorized-transport) to Active Mobility (Held et al. 2015). Framing was essential to the introduction of a new frame for "Cycling economy/economics" (Neun 2011, 2013; Neun/Haubold 2016). Framing can also be work in progress, as demonstrated by the Active Mobility Agenda and its individual steps (Neun 2015a,b).

We are not alone. One of the key issues of the Active Mobility Agenda we introduced at Velo-city 2012 in Vancouver (Sabelis and Kloof, 2012) was named "Diversity of Cultures", and it was already discussed in a comprehensive way (Cox 2015). The impact of this frame is intended to be high for transformation towards sustainability, as it was introduced as "Eigenart" to a "Normative Compass for a Great Transformation" by the WBGU, the German Advisory Council on Global Change (2016).

In some areas we are still at the beginning, but we are learning that complex realities need higher efforts in framing. For example, when we started to test whether cycling had a place in the UN SDGs and UN Settlement Report (UN Habitat 2016), the contributions of cycling were initially collected from scratch, but then systematically increased by using the frames of the Active Mobility Agenda (ECF et al. 2015). By the time we started working on the UN Settlement Report, our framing was beginning to pay off; our story has become stronger and more impactful at each iteration.

Framing is now essential for the mobility of the future. Urgency already emanates from the many new terms and approaches like ITS, MAAS, Internet of things, Smart Cities, Smarter Cycling, Autonomous Driving, etc. Understanding of these topics is often diverse and the discussions are far-reaching, e. g. the "Disruption of the Automotive Industry" (Jungwirth 2016). But, at the same time, this challenging situation offers great opportunities if we can frame cycling technologies in line with the increasing recognition of all cycling as part of the solution for many societal issues. For our industry, we are reframing its image as a globally important provider of hybrid solutions and innovations in connected mobility. These challenges and opportunities need framing so that our approaches are systemic and sustainable, and so that they elevate Active Mobility to the level of other major players in political decision-making.

Finally, if we intended researcher and practitioner networks (e. g. S4C 2017) to be seen as living and

learning communities, we cannot afford to miss opportunities for framing. There is a huge leveraging effect to be gained by using this momentum and cultural consciousness to establish the frames we need, also with regard to winning tenders for further research, and to overcoming the BAU, the non-sustainable business-as-usual.

In short, framing is essential for the cycling world. In terms of political framing we have made an important step forward with the European Cycling Strategy (2017). And, with the "International Mosaic", we had actively started to invest in and practice framing at the ICC.

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1.4 The International Mosaic – A global perspective on Inventive Cycling

Manfred Neun
Honorary President European Cyclists' Federation (ECF)

Heike Bunte
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When Karl Drais invented the velocipede in 1817 in Mannheim, he unwittingly introduced a means to mitigate a global natural disaster that is now looming further along the timeline. 200 years later, over 300 experts from around the globe convened in Mannheim to discuss 'cycling' at the ICC. This was no conference about compromise, but about the bicycle's overwhelming transformative value for future and sustainable mobility. In the meantime, the concept of Active Mobility has been accepted as a standard for promoting independent human-powered mobility and for enabling cities to create liveable places and at the same time to increase economic welfare (Held et al. 2015/Neun 2015).

The International Mosaic was introduced as a completely new concept for the ICC conference[3]. Six ambassadors[4] from around the globe endeavoured to provide answers to the main conference topic, 'Bridging the gap between research and practice'. Firstly, they presented their 'own' stories on cycling-related topics and discussed the relevant policies from the perspectives of their countries. Different frameworks on cycling conditions and activities were then presented, while the main questions behind all the ambassadors' pictures and stories were tackled: whether cycling can take on the role as a catalyst for change, on one hand, and whether it can be a positive instrument for dealing with economic and social issues, on the other.

The aim of the International Mosaic and the ambassadors attending it was to bring all the different tiny pieces of a mosaic together, with the hope of creating a whole picture by the end of the conference. At the beginning of the conference, the ambassadors arrived with their own pieces of the mosaic, consisting of different opinions and specific frames, and broached the question of how to get 'cycling' into society. During the two-day sessions, the ambassadors kept their focus on the diversity of cycling cultures and on the balancing act of taking wider aspects of sustainability into account. While we, as moderators, tried constantly to reflect all these topics towards 'framing and bridging'[5], in response, they developed different lenses and perspectives in the course of the sessions.

200 years of cycling with a view into the future – or a case study on stage!

The result was that in effect, during the three ICC-International Mosaic panels, we conducted a 'case study on stage' which ultimately led us to the four main dimensions of Inventive Cycling (see Fig. 1) under the perspective of the three main headlines: **'active mobility as a claim', 'active mobility as a system' and 'active mobility as a solution'**. Thanks to the International Mosaic we are able to classify the panellists' contributions according to these four dimensions, allowing us to state that this 'case study' is based not only on pure and simple 'personal expressions and impressions' with a highly subjective perspective, but also on the Framing and Active Mobility approach outlined in the ICC conference keynote, 'Framing for Cycling'. Here, essentials like prioritised Active Mobility and the benefits of the whole Active Mobility Agenda were presented. It was an important goal of the International Mosaic to show this, and to combine it with the three categories: **'active mobility as a claim', 'active mobility as a system' and 'active mobility as a solution'**. We systematically collected recommendations for 'framing and bridg-

3 Thanks again to Sebastian Bührmann und Sabine Schulten from the Difu/Germany as the source of inspiration for the 'International Mosaic'.
4 See also the Pre-ICC Brochure: International Cycling Conference 2017 – Bridging the gap between research and practice (p19ff.). The Mosaic Ambassadors were: Prof. Dr. Lake Sagaris (Chile); Alejandra Leal (Mexico); Dr. Anvita Arora (India); Amanda Ngabirano Aziidah (Uganda); Prof. Dr. Ana Santos (Portugal); Prof. Dr. Jason Chang (Taiwan): www.uba.de/en/icc2017
5 'Framing' according to Tversky and Kaneman, 1981 ff, as introduced by Neun for cycling and active mobility at the ICC conference, and ibid the 'Active Mobility Agenda'.

ing' so that city councils and administrations with their daily work experience will be able to work with the results of researchers' and vice versa.

With a systematic approach to 'cycling as a system for framing future mobility', we will be able to respond to different conditions in our cities of tomorrow. In this respect, while keeping the three headlines in mind, the main perspectives of the International Mosaic sessions with the ambassadors were as follows:

- Don't look at cycling in isolation – it's time for intermodal and connected mobility.[6]
- Talk about pedestrians (and different generations).
- Think about gender.
- Strengthen the relationship between planning and implementing authorities and researchers.
- Develop master plans for active mobility for all cities.
- Keep in mind that developing cycling policies is a long term process.
- Use modern technology.

One might argue that these perspectives of the ambassadors could be taken for granted, but here, again, framing is the catalyst for change. Taking cycling and active mobility seriously into account, one should bear in mind that the so-called 'common' global perspectives of the ambassadors add valuable contributions to the topic 'cycling as a system', and this can successfully bridge research and practice for the upcoming decades – or as one of the ambassadors said: "…. there is a deliberate move to link research and practice. It will not happen and it will not fall from heaven." So-called 'common understandings' need to be deeply reflected over, repeatedly, so that deliberate connections between all parties can influence public opinion in a positive way. In this way, the importance of the headlines above will contribute positively to the topic of 'bridging and framing'. The

6 For further perspectives on the approach see the Fusion Mobility concept (Neun 2018).

following stated goals of the ambassadors will influence Inventive Cycling in future related work:

- To develop a two-lense approach (taking into account at least two perspectives)
- To develop an entire spectrum of acuity related strategies
- To develop strategies to get access to the benefits of active mobility
- To develop strategies to strengthen citizenship
- To develop collaborations between cities and multidisciplinary team work
- To develop a base to synthesize indicators for all countries

Interdisciplinary work on an international level means being confronted with all sorts of (positivist) traps and claims (Cox 2017; p. 36) or, to put it another way, norms, values, habits and personal decisions formulate so-called rational choices[7] (Tversky ebd.). It is therefore important to reflect collectively on norms and values, and it is even more important to reconsider them in order to overcome the typical 'framings' we are working in (Kiso et al. 2017). We need to examine causes and effects in order to improve upcoming discussions about active mobility. The four dimensions of Inventive Cycling highlight the outcomes of the International Mosaic and identify the (inter-)relations (see Fig. 1) and driving forces.

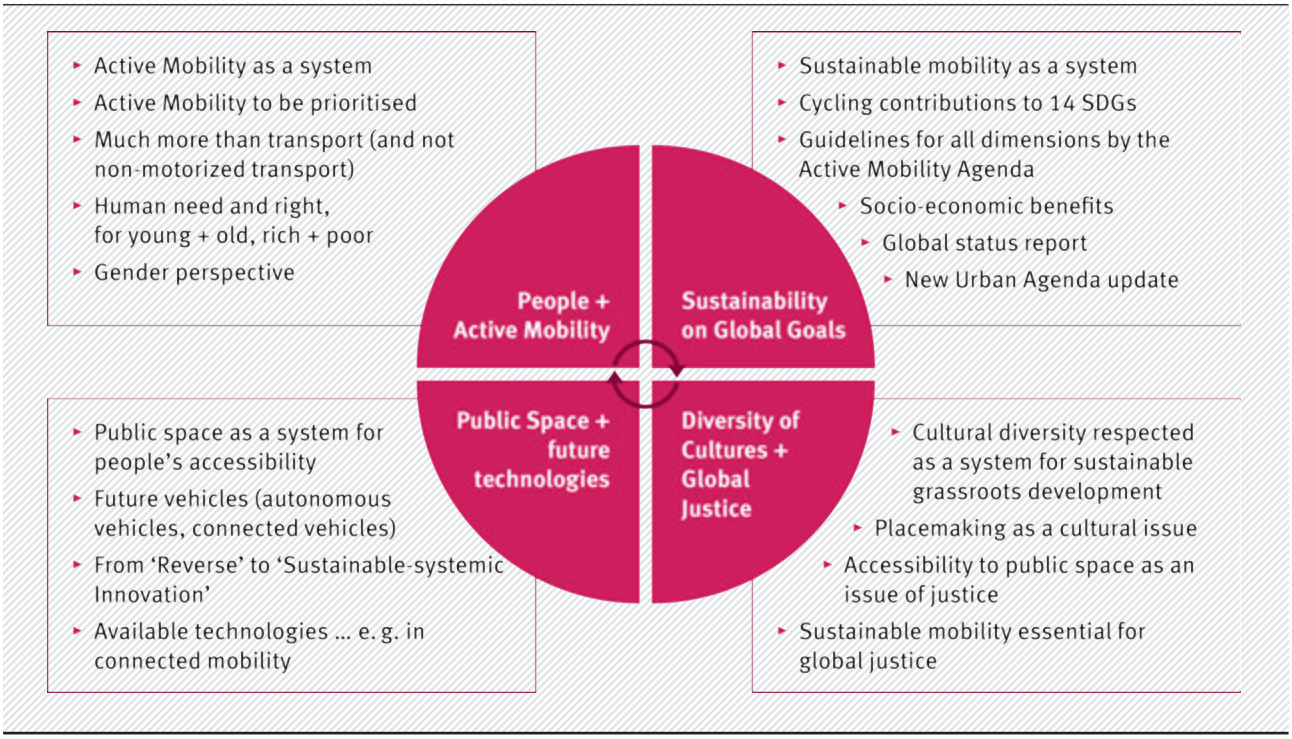
Future perspective – or keyword: Inventive Cycling

We all know that the individual stories and their evaluation will be analysed using qualitative research methods, and the numbers will be analysed using quantitative research methods. Meanwhile the struggle to determine the 'best' method will continue. Achievements were made during the International Mosaic by (1) reflecting on the different roles

7 This addresses the whole debate about 'homo oeconomicus' and the idea of rational choice theories; see for example: Esser 1996/Rosa et al. 2007:242.

Figure 1

Dimensions of Inventive Cycling – a systemic approach for sustainable development on the basis of the International Mosaic outcomes



Source: Own illustration, Neun

regarding the relationship between research and practice, (2) accepting the challenge of achieving transparency about 'causes and effects of framings', and (3) overcoming the principle of the lowest common denominator and embracing the cornucopia of rich cultural diversity. Through the International Mosaic, we have increased our knowledge about cycling and active mobility all over the world, enabling us to identify future general and specific topics. In addition, a new and positive role of the bicycle has been highlighted in a much wider frame, one which acknowledges it as necessarily culturally diverse.

'Bridging the gap' will also be an integral part of the work in progress. We need to move on from the scenario of practitioners sitting in their offices doing their planning under a ceiling of standard planning regulations while researchers keep themselves busy with perpetuating long-term so-called 'rational' (traffic) safety arguments. What sounds like a 'bad' comparison of roles is in fact daily (research) practice (Oosterhuis 2016), and needs to be deeply reflected on by all experts working on the topic of Active Mobility. The International Mosaic marked a successful beginning towards breaking through typical norms and values under the banner of 'active mobility as a claim', 'active mobility as a system' and 'active mobility as a solution'. And we will now be able to overcome the dependence of preferred framings without underestimating them within all (active mobility) subjects – while the wider frames discovered mutually by researchers and practitioners deliver transformative values.

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1.5 Citations from the International Mosaic at ICC 2017 Mannheim

Moderation
Heike Bunte, Manfred Neun

Mosaic Ambassadors
Anvita Arora *(iTrans, India)*, **Jason Chang** *(National Taiwan University)*, **Alejandra Leal** *(Céntrico, Mexico)*, **Amanda Ngabirano Aziidah** *(Makere University Kampala, Uganda)*, **Lake Sagaris** *(Pontifical Catholic University of Chile)*, **Ana Santos** *(Universidade de Lisboa, Portugal)*

Perceptions of cycling in different regions in the world

"We shouldn't look at cycling in isolation because it only works if everything works and if policies are working. For example, if we do not invest in thinking about proper policies for parking it won't help cyclists and pedestrians at all. It won't bring that topic forward because cars are parking on cycle paths in my country. So we need an interdisciplinary approach or: involve other people into the topic "cycling"". (Anvita)

"Just try to avoid mistakes and conflicts with pedestrians." (Lake)

In "former" times when I was young I thought cycling is a topic only for young people. And I thought that in Europe all people cycle. Now, I realised and I learned that it is different! Not everybody in Europe is cycling. So, I think we need patience to work on the topic in general and that will help especially in the long run to bring more women to enjoy the city. (Alejandra)

"A specific story about my country was that I made a 2000km cycling tour through Portugal and that was very hard – even with a pedelec/e-bike. But I enjoyed it very much because I talked to many local people and heard their different views on the topic "cycling". Most of the time they said: It's too hilly" but I showed them that even in my age it's no problem to do a long cycle tour in that hilly country." (Ana)

Comments and insights to the conference:

"So many women are here on stage! In my experience I'm usually the only "cycling woman" between men at conferences and here it is completely different – many women are participating. If one looks at the little film we made in Uganda/Kampala I'm also in daily life and traffic the only woman on the road. So it's good to see that here are many women also in daily traffic but I think neither in Uganda nor in the UK cycling is safe on the road." (Amanda)

"In terms of "bridging the gap" it is necessary to identify the gaps and make instruments more integral. It is important not only to think about cycling but also walking. And for example for transport justice as a topic for inclusion it would be necessary to include tricycles completely into the system. Last but not least: for transport justice we need to (re-)think how we share our public spaces." (Lake)

"Here, I like the interactions which happened within the sessions and I think it is important that the topic public health is a bigger issue within this conference." (Jason)

Lessons learnt:

"I would say that we need a very good masterplan for active mobility. And behind the masterplan we do need the research and planning. So that we can have a masterplan, which can be really workable and which can really be implemented at the national level and at the city level." (Jason)

"I think a big lesson I've learned in the last fifteen years of my work with cycling is that I'm unable to look at cycling in isolation. If I plan good cycling tracks and we don't have sidewalks all the pedestrians walk on the cycle track. If I don't plan for a vending space, then the venders park on the cycle track. If I don't have bus stops then all of them are on the cycle track. So I am absolutely unable to look at cycling in isolation from everything else that needs to be on the street and it only works if everything else works. I've realised that latest when working with the city of Pune (India). We have been trying to make a network, a masterplan

for cycling in the city and the one thing we need is a parking policy, because the space I need for making my cycling infrastructure is going to be space I am taking away from parked cars and if there is free parking or unorganised parking in the entire city my cycling infrastructure doesn't work. So it has to be an ecosystem approach and everything else has to be in place for a cycling infrastructure to work." (Anvita)

"... if we start talking about active or collective transport or public transport as well, then a whole new horizon of possibilities opens up and within that, thinking about gender means thinking about what it means for women who account for very, very high percentages of people walking in developing countries, and this means thinking about the kind of limitations that we are facing regarding access to jobs, access to education, for fulfilling these very multi-faceted roles that we're supposed to fulfil all in the same twenty-four hour day that men have just to get up, go to work and come home again. Just a warning that when we plan for cycling in developing countries we end up in a lot of conflicts with people who walk. Walking is always a majority transport mode, 34%, 40%, 50% in any city. If your figures are low it's because walkers are underrepresented in your data. We all start by walking. There's one last thing to mention: Walking also includes mobility assisted forms of getting around." (Lake)

"In our situation the 'M' in the NMT (non-motorised transport) is not only negative but it is responsible for resistance from the motorists. They immediately start thinking that you are talking about them and you want to get rid of them. We need to try to bring the researchers and the planning authorities together and as well the practical planning challenges with the problems being researched about." (Amanda)

"... cycling policy is a long term process so you have to believe that the things that you're doing now will change the way the city looks in five, ten, fifteen or even twenty years. Now, we need to build on young people because they are the first ones to take the bicycles but then they will become parents and they will have grandchildren and at the end all of us will be bicycle users." (Alejandra)

"Being a cyclist in Mexico City as a woman meant a lot for me, because it really gave me access to different things – things that I was not able to do before, for example going to a party and deciding on my own when I wanted to go back home. That was not possible before because public transport doesn't run twenty-four hours and you were always depending on someone else or thinking the whole time about how you will get home later. So you know these kind of benefits really made me think that working on this topic could really help women or others to enjoy the city in a different way." (Alejandra)

"One of the main arguments in Lisbon is that people are not cycling because it's hilly. And I started my project, a tour in Portugal, with almost two-thousand kilometres, parts of the stages were on week-ends and some during the holidays. I did ten stages and thousand kilometres in ten days. I showed to all people, namely in TV programmes, in a seductive way, with nice photos from Portugal, that a woman of fifty-three

years can do the Tour of Portugal (Volta a Portugal). I am not an athlete as you can see. The question that people ask is: How is it possible? And my answer is: With an e-bike, of course. The trick is to find a way to communicate ideas: the first Tour of Portugal followed a route that people love because it goes near the border, visiting almost all district capitals, it is an emotional itinerary and that's why it was the starting point of my project. I did it – the itinerary of the Volta a Portugal from 1927 – and I think that the success of our project is related to emotions that people feel with this romantic itinerary that visits all country, that shows the beauty of the landscape and that shows that it's possible to everyone, not just for athletes. (Ana)

Favourite highlights of the ICC?

"The most important is the meeting, all the people that are here from all continents". (Ana)

"I find it very interesting that people from different countries are presenting cases of their countries that have just started. That's interesting for me because normally I would say that you would speak from the countries that you know but it's also nice that there are more and more professionals getting involved in starting the policies and this is happening all over the world." (Alejandra)

"... there are many countries where cyclists are "cycling bugs" and then the other countries where we have "cycling ants", I found story that we can tell: For example, the UK has cyclists and Uganda has cyclists but there is a problem: it is not safe, it's not well implemented, it's attached to negativity, it's not popular. It is different for the Netherlands: It's a cycling country and even children are on the streets, women are on the streets and the air quality is better. This is a highlight for me and we need to switch from the bugs and work so hard to go to the ants in relation to cycling." (Amanda)

"... you know there are lot of studies on deliberation [Note: consensus building] and when like-minded people sit down and deliberate together, they end up in very extreme positions, because nobody challenges them so they just support each other and they end up in, like very liberate people can end up, in extremely conservative positions. Diversity isn't just something nice or funny or enjoyable, it's actually a very important method if we would really want to get to somewhere different from where we are today. But I'd also like to ground this a bit because we've had some very practical conversations here and what I really like is to see this cycling practitioners' and researchers' community moving towards establishing goals and indicators and methods for evaluation like PASTA or some of the other methods that have been presented because I think it is an extremely important way of influencing public opinion, policy, reinforcing advocacy, identifying gaps, there are a lot of gaps that exist and so on. I think it's a challenge to make those instruments more integral, it's not good enough if we're finding that cycling is going up but it's going up at the cost of walking, which happens a lot when sidewalks are suddenly shared rather than lanes on the road taken from cars and dedicated to not only bicycles but also tricycles and cargo bikes and so on. So I think that's a major challenge and I think one of the things we're working on in Chile this year and for the next four or five years is going to be [...] a transport justice report, that brings in walkability, cycle inclusion, universal accessibility, gender, inclusion of indigenous people – in many of our countries they are excluded from bus services or other kinds of social access and I think that this is a direction that we need to take. What is behind all these conversations is that we have one mode or another mode or a sustainable mode or an unsustainable mode, these are really fundamental issues of how we share our public space. And roads are twenty-five percent of the public space, of the physical space of any city so I think that underlines this transport justice [...] finding ways to move towards it are really crucial." (Lake)

"... Conversations at the conference made me realise that there are a lot of failures behind the best practices that we see in Europe and they have come a long way and they have failed at many places and not everything is worked out. And I think we need to have a conference on failures, we need to understand from a lot of things that went wrong before something went right, because we are still at the stage where things are going wrong and when we see things that are working right in other places we don't know what was the road you took from that point A to this point Z that we see here today and I think it would be great if we had a conference that says you [...] what we did wrong and this is what you need to watch out for. We would learn so much more." (Anvita)

"I also learned a lot from interactions. And here I will mention those research related topics which help public to do their evaluations since we need those evidence." (Jason)

1.6 A practitioner's view on bridging the gap – the City of Mannheim

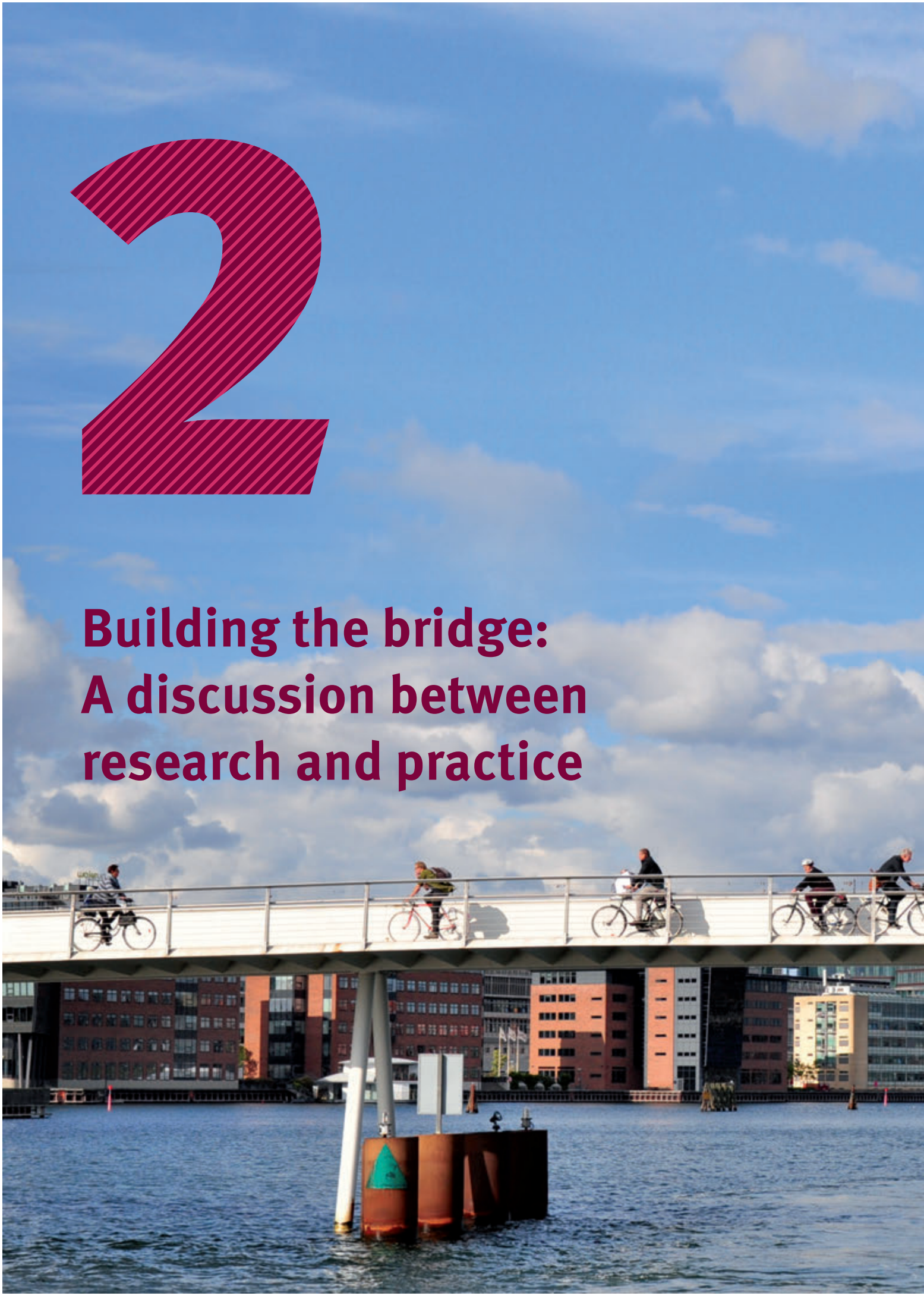
Peter Roßteutscher
Formerly City of Mannheim

For me, the ICC conference was a highlight of the entire anniversary programme organized by the City of Mannheim. Hosting this world-class symposium on the occasion of the 200th anniversary of the bicycle was, of course a very special honor for our city. But it also gave me valuable input for my future work in municipal practice. Let me give you two examples. For newcomer cities like Mannheim, comparing oneself with or learning from Copenhagen is hardly possible. The differences are too great. But at the ICC, I learned that the walking and cycling infrastructure in Copenhagen was not imposed overnight by new rules and laws from above, but rather through a process of "nudging". In other words, it was by emotionally and positively experiencing the changes in society that Smart City became possible. Without realizing it, we had a similar effect during the anniversary. At our big bicycle city party on closed streets, people rediscovered the public space of the city center and were thrilled. Now, traffic concepts for the city are being discussed and projects implemented that would have been unthinkable before.

I was particularly impressed by the example of London presented at the conference. The idea of looking at public space from a holistic health science perspective and deducing road and traffic planning from that inspired me a lot. If, in the future, we not only apply the current technical regulations in the conversion of more walking, cycling and public transport, but also increasingly ask ourselves whether the new space will make the city more beautiful, healthy and liveable, we will certainly achieve even better results.

2

Building the bridge: A discussion between research and practice

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2.1 Cycling in every period of life

Practice

Cycling with a baby – What do young parents need after the birth of their child to continue biking?

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Research

Get families to cycle more often by providing a family-friendly tricycle package

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PRACTICE

Cycling with a baby – What do young parents need after the birth of their child to continue biking?

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ABSTRACT

After the birth of their child, many parents in Germany stop using a bicycle, opting instead for a different means of transport; in particular, they tend to travel by car or on foot (own survey, infas). This switch often translates into purchasing a car. What makes cycling so unattractive during this period? What needs do parents with a baby have with regard to cycling? And what are the possibilities of making it easier for young parents to go by bike?

These questions are the focus of a three-year research project (from June 2015–May 2018). The objective is to develop, test and promote tailor-made offers for parents with a baby. Doctors and midwives also participate in our project, as they have direct contact with parents before and after the birth of their child.

In 2016, we conducted a survey with 650 parents and pregnant women. The results show

... that one fourth of the women surveyed already cut down on the amount of cycling during pregnancy and one third of them were discouraged from riding a bike at all during this time.

... that young parents have an extremely high need for security and they want to see infrastructure that they deem to be safe.

... that they would like to start cycling again soon, but it is difficult to do so (lack of parking spaces for bikes, security and health concerns, high acquisition costs),

Our project takes up the obstacles and needs of parents and extends offers to parents which make it easier for them to use bicycles, including

- reliable information
- action days on which bikes and bike trailers can be tested
- bike trailer rental service
- information for policy-makers and local administrations.

The project is financed by the German Federal Ministry of Transport and Digital Infrastructure with funds from the German National Cycling Plan.

Keywords: Children and babies, pregnancy, health, barriers, service offers, Germany

INTRODUCTION

"Cycling with a baby; that's really an unusual topic!" We hear this or similar statements again and again whenever we are at conferences to give a presentation on our project. It certainly is an unusual topic for a conference, yet it is one that arouses interest as can be seen at symposia where new parents or pregnant women come to listen to our presentation.

However, "cycling with a baby" is also important from the perspective of mobility research and transport planning: After the birth of their child, many parents in Germany stop using a bicycle, opting instead for a different means of transport; in particular they tend to go by car or on foot. This switch often translates into purchasing a car (by infas). At the same time, many new mothers express a desire to start riding a bicycle again. A transition phase in life (such as moving house, a new job or the birth of a child) can present an opportunity to point out new mobility options within the scope of a mobility management plan or break old (mobility) habits.

In a three-year research project (from June 2015 to May 2018), the traffic planning office 'Verkehr mit Köpfchen' (a spin-off office of 'Verkehrslösungen') is studying the following questions:

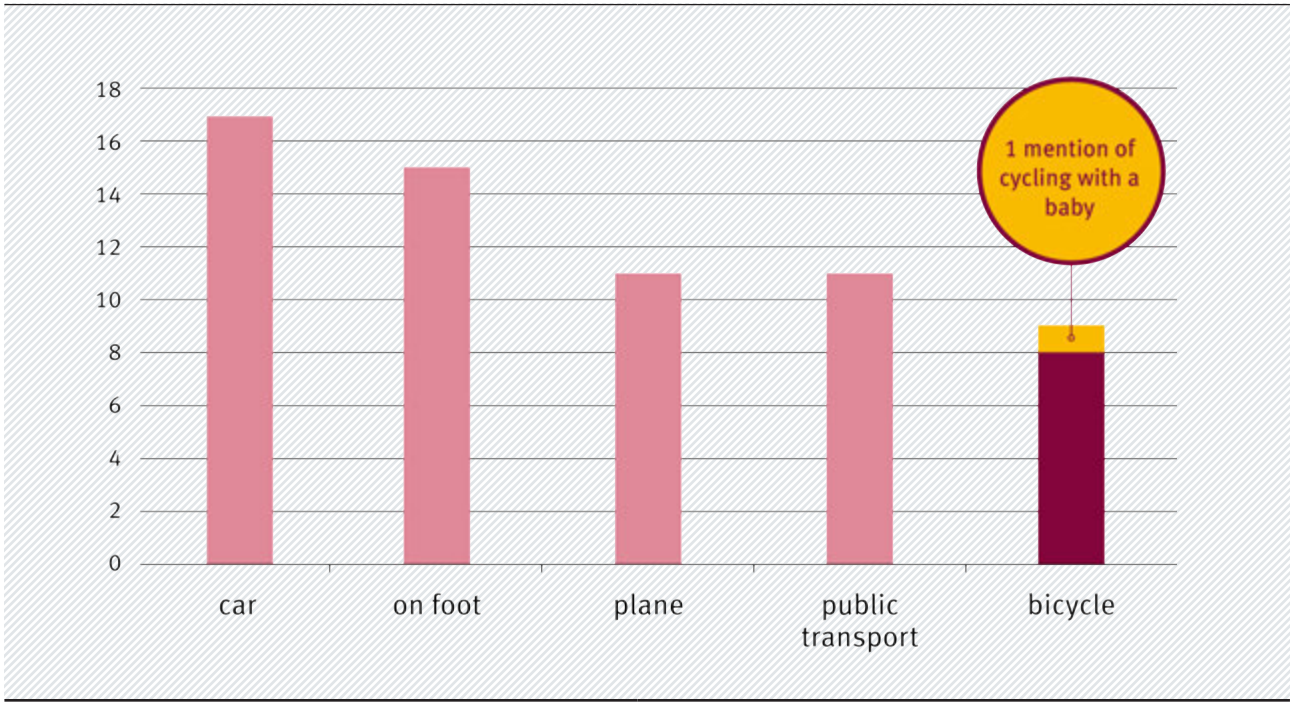
- What makes cycling so unattractive during this period?
- What needs do parents with a baby have with regard to cycling?
- And what are the possibilities of making it easier for young parents to go by bike?

The objective is to promote and increase opportunities for cycling after childbirth. The project is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) from resources for implementing the German National Cycling Plan.

The paper gives insights into the project and shows results from both research and practice.

Figure 1

Mention of modes of transport in 29 surveyed parenting guides



Source: Own illustration, Verkehr mit Köpfchen

CYCLING WITH A BABY – IS THIS A TOPIC?

In Germany, cycling with one or more children is fraught with (mostly subjective) uncertainties, while – at least in cities in which most people cycle – it is still more or less part of everyday life. Accordingly, a market for child seats and child trailers has developed, with cargo bikes being added to the mix in recent years, and now there are also running bikes, child's bicycles, child's helmets and other accessories such as horns and flags, etc. There are safety tests for child trailers and child's bicycles, a DIN standard for child bicycle trailers (DIN EN 15918:2017-05), reports published in a parenting magazine on "The best bike for your child", and much more.

A cloud, however, hangs over the topic of cycling with a baby, both in (family) practice and the public perception as well as in research and traffic planning. The following section shows its current status in the various areas:

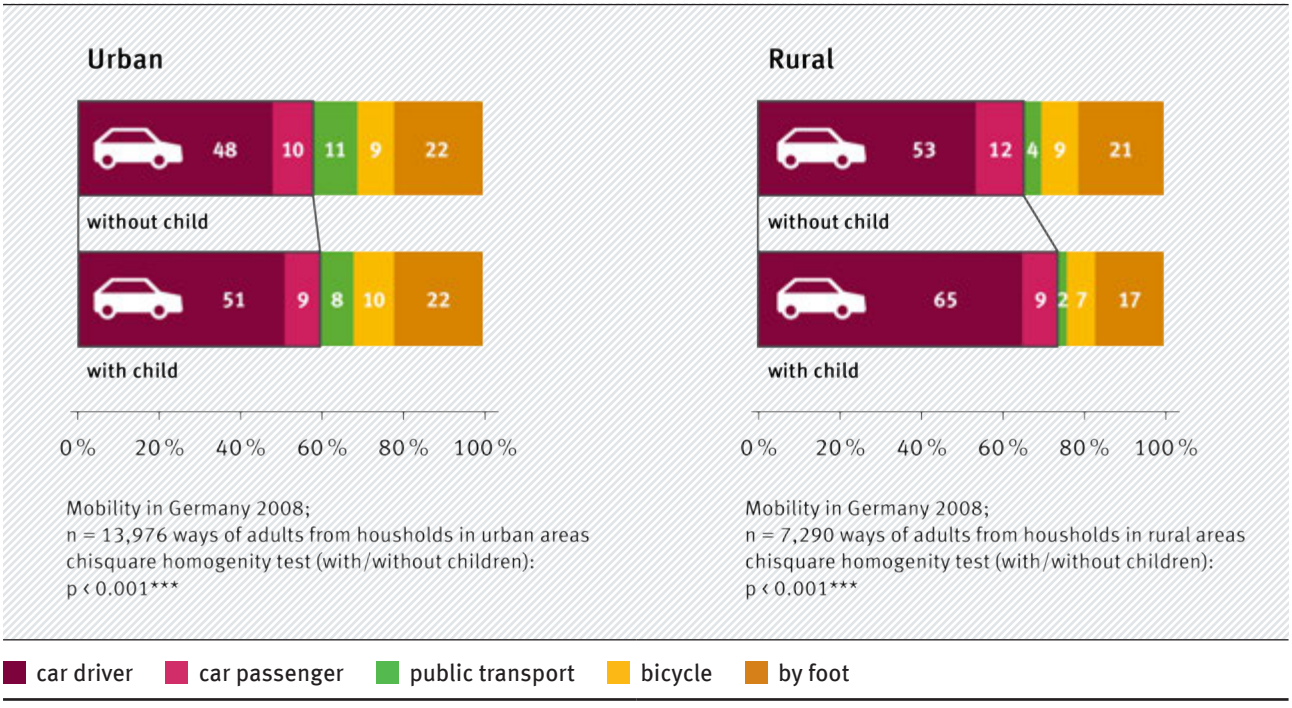
Public perception

Cycling with a baby has only recently been a topic of discussion on blogs written by mothers who are cycling aficionados. In conventional magazines, the topic is (almost) irrelevant. Within the scope of the project, 28 parent guidelines in book form, six parenting magazines (one year's worth of issues for each publication), and twelve websites addressed towards parents were examined on the topics of "Cycling with a baby" and "Cycling during pregnancy". The topic of cycling played only a minor role compared to other modes of transport (see Figure 1). Cycling was mentioned most often in connection with pregnancy and recommended as a suitable means of transport during this period. Only twice was cycling with a baby discussed, and only once specifically with a baby. The author noted that it is suitable to bike with a baby in a bicycle trailer fitted with a special baby seat for newborns and young babies.

The topic of cycling and cycling with small children is almost exclusively dealt with in terms of leisure activities in parent magazines and not as an everyday means

Figure 2

The choice of transport between households with or without children differ according to whether they live in an urban or rural setting (taken from Herget 2011, page 6, figures based on BMVBS 2010)



Source: Herget & Appel

Figure 3

the most common baby carriage options in Germany: Child trailer, child seat, cargo bike

Design: Johanna Berking

of transport. Cycling with a baby is hardly discussed. Only online services of parenting magazines and internet forums touch on the subject of cycling with a baby. There are tips for riding a bike in the winter and recommendations for what kind of bicycle trailer is suitable.

Family practice

According to the study "Mobilität in Deutschland" ("Mobility in Germany") (infas/DLR 2010), households with children are 14 % more likely to use a car than households without children. Households with children more often own cars, and these cars are also used for a larger share of mobility than in households without children (Herget 2012, see Figure 2). Women – and to a lesser extent men – use a bicycle after the birth of a child much less frequently, and instead they go by car or on foot (Scheiner/Holz-Rau 2012). Qualitative studies after the birth of the first child (Lanzendorf 2010) show a reduced level of cycling and less use of public transport as well as increased ownership and use of cars.

If bikes are ridden in families, then babies and toddlers in Germany are usually taken along in a bicycle trailer, in a child's seat, or with a cargo bike (for illustration, see Figure 3). Depending on the model, child trailers can be used to transport one or two children; babies can ride along in a special infant sling offered by the manufacturer which is similar to a hammock or (on some models) they can ride in an infant carrier. Depending on the manufacturer, babies can ride along by bike directly after they are born. As soon as a baby can sit safely on their own, they can ride in a child seat. Models that are approved for road conditions included seats mounted behind the rider (saddle tube, rear trailer) or in front of the ride (head tube). On some cargo bikes, is it possible to take a baby with you by fastening an adapter to a baby car seat. In Germany, babies that cannot yet sit by themselves are mostly transported in a hammock fixed in the trailer.

Mobility research, mobility management, traffic planning and traffic law

In mobility research, mobility management and traffic planning, cycling with a baby is not given much attention, if at all. Current approaches will be presented here in brief.

In German-speaking countries, research has been conducted on transition phases (such as after childbirth) and mobility behaviour, however, cycling does not play a role in it (Jaeger-Erben 2010, Schäfer et al. 2012). It is noted, however, that if we want to promote cycling with a baby, then parents should be informed and encouraged to do so, if possible before birth.

Within the scope of its programme on mobility management "Go! Family", the city of Munich sends new parents a coupon booklet that includes among other things a voucher for a free week-long trailer rental.

When it comes to traffic planning, parents cycling with a baby are not currently a target group. Current traffic regulations permit taking children up to seven years of age in a device suitable for this purpose; this also includes trailers (German road traffic regulations §21, (3)). A new provision in effect since December 2016 in the road traffic regulations (§2 (5)) also allows adults to ride their bike together with children on sidewalks (otherwise, in Germany cycling on sidewalks for adults and children above the age of ten is forbidden). Babies taken by bike are not explicitly mentioned in traffic law.

WHAT DO PREGNANT WOMEN AND PARENTS HAVE TO SAY ABOUT CYCLING DURING PREGNANCY AND WITH A BABY?

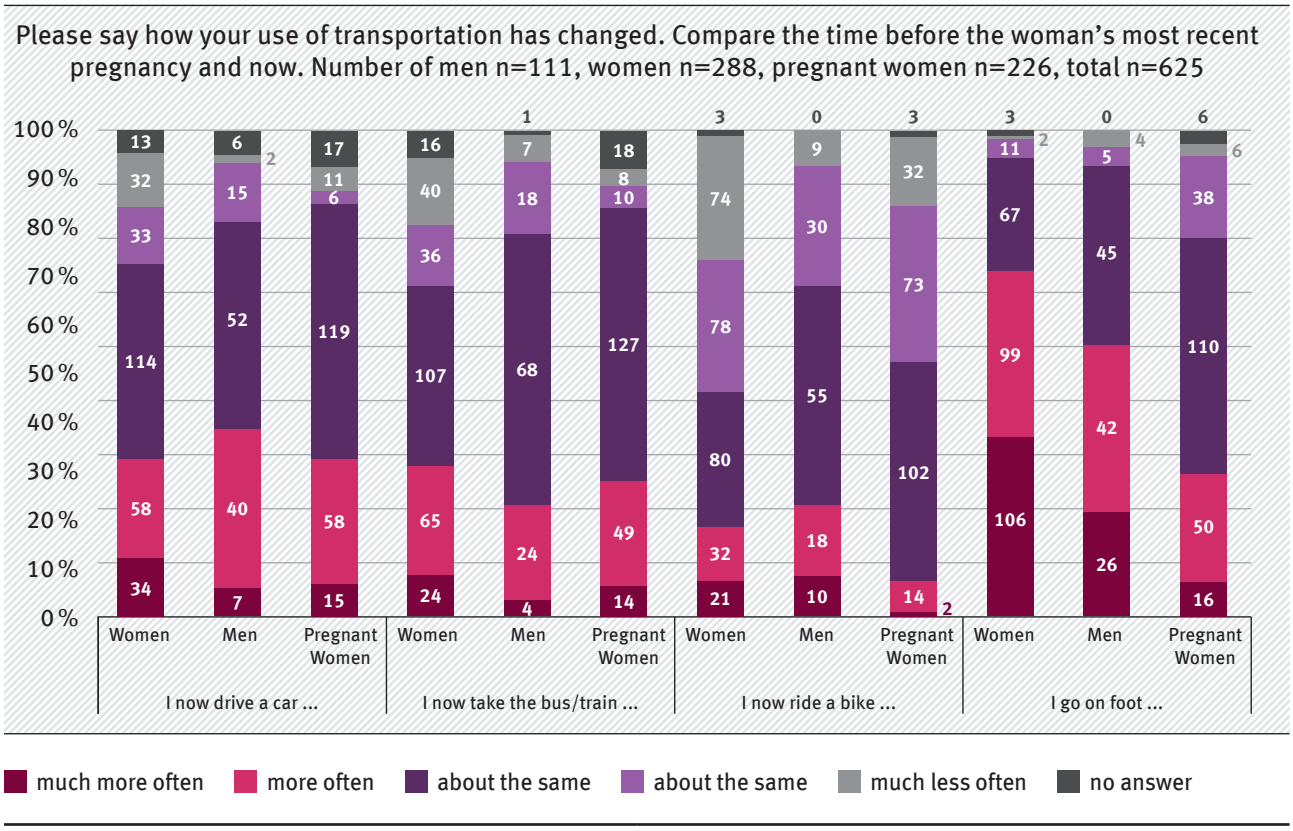
Apparently, cycling with a baby is hardly a topic of discussion – not even within the target group itself. To learn more about this and to understand the barriers and needs of pregnant women and young parents, we conducted an online survey (July to September 2016 with some 650 participants) and focus group discussions (March to September 2016, with about 50 participants) within the scope of the project. In the online survey, the use of a means of transport, changes in the means of transport after the birth of their child, barriers and needs with regard to cycling as well as other topics were surveyed extensively with the aim of achieving statistical comparability. The focus group discussions, however, mainly served to obtain original recordings and additional information.

Mothers predominantly took part in the online survey (almost half of the participants), followed by pregnant women (one-third) and fathers (20 % of the participants). The participants were mainly very keen on cycling: Approx. 98 % indicated that they like to ride bikes and over 60 % rode a bike everyday or almost everyday before pregnancy or the birth of their child (nationwide average in Germany in 2008: 19 % (infas/DLR 2010). The poll is therefore not representative. Nevertheless, it provides helpful information: First, because it is the first survey of its kind and thus provides new information, while, on the other hand, it shows that pregnant women and parents who like riding bikes change their mobility behaviour after giving birth to their child by opting against cycling, and even this group identifies a number of barriers and obstacles with regard to cycling.

Even the participants in our survey with their high affinity towards cycling show that roughly half of them already starting cycling less during pregnancy: 32 % slightly less and 14 % much less (see Figure 4). This trend is even more definitive with mothers: 25 % ride slightly less, 27 % ride much less than before

Figure 4

Changes in the choice of mode of transport compared to before pregnancy



Source: Own illustration, Verkehr mit Köpfchen

their last pregnancy. For fathers, the changes in every means of transport are much lower; therefore, they are only briefly discussed here.

In addition to health aspects (e. g., birth injuries), it can be assumed that this change has something to do with a modified daily routine. For example, pregnant women in the final six weeks before their due date are in maternity protection, which means they take extended leave from their jobs, and after giving birth it is women who still take parental leave significantly more often and longer than men. Their mobility and the chosen means of transport are different than during the time before pregnancy; this explains the significant increase in going on foot (see Figure 4). This explains only a part of the changes. Various other explanations are presented in the following section.

"Were you recommended to not cycle during pregnancy?" 33 % of pregnant women and 26 % of mothers answered yes to this question. Almost every one of them was discouraged by family members (including partners) as well as a vast part of their circle of friends and acquaintances. A scant one-third was discouraged by their doctor or midwife, just under 20 % by strangers (e. g., passers-by). This dissuasion was not always justified, and riding a bike with a baby was often simply labelled as being "too dangerous" (with comments about falls or accidents and vibrations supposedly harmful to the foetus) or "too strenuous". Other people's perception can differ considerably from our own: When responding to the statement "Cycling is physically too exhausting for me", among the pregnant women taking part in the survey themselves just 1 % answered completely correct, and 5 % rather correct. Over half of the pregnant women agreed with the statement: "Cycling is more pleasant than going on foot." and over three-fourths agreed with the statement "I feel good when riding a bike." One pregnant woman reported: "It was mostly those who barely exercise themselves who discouraged me from cycling." It can be assumed that most of the arguments against the cycling have no medical or other sound reasoning. In addition, only a small proportion of the pregnant women followed the advice, except when it came from medical personnel. Nevertheless, it can be assumed that at least for some of the pregnant women the dissuasion sparked uncertainty with regard to cycling.

For the period after giving birth, a distinction must be made between riding a bike with or without a baby. Some women are never out and about without their baby in the first few months (27 % of surveyed mothers, including mostly mothers with babies under six months, but also with older babies). They usually have no other choice but to take their baby with them when riding a bike for the first time after giving

birth. Other mothers go on their first bike ride after birth without their child, preferring to wait to take their baby with them by bike. Of the surveyed mothers, about one third started riding a bike within one month, and nearly 70 % after three months. This is certainly not a representative number, but rather has to do with the respondents' affinity for cycling. Even for this group of cycling aficionados, however, there was a trend towards waiting to take their baby by bike for the first time (43 % in the first three months).

Those respondents who said that they had yet to take their child by bicycle or could not imagine cycling with their baby were then asked: "Thus far, what has prevented you from or in your opinion what arguments are there against cycling with your baby?" The most common responses were (each 9–14 % of respondents):

- I think my baby is still too small for this.
- I'm afraid of having an accident.
- I cannot safely park the trailer or cargo bike (lack of parking options).
- A child bike trailer or a cargo bike is too expensive for me.
- I'm afraid that cycling isn't good for my baby's back.
- The network of bike paths is not very good where I live (no direct or safe paths).

The statement "My baby is too small" was said in connection with uncertainties about when and how a (small) baby can be taken by bike. Sometimes, false statements are also made (e. g., "Babies may not ride in a bike trailer before they are able to sit.") and also cycling with a baby is discouraged by others in other ways:[1] "Our paediatrician advises against transporting our little ones in a trailer.", or "Information brochures state that using bike trailers for children under four months of age is not recommended."

Over a quarter of the surveyed parents explicitly indicate that they feel informed only partially (15 %), rather poorly (10 %), or not at all (2 %) about the topic of "cycling with a baby". In particular, they would like more information on the minimum age at which a baby can be taken as well as the various ways of riding a bike with a baby (child seat, trailer, etc.). The topics of security (protecting against accidents, falling over...) and health (in particular any harmful effects to the back) also rank high in the list of information requested. Therefore, this can be a good place to start when it comes to promoting cycling with a baby.

What other starting points are there? To find this out, parents should specify what needs to change so that they will take their baby by bike or do so more frequently in the future. This question was answered by 27 % with the statement "Improving the cycling infrastructure", followed by the statement "Safe parking spaces for bicycles in public and private areas" (16 %), which also relates to infrastructure. A similar priority for secure infrastructure can be seen in the responses to a question we asked parents about being the mayor of their town.[2] The responses included concrete proposals with regard to improving infrastructure; the most common answers were (very common answers in bold): **safe and continuous bike paths;**[3] **wider bike paths (so that bike riders can use trailers or cargo bikes); bike paths and crossing points that are comfortable to navigate (flat surfaces without kerbs, no or insufficient circulation barriers that can easily be traversed, wide median strips,...); reduced (car) traffic through speed limits; safe, covered and flat parking spaces for bike trailers/cargo bikes** at home and key destinations (e. g., train station, day-care centres); cycling-friendly traffic-light circuits, biking routes with little inclines, car-free areas.

In addition to improving the infrastructure and traffic rules, the following requests were common: **Rentals of bike trailers or cargo bikes; grants for the purchase of cargo bikes and trailers and accessories (baby helmets, baby hammocks);** exchange platforms/flea markets for bike trailers, cargo bikes, child seats and accessories; more attention paid to cy-

1 No direct questions were asked about whether parents were discouraged from cycling with a baby, which means that we only have individual qualitative statements.
2 "Imagine you are the mayor of your town. And you are granted three wishes with which you can support cycling for young families with a baby. What would you do?"
3 The respondents did not make the usual distinction in German traffic planning between bike paths that are structurally separated from the road and bike lanes only separated by road markings or protection strips. The term "bike path" was used almost across the board, while often other cycling routes were implied in part and even separate bike paths were explicitly meant.

clists in traffic; sensitising all road users, particularly motorists; information on options for cycling with a baby, campaigns and test rides; taking bicycles on the train; promoting the use of helmets, monitoring compliance with regulations (with regard to speed limits, parking on cycling routes,...).

Despite their cycling affinity, the respondents had to overcome, at least in part, obstacles to cycling with a baby as well as other barriers. The aforementioned reasons show that action needs to be taken in the three areas of information/marketing, service and infrastructure. These are discussed in detail in Section 0 "Our recommendation: Service, information and infrastructure".

DOCTORS AND MIDWIVES: DIRECT CONTACT PERSONS DURING PREGNANCY, BEFORE AND AFTER CHILDBIRTH AND WHILE BREASTFEEDING

Midwives and physicians are important contact persons for expectant mothers (and to a limited extent also expectant fathers) during and after pregnancy: In Germany, there are a series of offers for pre- and after-care, which are performed by physicians/doctors or midwives, and the costs of these services are covered by health insurance. They are generally recommended and are used by a very large portion of pregnant or young mothers (over 90 %). In addition to the many topics dealt with during the course of the pre- and after-care offers, the area of mobility can also be addressed. The offers in detail are:

- **Monthly check-ups during pregnancy** (at the doctor's office [in some cases in hospital] by a physician/doctor or at home by a midwife; due to a limited number of midwives also by a gynaecologist):
  The main objective is to verify the physical health of the mother and foetus; if the screening is carried out by a midwife, other issues are almost always addressed (e.g., diet of the mother, carrying the baby in a sling, etc.)

- **Birth preparation courses** (at a midwife's practice or in hospital, with a midwife):
  This occurs in the third trimester of pregnancy and usually includes six appointments. In addition to the physical processes before, during, and after childbirth, infant care and nutrition of babies are important issues. In addition, a birth preparation course presents an opportunity for the participants to exchange ideas with each other and with the instructor on issues that are on their mind. Some expectant fathers also attend these courses.

- **Consulting directly before and after childbirth and while breastfeeding** (at the home of the new parents, with a midwife):
  The midwife pays a house visit at the beginning of every day, then every few days, and supports the new parents in all aspects of caring for the new baby. The topics addressed include infant care, nutrition, the needs of the baby, but also the possible "baby blues"

- **Medical examination** (at the doctor's office, with a gynaecologist):
  A final medical examination is done about two months after childbirth.

- **Postnatal exercise course** (at a midwife's practice or in hospital, with a midwife):
  This course is done after childbirth and is usually for six weekly appointments (from about 2 months after childbirth). The muscles that are stressed during pregnancy are exercised as to return them to their original form. The course can also be used by the participants to exchange ideas with each other and with the instructor about any further issues, e.g., teething of a child, dealing with sleep difficulties, etc.

- **Medical examination for the baby** (at a doctor's office with a paediatrician):
  In the baby's first year, a total of five medical examinations are provided for, which focus on health as well as the child's motor skills and social development.

Due to the frequent contact with medical personnel during pregnancy and after childbirth, this can be an ideal opportunity to discuss the topic of cycling with a baby or cycling during pregnancy. Various forms of cooperation with gynaecologists and paediatricians, midwives and staff at hospital have been tested within the scope of the project. The essential results are listed here:

The vast majority of people from the health care sector is generally open to the topic of "cycling with a baby" or "cycling during pregnancy". Their goal is to assist pregnant women and new parents; and if these women and parents are interested in the topic, then it is also a topic for medical personnel. However, there is little time for this topic on top of their core activities. In addition, some medical personnel (especially midwives) do not know enough about the medical aspects of cycling during pregnancy or with a baby. Very few medical personnel know about how a baby can be taken along by bike.

The prenatal and postnatal courses are usually full in terms of the amount of content to be taught. Therefore, the surveys originally planned in the context of the birth preparation courses were unable to be carried out there. The course instructors, however, distributed information such as flyers to anyone interested. According to our non-representative survey of midwives in March 2016, the topic of mobility, often the subject of cycling, is addressed in the courses by both parents and also midwives.

The flyer promoting participation in the survey, which was distributed at medical offices to pregnant women and parents with a baby, was met with great interest. The flyers were sent by post to all paediatrician and gynaecologist practices in Heidelberg, Rhine-Neckar county and Neckar-Odenwald county. Of the 206 participating individuals in these areas, 45 % found out about the survey from a flyer at a doctor's office.[4] We assume that there were two reasons for this great response: For one, there was practically no additional effort required for doctors or medical specialists to distribute the flyer, while, on the other hand, a visit to the doctor's office almost always entails waiting to see the doctor and informational material is often read during the wait.

A collaboration with hospitals[5] was also tested: Many hospitals give new parents a folder with information on newborns when they leave the hospital. This folder often contains information on offers from the hospital, but also promotional materials for baby care products, etc. Several of the hospitals approached

were willing to include our flyer on cycling with a baby in their information packs.

The service "test rides" (more information in Section 0) was also carried out in cooperation with two hospitals. This cooperation was made possible by the commitment of several individuals (senior physicians) who wanted to support the topic of cycling with a baby. An open-house day was also used to once again offer test rides. In hindsight, however, the location of a hospital did not provide any particular advantages compared to other test ride action days (e. g., within the scope of bicycling action days, etc.).

In summary, it can be stated that the subject of cycling during pregnancy and with a baby aroused quite an interest among people in health care, however this group still needs more training on the topic. For the rest of 2017, we are therefore planning further trainings for midwives. It is important to ensure the offers do not present too much additional work for health care personnel. They are gratefully accepted as a little support in their own work. Providing informational material in medical practices appears to be particularly useful.

4 For comparison: All bicycle dealers in the area received flyers, but only 4 % of the participants learned about the survey through this avenue.
5 In Germany, 99 % of all births are in hospitals (QUAG 2017).

Figure 5
Test ride dates: not only cycling, but also explaining and demonstrating are important elements of the action days (photo: ©Verkehr mit Köpfchen)

OUR RECOMMENDATION: SERVICE, INFORMATION AND INFRASTRUCTURE

Within the scope of the project, the following approaches were tested to support new parents and pregnant women to use their bicycles if they want to do:

- Service offers that can be tested: test ride action days and rental of bike trailers and cargo bikes
- Information: digital, flyer, brochure and magazine
- Policy recommendations

The objective of the service offers is to remove any inhibitions parents with a baby have concerning cycling. For the practical part, the services are tested within the project area (Heidelberg, Rhein-Neckar county and Neckar-Odenwald county).

The **test ride action days** are usually held in connection with other public events such as open-house days at a hospital or a street festival. Different types of bicycles with bike trailers, cargo bikes and child seats can be tested. Parents can also find out information on and watch demonstrations of how to place and strap in their child in a baby hammock, how to hitch a bike trailer, how a child seat can be locked and much more (see Figure 5).

Bike trailers, child seats, cargo bikes and accessories were purchased by us at a discounted price direct from the manufacturer. Two manufacturers gave us certain models for testing free of charge. The bikes needed to tow the bike trailers were rented on a monthly basis from a local bike shop. Given the high price of cargo bikes, only one such bike was purchased; we were able to offer a wider selection of them thanks to a local cargo bike dealer that provided one or two cargo bikes for the test ride action days free of charge.

Six such dates will have taken place by July 2017, and more are planned for the autumn. Thus far, the reactions of parents and pregnant women have been consistently positive. While some only wanted general information, others had already thought about the concrete possibility of buying one and wanted to try it out beforehand. Many also appreciated the fact that models from various manufacturers could be tested and there was no pressure to have to directly decide on a particular model.

An additional service offer desired by many parents is the **rental of bike trailers and cargo bikes**. This is expected to be launched beginning in mid-June 2017. The objective here is to have parents test the bike trailers in their daily lives. They can see if it is easy to park the trailer at home, if it fits through the front door, whether their baby likes cycling, in short:

whether everyday life is manageable with a bike trailer. The rentals are limited to one week, so that as many parents can test the offer as possible.

Four dealers in the project area are expected to take part. All dealers in the area were contacted and asked whether they would be interested. They were able to specify any desired brand and model. We then asked the respective manufacturers whether they wanted to make a bike trailer available at special rates within the scope of the project. The reactions were very different; from (temporarily) lending a model free of charge through offering an additional discount for dealers to an all-out decline of the offer. However, the reactions of the manufacturers were by and large positive.

The bike trailer can be booked online.[6] The interested parents can directly see which trailer is available at which dealer and book immediately. They then receive a confirmation email that they present to the rental dealer. Depending on the dealer, the rental is either free or costs up to 20 euros a week for parents. For each maintenance job and rental, the dealer receives a small compensation for expenses in coordination with us.

There is a high demand for reliable information among pregnant women and parents. We compile the most important information on our homepage and also published it in a brochure. The information includes options for transporting a baby by bike each with their advantages and disadvantages as well as on the baby's health, safety, tips on buying and tips for various weather conditions. This information is expected to be available from July 2017. There is already a flyer for pregnant women and parents to get acquainted with the topic. Due to the large survey participation thanks to flyers laid out in waiting rooms, the brochures and the flyers will be sent to paediatrician and gynaecologist offices within the project area.

In addition, we also try to place many articles in magazines that are read by parents. There are a number of parenting magazines throughout Germany as well as at a regional level which write about a range of child-related issues. Cycling and traffic magazines are also potential avenues to present the topic. These publications are probably read more by disseminators than parents. Disseminators are also midwives and physicians who should be informed in the appropriate trade journals about the project.

The surveyed parents placed particular importance on improvements to cycling infrastructure. Therefore, we plan to publish a recommendation for policy and administration in autumn 2017. This guideline will list the benefits of having parent- and child-friendly transport planning as well as provide specific recommendations.

CONCLUSIONS

Even if it is still an unusual topic for many newcomers, cycling with a baby is already part of everyday life for some parents. The technical possibilities are in place; they "only" have to do it. However, parents must overcome obstacles and barriers, from choosing the appropriate means of transporting their baby to concerns for the safety of the child. The aim of this current project is to show that cycling with a baby is becoming the norm and that it is safe and easy.

To achieve this goal, different options are currently being tested with almost exclusively positive feedback. The trial offers and information were tested until the end of 2017 and will be evaluated in early 2018. This ensures that the target group can take advantage of the offers. If necessary, the offers or recommendations for the deals will have to be adapted after the evaluation.

Many of the offers we created within the scope of our project will benefit not only the target group of cycling parents and pregnant women: All cyclists will benefit from infrastructure improvements (including parking facilities for bicycles), information in parenting magazines also appeal to parents who do not cycle (yet), more bike trailers and cargo bikes on public roads make bicycle traffic in general more visible. Parents who want to start cycling again after childbirth are one more reason why politicians and administration should promote cycling.

6 This is freely available software that was originally developed for the free cargo bike Kasimir in Cologne.

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RESEARCH

Get families to cycle more often by providing a family-friendly tricycle package

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ABSTRACT

Cycling with children is a sensitive topic since people tend to be more careful and risk aware when carrying younger children along on their bikes. The decision whether to cycle with children is not only affected by appropriate cycling infrastructure and proficiency on a bike, but also depends on the design of the vehicle, its comforts or restrictions (e. g. due to the additional weight, the limited space for goods) and the riding safety (e. g. stability when turning). Even though there are family-friendly bicycle designs on the market and most cities promote cycling amongst young families, a predominant part of the families in cities still avoid cycling. Market research showed that a family-friendly tricycle package providing stable vehicle design (due to three wheels and a tilting mechanism for stability during turns), personalised comfort-oriented routing and bicycle-training that supports inexperienced cyclists by covering different aspects like cycling techniques or road safety form an important part of a successful encouragement strategy.

In this paper we present the results of preliminary surveys that will be the basis of the development of the different elements of the above-mentioned tricycle package (vehicle design, personalised routing, training). A qualitative survey with twelve people and a quantitative survey with several hundred respondents were carried out. For the latter, people with care obligations for children younger than six years old were selected (since these children rarely cycle themselves) as participants, e. g. parents, grandparents, day mothers/fathers. The surveys cover topics like mobility-related group characteristics, group specific user behaviour, and service and design expectations. The gathering and elicitation of design requirements was realised by providing the interviewees with pictures of different design options with the additional feature of carrying children and/or goods which were evaluated critically by them showing a clear preference for robust and save looking transportation options for children.

The results of the surveys will be used by a team of transportation researchers, cycle designers and a cycle instructor to develop and test a family-friendly tricycle package, i.e. to design the tricycle, optimise the routing, conceptualise the training concept and elaborate a market strategy to encourage all members of families to cycle more often.

Keywords: encourage cycling, family-friendly tricycle, tricycle prototyping

INTRODUCTION

Active mobility forms have the potential to help tackle several challenges ranging from environmental problems to improving the quality of life and relieving the overloaded transport systems since they are healthy (WHO 2016), carbon-neutral, cheap and space-efficient compared to other modes of transport (Lähteenoja et al., 2006). Nonetheless, many cities have a relatively low share of cycling and walking in their modal split despite various efforts to increase the use of bicycles by enhancing infrastructure and promoting it through campaigns (Wunsch et al. 2016). These interventions improve the overall system and help to increase the share of cycling in the modal split. However, significant changes in the mobility behaviour of those groups who have never cycled before, have not used the bicycle for a longer period or have special requirements on their day-to-day journeys cannot be expected to be achieved by these measures since they do not address the barrier of entry. Barriers such as safety concerns regarding cycling in the street due to an incomplete bicycle network, the fear of unknown routes, insufficient routing options that do not take individual preferences into account as well as balance problems on conventional two-wheeled bicycles are not properly addressed so far for specific target groups. In this paper, we concentrate on routing and training approaches to overcome the safety concerns and the design of an appropriate vehicle to deal with concerns about balance in conjunction with the transportation of kids and goods on the bike.

To increase the share of cycling in the modal split it is essential to engage under-served groups since they carry yet unrealised potential for the increase of active mobility in cities. Among other groups, single parents and migrants (bmvit, 2013) are known to be willing to cycle more often given the opportunity and circumstances but are currently not well represented amongst cyclists. To target both groups, addressing families including persons with care obligations for small children is a promising approach. This has to some extent already been realised by certain campaigns (Pucher/Buehler, 2007) but these fail to engage a wider audience to start cycling. To address the concerns of different members in the target group it is essential to first learn their needs to be able to offer appropriate technical innovations such as a suitable vehicle as well as additional services to support them in starting to cycle.

With regards to promising vehicles, tricycles are more stable when standing and therefore easier to handle than conventional bicycles when loading the bike or stopping at traffic lights and intersection; especially when adding a tilting mechanism that adds stability in corners in stressful environments like the urban context they provide a better starting point for encouraging cycling. Special tricycles for disabled, older people and families are available on the market but do not meet the expectations like appealing design and usability for transport purposes in a dense and busy city environment that would be essential for cycling with children. Needs-based adjustments to tricycles currently available on the market, accompanied by cycle training and safe, comfort-oriented and easy routing tailored to families can facilitate the (re-)entry, since they reduce many barriers at once (AustCycle, 2013). Targeting families, especially safety is of major importance since the decision to cycle with children depends on the vehicle as well as the route.

With respect to routing, there are some services and apps like naviki (Naviki, 2017) or bikecitizens (Bike Citizens, 2017) that are geared exclusively at finding routes for cyclists. However, while these services offer the chance to create either fast or more leisurely routes, they are geared mostly towards experienced cyclists. There is also some research on route choice behaviour of cyclists based on GPS data collections (see e. g. Rudloff et al., 2017). Again, these route choice models are based on revealed preference data from experienced cyclists. While these services and models offer some insight into route choice behaviour of cyclists, more information is necessary to see if these models are suitable for inexperienced cyclist or if further modelling is necessary. It needs to be determined what infrastructure elements are particularly pleasant for the target groups and which ones need to be avoided.

This paper gives insight into the requirements and preferences on (1) design, (2) routing and (3) training to encourage cycling by providing a suitable prototype and service package for families and inexperienced. We first describe the methodological approach and afterwards focus on the results of qualitative and quantitative surveys which are the basis for the development of a family-friendly tricycle package.

RELATED STUDIES

Families consist of persons with different requirements and needs. Related to their age, constitution and culture, there are different factors that should be considered when providing a family-friendly tricycle package. To capture different aspects that might be important for design and service options, literature on cycling among under-served groups was studied. This included user types together with attitudes towards cycling, behavioural patterns, abilities and restrictions due to physical/psychological variables and age as well as language barrier and cultural predispositions among migrants.

Surveys show that cycling is to a large extent regarded as recreational activity, despite increasing numbers of cyclists. Although many bicycles are available in the households, the use of them is relatively low and depends on factors such as age, gender, infrastructure and the distance to be travelled.

In a study on attitude-based mobility types by Hunecke and Haustein (2007) standardised survey results revealed a below-average orientation towards cycling but in-depth interviews have shown that this is not a fundamental rejection of the bicycle. In fact, the bicycle is viewed as leisure mode rather than everyday transport mode and accordingly used dependent on the weather. The key findings of the mobility survey 2008 in Germany (Follmer, 2008) are existing potential for cycling in all age groups but also that specific demand for population groups or certain purposes is not obvious. Lohmann and Rölle (2005) examined that regarding cycling the willingness plays an important role for younger people, the ability becomes crucial with increasing age. In this context, the authors point out that for the latter it is not enough to arouse a positive attitude towards the bicycle, but rather to create corresponding areas of action. Physical deficits and age-related limitations are insurmountable obstacles only in specific cases. Also, insecurity in traffic increases with age.

A Swiss study (Girod 2005) indicates that considerable potential for an increase in cycling exists for women and elderly people and can be captured by group-specific support. Especially younger seniors (75 years and below)

are regarded to be easily motivated for cycling due to their physical shape (Fertmann, 2011) but declining perception, muscular and motor changes leads to a higher risk of accidents with severe injuries. Therefore, security enhancements that both raise awareness among the seniors (Bauer, 2006), an offer of adequate training sessions (Hagemeister/Wagner, 2015) and the inclusion of the use of a suitable bicycle (Ehlers, 2010) are suggested. In this context, suitability is measured by stability, convenience and easy ways to get on and off the saddle. Furthermore, the bicycle should offer excellent brakes, electric pedal assistance and the possibility of transportation of goods or luggage and a youthful design.

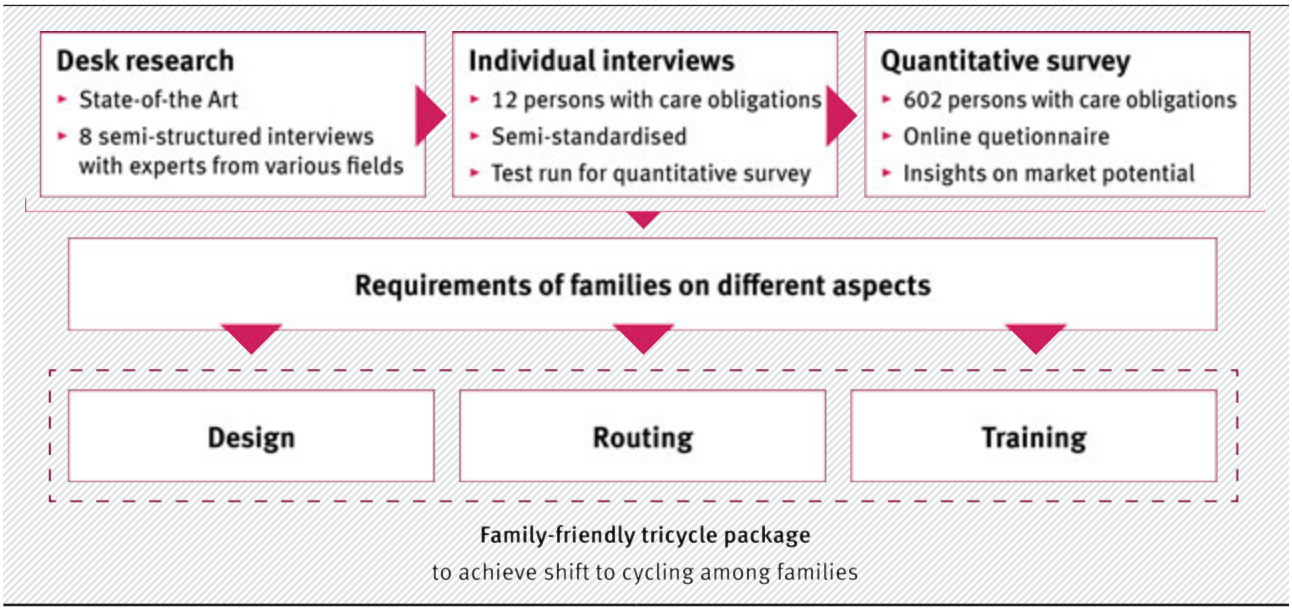
Studies indicate the importance of promoting cycling among underrepresented groups like women and older people (Lenz/Goletz, 2012). The project 'fem. el.bike' points out that the transport of children and goods as well as the age of the user are the main reasons for purchasing a bicycle with electric support (Chaloupka-Risser, 2015). Further studies suggest that depending on the gender and age different reasons lead to non-use of bicycles. While men tend to focus on comfort aspects, for women the setting is crucial for the usage in old age (Lohmann/Rölle, 2005). Migrants are a group facing various barriers that range from lack of knowledge how to cycle to money issues and cultural issues not allowing women to travel by bike. Studies have shown that the mobility of people with or without immigration background is different and that local men cycle the most frequently whereas female migrants have the lowest share in cycling (Welsch et al., 2014). Some scientist regard cycling as an opportunity to foster a successful integration (Fassmann/Reger, 2014) and view this group as important for the mobility change, since it represents a growing share of the population with a large undiscovered potential (Segert et al. 2015). Projects focussing on encouraging female migrants to cycle not only give them self-esteem but also bring forward their mobility needs (Ehmayer, 2013).

For the remainder of the work, the development of a program to introduce families to cycling was studied. This group was chosen since all above user groups are incorporated in the larger family which ranges from parents, grandparents, uncles/aunts to day nanny and other persons with permanent or temporal care responsibilities. Furthermore, their needs for a bike for child and good transport, support measures like courses and the need for comfortable routes are comparable and their physical/psychological predispositions allows them to cycle.

Therefore, family members both from local as well as migrant families in different age groups were included into the study targeting those with younger children that should be carried along on their bikes.

Figure 1

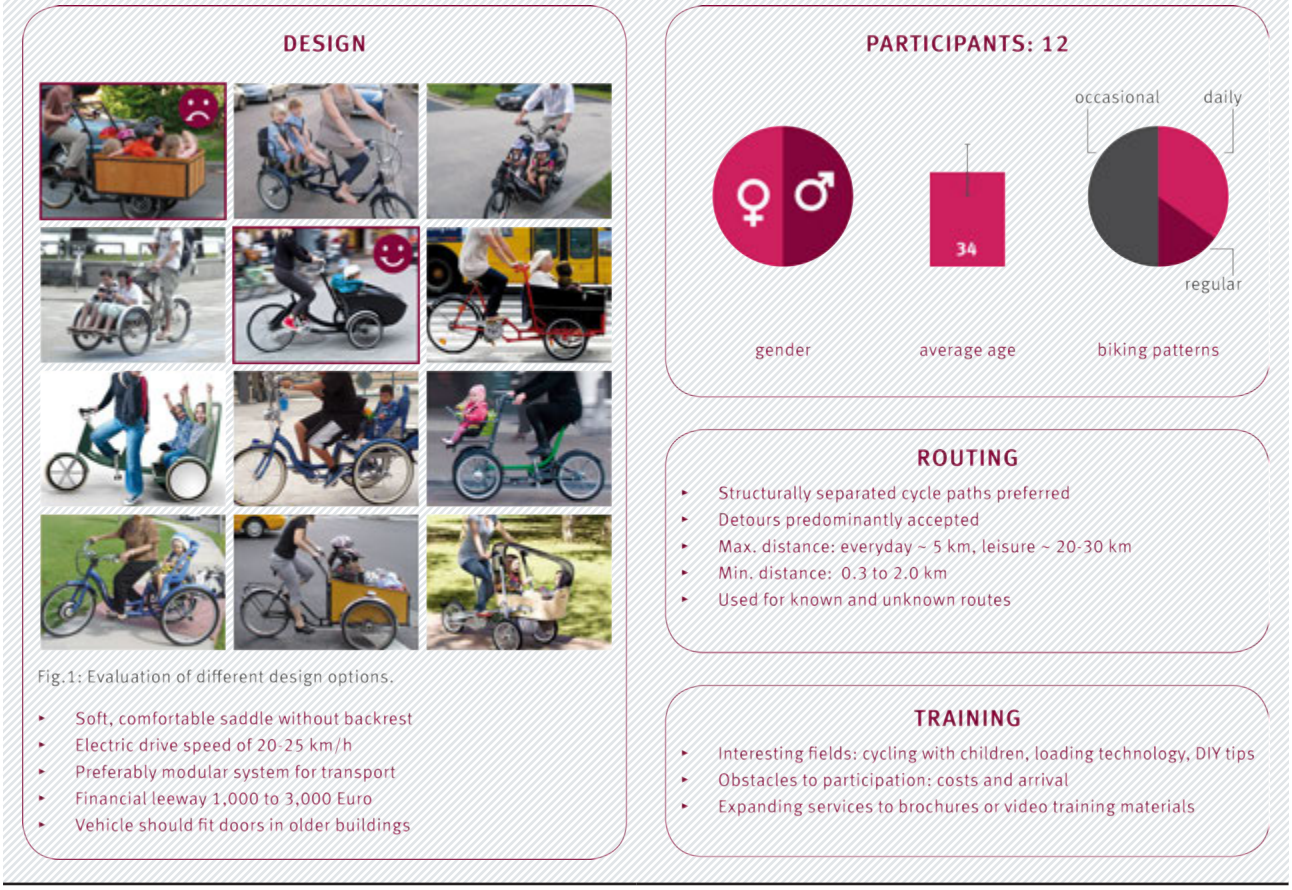
Study Design



Source: Own illustration

Figure 2

Results from individual interviews.



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METHODOLOGICAL APPROACH

The methodological approach consists of three pillars (see Figure 1). Apart from the desk research, individual interviews and quantitative surveys were performed to capture different aspects of cycling among families.

Individual interviews

The twelve interviewees representing family members were between 25 and 50 years old, from different social backgrounds and life situations. Most of the respondents stated that their mobility behaviour is currently strongly influenced by the distance between their home and work place which leads to the same mode of transport being used in most situations. However, some interviewees were relatively flexible in their choice of transport modes. None of the respondents named the distance between home and child care facility as essential for their choice of locomotion. Among the interviewees, main reasons for not cycling were safety concerns, long distances and problems with appropriate child transportation possibilities.

The gathering and elicitation of design requirements was realised by providing the interviewees with pictures of different design options with the additional feature of carrying children and/or goods (see Figure 2). Eleven options are representative for the tricycle models that are currently available on the market. In addition to that, one bicycle design was added due to the innovative approach on carrying children with the bike.

The participants of the interviews were rather sceptical towards the different design options. Main arguments in the evaluation process concerned the safety and comfort for children, storage space, required space of the vehicle, manoeuvrability and possible

driving speed, design and quality of the component. The highest ranked design was chosen due to modern design, manoeuvrability and good protection of the child which is furthermore in the field of vision. At the same time, the lack of a carrier and a crumple zone was pointed out. These points also apply to the lowest ranked tricycle model which was furthermore regarded as too cumbersome, not safe for children (no belts) and unattractive due to 'tinkered' look.

The interviewees became very selective and careful when it comes to route choice since starting to travel with children. Cycle paths structurally separated from the road, which are already preferred by most people even without accompanying children, are regarded as mandatory for most of the interview participants when cycling with children. This preference affects the route selection and was cited as reason for not choosing the direct path (see Figure 2). Further, it could be found that detours are accepted if cycling is as fast as going by public transportation.

The interviewees expressed a positive attitude towards the idea of a training program. Nevertheless, only a small proportion would claim training opportunities, since they do not feel the need for it. To be interesting, the training content must exceed the provision of general information on cycling technique, road safety and traffic rules to arouse interest. Cycling with children, loading technology and Do It Yourself tips are regarded as interesting topics for trainings, brochures and tutorial videos (see Figure 2).

Quantitative survey

The results of the qualitative survey served as the input for the design of a quantitative online survey. Among the 602 participants, 26 % stated that they cycle at least more than once a week. Only 6 % do not cycle at all and 4 % do not own a bicycle. 27 % revealed that they (or their partner) currently take their children with them on the bike, 36 % previously did so and 36 % never cycle with children. 83 % need separated cycle paths, 65 % do not want to ride on steep uphill paths, 65 % need an attractive surrounding (park, water, etc.) and 59 % paved roads. Only 51 % state that cycling the shortest path is important to them.

To assess the attractiveness of different design options, five renderings were provided differing in the position of the child transportation and wheel size (see Figure 3). The most popular design among the target group was the tricycle with bigger wheels and the transport area in the back (38 %). As most appropriate for cycling with children, the rendering offering big wheels and a transport area in front was chosen (45 %). As main advantage of this design, the stability and having the child in the field of vision were named.

Questioned on the most interesting usage scenarios, shopping trips and transport of goods (69 %), transport of a child (63 %) and the use for spare time activities (61 %) were chosen by most of the participants in the survey. Less people stated that an e-tricycle could replace another mode of transport and only a minority would use it to go to their workplace (20 %). Sharing concepts dividing costs were regarded as interesting or rather interesting by 44 %, while 20 % would not want to share an e-tricycle at all.

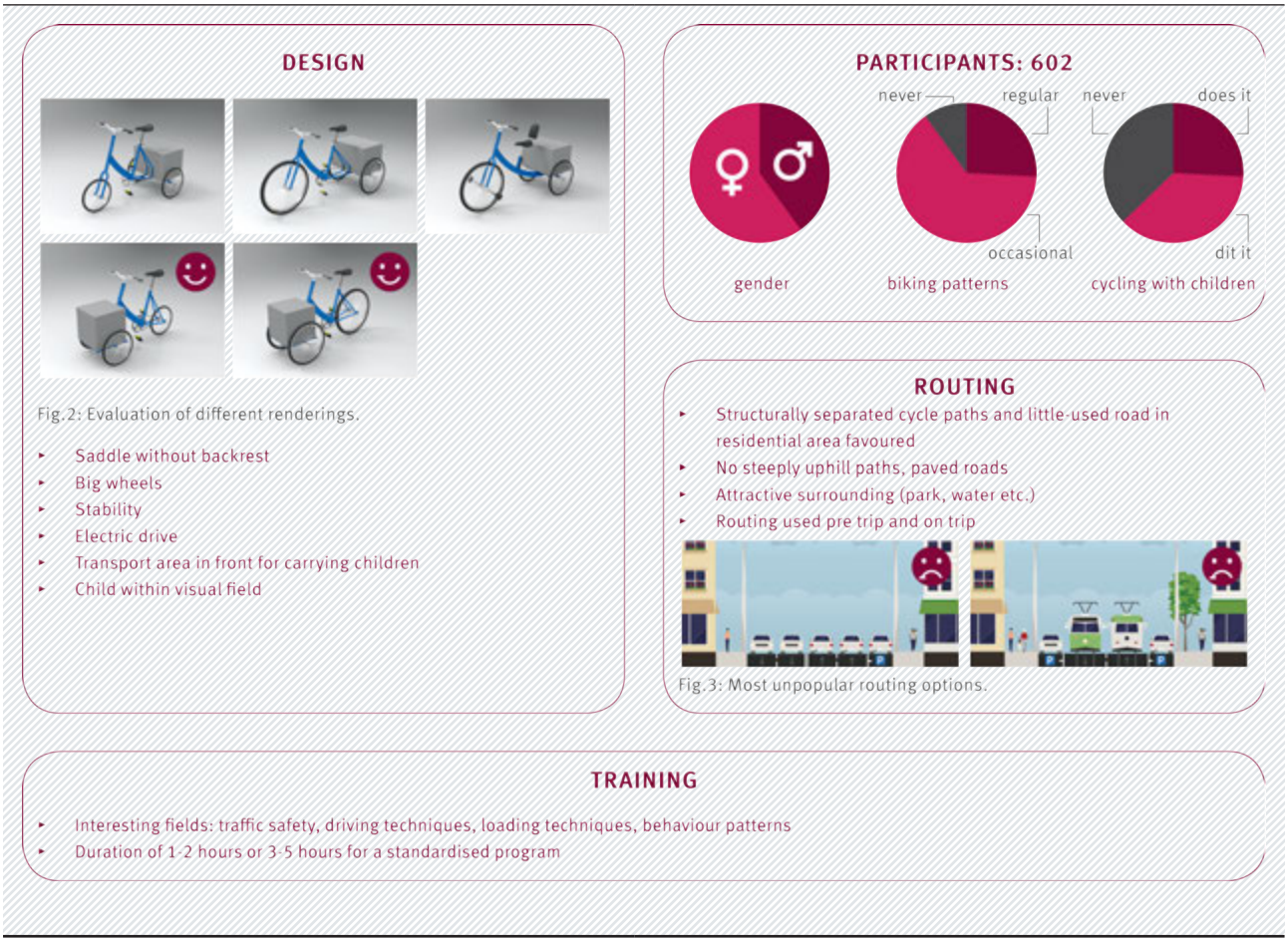
15 % of the survey participants always check routing websites before cycling, 47 % only sometimes. During cycling trips only 6 % use navigation devices on a regular basis and 41 % occasionally.

When asked about their opinion of different infrastructure elements for cycling, separated cycling paths were favoured by most participants (84 %) same as little-used road in residential area (84 %) (Examples see Figure 3). Half of the participants did find main roads with marked cycle lane and no parked cars attractive (57 %) and little-used one-lane one-ways in residential areas where cycling is permitted against the one-way (53 %). Rated as least attractive are main roads with tram tracks (4 %), four lane main roads (5 %) and national roads with a speed limit of 100 km/h (5 %).

For additional training, cycling with children in terms of traffic safety was regarded as most interesting by 76 %. Other topics important to more than half of the participants in the survey are driving techniques (55 %), loading techniques (55 %) and behaviour patterns on the tricycle (51 %). The majority would appreciate training offers with duration of 1–2 hours (46 %) or 3–5 hours (32 %). 13 % would rather not have training. 46 % of the target group members further state that a standardised program should be sufficient and only 35 % would like to practice their day-to-day trips (see Figure 3).

Figure 3

Results from online survey.



Source: Own illustration

To find out how to reach people in the target group and offer them not only routing but also an adequate training, they were asked on their purchase behaviour. It was revealed that 75 % would buy a tricycle most probably at a bicycle retailer, 18 % in a sports store and only 8 % online. 84 % stated that recommendations are very important or important for their decision to buy a certain e-tricycle. The majority relies on recommendations provided by independent testing bodies (77 %), retailers (73 %), family and friends (70 %). Given their current state of knowledge on e-tricycles, they would choose most probably the following vehicle model: bicycle (2 wheels) with electric drive: 14 %, bicycle (2 wheels) without electric drive: 16 %, tricycle (3 wheels) with electric drive: 50 %, tricycle (3 wheels) without electric drive: 7 %, would not cycle with children: 14 %.

CONCLUSIONS

Even though the benefits of cycling are well known, people with care obligations hesitate to take their children along on a bicycle due to various reasons such as safety concerns, comfort and stability. To address the current shortcomings and improve the situations for families, a family-friendly tricycle package is developed which offers (1) an appropriate vehicle design, (2) routing services and (3) training opportunities.

To create such an offer, an extensive knowledge of the needs, desires and preferences of the target group is required. A combination of qualitative and quantitative surveys ensured the quality of the information collected and offered not only in-depth information (individual interviews) but also the big picture and market potential (online survey).

The results on design, routing and training indicate preferences for a stable, compact, practical design placing the child in front. Routing should be available pre-trip and on-trip and favour separated cycling paths as well as little-used roads in residential areas. Small detours are accepted if an attractive surrounding and no steep uphill sections are offered. Training needs are identified in traffic safety carrying children, driving/loading techniques and behaviour patterns and should be addressed by rather short training sessions with a standardised program.

The results of the surveys were applied by a team of transportation researchers, cycle designers and a cycle instructor, to develop and test the family-friendly tricycle package. Based on all findings (desk research, individual interviews, quantitative survey), the prototype was build, the comfort oriented route choice model was developed and the cycle training plan as well as a concept for market launch were elaborated.

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EXPERT COMMENT

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Life events can be important turning points in a person's mobility biography that influence a range of aspects from modal choice to route options. The arrival of a baby constitutes such a life event and is the focus of the two articles covered in this commentary. The contribution by Hannah Eberhardt and Anna Gering presents readers with some insightful reflections on the opportunities and challenges that shape the cycling practices of parents. They ask why many parents in Germany stop cycling and switch to other transport modes following the birth of their first or subsequent child. These authors also show how this important life event may trigger the purchase of a first or subsequent car. Drawing on existing mobility biographies research, they are able to present very convincing arguments for further research on cycling with a baby as well as new policy initiatives to support parents of babies and toddlers in their wish to continue cycling.

In the concluding part of the paper, Eberhardt and Gering make a case for a range of demonstrator initiatives that allow parents to test equipment, services and bike sharing offers for cycling with a baby. A particularly pertinent point raised here relates to the potential role of medical personnel (e. g. midwives, gynaecologists, paediatricians) and organisations (e. g. maternity hospitals) in advising pregnant women, expectant fathers and young parents on mobility options before and after the birth of their child. This appears to be a very promising avenue for policy roll-out, given that these professionals have very regular contact with the target group both before and after the birth of the child.

Karin Markvica and Christian Rudloff offer an applied research paper on a closely related topic, namely the potential of tricycles with cargo- and people-carrying functions in promoting cycling with young children under the age of six. Drawing on interview and online survey data, these authors deliver interesting results in relation to people's design and cycling infrastructure preferences as well as their attitudes towards cycling. These results are intended to inform the development of a tricycle prototype as well as related promotional measures such as training. Visual cues such as pictures of different tricycle design options complement these methods. A special focus of this paper is on social groups that display lower-than-average cycling rates (e. g. migrants, women, older people).

Although written from different perspectives, both papers complement each other by providing highly relevant insights into how different attitudinal, infrastructural and equipment-related factors can act as barriers to cycling with babies and small children. They thus contribute to closing a research gap. Concerning accessibility and readability of the material, both teams of authors have opted for a clear style of writing that avoids unnecessary jargon and presents findings in a concise and easy-to-understand way. The use of visuals (e. g. photos of information events for parents, pictures of tricycle design options, tables) further enhances the accessibility of these articles for different audiences (e. g. researchers at different stages of their career, practitioners and cycling advocates and policy-makers).

Concerning existing research, Eberhardt and Gering's article shows that mobility researchers, practitioners and policy makers can already draw on a substantial body of literature that considers the role of key life events and 'mobility milestones' in shaping people's mobility biographies (e. g. Lanzendorf 2010, Jaeger-Erben 2010, Schäfer et al. 2012, see also Müggenburg et al. 2015, Rau and Manton 2016). Markvica and Rudloff's selection of literature reflects their strong interest in pro-cycling policy, modal choice of families with small children and the impact of already existing initiatives to encourage cycling by members of social groups with low cycling rates. There is a strong emphasis on contributions from Germany, Austria and Switzerland.

At the same time, both articles reveal the urgent need for further research. For example, they either explicitly or implicitly highlight the strong influence of people's social and cultural environment on their decisions to (not) cycle with babies and small children, a phenomenon that remains poorly understood. The issue of social norms, that is, popular opinions in society regarding what constitutes 'appropriate' mobility choices at different life stages (e. g. early parenthood) also presents itself as a closely related and hitherto under-researched topic. Finally, a rapidly growing body of work on the subject of mobility socialization demonstrates its relevance for transport research, policy, and practice (e. g. Tully and Baier 2016, Döring et al. 2017). Yet, this pressing issue of intergenerational (dis)continuities in mobility practices has yet to reach key decision-makers and influence transport policy in Germany and internationally. In sum, considerable gaps remain in the study of mobility across the life course, which targeted funding programmes at national and EU levels could help to close. Moreover, existing work linking life events and mobility practices, including the two studies covered in this commentary, has yet to be effectively translated into transport policy and sustainable transport change initiatives.

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2.2 Safety

Practice

Gaps between the links – Understanding required changes to the fragmented cycling facilities in the developing world context

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Research

Cycle paths – love them or hate them? Why do some cyclists prefer cycle paths and others cycle lanes?

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PRACTICE

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ABSTRACT

While developing cities attempt to provide better policies and guidelines for cycling facilities, the improvements in cycling infrastructure remains mostly limited. This article discusses the improvements of the cycling facilities in Cape Town, South Africa. Cape Town has identified cycling as a mode of transportation in several official documents, however, the cycling challenges remain significant. While the City of Cape Town acknowledges the importance of cycling and some of the challenges, little evidence is documented to indicate progress made or the positive effects of past policies, strategies, and implementation. This brings into question what has been achieved in real terms for the cyclists in Cape Town. Cycling related efforts include road safety education, building awareness around cycling, increasing bicycle supplies, and identifying safe routes for cyclists, as well as providing better infrastructure for cyclists. The focus of this article is on the progress made with regards to the physical cycling infrastructure. The current selection of the location and design of the cycling facilities are not generating meaningful improvements in safety for the cyclists or an increase in volumes of cycle trips (Baufeldt, 2016). To increase the quality and effectiveness of the cycling facilities, the City could consider a change of practice. Activities, such as benchmarking and prioritising resources to the most critical cycling facilities and links may help generate the most benefits, therefore, optimising the city's resources, instead of the current approach, which is mostly ad-hoc and sporadic. Higher prioritisation of creating complete links for selected communities to places of work, education and services could be one way to improve the connectivity of cycling, considering the limited resources available.

Keywords: cycling, facilities, challenges, developing cities

INTRODUCTION

Introduction to Cycling in a Developing City

Cycling is a healthy and low-cost form of transport, benefiting both users and society at large. Kalter (2007) established that the benefits for society include environmental sustainability (no direct emissions of pollutants, CO_2, or noise), low infrastructure requirements and improvements in public health. With respect to communities, urban dignified spaces that, by their very nature, include cycling facilities and encourage more people to cycle, increase levels of community interaction. These motivators are perhaps counter-balanced by those who choose not to cycle out of perceived dangers or inconveniences. These include conditions that are too dangerous, too

much traffic, harsh weather, lack of daylight, too much effort, inconvenience, uncomfortable and lacking sufficient fitness (Heinen et al., 2010). The public images of cycling – how we view cyclists – can act as barriers or facilitators of cycling. The perception of a cyclist as 'brave', 'fit', 'environmentally friendly', 'inconsiderate' or 'hazardous' can influence a non-rider's choice of whether to ride or not in different contexts (Skinner/Rosen, 2007). In Cape Town, these non-rider reasons are not without justification, as low personal security, as well as poor road safety, contribute to the considerable risk of injury or fatality. However, many of these barriers vanish for non-riders, if they take up cycling (Daley et al., 2007). This may not be entirely the case in cities, such as Cape Town, where the risk of injury or death is much higher. These initial personal fears and road safety concerns may be more difficult to overcome in developing cities, without clear encouragement and improvements to the physical environment. However, despite the barriers of cycling in Cape Town, cycling remains an efficient, low cost mode of transportation that has the potential to increase both the accessibility and mobility of an individual. This is a motivating reason for Cape Town to invest and support cycling, as much as possible, as a high portion of the population has less disposable income.

Creating the necessary urban environment that can be conducive to cycling is important though. Research conducted by Hunt and Abraham (2007) established that various attributes, related to cycling and personal characteristics, have been shown to have significant influences on attitudes to non-recreational cycle use, including the type of cycling facility and the length of time spent on it, the availability of showers and secure parking at the destination, cyclist age, levels of experience and comfort of cycling in mixed traffic, the cycle purchase price and local availability. The importance of these facilities and services in developing cities is critical in creating the urban environment that encourages those who have the characteristics to cycle to do so, especially for commuting trips. This is especially true in cities, such as Cape Town, where commuting cycling is a minor mode of transportation (<1 % according to the National Household Travel Survey (NHTS) data, 2013), yet there are well-established and growing communities of recreational cyclists. Amenities that increase the practicality of cycling as a commuting trip are often lacking, as the commuting cycling culture in Cape Town is minor.

Cape Town does have a long history of cycling, especially sporting and recreational events. However, the cycling commuting modal share of the city has dramatically decreased over the decades as motorised transport has increased in dominance over the road network. Furthermore, cycling in Cape Town faces several challenges and hindrances, which deter individuals from making cycling trips. These challenges are numerous and range from urban sprawl, low bicycle supply, poor road safety and personal security threats. Several policy and strategy documents aim to address the numerous challenges, however, changes in practical terms remain slow. Stakeholders of cycling initiatives often have their own objectives, which result in demands for different services and facilities from the City officials. Furthermore, cycling initiatives often lack consistency or long-term strategies. This has resulted in a fragmented cycling network and inconsistent levels of cycling.

The next section elaborates the role of the cycling policies and strategies of Cape Town and will focus on the key points. Section 3 elaborates on the progress and challenges so far, after which Section 4 presents some suggestions on how Cape Town could move forward. Finally, in Section 5 presents the conclusions and final comments.

THE ROLE OF CYCLING POLICY AND STRATEGY IN A DEVELOPING CITY

Historically, Cape Town has been the leader of cycling development in South Africa. Cycling in South Africa has often been considered, firstly, as a recreational activity (for middle and higher income groups) rather than a mode of transport for daily commuting. This often turns investments into cycling into a political issue, which then lacks the public understanding and support. Furthermore, with cycling tourism becoming an increasing priority, projects and resources are being allocated to improve the more scenic recreational cycling areas. This is logical from an economic perspective, as attracting international and local cyclists to the province yields far higher economic returns. From a social perspective, however, the investment in

the pristine cycling areas does very little to address the challenges that the current commuting cyclists in Cape Town experience. Commuting cyclists, generally, travel through far less pleasant areas (generally industrial areas) with little space and priority during daily peak traffic. Consequently, commuting cyclists often ride in the shoulder of the roads, which have higher speed limits (60km/hour and above), as well as in industrial areas where there are a higher number of heavy vehicles. These conditions create an environment where there is no, or very little, physical protection for the cyclists from the vehicles. Generally, the speed differentials between the cyclists and the motorised vehicles are unacceptably high, as well as other motoring behaviours, which makes cycling on roads dangerous. Further elaboration is presented in Section 4 of this paper.

The challenges for all cyclists and the importance of cycling facilities have been acknowledged both within Cape Town (CoCT, 2005), as well as on a national level (Vanderschuren et al., 2014). The process has been slow and inconsistent, which has contributed to the slow and fragmented roll-out of cycling facilities. There are strategy and policy documents that aim to support and encourage cycling, both as a commuting mode, as well as recreational. Three of the more recent documents include:

1. City of Cape Town: NMT Policy and Strategy, Volume 1: Status Quo Assessment (October 2005)

Key Points

- Non-motorised transport (NMT) is a **valuable** component of the transportation system.
- A comprehensive plan regarding the **planning and implementation of programs and facilities to accommodate NMT users** was previously lacking.
- Vision Statement: "Cape Town will be a city where all people **feel safe and secure** to walk and cycle, NMT is part of the transport system, public space is shared between all users (NMT, special needs people and motorised users) and everyone has access to urban opportunities and mobility".

2. Comprehensive Integrated Transport Plan 2013–2018 (2015) Review, Transport for Cape Town

Key Points

- Approximately 435km of walkways and cycle-ways have been constructed since 2010.
- Many kilometres of facilities have not been captured.
- A key objective mentioned is that the number of dedicated cycle lanes "must" increase by 2014.

3. NMT Facility Guidelines, (Vanderschuren et al., 2014), National Department of Transport

Key Points

- These guidelines aim to "**enhance integrated transport** to ensure that the proper movement (or mobility) of people will be able to **increase safety, reduce fatalities**, produce a universally designed infrastructure and **improve equity** for all road users".
- These guidelines do not aim to set out new policy but rather to **give effect to the existing policy** through outlining a more balanced approach to the design of facilities.
- There is an **urgent need to improve safety** on South African roads, among other issues.

From the key points of these three documents, cycling should be accessible, safe and an efficient mode of transportation within Cape Town. However, the modal share of cycling trips remains extremely low. In the most recent NHTS data (2013) for South Africa, only 1.3 % of workers cycled all the way to work. While cycling may have been better accommodated in the most recent NHTS, in previous travel surveys the role of cycling in South Africa was assumed to be so insignificant that it was grouped with all other alternative modes of transportation. This can be seen in Table 1. Furthermore, the growth of privately owned motorised vehicles can be seen, as well as the growth of the taxi sector.

In Section 3, a more detailed context of cycling in Cape Town is presented.

Table 1

Modal Share of Main Modes of Transport in South Africa by Various Surveys

Main Mode of Travel		OHS 1996 (NHTS, 2003)	OHS 1997 (NHTS, 2003)	Census 2001 (NHTS, 2003)	NHTS 2003 (NHTS, 2003)	NHTS 2013 (extract by Authors)
Train		6.0	6.1	5.2	5.9	4.9
Bus		12.3	11.4	9.1	8.6	6.1
Taxi		23.8	24.2	20.9	25.2	24.7
Car		30.8	30.3	34.5	31.7	35.6
Walk		23.0	23.5	27.1	23.2	22.8
Other		4.2	4.5	3.2	5.4	5.9
Public Transport		42.0	41.7	35.2	39.7	35.7
Public Transport as % of all motorised trips		57.7	57.9	50.5	55.6	50.1
% of Public Transport	Train	14.3	14.6	14.8	14.9	13.7
	Bus	29.1	27.3	25.9	21.7	17.1
	Taxi	56.6	58.1	59.4	63.5	69.2

OHS = October Household Survey; NHTS = National Household Travel Survey

SUPPORTING CYCLISTS IN A DEVELOPING CITY

While many developing cities acknowledge the benefits of cycling, the reality of the urban environment is, that infrastructure provision remains poor, despite the development of policies and strategies. This may be, because there is a lack of integrating efforts, a lack of local knowledge, as well as significant assumptions that are made without data or the necessary investigations to support the decisions that are then made. Developing cities often have limited resources, which are then split across various initiatives that may improve the cycling environment. In Cape Town, these have ranged from:

- **Increasing bicycle supply** (NGO's, such as BenBikes and Qhubeka): Bicycle availability has a considerable influence on levels of cycling. However, as the national bicycle supply initiative, Shova Kula, learnt – if individuals do not have safe routes to ride their bicycles then the bicycles are often abandoned. Furthermore, the importance of bicycle maintenance was another lesson learnt as bicycles, despite having a robust design, still fell into disrepair, as a lack of bicycle maintenance education was observed.
- **Road safety education programmes and initiatives** (NGO's and government driven initiatives): While some progress has been made in furthering the protection of cyclists in Cape Town by the recent bylaw that states that motorised traffic should pass cyclists with at least 1m clearance, much more progress is needed before cycling in Cape Town could be considered (relatively) safe. The bylaw was passed to improve the safety of cyclists when being overtaken by motorised vehicles, but also to increase the success rates of prosecutions against reckless motor vehicle drivers that hit cyclists. However, the enforcement of this bylaw remains weak and many consider it merely a measure to be better able to prosecute drivers that hit cyclists when passing them, rather than preventing the action in the first place. On a positive note, increased awareness of the needs of cyclists through campaigns, such as "Pass Wide(r) of the Rider" and the related bylaw of passing clearance distance of 1m (Western Cape Government, 2013), some motorists have changed their behaviour and there is a noticeable change in how motorised vehicles have increased the space between them and the cyclists.

- Pro-cycling events (including recreational and commuting, for example the Cape Cycle Tour and Bike to Work Day),

- Grass-root driven events and communities (such as OpenStreets, with various themes ranging from safety and security information sharing, to social rides to increase social integration).

Less common are initiatives that aim to change the urban environment to be more conducive to cycling in terms of improvements in physical infrastructure and the structure of the city. These are two important aspects that developing cities are often the slowest to address, due to the implied financial investment needed to successfully achieve meaningful change.

The physical environment and structure thereof is critical for supporting cycling in terms of efficiency of cycling trips and convenience. Several studies have examined the relationship between the urban environment and travel behaviour (Heinen et al., 2010). Increased trip distances result in cycling having a much lower share in mode choice (Moritz, 1998; Zacharias, 2005; Pucher/Buehler, 2006). Urban characteristics, such as density and network design, greatly influence trip distances. In Cape Town, where urban sprawl continues to be a problem, especially for the urban poor, this could be mitigated by increasing the quality of the cycling facilities significantly, to reduce the amount of effort needed to navigate and cycle from the outer areas towards places of employment and education. This is supported by the European commission (EU, 2010 based on Pucher/Buehler, 2008), which consider the most important pro-cycling measure (enabling condition) to be implementing extensive and coordinated cycle paths and lanes and short cuts. Where separate paths and lanes are not possible, traffic calming measures play a key role in cycling safety. For example, the speed limit in most residential areas in Denmark, Germany and The Netherlands has been reduced to 30km/hr. Road junctions have also been extensively modified to make them safer and more convenient for cyclists. This is contra to what can be seen in Cape Town with speed limits in urban areas being 60km/hr and limited separated cycling facilities. Furthermore, there is, generally, a higher resistance to adhering to the posted speed limits, with high rates of non-compliance to road traffic laws, as well as public outcry at potential reductions in allowed speeds.

There are further reasons to believe that more cycling facilitates create safer cycling. The phenomenon of 'safety in numbers' has consistently been found to hold over time and across cities and countries. Fatality rates per trip and per kilometre are much lower for countries and cities with high bicycling shares of total travel, and fatality rates fall for any given country or city as cycling levels rise (Jacobsen, 2003). Safety is often mentioned as a reason not to cycle. If there is a heightened risk of having an accident, the assumption is that people will cycle less (Pucher et al., 1999; Rietveld/Daniel, 2004; Pucher/Buehler, 2006). To improve road safety, enforcement and education programs are required. The availability of safe bike routes and encouragement programs that result in more people cycling, helps to reduce bicycle accident and fatality statistics. There is a positive correlation in cities with increasing levels of cycling and reducing cycling fatality rates (Bogotá Como Vamos, 2014). However, in many cases, as Krizek et al. (2007) suggest, the potential to quantify the degree to which bicycle facilities increase bicycle use is made more difficult, given the fact that many bike lanes have only recently been constructed and it will be some time before one can accurately assess the advantages.

The importance of infrastructure in drastically improving the safety of cyclists on the roads is central to making progress (Bogotá Como Vamos, 2014). While this may be achieved through several measures, physical separation may be the fundamental change that is needed to increase the safety of cyclists. In Cape Town, the completeness of the cycling network may be more critical, given the high level of concern regarding road safety. When reviewing the number of fatalities and injuries of cyclists and pedestrians in Cape Town, the necessity of separate cycling facilities is clear (MacKenzie et al., 2008). However, the quality of the design and implementation often leaves much to be desired. Integrated and seamless cycling facilities are difficult to find, with most facilities struggling to meet the fundamental needs of the cyclists. The most fundamental of these needs include:

- adequate space allocated to cyclists,
- sufficient protection from motorised vehicles, especially at dangerous speed differences between motorists and cyclists,
- clear integration of cycling facilities at intersections, over and underpasses and public transportation facilities, to allow for efficient and convenient trips for cyclists.

Cycling facilities are often insufficient in terms of all three of these aspects, with some facilities barely being 0.5m wide, indicated only by a dotted white line, with no physical barrier and little or no integration with surrounding links. Motorists in Cape Town either ignore or are unaware that these narrow spaces are allocated to cyclists. However, the more recent cycling facilities, which are indicated with bold bright green paint and are more user-friendly, have also been unsuccessful. Motorists are consistently found to be parking stopping and driving directly in these clearly marked cycling facilities. This is evident for both types of cycling lane demarcation, in both the City's Central Business District, as well as routes in surrounding areas.

While cyclists may have some sections of the trips with adequate cycling facilities, many of the sections of their trip are likely to have facilities that do not provide adequate space or separation (Baufeldt, 2016). Therefore, more specific investigations into critical missing links in the cycling facility network need to be identified so that prioritised and systematic roll-out of cycling facilities can be implemented.

A more complex challenge that needs to be addressed for both commuting and recreational cyclists, is that of personal security. Attacks on cyclists is common in Cape Town with cyclists often attacked at knife-point or gun-point. Cyclists are often advised not to use cycling facilities if a syndicate is targeting that facility. However, this is counter-intuitive in the aim to increase cycling. With high levels of crime and inadequate police resources – the (metro) police is often not able to address these types of crimes on cyclists. Furthermore, the fear of crime also influences the take-up of cycling, often greater than the actual crime (Lemanski, 2004). This further deters individuals from cycling in the first place, as well as deterring them when a cycling facility/link is targeted for a time span.

While lower-income individuals, who cycle as a mode of commuting, may not be able to change from cycling to other modes of transportation when faced with personal security risks, middle-income and higher incomes individuals will most likely change to another mode, usually the use of private motorised transportation, a mode which has the largest negative impact on the urban environment. Therefore, addressing the security of all cyclists should be considered a priority not only for ensuring accessibility and mobility but also for addressing the elevated levels of congestion in Cape Town.

ADDRESSING THE CHALLENGES IN PRACTICAL TERMS

Without significant physical changes to the environment, combined with better road safety and security, it is unlikely that cycling will grow in a safe and sustainable manner. Improved identification of dangerous or broken cycling links need to be prioritised, so that resources can be better invested. This will require an integrated and comprehensive understanding of current cycling in Cape Town and how it could best be improved through a transparent and systematic approach that can be supported by Cape Town's governmental officials and the people of Cape Town. Thereby, mitigating and avoiding any civil or political manipulation against future cycling facility projects.

The next most urgent aspect is improved training of designers and implementers of cycling facilities. There is much room for improvement in both the micro and macro aspects of cycling facility design and implementation. While there seems to be some effort to renew and update the documents pertaining to the design of cycling facilities, the distribution and inclusion of this information into the curriculum and training of the various professions is severely lacking. Without sufficient dissemination of the new practices and guidelines, together with a system of accountability for the quality of cycling facilities by individuals who have the necessary knowledge, it is unlikely that great improvements will be seen in practice. This should be the next critical step in developing the abilities of those involved in designing and implementing cycling facilities in Cape Town.

Better protection and enforcement of the space allocated to cyclists against other road users is necessary if cyclists are to gain the benefit of these cycling facilities at all. Both education, awareness and adequate penalties to motorists should be implemented, to change the negative attitude and disrespect of motorised road users towards cycling facilities and cyclists. Investigations into automated regulating systems that could identify, and fine offending drivers could be implemented along key routes.

CONCLUSIONS

The progress made on a policy and strategy front regarding cycling inclusive planning is a step in the right direction. However, without wide-spread training of the related professions and technicians, it is unlikely that improved, integrated, and efficient cycling facilities will become a fundamental feature within the transportation network in Cape Town. Practitioners within both, the public and private sectors should be adequately trained so that cycling facility designs and implementation improve significantly. Furthermore, improving or establishing cycling facilities should always be considered when maintaining or establishing new roads in urban areas, instead of considering the needs of cyclists after the road has been built or the maintenance has been completed.

Additionally, attention to creating commuting corridors for cyclists, which are complete rather than fragmented facilities over a larger area. This is to ensure that, the cycling upgrades provide more substantial and meaningful benefits. Finally, without adequate enforcement of the rules of the road and the rights of cyclists, the practical implications will remain minor.

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RESEARCH

Cycle paths – love them or hate them? Why do some cyclists prefer cycle paths and others cycle lanes?

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ABSTRACT

Cycle paths and cycle lanes have become a symbol for the promotion of cycling in Germany and in other countries. Both kinds of infrastructure have their proponents and opponents. We programmed an online study in order to find out why different cyclists prefer different kinds of infrastructure when cycling on a main street with little or lots of traffic. 424 female and 1330 male cyclists aged 18 to 76 answered most of the questions in the survey. 70 % of the sample said that they biked every day. On busy main roads cycle paths are more attractive than on moderately busy cycle lanes. Cyclists who cycle more frequently, use the bike as their main means of transport and cycle when there is ice or snow had a higher preference for cycle lanes than for cycle paths.

The preferred kind of infrastructure was judged better or at least as good as the non-preferred infrastructure. Both are less demanding to cycle on, need less attention, are safer, a crash is less likely and would be less severe. The rather undifferentiated image of the preferred ("loved") and not preferred ("hated") kind of infrastructure shows that preferences and their "reasons" are closely related. Avoiding cars which are passing fast and seeing a crash as less likely are most important for preferring cycle paths rather than cycle lanes.

Of interest for further studies is the degree to which the quality of the infrastructure, one's own experiences with conflicts, observation of other road users, and information from media contribute to a preference for cycle lanes or cycle paths.

Keywords: cycle path; cycle lane; separation; subjective safety; choice of way

INTRODUCTION

In Germany, the modal share of cycling has risen in the last decades and is still rising. The modal share differs markedly between regions, and is higher in urban than in rural areas (Follmer et al., 2010). Cycling infrastructure, mainly in the form of cycle paths, and more and more also in the form of cycle lanes, has become a symbol for the promotion of cycling in Germany and in other countries.

In Germany, a large variety of kinds of infrastructure for cyclists exists. In general, knowledge about the legal situation regarding which infrastructure must be used by cyclists and which can be used by cyclists is low for all kinds of road users; for drivers even lower than for cyclists (Alrutz/Bohle/Müller/Prahlow, 2009; Ellinghaus/Steinbrecher, 1993; Gaffga, 2016). As knowledge and enforcement are low, cyclists might just choose the part of the street which they prefer. Preferences for infrastructure might influence which route cyclists choose and on which part of the road they cycle (Mertens et al., 2016).

This study explores the reasons why some cyclists favour cycle lanes while others prefer cycle paths. Separation of cycle and motor traffic is considered more necessary the more motor traffic there is on a road and the faster this traffic travels (Forschungsgesellschaft für Straßen- und Verkehrswesen, Arbeitsgruppe Straßenentwurf, 2010). Cycle paths and cycle lanes are on the same level of separation in the guidelines, but cyclists differ in their preference. This study focusses on the question as to which cyclists prefer cycle lanes and which cycle paths and why they prefer them.

In Germany, many cyclists prefer cycle paths to cycle lanes. In interviews of cyclists on the road in four cities and a representative phone survey in Germany, cycle paths were rated as safest and most comfortable; cycle lanes as fastest. Cycle paths were preferred most, mixed traffic least (Kolrep-Rometsch et al., 2013). In a survey which was representative for Germany (Gehlert/Genz, 2011), cycle paths were rated as safest, followed by cycle paths shared with pedestrians. Cycle lanes and mixed traffic were rated as unsafe. In a postal survey of inhabitants who were representative for the city of Erlangen, cycle paths were seen as safest, followed by cycle paths shared with pedestrians and cycle lanes (Stadt Erlangen, 2010). The quality of infrastructure affects the preference for a road but the positive effect of separation is much larger (Mertens et al., 2016).

Research about walkability of environments shows a large discrepancy between objective and subjective walkability (Gebel/Bauman/Owen, 2009). What are the subjective perceptions which make cycling on a cycle lane or on a cycle path attractive? Cyclists' needs, perceived safety, the threat of certain kinds of crashes, the potential to avoid them?

The majority of cyclists prefer separation from car traffic but the different kinds of separation have different advantages. In an online survey in Germany, cycle lanes were rated as better in 11 aspects (e. g. safety, rapidity, no conflicts) than cycle paths. The cycle path got better ratings for passing distances (Hagemeister, 2009). In interviews with cyclists on the road in Heidelberg, cycle paths for cyclists only were rated best in many aspects (and better than cycle paths shared with pedestrians); cycle lanes got the second best ranking on average; cycling in mixed traffic was least attractive (Zimber, 1995). Different cyclists might have different needs and different priorities. These might lead to different preferences. Persons who cycled in mixed traffic said that fast cycling was more important for them than safety. Persons who cycled on cycle paths shared with pedestrians stressed relaxation, safety and enjoyment of nature (Zimber, 1994). We expect to be able to replicate that persons who cycle more frequently (Gaffga, 2016) and persons who cycle to work (Taylor/Mahmassani, 1996) have a lower separation preference. The question of how other cycling purposes are related to separation preference remains open.

Cycling is attractive if it is safe (Heesch/Sahlqvist/Garrard, 2012). For this reason we expect the subjective safety of one kind of infrastructure to be closely

related to a preference for this kind of infrastructure. Potential threats to safety may vary widely and may be perceived as more or less important. For this reason we asked how often cyclists think that they might become involved in a crash and how afraid they are of crashes with other road users or of single bike crashes. We assume that crashes which are more closely related to one kind of infrastructure make this infrastructure less attractive. We assume that crashes with cars travelling in the same direction are more often perceived as a problem on cycle lanes. We assume that crashes with pedestrians are most typical for cycle paths because pavement and cycle path often run beside each other and pedestrians often walk on them. We wanted to analyse which potential crash types are more closely related to preference of cycle lanes and cycle paths.

Infrastructures may have other advantages than safety. Having to pay more attention makes an infrastructure less attractive; encountering fewer obstacles and being able to avoid them easily makes an infrastructure more attractive. Cycle paths are more attractive because there are no conflicts with cars, no close passing, no being honked at or shouted at by car drivers. Cycle lanes are more attractive because maintenance in winter is better on average in Germany, pedestrians are seldom encountered, as are persons cycling in the wrong direction. Any kind of infrastructure which is only for cyclists takes up the space of other road users. We asked if a feeling of taking away other road users' space is related to separation preference.

Gender and age are related to separation preference. Women prefer more separation than men (Emond et al., 2009; Gaffga, 2016; Heesch/Sahlqvist/Garrard, 2012). This result is explained by women's higher risk aversion (Garrard/Rose/Lo, 2008). Younger and older adults prefer more separation than the age group in between (Gaffga, 2016). We expected to be able to replicate these findings.

METHODS

Questionnaire

An online questionnaire was programmed with the tool soscisurvey (Leiner, 2014). Its main parts were (1) demography, (2) personality questionnaire (BFI-K, a short version of the Big Five Inventory, Rammstedt/John, 2005), (3) preference of infrastructure, perception of other road users and obstacles, (4) frequency of cycle infrastructure when the respondents were young compared to nowadays, (5) perception of risk and crashes, (6) description of personal style of cycling and mobility habits. Results concerning parts (2), (4), and (6) are not reported here.

In the introduction to Part 3 of the online questionnaire, we reviewed the definitions of a cycle path and a cycle lane, their level, their markings, and their traffic signs. We presented one photograph for a cycle path and one for a cycle lane. Then the participants were asked to state which infrastructure (cycle path, cycle lane or mixed traffic) they preferred on moderately busy and on busy main roads and which they used most. The participants could mark all kinds of infrastructure. Each kind of infrastructure was represented by a small photograph of a main road in Dresden with two car lanes in each direction. The terms moderately busy and busy main road were not defined because traffic levels differ between regions and cities. The photographs presented situations in a city, the questionnaire explicitly referred to cycling in built-up areas. In Germany, cycle lanes may only be marked in built-up areas (Forschungsgesellschaft für Straßen- und Verkehrswesen, 2010).

Participants

Participants were recruited via personal connections and websites related to cycling and traffic. We did not aim for a representative sample of cyclists in Germany. The aim was a heterogeneous sample of adult cyclists with different habits, experiences, needs, and attitudes in order to allow correlations to be calculated between the characteristics of the respondents and their stated preference for different kinds of cycling infrastructure.

We excluded one data set from a person who was younger than the minimum age of 18, 14 data sets from persons who failed to mark which federal state they lived in (we only addressed persons living in Germany because laws and infrastructure are different in other countries), 8 data sets from persons who did not answer the question as to where they preferred to cycle on a moderately busy or on a busy main road. Questionnaires with more than 25 %

missing answers were excluded as well. 1789 questionnaires remained for further analysis.

Among the participants 74.9 % were male, 23.7 % female. The mean age of those persons who provided this information was 43.36 years old (standard deviation 14.26 years). The sample had a rather high level of education: 57.6 % held a bachelor or master degree. Most participants lived in larger cities. Table 1 shows the frequency of bike and car use: 90.8 % of the participants used their bike for errands, 84.4 % for leisure or sports, 77.5 % to cycle to work or place of education, 71.2 % cycled in their holidays, and 72.0 % said that their bike was their main means of transport. These numbers show that the study addressed persons who cycled frequently and for several purposes, and drove less often than they cycled.

Table 1

Frequency of bike and car use of the participants (N=1789).

Frequency of use	bike	car
Daily	69.8 %	8.0 %
3–4 times per week	26.6 %	12.1 %
1–2 times per week	8.5 %	23.9 %
1–2 times per month	3.1 %	18.3 %
Less often	1.0 %	13.0 %
Never or almost never	0.2 %	24.7 %

RESULTS

Preferences depending on the amount of traffic on the main road

Table 2 shows the infrastructure preferences ("I prefer cycling on/in ... most") for moderately busy and busy main roads. In general, there was a marked shift of preference from cycle lanes on moderately busy main roads to cycle lanes and cycle paths on busy main roads. The question required the person to decide ("most"), but it was possible for them to mark more than one kind of infrastructure. For space reasons all further analyses are limited to the preference of cycle lanes versus cycle paths.

Preference, demographic characteristics, and mobility habits

We found very small quadratic relations (significant with $p<.0001$) between age and preference on moderately busy main roads ($F=8.263$, $R^2=.020$, $df=2$, $N=879$) and on busy main roads ($F=20.297$, $R^2=.030$, $df=2$, $N=1332$). Cyclists of 40 years (moderately busy main roads) and 42 years (busy main roads) preferred cycle lanes more than younger and older cyclists.

The rank correlations between separation preference and mobility habits are presented in Table 3. Persons who cycle more often, persons who consider the bike to be their main means of transport, and persons who also cycle when there is ice or snow prefer cycle lanes to cycle paths. Persons who cycle to work or their place of education and persons who cycle for errands prefer cycle paths. Persons who drive more often, persons who cycle as a hobby or sports, persons who cycle in their holidays and persons who accept a larger detour for a more attractive route prefer cycle paths on busy main roads.

Table 2

Preferred infrastructure: Number of persons who like to cycle on this kind or two kinds of infrastructure most.

	Mixed traffic	Mixed traffic/ cycle lane	Cycle lane	Cycle lane/ cycle path	Cycle path
on moderately busy main roads (n=1747)	561	223	673	95	195
on busy main roads (n=1772)	142	54	707	149	720

Table 3

Rank correlations (Spearman rho and 2-sided p) between gender and mobility habits and preference for cycle paths compared to cycle lanes.

Preference on	moderately busy main road (N=893–963)		busy main road (N=1465–1576)	
	rho	p	Rho	P
Gender	.09	.0072	.18	<.0001*
How often do you cycle? [Frequency]	-.20	<.0001*	-.20	<.0001*
How often do you drive? [Frequency]	.09	.0083	.11	<.0001*
I use the bike as the main means of transport	-.19	<.0001*	-.20	<.0001*
I cycle to work/education	.16	<.0001*	.18	<.0001*
I cycle for errands	.15	<.0001*	.12	<.0001*
I cycle as a hobby/sports	.02	.5538	.07	.0040*
I cycle in holidays	.06	.0613	.09	.0002*
I also cycle when there is ice and/or snow	-.15	<.0001*	-.26	<.0001*
I accept a larger detour for a more attractive route (noise, pollution, environment)	.08	.0105	.14	<.0001*

Note. Preference was coded as 3=cycle lane, 4=cycle lane and cycle path, 5=cycle path. Gender: 1=male, 2=female. Frequency was coded as 6=daily, 5=3–4 times per week, 4=1–2 times per week, 3=1–2 times per month, 2=less than 1–2 times per month, 1=(almost) never. The answers of the other questions were coded 0=no, 1=yes. p-values marked * were significant after Bonferoni-Holm correction for 66 significance tests of correlations.

Table 4

Rank correlations (Spearman rho and 2-sided p) between fear of crashes with different kinds of road users and preference for cycle paths compared to cycle lanes.

Preference on	moderately busy main road (N=863–960)		busy main road (N=1391–1572)	
	rho	p	rho	P
I think I might be involved in a crash. (5f)	-.05	.1593	.01	.5952
When cycling I am very afraid of …				
… crashes with a car travelling in the same direction as me (5a)	.27	<.0001*	.29	<.0001*
… crashes with cars that are turning (5a)	.01	.7448	.05	.0610
… crashes with cars that are parking or with opening doors (5a)	-.02	.5924	.04	.0926
… crashes with pedestrians (5a)	-.11	.0004*	-.06	.0142
… crashes with cyclists (5a)	.03	.3529	.03	.2488
… crashes at rail crossings and along tram rails (5a)	.04	.1680	.05	.0336
When cycling I am very afraid of falling or slipping due to a slippery road surface (ice, snow, rain) (5a)	.07	.0406	.10	<.0001*

Note. Preference was coded as 3=cycle lane, 4=cycle lane and cycle path, 5=cycle path. Answer formats. 5a: agreement 5-point rating scale 1=”do not agree at all” to 5=”agree very much”; 5f: frequency 5-point rating scale 1=”never or almost never” to 5=”always or almost always”. p-values marked * were significant after Bonferoni-Holm correction for 66 significance tests of correlations.

Table 5

Rank correlations (Spearman rho and 2-sided p) between features of the infrastructure and preference for cycle lane and cycle path. These analyses are based on the data of those persons who prefer a cycle lane and/or a cycle path.

Preference on	moderately busy main road (N=509–959)		busy main road (N=634–1569)	
	rho	p	rho	p
When cycling I have to pay more attention on a cycle lane (coded 3)/cycle path (5)/same on both (4)	-.45	<.0001*	-.50	<.0001*
I perceive cycling as more demanding on a cycle lane (coded 3)/cycle path (5)/same on both (4)	-.58	<.0001*	-.57	<.0001*
When cycling I encounter more obstacles (in the form of cars travelling or parking, objects, pedestrians) on a cycle lane (coded 3)/cycle path (5)/same on both (4) (*)	-.21	<.0001*	-.22	<.0001*
I am more bothered by obstacles on a cycle lane (coded 3)/cycle path (5)/same on both (4) (*)	-.03	.4463	-.14	<.0001*
I can best avoid obstacles on a cycle lane (coded 3)/cycle path (5)/same on both (4) (*)	.36	<.0001*	.42	<.0001*
I think I am more likely to have a crash on a cycle lane (coded 3)/cycle path (coded 5)/same on both (coded 4)	-.52	<.0001*	-.57	<.0001*
If I have a crash. it is probably more severe on a cycle lane (coded 3)/cycle path (coded 5)/same on both (coded 4)	-.33	<.0001*	-.49	<.0001*
I prefer to cycle on a cycle path because fast cars pass me on the road. (5a)	.53	<.0001*	.67	<.0001*
When cycling on a cycle lane, I have the feeling that I am taking up the cars‘ space. (5a)	.33	<.0001*	.37	<.0001*
When cycling on a cycle path, I have the feeling that I am taking up the pedestrians‘ space. (5a)	-.21	<.0001*	-.23	<.0001*
Car drivers honk or shout at me when I cycle on the cycle lane. (5a)	.00	.9413	-.01	.5566
It bothers me when car drivers honk or shout at me. (5a)	.02	.6104	.08	.0011*
In general it is safe to cycle on a cycle path. (5a)	.44	<.0001*	.54	<.0001*
In general it is safe to cycle on a cycle lane. (5a)	-.37	<.0001*	-.30	<.0001*

Preference was coded as 3=cycle lane, 4=cycle lane and cycle path, 5=cycle path. Answer formats. 5a: agreement 5-point rating scale 1=”do not agree at all” to 5=”agree very much”. (*) Here, the answer options were cycle path, cycle lane and road but in this analysis only persons were included who had ticked the answers cycle path and/or cycle lane. p-values marked * were significant after Bonferoni-Holm correction for 66 significance tests of correlations.

Preference and fear of crashes

The rank correlations between preference and fear of crashes are presented in Table 4. Persons who prefer cycle paths are more afraid of a car travelling in the same direction. Persons who prefer cycle lanes on moderately busy main roads are slightly more afraid of crashes with pedestrians. Persons who prefer cycle paths on busy main roads are slightly more afraid of crashes due to a slippery road surface.

Preference, safety and attention

The correlations between perceived features of cycle lanes and cycle paths and preference are shown in Table 5. Most comparisons were in favour of the preferred kind of infrastructure. It is less demanding, a crash is less likely and will be less severe, the cyclist has to pay less attention, can best avoid obstacles and encounters fewer obstacles, and is also less bothered by them. Cyclists who prefer cycle lanes feel more strongly that they take up the cars' space when cycling on a cycle lane and feel less strongly that they take up the pedestrians' space when they are on a cycle path. Cyclists think that the preferred infrastructure is safer. Persons who prefer a cycle path agree more to the statement that they prefer to cycle on a cycle path because fast cars pass them on the road. Preference and the experience that car drivers honk or shout when a person is cycling on a cycle lane are uncorrelated.

DISCUSSION

The sample and the focus of the study

In earlier studies, we made the experience that surveys on cycling attract persons who cycle more frequently, for more purposes and for longer distances than the average cyclist (Follmer, 2010). In this survey, too, the proportion of participants who prefer to cycle in mixed traffic is much higher than in the population of cyclists in Germany (e. g. compared to observations by Alrutz/Bohle/Müller/Prahlow, 2009). For this reason, the results presented here are not considered as representative for all cyclists in Germany in terms of the frequencies of behaviours or attitudes. In spite of the non-representative sample, the participants were diverse in age, in gender, in education, and in their places of residence – and some preferred cycle lanes, others cycle paths. This means that the correlations which we found do in fact allow us to infer which factors are more and which are less important for a preference for cycle lanes versus cycle paths.

Preferences depending on traffic on the main road

Our participants had a higher preference for cycle paths on a busy as opposed to a moderately busy main road. The recommendations for cycling infrastructure suggest cycle paths and cycle lanes under the same conditions of traffic volume and speed (Forschungsgesellschaft für Straßen- und Verkehr-

swesen, Arbeitsgruppe Straßenentwurf, 2010). Cyclists have a higher preference for cycle paths – cycling further away from motor traffic – when a main road is busier. The question of how far further criteria in the recommendations which affect the decision to implement a cycle path or a cycle lane are shared by cyclists remains open. Such criteria are potential conflicts with cars entering or leaving parking spaces or slopes which affect cyclists' speed.

Preference, demography and mobility habits

We were able to replicate some results from other studies. Women prefer more separation from car traffic than men (Heesch/Sahlqvist/Garrard, 2012), but only on busy main roads. Persons who see the bike as their main means of transport and persons who cycle more frequently prefer less separation (Gaffga, 2016). Contrary to the results of Taylor and Mahmassani (1996), persons cycling to work/education or for errands prefer more separation than persons not cycling for these purposes. A possible explanation is that persons who cycle to work prefer separation because it allows them to pass traffic jams.

Love them or hate them? Why are cycle paths or cycle lanes preferred?

Cyclists who prefer cycle paths are more afraid of crashes with cars travelling in the same direction and slightly less afraid of crashes with pedestrians. Persons who prefer cycle paths on busy main roads are slightly more afraid of falling or slipping due to a slippery road surface. One reason why some cyclists prefer cycle paths to cycle lanes are fast passing cars on the road.

Cyclists ascribe many positive attributes to the kind of infrastructure they prefer. It is safer, needs less attention, is less demanding, fewer obstacles are in the way, and these can be avoided more easily. Crashes are less likely and would be less severe. The opposite attributes are ascribed to the other kind of infrastructure. This is a rather biased picture – either "love" or "hate" – which does not leave much room for unbiased experiences with new infrastructure.

As cycle paths are much more common in Germany than cycle lanes, we have good reason to assume that all cyclists have experience with cycle paths. Cycle lanes are less common in Germany than cycle paths. For this reason we can assume that not all participants have experience with this kind of infrastructure. This study leaves an important question open: How much experience do cyclists who prefer a cycle path to a cycle lane actually have with cycle lanes compared to those cyclists who prefer a cycle lane? If cyclists who do not feel safe on cycle lanes have little or no personal experience, is their preference based on observations of other cyclists, on information in the media (as proposed by Macmillan et al., 2016), or on prima facie evidence? And there is a very practical question: Does the perception of cycle lanes change if cyclists use them, and in which direction, depending on the cycle lanes' width and quality?

Why some cyclists see cycle paths as necessary

The correlations between demography and mobility habits on the one hand and preference for cycle lanes or cycle paths on the other are relatively low. Preference can be explained better by attitude towards car traffic and by safety perception. The preferred infrastructure is seen as safer; the perceived crash probability and severity are lower. The feeling that one is taking up the pedestrians' space is less important for the infrastructure preference than the feeling that one is taking up the cars' space.

Fast cars passing a cyclist are a reason for preferring cycle paths to cycle lanes. In reality, accidents with cars travelling in the same direction are a minor cause of severe cyclist crashes, about 2–6 % of the crashes in which a cyclist is involved (Lieb, 2012). If motor traffic is seen as a threat, separation from this threat is a subjectively rational solution. A question which deserves investigation is how the quality of cycle lanes influences their acceptance, quality being mainly a matter of comfortable width and no parallel parking, both of which features would allow cyclists to keep their distance from passing cars.

Demanding lower speeds in inhabited areas and stricter enforcement of speed limits would be another solution, at least on sections where any separation of cyclists from cars is impossible (Forschungsgesellschaft für Straßen- und Verkehrswesen. Arbeitsgruppe Straßenentwurf, 2010). Cyclists are more willing to cycle in mixed traffic if the speed limit is 30 km per hour instead of 50 km per hour (Gaffga, 2016; Mertens, 2016). We assume that lower speed limits and even strict enforcement of the 50-km/h limit would improve the acceptance of cycle lanes.

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EXPERT COMMENT

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We, as humans, are masters at self-justification. So far as cycling is concerned, we might justify not taking part by saying 'it is too dangerous'. But experience shapes opinion, and once we have tried something our thinking and language may change.

And language is so important because it is bound with our philosophy. We unthinkingly often use the term 'vulnerable road user' but if we stop to think about this, we are implicitly suggesting that there are others on the road who have the right to cause vulnerability. Why might we be content with this extremely morally challenging state of affairs? Further, 'non-motorised road user' is also often used as a term, but this describes a cyclist only in relation to what they are not, and indeed relative to some other type of vehicle, with the implicit assumption that this other type of vehicle is the norm. Indeed, if it is a trap to do so, then Vanderschuren and Baufeldt fall into this trap.

Perhaps the most pernicious use of language in relation to safety is the very loose way that vehicles themselves are personified to the extent that the media often reports the cause of death on the road as, for example 'car collides with cyclist' when the agency is entirely with the driver. Of course our precision in differentiating may, ironically, become better in this regard with the advent of autonomous vehicles.

Technical discussion of safety, however, needs to be precise and to avoid bias. We do not speak of danger, but we speak of risk, but even when speaking of risk our every-day lived experience can so readily cloud our judgement. When provision is made for cycle traffic it is often on the basis of increasing either safety, or at least the perceptions of safety. The problem, however, is that whenever a situation is changed, then the balance of the risks are changed: managing risk changes all the risks. Removing cycle traffic from a carriageway may reduce the (relatively low) propensity for read-end shunts, but if it creates many side road crossings there could be many more conflict points introduced. This would be the case where the design of the off-carriageway infrastructure for cycle traffic is poor. This concern is perhaps at the root of the concern in Hagemeister and von Harten's paper.

We decide on the level of risk we are comfortable to take based partly on our inherent propensity to take risk, and partly on the level of the reward that we achieve. Our 'experience', flawed and biased as it will be, will suggest to us the probability of any losses which we might incur in the process. Interestingly, the thoughts and actions of civic society, manifest in government action, may be rather different from the actions of individuals. Governments, with access to objective data and scientific methods, are able to provide relatively robust estimates of potential losses, even to the point of, rather controversially, estimating the economic value of saving a life. Risk is however always relative because any management of the risk will modify the risk. Such measurements cannot, so far as the human subjects are concerned, be objective though, and this is because of the perceptions that the human make about the risk. Tragic medical cases where the science suggests one course of action while the emotions suggest another are perhaps the most extreme example, and the extremity is enhanced as a result of the pre-meditation involved.

We all take risks every day, however large and however small. On this basis 'accidents will result'. The job of those designing and managing transport infrastructure is to try, and the operative word is try, to create environments in which fewer collisions occur, and when they do occur, try to ensure that their consequences are minimal for the human frame in terms of injury. Easier said than done in an environment where those driving motor vehicles can so readily adopt a behavioural stance of 'might is right'.

Further, and crucially, the source of the risk has to be recognised. It is not cycling per se that is the source of danger, but it is the consequences of the actions of those driving the larger and faster vehicles that is the source of the danger. This is where the notion of strict liability in law may have a bearing. Strict liability suggest that the default presumption is that the driver

of the more threatening vehicle is liable for compensation in civil law, unless the contributory negligence of the more vulnerable person can be proved. However, the size of the effect of stricter liability is contested. For those countries, such as the UK, which do not have such a law, the arguments against introducing one are probably more to do with perpetuating the dominating position of the majority mode, that is to say the car.

So, critical in all discussions about risk is understanding the source of the risk. Putting others at risk is morally wrong, but it happens every day on the road. We have become so inured to these circumstances that we accept them as a norm. The worst part is that there is a large section of the road safety profession that is rather ambivalent in this regard as well. Slowing the cyclist to 'save them from themselves' seems to be a common view-point.

Historically, in situations with relatively low cycle volumes, it has often been the case that interventions have only ever been instigated at discrete locations to 'solve' a safety problem, and these have often been solved by encouraging the cyclist onto the footway to remove them from the source of danger, but with no thought to the actual needs of the cyclist. This patchwork inadequate infrastructure can make the life of the cyclist more difficult.

What is required are comprehensive networks for cycle traffic which are properly designed: after all every other transport network receives just that, a network. It is only cycle traffic which has had to thread its way within networks designed principally for other types of movement. Motor traffic received much attention in the latter part of the twentieth century in terms of new routes and comprehensive area wide traffic management. An issue with this was that it in fact militated against cycle traffic by creating wide one-way roads, and signing and routing for motor traffic necessary to cope with motor traffic volume that was at best, not effective or efficient for cycle traffic, and at worst made the situation for cycle traffic much worse.

Comprehensive networks for cycle traffic require similarly well thought through area-wide traffic management to create a local network which links to a network of arterial routes for cycle traffic. All the techniques that are required are available, it 'just' requires the willingness to reconsider the layout of highway networks in urban areas with an eye on the needs of cycle traffic as well as motor traffic.

Hagemeister and von Harten consider, in the German situation, what has been a vexed question in cycling circles: should cyclists be mixed or separated from motor traffic? They investigate the views of cyclists, which conform to a large extent to the principle of self-justification as noted at the outset. Critically, the issue is noted as being manifestly linked with the amount of attention that needs to be paid, and also the level of stress that results in these different situations. They find that people who cycle more have a greater propensity to be comfortable in mixed conditions. However, it is important to understand the quality of the infrastructure that is being considered when people are making the choice to not use a facility that is separated from motor traffic: all too often these facilities have not been fit-for-purpose so far as any reasonable assessment of level of service is concerned.

Vanderschuren and Baufeldt tackle head on the difficulties for cyclists of facilities which do not form a comprehensive network. The context of the developing city of Cape Town in South Africa is particularly challenging, but there are factors, such as significantly growing tourism, which can assist in a journey towards greater cycle use. They identify four requirements for support for cycling: increasing the supply of the bicycle itself, road safety education, pro-cycling events and events which come from the grass roots.

We hope you enjoy reading these two papers.

2.3 Electric bikes and safety

Research

Accident analysis and comparison of bicycles and pedelecs

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Practice Comment

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RESEARCH

Accident analysis and comparison of bicycles and pedelecs

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ABSTRACT

The number of electric bicycles (pedelecs) has increased in recent years and continues to increase both in Germany and elsewhere. Recent research shows that pedelec users ride somewhat faster than conventional cyclists, there is more variation in speed (Schleinitz et al., 2014, 2016) and car drivers use shorter gaps for turning off in front of pedelec users (Schleinitz et al., 2015). This raises concerns about higher accident risks for pedelecs. In Germany, recently representative police accident data became available which distinguishes between cyclists and pedelec users. For the investigation presented in this paper a sample of 2,458 pedelec accidents from 2012 to 2015 was analysed in comparison to a sample of 82,171 bicycle accidents. Compared to bicycle accidents the share of elderly was higher for pedelec accidents. Also there were more fatal accidents and accidents with severe injuries for pedelecs. Compared to bicycles for pedelecs, there were more driving accidents where the user loses control over the vehicle. Moreover, for pedelecs more accidents with inappropriate speed as cause of accident, especially among the elderly cyclists, occurred. Furthermore, there were more often other bicyclists involved in pedelec accidents compared to bicycle accidents. In summary there are specific accident risks due to the current user group – mainly middle aged and elderly cyclists – and the pedal assistance of pedelecs. Controlling a pedelec in a critical situation seems to be more difficult than controlling a bicycle in general. Especially elder pedelec users may cycle too fast given their ability to control the pedelec. Therefore, especially elderly pedelec cyclists may be at risk.

Keywords: pedelecs, bicycle, accident analysis, elderly

INTRODUCTION

The number of electric bicycles has increased in recent years and continues to increase in Germany, as it does elsewhere. There, the market share of electric bicycles on all bicycles amounts already up to 19%. About 99% of them are so-called pedelecs (ZIV, 2018). These are bicycles with electric motor assistance up to 25 km/h and 250 Watt. They are legally classified as bicycles. As a consequence, pedelec

cyclists do not need a driving license, motor vehicles insurance or a helmet. They are allowed to use the bicycle infrastructure.

The growing number of pedelecs and the possibility of higher speeds give rise to concerns about road safety, in particular the risk of accidents. In 2017 in Germany there were 5,204 accidents with pedelec cyclists involved (68 fatalities, 1,373 severely injured and 3,673 slightly injured pedelec cyclists). Compared to 2016 this is an increase by 31% for pedelec accidents, 11% for pedelec fatalities, 26% for severely injured and 33% for slightly injured pedelec cyclists (Federal Statistical Office, 2018). The absolute values of pedelec accidents are still small. That contributes to the high increase in percentages, but we expect similar increases in the near future.

There are international studies analyzing the characteristics of e-bike accidents. Most studies are from China, the biggest market for e-bikes. However these studies include very different types of e-bikes ranging from pedelecs up to motorcycle-style e-bikes (Fishman / Cherry, 2016). Also traffic and road characteristic are very different from Europe, so the results cannot be transferred.

In Switzerland e-bike accidents are recorded since 2011. However, there are relevant differences in legal requirements compared to Germany and the European Union in general. Swiss legislation also restricts motor assistance to 25 km/h for so called slow e-bikes (equivalent to pedelec), but allows motor power up to 500 Watt. That is double to what is allowed in Germany and the EU respectively. Thus, Swiss slow e-bikes / pedelecs are more powerful which might affect accident severity for instance. Having this in mind two swiss accident studies found (Scaramuzza / Uhr / Niemann, 2015; Uhr / Hertach, 2017):

- more single accidents for slow e-bikes compared to bicycles,
- a higher share of severe injuries for e-bikes compared to bicycles even if ad-justed exposure (kilometre cycled),
- an increase in accident risk the older the cyclists are,
- a higher accident risk for women than men for e-bikes.

In the Netherlands there is the same regulation concerning e-bikes / pedelecs as in Germany. There are two Dutch studies comparing crash risk for pedelecs and bicycles (Schepers / Fishman / den Hertog / Klein Wolt / Schwab, 2014). The authors interviewed accident victims treated at emergency departments. Pedelec accidents were more often single-bicycle accidents while (dis)mounting. Pedelec cyclists were more likely to report an accident which requires treatment at an emergency department compared to bicyclists.

For Germany there are only two small accident studies. Lawinger and Bastian used police-reported accidents including 126 pedelecs (Lawinger / Bastian, 2013). They found a higher share of fatal accidents for pedelecs compared to bicycles. Also the share of injured persons was higher for pedelec accidents compared to bicycle accidents.

Otte, Facius and Müller (2014) used data from the in-depth accident study (GIDAS) including 30 pedelecs. For pedelecs they found a higher share of driving accidents and single accidents as well as a lower share of turning and crossing accidents compared to bicycles. The majority of pedelec cyclists were 60 years or older compared to 37 years or older for bicyclists. Especially for single accidents, collision speed was somewhat higher for pedelecs (50% cycled 17km/h or faster) at the time of the accident compared to bicycles (13 km/h). Despite this, there were no differences in accident severity between pedelecs and bicycles.

In summary, statistics show that not only the number of pedelecs rises but also the number of pedelec accidents. There are indications for special characteristics of pedelec accidents, such as a higher accident severity or a higher share of driving and single accidents. However, sample sizes in accidents studies are still small, since e-bikes / pedelecs are a new travel mode. So far the existing studies do not provide a consistent pattern of results. Therefore, the aim of this paper is to analyse a large sample of pedelec accidents in-depth and compare it with bicycle accidents. Do pedelec accidents differ in relevant accident characteristics from bicycle accidents? What are the differences and what do they imply?

METHOD

Research design

To calculate accident risks it needs accident data as well as data on the exposure to have an accident, e.g. cycling frequency, kilometre cycled etc. For pedelecs there is no representative travel behaviour data available yet. Therefore, differences between the accident risks of bicycles and pedelecs can only be derived by comparing the accidents characteristics of pedelec and bicycle accidents.

In Germany, traffic accidents are documented by the police of each federal state. This is also the data base for the national road accident statistics. The distinction between pedelecs and bicycles when documenting accidents was introduced in 2014, in a few federal states already in 2012.

Sample description

The sample consists of data from nine federal states including urban and rural areas from 2012 onwards until the end of 2015. The comparison sample of bicycle accidents was drawn for each federal state separately due to the different starting points in the registration of pedelec accidents.

The accidents statistics included data about the accident itself such as accident type, location etc. and data about the persons involved, e.g. age, accident severity etc. For each accident the statistics include information of up to 7 persons involved. Therefore samples sizes vary depending on the level of analysis (accident vs. person). Furthermore, there are variables that are only relevant in some cases. For example the cause of an accident is only recorded for persons involved that are regarded as at least partly responsible. Therefore, there are varying sample sizes across the analyses.

On the level of accidents the sample consists of up to 2,458 pedelec accidents and up to 82,171 bicycle accidents where at least one pedelec cyclist resp. bicyclist was involved. On the person level the sample includes up to 2,495 pedelec cyclists and 87,800 bicyclists.

Data analysis

The accident data was analysed for differences between bicycle types (pedelec vs. bicycle), age groups and gender. Normal and ordinal scaled depended variables (e.g. accident severity) were analysed using nonparametric tests. For metric variables such as age T-test was used even though data was not normally distributed. However, his test is robust against violations of normality.

RESULTS

Cyclist's and trip characteristics

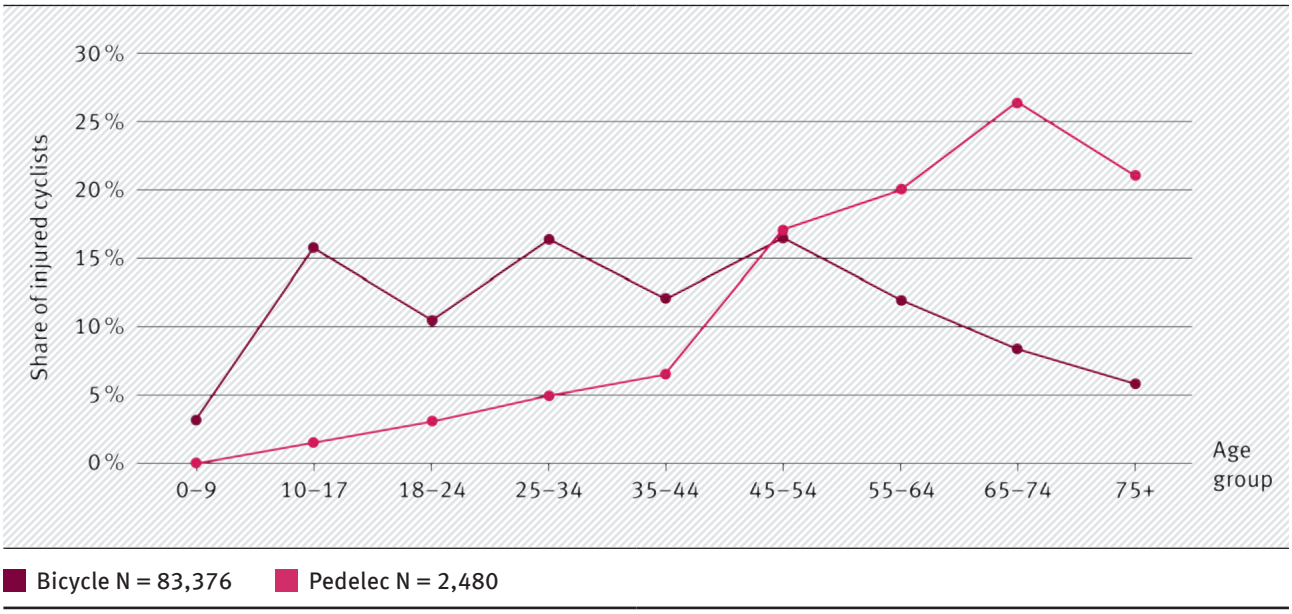
Pedelec cyclists involved in an accident are older than bicyclists involved in an accident (Mpedelec = 60.2 years (SD = 16.7). vs. Mbicycle = 39.7 years (SD = 20.7), p<.01). Figure 1 illustrates the age distribution of pedelec cyclists and bicyclists being involved in accidents. There is a reverse trend. For pedelec accidents the share of old age groups increases whereas it decreases for bicycle accidents. In contrast there are hardly any young pedelec cyclists involved in an accident up to an age of 44 years. That reflects the current user group of pedelecs. Currently, pedelecs are most popular among elderly cyclists (German Insurer's Accident Research, 2017).

Overall there were 65.3% male and 34.7% female persons involved in an accident. There were only small but significant differences between pedelec cyclists and bicyclist. There was a higher share of female pedelec cyclists compared to bicyclists (female pedelec = 38.4%, female bicycle = 34.6%, Chi2 (1) = 15.19 p < .01).

There is a higher share on injured pedelec cyclists compared to bicyclists on the weekend (Chi2 (6) = 26.73 p < .01). That again reflects the current travel behaviour pattern of pedelec cyclists with more leisure trips (German Insurer's Accident Research, 2017).

Figure 1

Share of injured cyclists per age group and bicycle type



Source: German Insurance Accident Research

Accident characteristics

The accident type describes the conflict situation which resulted in the accident. That is the moment in which the further course of events could no longer be controlled. The accident types have been mainly developed for and applied to motor vehicles. Thus they do not fully account for the characteristic of bicycles. Table 1 shows the distribution of accident types for pedelec and bicycle accidents respectively.

For pedelec as well as for bicycles the most frequent accident type is the turning into accident. That is a situation where a road user who turns into or crosses a main street gets in conflict with another road user with right of way. For example, a vehicle turns into the main street and the driver overlooks a cyclists cycling on the bike path of the main street in or against the direction of travel.

Table 1

Accident types by bicycle type

Accident type	Pedelec accident		Bicycle accident	
	n	%	n	%
Turning into accidents	839	33.6	32,226	36.7
Driving accident	482	19.3	10,359	11.8
Other accidents	363	14.5	11,678	13.3
Parallel traffic accidents	338	13.5	13,235	15.1
Turning off accidents	332	13.3	12,904	14.7
Crossing accidents	37	1.5	1,646	1.9
Accidents involving stationary traffic	104	4.2	5,690	6.5

There are significant differences between the distribution of accident types for pedelecs and bicycles (Chi2 (6) = -0.01, $p < .01$). Most notably there are more driving accidents for pedelecs compared to bicycles. Driving accidents are accidents where the person loses control over the vehicle without other road users being responsible for it. Driving accidents are often single bicycle accidents involving only one bicycle (Table 2). Usually the bicyclist falls due to various circumstances (personal, road surface, bicycle etc.) For both pedelec and bicycles the majority of driving accidents are single accidents, but the share of single accidents is again higher for pedelecs than for bicycles (Pedelec: 91%, Bicycle: 85% of driving accidents).

For bicycle accidents there is the problem of underreporting in the police accident data. That means a considerable share of bicycle accidents is not included in official accident statistics, because they are not reported to the police (Juhra et al., 2012). That holds especially true for falls (Shinar et al., 2018). Pedelec accidents might be reported more often to the police as this is a prerequisite for insurance claims. Since pedelecs are quite pricey, pedelec cyclists might be more motivated to report a single accident to the police. However, Shinar et al. (2018) found no difference in underreporting between conventional and electrical bikes.

Accident opponents

Both, pedelec riders and bicyclists are most often involved in an accident with cars (Table 2). After that, there are single accidents. Thirdly, there were accidents with other bicyclists or pedestrians. This ranking of accident opponents corresponds with the national accident statistics and characterises bicycle as well as pedelec accidents (Federal Statistical Office, 2017).

As already noted there is a higher share of single accidents for pedelec compared to bicycle riders.

Table 2

Accident opponents by bicycle type

Accident opponent*	Pedelec accident		Bicycle accident	
	n	%	n	%
Car	1,254	51.2	51,944	63.5
Single accident	636	26.0	13,146	16.1
Bicycle	216	8.8	5,006	6.1
Pedestrian	103	4.2	4,449	5.4
Light truck	120	4.9	3,082	3.8
Other vehicles	29	1.2	1,722	2.1
Powered two-wheeler	38	1.6	1,115	1.4
Unknown	7	0.3	603	0.7
Bus	20	0.8	522	0.6
Pedelec	25	1.0	216	0.3
Total	**2,448**	**100**	**81,805**	**100**

*only up to 2 persons involved

Accident site characteristics

Most accidents occurred in urban areas for pedelecs (84%) as well as for bicycles (91%). The figures correspond quite well with the national accident statistics for 2016 where 91% of all bicycle accidents and 81% of pedelec accidents occurred in urban areas (Federal Statistical Office, 2017).

However, there is a higher share of accidents in rural areas for pedelecs compared to bicycles (16% vs. 9%; Chi2 (1) = 162.36, p < .01). That again reflects the current travel behaviour pattern of pedelec cyclists (Gehlert, 2017). Among various accident site characteristics (e.g. junction, roundabout, entry) only the characteristics describing the terrain differ between pedelec and bicycle accidents (Chi2 (7) = 153.66, p < .01). There are significantly more pedelec than bicycle accidents that occurred downhill (15% vs. 10%). Altogether there are only few accidents which occurred uphill, but again there were more pedelec than bicycle accidents that occurred uphill (3% vs. 1%).

Injury severity

Pedelec cyclists have a higher share of fatalities and severe injuries compared to bicyclists (Table 3). Taken fatalities and severe injuries together the difference amounts up to 10 percent (Chi2 (2) = 163.34, p < .01).

Since pedelec cyclists are on average older than bicyclists the higher injury severity could be also the result of the higher share of elderly within pedelec accidents. Elderly are more vulnerable and prone to more severe injuries in case of an accident compared to younger people. Therefore, we analysed the injury severity for pedelec and bicycle across different age groups (Table 4). Due the limited sample size of pedelec accidents for younger age groups and fatalities in general we collapsed fatalities and severe injuries in one category and distinguished only between younger / older people along the age median (63 years) of the pedelec cyclists. The results show that in both age groups the share of fatalities and severely injured people is higher for pedelec compared to bicycles (Chi2 (2) = 58,54, p < .01).

Table 3

Injury severity by bicycle type

	Pedelec cyclists		Bicycle cyclists	
	n	%	n	%
Fatality[a]	36	1.4	362	0.4
Severely injured[b]	688	27.6	14,976	17.1
Slightly injured[c]	1,496	60.0	53,936	61.4
Not injured	243	9.7	15,506	17.7
Unknown	32	1.3	3,020	3.4
Total	**2,495**	**100**	**87,800**	**100**

[a] all persons who died within 30 days as a consequence of the accident
[b] all persons who were immediately taken to hospital for inpatient treatment of at least 24 hours
[c] all other injured persons

Table 4

Injury severity by bicycle type and age groups

		Fatality + severely injured		Slightly injured		Not injured	
		n	%	n	%	n	%
‹ 63 years	Pedelec	291	24.6	761	64.2	133	11.2
	Bicycle	11,407	16.8	45,593	67.3	10,760	15.9
63+ years	Pedelec	433	34.3	733	58.0	97	7.7
	Bicycle	3,907	29.7	8,125	61.7	1,145	8.7

Cause of accident

A police officer records on-site the causes of accidents for each accident and each person involved, if he / she is regarded at least partly responsible. The causes of accidents are based on standardized categories. That can be accident causes related to the person (e.g. alcohol, speeding, disregard right of way), related to road conditions (e.g. icy road) or to the vehicle (e.g. brakes, lights):

- The most frequent cause of accident for pedelec and bicycle accidents is "Other mistakes made by the driver" (pedelec 35% vs. bicycle 29%). These are most often falls by the cyclists. That corresponds to the high share of driving and single accidents for pedelec and bicycle accidents.

- For pedelec accidents the second most frequent cause is "inappropriate speed in other cases" (pedelec 13% vs bicycle 8%). That means without exceeding the speed limit. That could also be at low speed. Compared to bicycle accidents, this share is about 5 percent higher for pedelec accidents.

- For bicycle accidents the second most frequent cause is "Use of wrong carriageway or unlawful use of other parts of the road" (Bicycle 16% vs. Pedelec 11%). That could be cycling against the direction of travel or cycling on the pathway or both.

Interestingly, the difference for inappropriate speed between pedelec and bicycles is higher for older age groups 65 to 74 years and above (Table 5). However, there are no definitions or benchmarks of what speed is inappropriate. It is up to the police officer on-site to decide whether or not the suspected speed was inappropriate and may have contributed to the accident. That is highly subjective. Attitudes and stereotypes may influence this decision. It could be that a police officer is a priori more likely to assume that elderly pedelec cyclists cycle too fast given their abilities compared to elderly bicyclists or younger pedelec cyclist. Unfortunately, there is no information about actual speed in the accident database to investigate this.

Table 5

Inappropriate speed as cause of accident by age group and bicycle type

Age group*	Pedelec		Bicycle		
	n	%	n	%	% +/-
...					
35–44	13	22.0	766	19.6	2.2
45–54 years	38	22.2	1,112	20.9	1.3
55–64 years	51	23.7	713	18.4	5.3
65–74 years	76	24.3	423	14.9	9.4
75+ years	50	18.2	222	9.9	8.3

* for age groups < 35 year sample size for pedelec cyclists is < 10

DISCUSSION

This paper analyses and compares a large sample of pedelec and bicycle accidents. The question is whether or not pedelec accidents differ in relevant characteristics from bicycle accidents and what the differences are.

In summary pedelec accidents are by and large similar to bicycle accidents, e.g. concerning accident type, accident opponent and the causes of accidents. Just as bicycle accidents pedelec accidents occur most frequently in urban areas while turning into a road or by crossing it and involve another car. Wrong or unlawful use of carriageway on behalf of the cyclists often contributes to the accident. Secondly, pedelec and conventional cyclists often fall with nobody else being involved. This could be due to the bad road conditions but also inappropriate cycling behaviour or cycling abilities. That means, any road safety measure improving cycling safety in general and especially in urban areas will also increase pedelec safety.

But there are also notably differences between pedelecs and bicycles. Firstly, pedelec cyclists have a higher share of driving accidents and single accidents compared to bicyclists. These are accidents, where the cyclist loses control over the bicycle without others being involved. Secondly, pedelec accidents occur more often in difficult terrain (uphill, downhill) and in rural areas compared to bicycle accidents. Thirdly and foremost, accident severity is higher for pedelec accidents compared to bicycles not only for elderly cyclists.

These results confirm by and large previous studies which mainly found higher accident severity for pedelec accidents (Scaramuzza et al., 2015, Schepers et al, 2014, Lawinger / Bastian, 2013). Like Scaramuzza et al. (2015) and Otte et al. (2014) we found a higher share of single accidents for pedelec accidents.

The reasons for these differences are yet not fully understood. It could be due to characteristics of the pedelec cyclists and / or the pedelec itself. Apparently, pedelecs appeal to a different user group with different travel behaviour characteristics compared to bicycles. Indeed, even though there is no representative travel behaviour data for pedelec so far, it seems that in Germany pedelecs are used mainly by elderly cyclist for leisure trips, among others (Gehlert, 2017).

Other results indicate that the pedelec itself could be a problem. Accident severity is higher not only for older age groups, which could be explained with their higher vulnerability. Accident severity is also higher for younger age groups. Also the fact that there are more driving accidents and accidents in difficult terrain for pedelec accidents emphasizes that controlling a pedelec in a critical cycling situation might be more difficult compared to a conventional bicycle. This could be a problem in particular for elderly pedelec cyclists, as the higher share of inappropriate speed as cause of accident suggests. Research on pedelec cyclist's speed shows that they cycle significantly faster than conventional cyclists, but the differences amounts only up to 1 to 2 km/h on average (Schleinitz / Petzoldt / Franke-Bartholdt / Krems / Gehlert, 2017). Especially elderly cyclists seem to use the motor assistance mainly for comfort rather than speeding. But nevertheless, they may cycle too fast given their ability to control the pedelec. Therefore, they may be at risk. Even though elderly cyclists are already regarded as a risk group given their increased vulnerability, so far, this group was very small. Now their numbers are increasing due to pedelecs. Therefore, they deserve special attention in traffic safety research and practice.

We conclude that pedelec safety could be enhanced by linking the motor assistance of a pedelec more closely to the manual power the cyclist is able to provide. That means the more cyclists are able to push the pedal the more motor support he / she gets. Such an assistance rate would ensure that the motor support corresponds at least to some extend with the physical abilities of the cyclist. The technical design should ensure still enough support for elderly or hilly areas. Such an assistance rate is already required for type approval for S-pedelecs.

Furthermore, training might be useful to cycle safely with a pedelec. This holds especially true, but is not limited, to elderly cyclists. Ideally such training raises awareness for the differences in bicycle dynamics between pedelecs and bicycles. It should also practices cycling / braking on higher speeds, uphill and downhill cycling. For their own safety we recommend wearing a helmet for all cyclists.

Finally, further research is needed to determine accident risks of pedelec and appropriate countermeasures.

- Even though we include a large sample of pedelec accidents for some in-depth analysis sample sizes are still too small especially because the numbers are not evenly distributes across age groups. Therefore it still needs larger sample sizes for in-depth analysis or more sophisticated statistical tools that account for this unbalance.
- It needs representative travel behaviour data to account for differences in travel behaviour patterns between pedelec and bicycle cyclists and to have exposure data to calculate accident risks.
- The underreporting of bicycle accidents in police and national accident statistics is a problem that is still not solved.
- S-pedelecs with motor assistance up to 500 Watt and 45 km/h are not widespread yet. But their accident severity might be even higher given their higher potential speeds. Also it seems they attract younger age groups.

Therefore it is necessary to continue analysing and monitoring accidents of all types of electric bicycles in the future.

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PRACTICE COMMENT

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European Cyclists' Federation (ECF)

The authors get as much as they can from the available data but still there are a lot of questions. The available data is not available enough to make specific policy proposals. Common sense tells us that infrastructure should be at its best to accommodate pedelec use, unfortunately as suggested there is not enough data to back this up with research.

There is interesting research from Schepers and others in the Netherlands, and also from TOI in Norway that show there is not a great deal of difference between bicycle and pedelec crash, fatality, or injury rates. Of course this is in countries with great infrastructure, but perhaps shows us that crashes can be better controlled with infrastructure. This is not to disregard training for cyclists but does point to improving cycling within the context of safer systems can be improved.

It was interesting in the article that accident type for cyclists uses a motor vehicle description and is not relevant for cyclists. This would seem to require an update. When the article says that "Driving accidents are accidents where the person loses control over the vehicle without other road users being responsible for it" this is then explained as a single vehicle crash, we should see whether this is an infrastructure issues or not being able to control the vehicle (bike). This would I guess be related to categorising the accident type.

It also shows that though there may be slightly higher risks for pedelec use, it is not the road safety disaster that pedelecs was expected to be. And as mentioned above it is shown that the slightly higher speeds of pedelec users can be catered for through solid infrastructure planning.

Other than that the lack of data, and lack of exposure data would be the main thing learnt. Of course we would have to look also at speed pedelecs as separate from lower powered pedelecs, I would imagine a different road safety story again.

With regards to how this can help practitioners, it shows the importance of exposure data issues, also general crash data as well as things like 'uphill' or 'downhill'; is the fact that pedelec users use different geographical areas that they are on more hills that is why they have more crashes on 'uphill' and 'downhill' etc. And of course age is still important, more elderly people "pedelecing" will mean more elderly crashes. This info is essential for added value. It seems to me that pedelec road safety is similar to cycling road safety, i.e. elderly people are most at risk, serious injuries are single bike accidents and fatalities are crashes with motor vehicles, yet without appropriate exposure data or higher granularity of data, we can't really know for sure.

It would be interesting to look at infrastructure in relation to single vehicle crashes. We often say that "... pedelec and conventional cyclists often fall with nobody else being involved" implying that it is due to human error etc. but it could also be infrastructure or behaviour of passing vehicles. In particular what improvements can we make to infrastructure, how can we better train people (other road users and riders).

As such the article creates more questions than answers (not the author's fault) and shows the paucity of data surrounding cycling and pedelec riding crash data.

Perhaps an interesting topic could be the assessment of cycling crashes at the site and how they are categorised. It seems that most on-site forms to be filled in and designed around motor vehicle crashes and are not as relevant for cyclist or pedestrian crashes. How would a police officer determine "Use of wrong carriageway or unlawful use of other parts of the road" if he/she does not know how a cyclist interprets the road? How would inappropriate speed be interpreted in respect to single bicycle/pedelec crashes? How would 'correct' speed be determined?

Understanding single vehicle crashes properly would be a really useful addition. Rider behaviour, infrastructure, or interaction with other road users, how this changes with pedelec use. Particularly relevant for pedelec use. Increased serious injuries for elderly pedelec users, is this an issue of reduced reactions and reduced riding ability or frailer bodies being more prone to injury. If it is the second then there may not be more crashes but more injuries. All of which suggest further research needs of course.

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2.4 Policies for promoting cycling

Practice

CicloviaSP – Promoting a sustainable bicycle program in São Paulo city

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Research

Impact evaluation of cycling measures – exploring the state-of-practice in German municipalities

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Expert Comment

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PRACTICE

CicloviaSP – Promoting a sustainable bicycle program in São Paulo city

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ABSTRACT

São Paulo is a city of 12 million people and the most populous municipality of Brazil. It is also the main financial, corporate and commercial centre of South America. In 2013 São Paulo developed the Strategic Master Plan, and in 2015 the Mobility Plan. The main elements of these are the Mass Transport Policy with the implementation of a Bus Rapid Transit and the deployment of a cycle system. This involves the creation of 400 km (248 miles) of bike lanes by 2016. Before this policy was put into practice, São Paulo had just 63 km (40 miles) of bike lanes. After the implementation of the plan, the city had increased these to more than 400 km (248 miles) in 2016 as well as enabling intermodality at subway, train and bus stations. The program also included new bicycle parking in all bus terminals and 2,500 new bike parking racks along the bicycle lanes. Other additional measures were rolled out during the program, such as adapting old bridges to bicycle traffic, and constructing new bridges that contained bicycle lanes and pedestrian walks.

It was a bold goal, which was achieved by the Transportation Secretary of São Paulo. The program was put into practice with the help of social participation, including hundreds of people in the process. The Mobility Plan sets the city the target of building a network of 1,600 km (995 miles) of bike lanes by 2030.

Keywords: Strategic Master Plan – Mobility Plan – bike lanes – bicycle parking

INTRODUCTION

São Paulo is a city of 12 million inhabitants and is the largest municipality of Brazil. It is also the main financial, corporate and commercial centre of South America. Its territory covers 1,530 square meters, and the vehicular fleet is approximately 8 million cars. Like most major cities, transport policy had been prioritizing individual motorized vehicles over the last 30 years.

In 2012, the National Law of Urban Mobility Policy was passed. It defined a new perspective on urban mobility, establishing hierarchies among different modes of transport. It also established a prioritization concept of Public Policies for investments in active mobility and public modes of transport. Likewise, the Law of the Strategic Master Plan of the Municipality of São Paulo in 2014, which guides the development and growth of the city by 2030, also established the prioritization of pedestrians, cyclists and users of public transport.

In this context, the planning of the Cycle System of the Municipality of São Paulo was designed to encourage the use of bicycles as a means of transportation in the city. It did so by integrating bicycle parking and bike sharing into the urban transport in-

frastructure: The city had only 68 km of bicycle lanes in 2013. It implemented another 400 km of infrastructure and more than 2500 bike racks in all regions of the city. This implementation was accompanied by the consolidation of the Cycle System in line with the Urban Mobility Plan of the Municipality, which had been prepared in an integrated and participatory manner and was finalized in 2016.

CICLOVIASP PROGRAM

CicloviaSP Program was conceived on the basis of the São Paulo Municipality's Plan of Goals. It proposed the construction of 400 kilometres of cycle paths within the city's road structure, consolidating the first stage of the Structured Cycle Network in São Paulo. This structured network, when completed, will total more than 1,600 km of infrastructure in the city, connecting the city centre with the city outskirts, throughout the territory of the Municipality. Therefore, the creation of 400 kilometres of bike lanes was a fundamental step in this process, making cycling safer and more attractive.

HISTORY OF PLANNING THE CYCLE NETWORK IN SÃO PAULO

The objective of the historical survey was to assess existing studies. It took almost six months to collect texts, maps and tables, which were then systematized and geo-referenced to organize the information.

There are studies on cycling infrastructure inclusion in the city going back to the 1980s but the findings of the studies had not been implemented. In 1981, the first Bicycle Cycle Plan was drawn up in the city, envisaging a network of 185 km in length. It included cycling infrastructure as part of the existing roads and new road openings, but the plan was not implemented.

In 1994, a new Cycle Plan was drawn up under the "Cyclist Project" program, comprising 110 km in length, part of which had already been envisaged in the 1981 plan. Some projects were developed and implemented, but since there was no continuity in the implementation process, many bicycle paths ended up turning onto sidewalks.

In 2004, during the process of drawing up the Strategic Regional Plans coordinated by 32 regional administrations, 105 km of cycling infrastructure in the city were proposed. However, here the concept of an actual Structured Network as foreseen in the previous plans was already being weakened.

This background served as a reference for the consideration of a Cycle Plan proposal, which contained a Structured Network with several links, in order to allow the effective inclusion of the bicycle mode in the city.

Based on the analysis of these past studies, our Traffic Engineering Company defined a planning strategy to consolidate concepts, produce guidelines and define actions, aiming to establish structural cycle planning for the city.

Figure 1

Map of interventions proposed in the 1981, 1994 and 2004 plans

Cycle Plan 1981 Cycle Plan 1994
Cycle Plan 2004

Source: Own illustration

PLANNING THE CYCLE SYSTEM

CicloviaSP Program started with the aim to consolidate the Cycle System, beginning by defining guidelines to steer the development of the proposals.

1. Cycle System Guidelines

To define the component elements of the Cycle System, it was decided to initially analyse legislation in force, any data already being collected and analysed as well as existing cycle network proposals and case studies.

In the beginning activities focused on the proposal of the Cycle Framework Network due to the greater amount of data on the topic.

1.1 Cycle Structural Network Guidelines

This aforementioned analysis indicated the need to establish guidelines for consolidating the Cycle Structural Network and for future interventions. The resulting guidelines adopted were:

- **Perimetric and radial connections:** the establishing of a structural bicycle network, which is composed of radial road structures, that is, connecting the centre to the neighbourhoods and perimeters, which form the connections between the radial axes.

- **Route connectivity:** cycling routes must connect travel destinations, so the cyclist can make efficient use of the network. The connection points function as path integration nodes, allowing the user to plan their journey in the way that suits them best.

- **Linearity:** the shortest distance in the user's journey. The definition of routes with greater attractiveness to the bicycle will be considered from the point of view of cyclists, regardless of the travel direction of the other transport modes.

- **Intermodality:** connection with the terminals and public transport stations and their nodal points, particularly through the implementation of bicycle parking in these places, as well as measures that enable transporting bicycles on public transport;

- **Functionality:** propose the infrastructure for the places of interest for commerce, services, schools, among others

1.2 Bicycle Parking Guidelines

Since the bicycle parking policy included the setting up of bicycle parking facilities and bicycle racks, the Traffic Engineering Company was planning to implement bike racks along the Cycle Structural Network. The establishment of bicycle parking facilities was being planned for areas of greater demand by users, associated with main shopping facilities.

To ensure the standardization of the model and the installation of the bicycle racks, our company prepared the "Installation Manual for Bicycle Racks in the City of São Paulo".

2. Elaboration of the Proposal for a Cycle System in the Mobility Plan

The preparation of the São Paulo Mobility Plan – PlanMob/SP began in August 2014 with an Intersecretarial Working Group constituted in the Municipality of São Paulo with representatives of different municipal secretariats. PlanMob/SP is the technical reference and strategic proposal that aims to create the Urban Mobility System.

2.1 Legal Background

The Strategic Master Plan of São Paulo – PDE, Law No. 16.050/2014, created the need for a Mobility Plan for the Municipality of São Paulo. This is in compliance with Federal Law No. 12,587/2012 which establishes the National Urban Mobility Policy, PNMU. The PDE 2014 calls for a Cycle System for the city. A base document on bicycle use was to be developed which could be integrated into the Mobility Plan. This would eventually help to establish technical parameters for a Cycle System.

2.2 Cycle Structural Network in Mobility Plan

The Cycle Structural Network must cover the whole municipality, allowing the safe movement of cyclists throughout all regions of the municipality. It should enable everyone to use a bicycle as a mean of transportation, thereby promoting sustainable transport in the city. Tackling points of conflict between different transport modalities became an essential part of the implementation of this network. Only through the

continuity of the network can a novice cyclist feel safe to move around the city in a different way than they are used to.

Identifying the desired routes and potential points of conflict of cyclists with the other modes of transport was the most difficult task for deciding on any new routes to be developed. It was crucial to read the urban tissue with special regard to road classification, topography, traffic and the location of points of interest as they all influence the proposal of the cycle network. Where there is a road hierarchy, the urban tissue generally reflects greater urban organization. In these places points of interest usually occur cumulatively and the topography is generally the most suitable for active mobility.

A network of hire bicycles also needs to cover the entire municipality, integrated into the public transport network.

The proposal of several components for the Cycle Network reference map followed these premises:

- 1. Key roads of the municipality (Rapid Trans Routes, Arterials and Collectors routes) must have sufficient space that can be segregated for active mobility modes as well as suitable speed limits.
- 2. Roads to be opened or redesigned shall include improvements for cyclists. For this reason all proposals referring to bus corridors must include cycle space.
- 3. Bridges and viaducts must be designed for the use of cycles. Pedestrian crossings need to be compatible with bicycle infrastructure.
- 4. Introduction of suitable speed limits for motorized traffic on roads that will be equipped with cycling infrastructure.

2.3 Social Participation in the development of the Mobility Plan

Social participation was institutionalized through Municipal Decree 58.058/13, which created the Municipal Transport and Traffic Council (CMTT). In 2015, the composition of the Thematic Chamber of Bicycles was formalized with 22 representatives. This organization made it possible to maintain an integrated work routine, both for discussions regarding the development of the bicycle road network, and for other guidelines on bicycle usage, as well as for the follow-up of bicycle planning actions. In addition to the bimonthly general meetings with all the representatives of the Chamber, several meetings were held, with the aim to discuss cycling interventions in various regions of the city and to analyse territorial structures and assessments.

The base document developed was submitted to the members of the Thematic Chamber and made available on the internet to raise public awareness and invite contributions. This consultation ran for 60 days, ending on April 17, 2015.

At the meeting of the Thematic Chamber on 1 April 2015, the bicycle-relevant sections in the basic text of the Mobility Plan were presented and discussed. Then sectoral meetings were held with members of the Thematic Chamber and other people, who had been specifically invited due to their local knowledge and experience with the aim for them to get to know the proposals, to express their opinions and to present their own proposals for the Reference Cycle Network in their region.

Meetings with members of the Thematic Chamber of Bicycles (April/15) (© Suzana Nogueira)

This public hearing was made public, among other channels through posters which also announced the possibility for people to participate via the internet.

The presentation of the proposals and final discussion took place during the public presentation of the Mobility Plan on April 11, 2015. This included a presentation on the contents and a discussion of the themes on the bicycle sections of the Plan. Further, a workshop was proposed to suggest new routes for analysis.

The presentation on cycling was attended by people from all regions of the city. Above, the image on the left shows the presentation of specific proposals for the bicycle sector. In the image on the right, people can be seen discussing the maps that showed the proposed structural network of reference. People present could also include their own proposals.

PROJECTS DEVELOPMENT

Before starting the development of the projects, a fundamental guideline was developed: the Manual of Urban Signaling – Volume 13 – Cycle Spaces, available at www.cetsp.com.br/media/392076/msu-vol13_espacocicloviario.pdf. This guideline standardizes concepts and solutions for the development of the projects. It was much needed as a standardization manual since the existing authorities had not solved existing diversities in the São Paulo City road system. At the end of this process more than 1,300 projects had been elaborated, covering all regions of the city. Currently, the Manual is being used as a reference for the development of a set of nation-wide cycling projects.

IMPLEMENTATION PROCESS

Being a great innovative project the bicycle signage process was being perfected throughout the project. In the beginning of the deployment process there were few material choices for many different uses. Initially, cold paint deployments were used which presented a lower cost but also a lower durability option. It was agreed that pioneering solutions in cycling signaling would be acceptable, even though there was little knowledge on their cost-effectiveness. During the implementation process the methods were improved by using materials of greater durability, adopting new types, such as hot spray, plastic methacrylate and film. These experiments demonstrated greater durability for certain types of materials in relation to their use, which then were adopted for the new bicycle interventions. As for the amendment of actual infrastructure, pigmented concrete and pigmented asphalt techniques were used. They were found to be great implementation solutions, even though they came at a higher cost than pioneering bicycle signaling applied in the past.

1. Paulista avenue bicycle lane

Constructing a bicycle lane on the city's most famous avenue was a goal that required meticulous studies, aiming to deliver benefits to all people who use the avenue. This is because the technicians had to consider the whole context of the avenue, including subway and bus lines and more than a dozen health and care centres, with the added difficulty that the bicycle lane construction was not to lead to the removal of existing lanes or reduced pedestrian space.

In all of its 2.7 km of length, the central bed of the avenue was extended, also guaranteeing the improvement of space for pedestrian traffic. The width was increased by approximately 4 meters throughout, increasing capacity and providing greater security. At road crossings the lane level is similar to that of the street to facilitate the movement of persons with reduced mobility. The installation of ducts for fibre optic connections and cabling also allowed the setting up of speed surveillance radars in the avenue. To begin with people had assumed that the bicycle path would lead to reduced safety. However to the contrary all of these measures have created the certainty that pedestrians, cyclists, drivers and bus passengers will be safer here than before.

Picture 3 – Paulista's bicycle lane inauguration (© Carlos Alckmin)

2. Cycle infrastructures on bridges and viaducts

The bridges are elements of road structure that cross the main rivers of the city of São Paulo, the rivers Pinheiros and Tietê. To connect the districts with the most central regions of the city, interventions were carried out on 12 existing bridges. A bridge with a designated pedestrian and bicycle lane was built and the implementation of exclusive bridges for pedestrians and cyclists begun.

The below image illustrates one example of a viaduct that was suitable for inclusion of a bike path.

Below is a photo of the new Laguna Bridge, whose design was already conceived with the implementation of a bike path in mind.

Picture 4 – Photo of the Antarctic viaduct – before and after the intervention (© Google Earth (access on 10/11/2016))

Picture 5 – Aerial photo of Laguna Bridge (© Municipal Communication Secretary)

3. Implementation of bicycle parking

In the years 2015 and 2016, 2,500 bicycle racks were installed along the Cycle Structural Network to offer parking spaces to cyclists. Also, two municipal bicycle parking buildings were built in places with high numbers of cyclists to meet the demand in main areas of the commerce and services sectors. At the bicycle parking Largo da Batata in the Pinheiros neighbourhood there are 100 places that are free of charge 24 hours a day. This place was inaugurated in August 2014 and is next to the Faria Lima subway station facilitating modal integration with public transport.

In addition, adequate and safe parking are essential for the integration of the Cycle Network and the implementation of an effective intermodality policy, integrating non-motorized transport with public high-capacity transport. These measures offer attractive conditions for citizens of all regions of the city to adopt the bicycle as a means of transport, at least for one part of their journey.

Picture 6 – Bicycle racks at a cultural centre and on the street (© Suzana Nogueira)

SOCIAL MOVEMENTS IN THE IMPLEMENTATION PROCESS

The implementation of the Cycle Structure in the Municipality of São Paulo was not easy. There were many difficulties throughout the process in different segments, mostly due to the “loss of car space”. Thus, various municipalities, associations, councilors, the State Public Prosecutor’s Office and the Municipal Court of Audit were constantly making inquiries. The discussions included the parking spaces for private vehicles, the relocation of taxis stops, loading and unloading areas and other existing uses of private and public interest. The legal explanation of the Plan of Goals, Public Policy and the need to guarantee the safety of cyclists remained in the background, always motivated by the preservation of privileges for individual motorists. This brings to light issues already overcome, such as preservation of fluidity and guarantee of public spaces.

Also during the process, cyclists participated in several acts defending and demanding the continued implementation of cycle structures. The greatest campaign occurred on Avenida Paulista in 2015 when more than 7,000 cyclists participated in a “critical mass” demonstration demanding the implementation of more cycle structures.

Picture 7 – Bicycle parking in Pinheiros neighbourhood (© Secretary of Urban Management)

Picture 8 – Critical mass in Paulista Avenue to improve bicycle lanes in São Paulo (© Alex Gomes)

CONCLUSIONS

The involvement of public stakeholders in the planning process was crucial in the development of a Cycle Structural Network for the Municipality of São Paulo, and it had fundamental importance for the acceptance by all stakeholders involved.

It was also evident that there is a need to reorganize the city for public and active modes of transport, in order to optimize the use of public spaces, and to promote the recovery of spaces for people. This is often to the detriment of space used by motorized vehicles, but it increases bicycle usage and promotes sustainable transport in the city. Everyone wants a better city to live in, to raise children in, so it is very important to understand that urban mobility changes improve public and active modes of transport and could be very important to everyone.

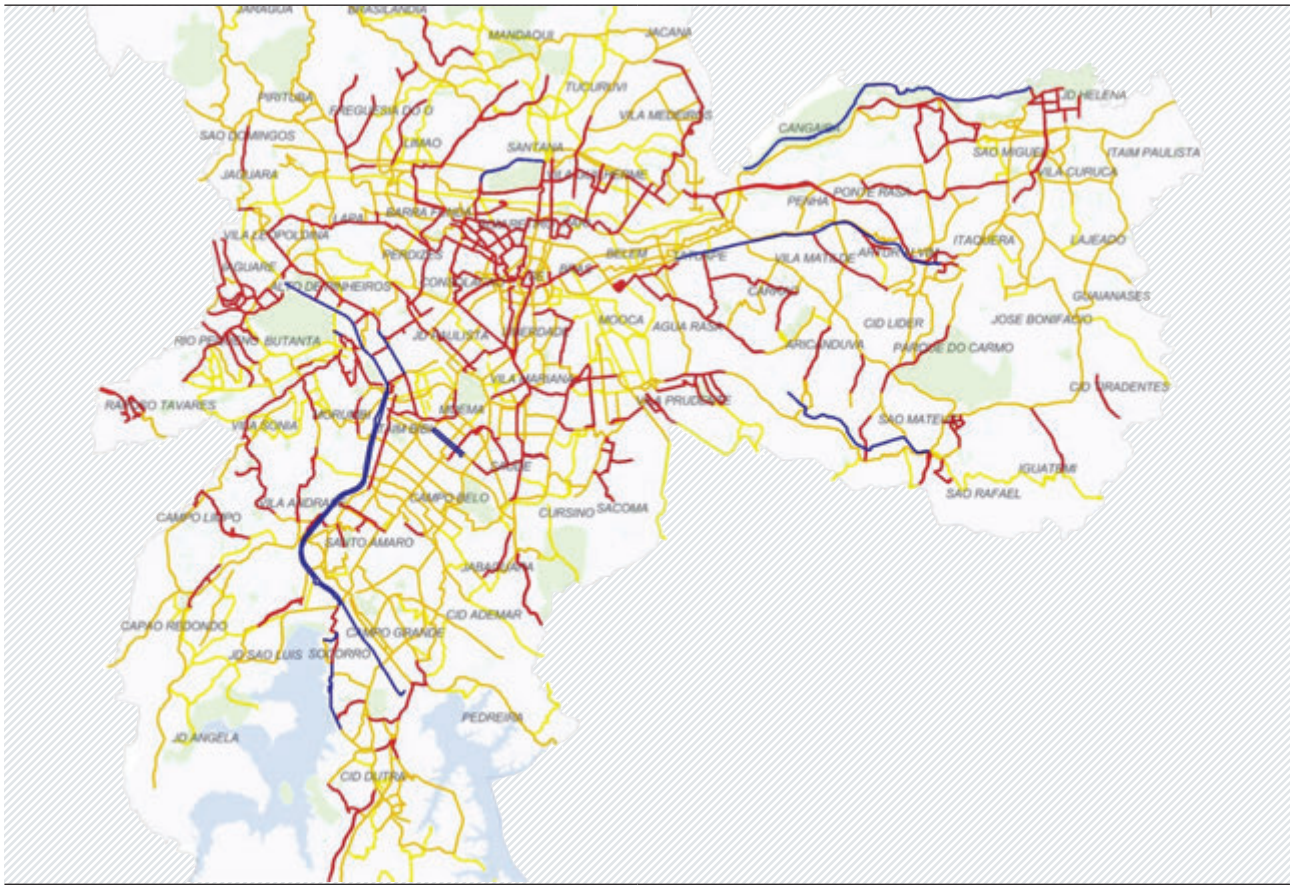
Dialogue is an important strategy for public policy making, so the process not only brings learning but shows how social participation can be improved. It is also fundamental to consider and implement control mechanisms so that the process is continuous.

The final product of the process, contained in the Urban Mobility Plan, specifically with regard to the bicycle system, allows others to learn from this development of a Cycle System in the city. In that way it can function as a tool for the expansion and management of cycle networks elsewhere, as well as a reorientation of the urbanization model and transport paradigm in cities.

When analysing the network currently in place, and the network as envisaged in the Mobility Plan, we can observe the existing coverage throughout the territory, consolidating the first stage of the Cycle Structural Network.

Figure 9

Cycle Infrastructure – Reference Network PlanMob until 2030



Bycicle Structure – until 2013 Bycicle Structure Planned – 2016 Bycicle Structure Planned – 2024
Bycicle Structure Planned – 2030

Source: Own illustration

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RESEARCH

Impact evaluation of cycling measures – exploring the state-of-practice in German municipalities

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ABSTRACT

This article explores the current state-of-practice of data collection and evaluation of cycling measures in German cities. It is based on the results of two online surveys among municipal cycling commissioners and traffic planners. Presenting the survey results, this article explores the evaluation needs as seen by cycling commissioners such as measures and impacts of interest, reasons for the current lack of evaluations and resources and data needed in order to encourage future evaluations.

Finally, conclusions are derived regarding the current gaps in cycling-specific evaluation practice. This allows determining the future need for action for municipalities as well as for national politics and the scientific community.

Keywords: impact evaluation, monitoring, evaluation experiences, evaluation needs, evaluation research, data collection

INTRODUCTION

Cycling is generally promoted as an environmentally friendly, inexpensive and socially inclusive means of transport (DStGB et al. 2016; Litman 2017; Umweltbundesamt 2016).

However, impacts of cycling measures have seldom been evaluated empirically in the past. Meanwhile the interest in evaluating transport related measures is rising. In times of financial scarcity, many municipalities are interested in assessing the effectiveness of implemented projects. At the same time, the funding of infrastructure and other measures has been increasingly linked to the development and implementation of a suitable impact evaluation concept.

With this in mind, this article explores the current state-of-practice for impact evaluations of cycling measures in German cities. It is based on the results of two online surveys among municipal cycling commissioners, which have been carried out within two ongoing research projects "RADeval" and "Municipal Bicycle Reports".

We structured the article as follows: first, we give a short overview on the existing literature and introduce the survey methodology. Afterwards, the main results of both surveys are presented. Based on these surveys, conclusions are derived regarding the current gaps in cycling-specific evaluation practice.

LITERATURE REVIEW: STATE OF IMPACT EVALUATION AND BEST-PRACTICE EXAMPLES

A number of reviews confirm a positive impact of cycling promotion measures on the level of cycling and then again of cycling in turn on health and sometimes CO_2-emissions (e. g. Pucher et al. 2010; Buehler et al. 2016; Yang et al. 2010; Stewart et al. 2015, Scheepers et al. 2014; de Nazelle et al. 2011). However, these reviews also state "most studies fall short of the ideal research design for evaluating interventions". (Pucher et al. 2010, 121)

Studies often do not include relevant control groups and/or suffer from high rates of loss to follow-up. (Stewart et al. 2015, 8) For this reason, we still do not have much scientifically sound empirical evidence of the positive impacts of cycling measures. This applies in particular to the evidence of behavioural change and the choice of different transport modes (modal shift). (Scheepers et al. 2014)

Nonetheless, methodologically sound evaluation projects can also be found, which may serve as benchmark for future cycling-evaluation projects. A number of evaluation studies have been conducted as part of American and especially British cycling-specific funding programmes. Worth mentioning here are in particular the US American "Non-motorized Transportation Pilot Program" (U.S. Federal Highway Administration 2012) and the two British funding schemes "Cycling Demonstration Town Investment Programme" (Cope et al. 2009) and "Local Sustainable Transport Fund" (UK)(DfT UK 2017).

Another example is the iConnect study, which collected quantitative data on infrastructure perception and use once before and twice after the implementation of cycling infrastructure measures in Southampton, Cardiff and Kenilworth. The counterfactual scenario was constructed based on different exposure levels depending on the distance to the intervention location. Among others, advanced statistical analysis was used to evaluate the physical activity and carbon impacts of the cycling interventions. Besides, supporting factors influencing the use of cycling infrastructure and possible pathways to behavioural change have been analysed. (Ogilvie et al. 2011; Ogilvie et al. 2012; Goodman et al. 2014; Brand et al. 2014; Song et al. 2017; Panter et al. 2015; Panter et al. 2017)

Finally, a similar approach was used to evaluate the transport, health and economic impacts of new cycling infrastructure in Sidney. Again, the necessary data was collected from a study group living within two kilometres of the new bicycle path and an unaffected control group once before and twice after measure implementation. (Rissel et al. 2013; Rissel et al. 2015)

Overall, these evaluation studies can serve as best practice examples of scientifically grounded impact evaluations with the strong additional aim of generating new knowledge e. g. on how exactly an observed outcome can be achieved. However, municipality-led evaluations will not focus so much on improving the available knowledge base in a scientific way, but rather on being able to report their stakeholders and the general public quantitative numbers e. g. on changes in daily bicycle traffic. But even so, the barriers for conducting meaningful impact evaluations are high. This makes it inevitable to support (municipal) cycling commissioners in the process of planning and executing cycling-specific impact evaluations. Within the literature, some handbooks and manuals could be identified which offer such support. Most publications address the evaluation of transportation projects more generally (Forschungsgesellschaft für Straßen- und Verkehrswesen 2012; Dziekan 2013). Some guidelines even focus partly on the specific evaluation of cycling measures (Hoogzaad, et al. 2013; Litman 2017).

However, these guidelines are rather general in nature and do e. g. not include recommendations differentiated for specific types of measures. In the same way, a collection of sound case studies is still missing. Filling those gaps can help to enable municipalities conducting their own professionally grounded evaluation projects.

STUDY METHODOLOGY

The results presented in this article are based on data collected with the help of two online surveys. The first survey (called data availability survey in the following) focussed on cycling-specific data needs, data availability and data quality in German municipalities, while the second survey (called evaluation survey) concentrated on the current cycling-specific evaluation practice within municipal administrations. Municipalities could participate in the data availability survey between November 2015 and April 2016. The survey period for the evaluation survey was between September and October 2016.

Participants

Target group of the surveys were municipal employees responsible for bicycle traffic. Often, this would be a dedicated municipal cycling commissioner. In smaller municipalities, however, this could also be the (only) traffic planner, a staff member of the regional development department or in very rare cases even the mayor. Overall, responses from 120 municipalities and five districts in the case of the data availability survey and from 155 municipalities in the case of the evaluation survey could be used in the data analysis.

Regarding their geographic location, responses from municipalities with more than 50 000 inhabitants showed a reasonably representative distribution in both surveys. However, responses from municipalities with less than 50 000 inhabitants showed a strong geographic bias towards the federal state of Saxony in the evaluation survey as well as to a lesser extent towards the federal state of Brandenburg in the data availability survey. Thus, results obtained for small municipalities are less representative for Germany as a whole. However, since small municipalities in general struggle with a lack of cycling-specific personnel resources, few financial resources and a small area of responsibility when it comes to infrastructure planning, we believe that we can show the main tendencies for smaller municipalities though we do not reach good overall representation for this size class in our sample.

Instruments

The data availability survey focussed mainly on the collection of information about what kind of data already exists and what kind of data is needed from a municipality perspective in order to be able to assess and monitor the development of bicycle traffic. The set of questions was deduced from a content analysis of existing municipal bicycle reports as well as from a literature review on impact analysis for cycling.

The questionnaire collects data about the financial budget dedicated for cycling as well as the availability of staff engaged in cycling within the city administration. Additionally, the questionnaire focusses on the availability of traffic related data concerning e. g. the quantity and quality of cycling infrastructure and parking facilities as well as behavioural data about bicycle usage such as modal split values and regular bicycle counts.

The evaluation survey collected data on the common evaluation practices in municipalities. We asked about experiences in evaluating cycling measures and if such evaluations are planned or at least desired. Furthermore, we asked how important it would be for participants to have more information on 18 potential impacts of cycling measures. The list of potential impacts was also derived from the literature review and grouped into the categories transport, environment, economy and society. The second part ended with the question about the main evaluation barriers in practice.

RESULTS

Data availability

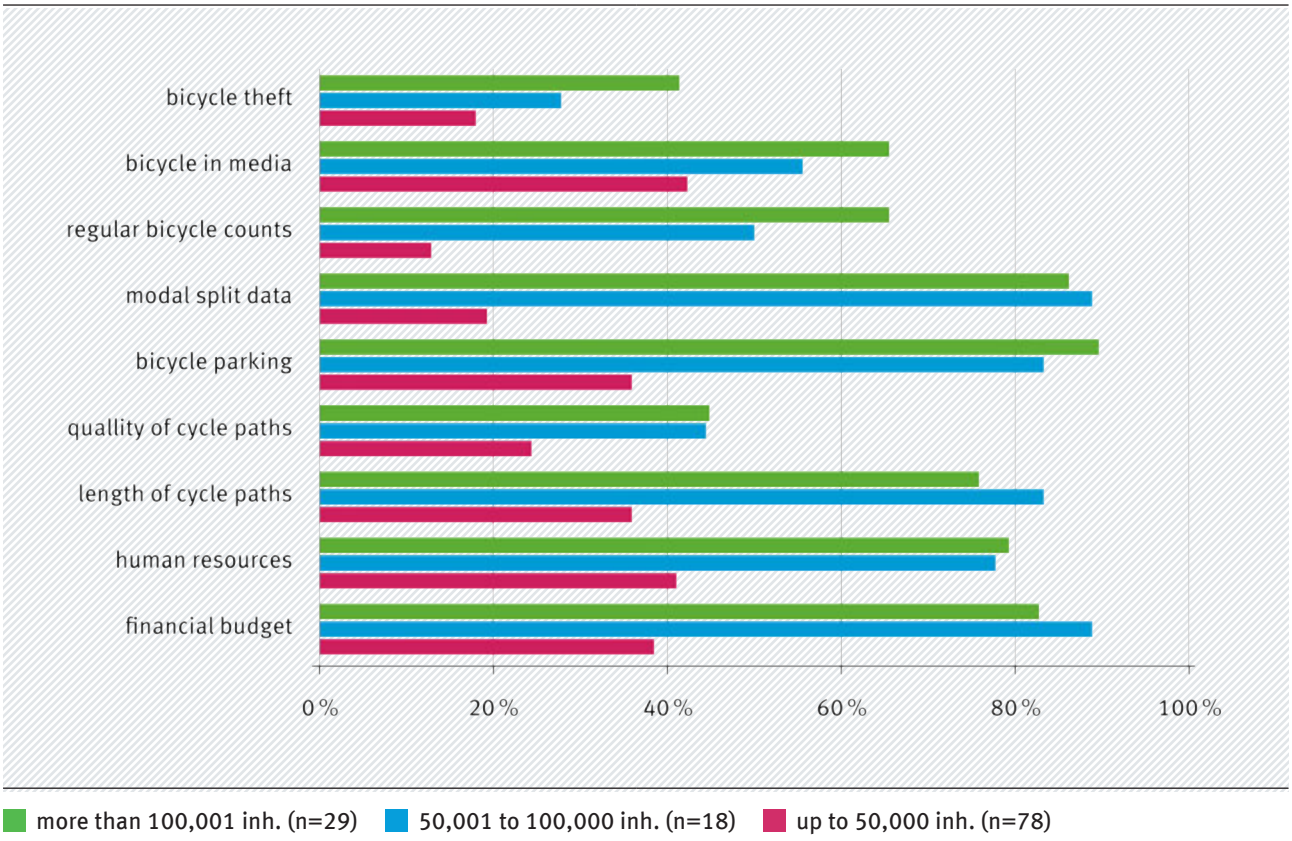
Availability of regularly collected data is essential for monitoring the overall development of bicycle transport in municipalities. Furthermore, data available for long time series allows assessing the joint impacts of municipal cycling promotion more precisely. Last, but not least, experiences with the collection, processing and analysis of cycling data can be seen as an important base for methodologically sound evaluation projects. Additionally, regularly collected data itself might help to keep evaluation costs at a reasonable level. The data availability survey therefore analyses the question to what extend municipalities collect data for monitoring purposes. This gives insight into the ability of municipalities to evaluate the overall development of bicycle transport and to provide necessary background data for measure-specific impact evaluations.

Figure 1 shows the percentage of municipalities in the survey for which bicycle related data in different fields is available. As one can see, municipal data availability depends on the size of the municipalities and on the kind of data. While in larger cities data is often available for a number of cycling-related topics, data is generally seldom available in small municipalities.

Analysing the individual answers of each municipality, we had expected to find a considerable number of municipalities with a systematic and comprehensive approach in data collection while other municipalities – especially the smaller ones – leave out the more specialized topics and the data difficult to obtain. However, we did not find such a pattern. In fact, a systematic approach for data collection seems to exist very seldom.

Figure 1

Data availability survey: percentage of cities and towns with availability of bicycle related data (n = 125)



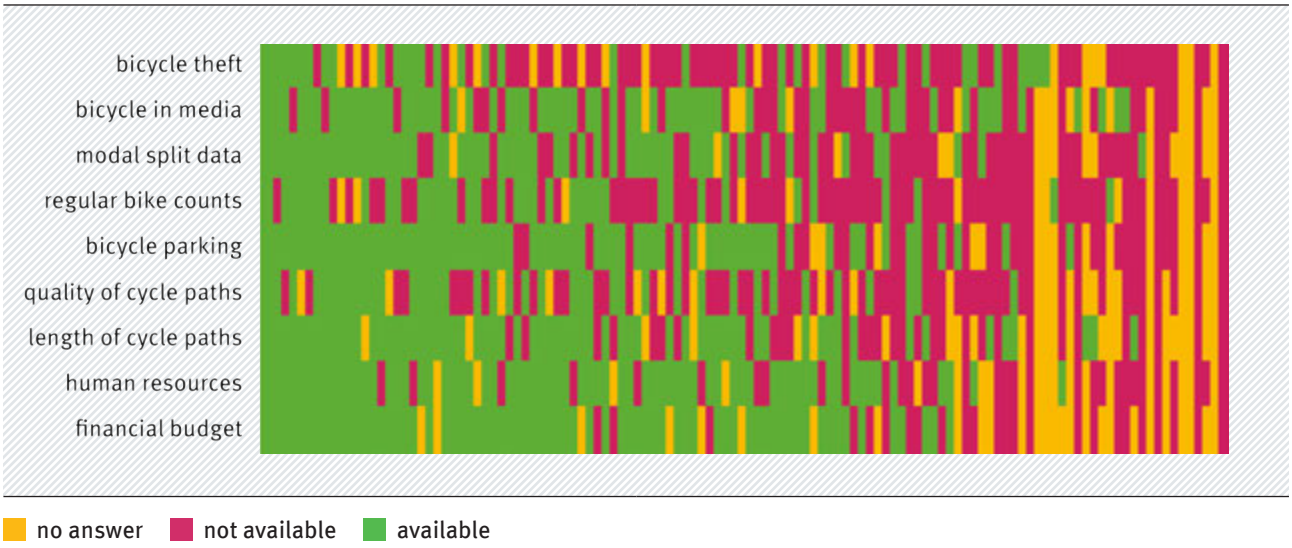
Source: Own illustration, TU Dresden

Figure 2 shows the individual answers of the 125 participating municipalities and districts concerning data availability. Each column defines the answers of one municipality. Only two municipalities stated availability of data in each of the nine topics. For the remaining municipalities no distinctive pattern of data collection priority can be recognized.

As Figure 3 shows, it can be said that even the availability of regular bicycle count data is not ubiquitous yet. Permanent automatic counting stations are available only in half of the larger cities and less than 10 % in the other municipalities. Most smaller and medium-sized municipalities conduct only irregular bicycle counts which lead to a very poor data base for long-term monitoring and evaluation.

Figure 2

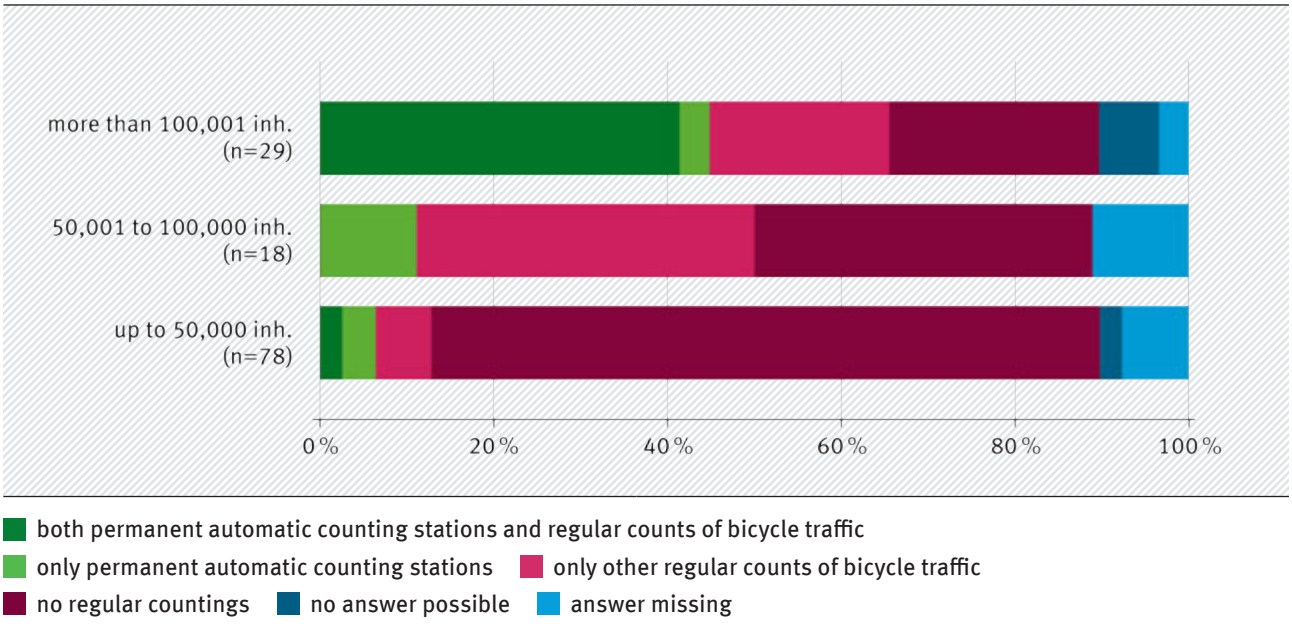
Data availability survey: individual answers of the participating municipalities concerning availability of bicycle related data sorted by decreasing number of inhabitants (n=125)



Source: Own illustration, TU Dresden

Figure 3

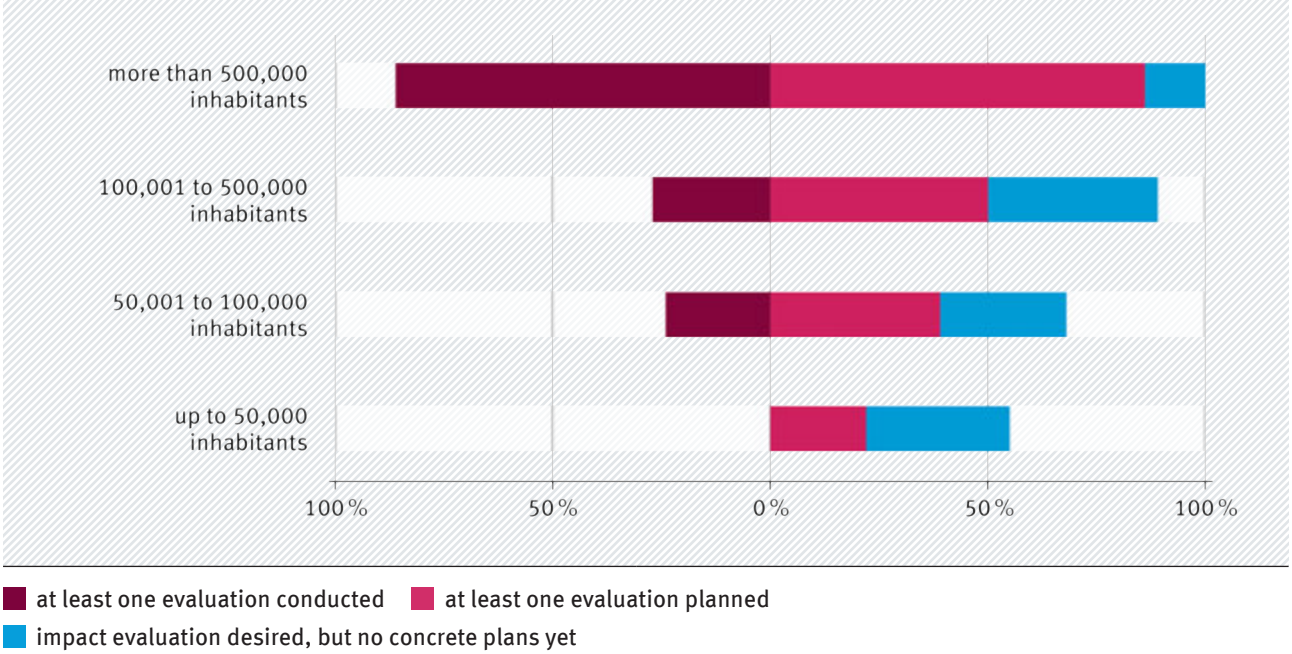
Availability of regular bicycle counts (n=125)



Source: Own illustration, TU Dresden

Figure 4

Percentage of municipalities with impact evaluation experiences or impact evaluation plans by size class (n = 155)



Source: Own illustration, TU Dresden

Evaluation experiences and future importance of the topic

Until present, German municipalities very seldom monitor the impacts of the cycling measures conducted. Figure 4 shows that evaluation experience is clearly related to the size of the municipalities, with bigger municipalities implementing more measures to promote cycling (in absolute numbers) and having more resources available for engaging in impact evaluations.

But Figure 4 also shows that the interest in evaluating the impacts of cycling measures will increase in future. Around 40 % of the municipalities with less than 100 000 inhabitants plan to engage in evaluating cycling measures for the first time, as well as half of the municipalities with more than 100 000 and less than 500 000 inhabitants. For those municipalities, practical guidance on how to conduct impact evaluations and how to avoid typical pitfalls may ease the transition toward a better evaluation culture in bicycle planning.

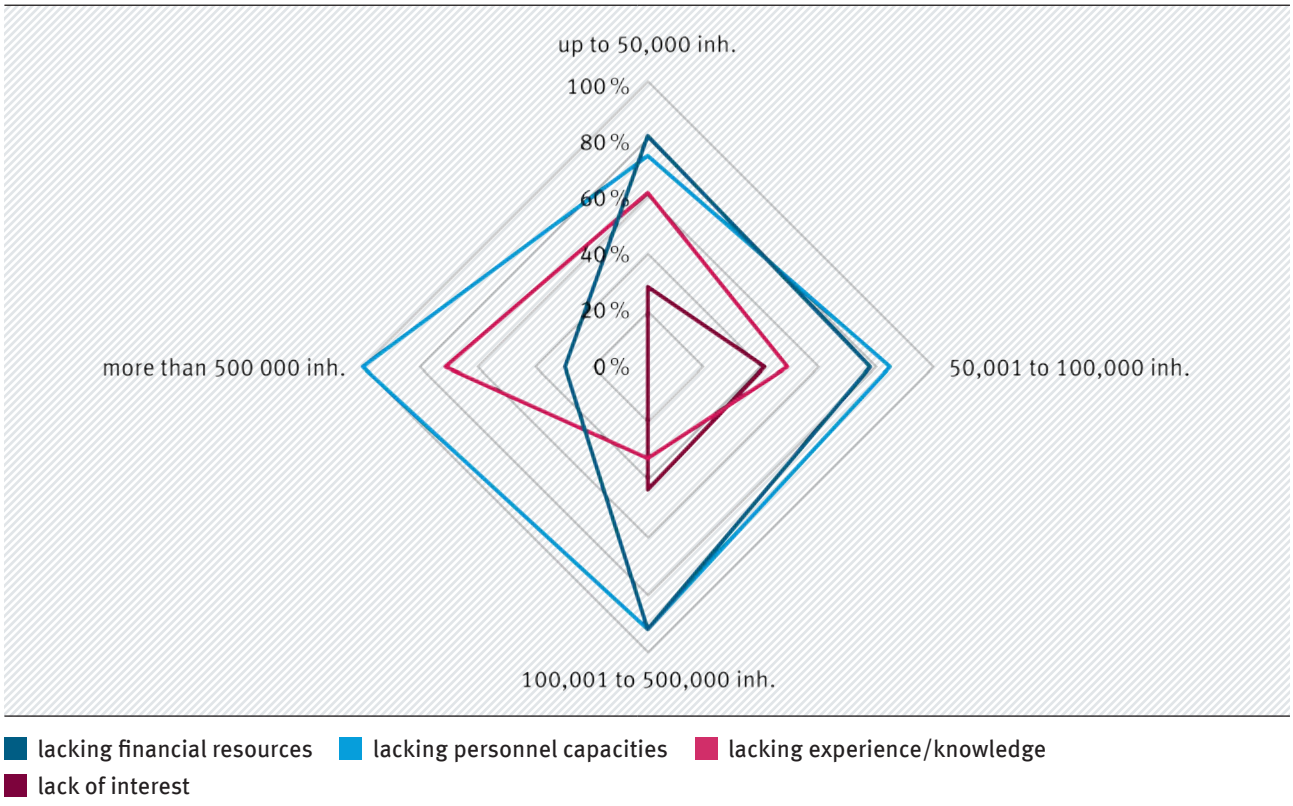
Evaluated cycling measures and future evaluation interests

Municipalities already engaged in cycling-specific impact evaluations typically provided more than one exemplary evaluation project. In total, we identified 50 examples of previous evaluations of cycling measures conducted from 26 municipalities within the sample. From those, 37 referred to specific measures. In 13 evaluation projects, the municipalities stated general monitoring activities such as undertaking household travel surveys, installing automated counting devices or conducting policy audits (BYPAD) as examples.

Approximately one-third of the named examples aimed at evaluating the impacts of infrastructure measures (such as bike lanes), mainly through "simple" counting the number of cyclists before and after implementation (16 projects). In addition, municipalities evaluated the impacts of regulatory measures to make roadways more cycling-friendly, such as the establishment of cycling boulevards (10 projects). Although many municipalities engage in publicity campaigns and the construction of bicycle parking facilities, these measures are evaluated less frequently (6, respectively 5 projects).

Figure 5

Percentage of municipalities in size class, which stated the named reason for not conducting cycling-specific impact evaluations (n = 155)



Own illustration, TU Dresden

In the future, municipalities are likely to continue to focus on evaluations of infrastructure measures. Evaluations are planned for innovative and in Germany still uncommon measures, such as the establishment of cycle highways or shared bike lanes. Besides, municipalities naturally concentrate on larger infrastructure improvements, e. g. the construction of bikeways and bicycle parking facilities.

Perceived barriers for impact evaluations and evaluation interests

Within the survey, we asked why municipalities so seldom evaluate their cycling measures. Independently of their size, municipalities most frequently stated a lack of personnel capacity as reason. For municipalities with less than 500 000 inhabitants, lacking financial resources seem to be of similar importance. For big cities, financial restrictions are less important. A lack of experience, respectively knowledge is another relevant reason stated by approximately half of all municipalities in the sample. Fewer municipalities seem to deal with a lack of interest from local politicians or decision-makers. (see Figure 5)

Nevertheless, German municipalities are in general interested in getting to know the effects of their efforts to enhance cycling conditions. Within the evaluation survey, we asked the municipalities, how important it would be for them to know the transportation-related, environmental, economic and social impacts of their local cycling measures.

Municipalities are especially interested in evaluating the impacts of cycling measures on the number of cyclists, mode choice as well as cycling accidents and the satisfaction of cyclists Economic impacts seem to be less important, the same holds true for environmental impacts. Municipal cycling professionals thus concentrate on the rather direct and comparably easy to measure impacts.

DISCUSSION AND CONCLUSIONS

The data availability survey showed that regularly collected cycling data is only available in bigger cities. However, even in those cities, the kind and amount of available data varies greatly. Whether the available data is sufficient and suitable for general monitoring purposes or for backing up impact evaluations of specific measures can therefore only be decided on a case-by-case basis.

The evaluation survey showed that municipalities are in general not very experienced in conducting cycling-specific impact evaluations. However, a rising number of municipalities see the importance of the topic and intend to engage in evaluation projects. Especially for these municipalities, practical guidance is necessary to smooth the way towards a better evaluation culture in bicycle planning.

Overall, municipalities will need time to gain further experiences in evaluating the effects of their cycling measures. As stated from a number of respondents, impact evaluation obligations within funding schemes may accelerate this process. However, if impact evaluations are requested on behalf of the funding programme, it is important to support municipalities in the process of planning and conducting these evaluations. In most cases, municipalities will not have the necessary resources and experience to realize complex evaluation designs without external support.

Overall, we recommend that municipalities aiming at a more systematic monitoring and evaluation culture in bicycle planning should consider the following:

- Evaluations and monitoring are facilitated by a holistic monitoring concept. This includes the definition of overarching goals for the promotion of cycling and a number of suitable indicators, for which data will be collected regularly. Depending on size class and experience, it might be better to start with a very reduced number of indicators but make sure that the necessary data for these indicators will be collected frequently.

- Additionally, municipalities should develop evaluation strategies, which state in a general manner, in which cases impact evaluations of single measures should be planned and how and when the necessary data should be collected. Such a general strategy will reduce the effort to initiate impact evaluations for specific measures and gives necessary orientation on the type and magnitude of necessary activities. Again, this strategy could concentrate on a reduced number of activities and projects in the beginning. For many municipalities, it would already be a major improvement to systematically count the number of cyclists before and after infrastructure measures for a sufficient time span.

- For municipalities, it is important to also thoroughly discuss which type of impacts can be readily assessed in-house and in which cases external support, e. g. from engineering offices or research institutions is needed. For example, while the collection of count data or information on the acceptance of the dedicated infrastructure might be easily done by municipal staff, the assessment of safety conflict situations or distances between cyclists and motorized vehicles in the process of overtaking might not be as straightforward. This is even more obvious in cases where the focus of evaluation is on behavioural changes and the associated effects on health or environmental impacts.

- Count data is especially important for monitoring and planning processes. Ideally, count data can in part be obtained from permanent automatic counting stations. This allows for monitoring long-term development and the influence of external factors like the season or the weather. Data from permanent automatic counting stations can also support the interpretation of data collected for specific evaluation measures.

- It is very important to make sure to have sufficient personnel and financial capacities to engage in regular bicycle data collection processes. We believe that the experiences gained during regular monitoring processes can significantly reduce the efforts necessary for planned measure-specific evaluations.

- Publication of the regularly collected data as “municipal bicycle report” ensures rising awareness for cycling in the public. It might increase the use of the collected data for monitoring, benchmarking and evaluation purposes.

ACKNOWLEDGEMENTS

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EXPERT COMMENT

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Anvita Arora
Innovative Transport Solutions

The researchers have highlighted the importance of impact evaluation in the context of bicycle measures taken by different size municipalities in Germany. They have also analysed the gaps in existing evaluation process, method and data availability. The final recommendations of the research include capacity building and allocation of more funds to the future bicycle measure impact evaluations process and methods especially in case of smaller municipalities across Germany. These are particularly of higher importance for the practitioners as they are exhibiting the case of bicycle and non-motorised infrastructure in Sao Paulo city in Brazil.

The practitioners from the capital city of Brazil have explained the process of making the Sao Paulo more liveable city by the way of planning, designing and implementing a city-wide cycle network along with complementary infrastructure. The article represents the road map to achieve an ambitious target of constructing 400 km of cycle track across the city. It highlights the various milestones of the road map like strategy planning, network design guidelines and the very important aspect of stakeholder consultation and citizen participation. It could be very enlightening for the researchers to witness the various stages and process followed to implement a huge non-motorized focused mobility plan in a highly populated city with the active participation of different stakeholders. It could give the researchers evidence to create a robust impact evaluation framework for bicycle-related measures.

It is evident from comparing the two articles that there are some gaps between the empirical research and the practitioner's case study article. The gaps are related to approach adopted by the two articles towards the cycling infrastructure. The practitioner's article describes the various stages of planning, network guidelines, social participation, and implementation process. However, the rational for choosing a specific design of non-motorized infrastructure, for example, bicycle lane in the middle shown in pictures 6, 7 & 8 and post-implementation evaluation process/ measures could be added to the article to make it more comprehensive. The empirical research article provides the in-depth analysis of bicycle infrastructure data and impacts evaluation indicators. It makes specific recommendations to improve the existing evaluation process. The existing or proposed legal and institutional framework, where in such recommendations can be incorporated, can be added to the article to make it more holistic.

The researcher's article is complementary to the practitioner's article in many ways. It is not only providing the list of bicycle measures, for reference, undertaken by different municipalities in Germany also the process of post-implementation evaluation. The adoption an inclusive and ever-evolving evaluation framework could enable Sao Paulo city to develop a state of the art non-motorised infrastructure for a better life of citizens. The recommendations provided in the researcher's article are easy to understand and implementable from practitioner's stand point.

The practitioner's article provides an opportunity for researchers to understand the process, challenges and barriers faced while implementing the bicycle infrastructure. The dynamic planning, designing, and implementation process could impact the targeted effect of the cycling infrastructure. Thus, effecting the development of post-implementation evaluation framework. The integration of social participation, in Sao Paulo case study, in a pre-implementation phase like public hearings, thematic debates, and critical mass movement during the implementation, keep the project on track and serve as a strong structure for post-implementation evaluation. The active social participation makes sure the people or users take the onus of the infrastructure and enable the regular evaluation with steadily evolving evaluation framework which was lacking in Germany, as highlighted by the researchers in their article.

The impact evaluation article focuses on the data availability, current, and potential evaluation indicators, capacity of the municipalities to undertake regular evaluations and gather bicycle measure related data. However, there are other impact evaluation frameworks available in the international literature and case studies around the world highlighting the effects of different land use type – change in type and mixing of land use, real estate prices, compactness, the density of the built environment which can impact the efficacy of measures. The annotators suggest that these types of indicators and case studies, especially in other European cities, can be taken up for further study using spatial techniques, to comprehensively understand the entire breadth of benefits investments in regular impact evaluations can bring to a city. Another possible area of research, for practitioners, is to analyse the impact of citizen participation in choosing the different design of bicycle lane infrastructures like middle vs on both sides or one side contra flow designs.

The comparison of the two articles provides an opportunity to both practitioners and researchers to learn from each other also understand each other's perspective to bridge the gap between the research and practice. The practitioners may consider learning from the other case studies of the cycling infrastructure and incorporate the failures and success, while researchers may emphasize on the practical implications and way to implement the recommendations of the empirical research. This will eventually help the practitioners and researchers to develop more liveable cities across the globe.

2.5 Strategies to boost cycling

Practice

New strategies and digital applications to boost cycling

Tilman Bracher
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Sebastian Bührmann
German Institute of Urban Affairs (Difu), Department of Mobility, Team Leader Cycling Policies

Research

Social practices and the importance of context

Peter Cox
University of Chester

Heike Bunte
German Environment Agency

Expert Comment

Holger Haubold
European Cyclists' Federation (ECF)

PRACTICE

New strategies and digital applications to boost cycling

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ABSTRACT

200 years after the invention of the bicycle, cycling has become an integral part in modern digital mobility concepts worldwide. It has potential to become part of a new urban mobility system, which provides more livable, healthier and economically successful cities.

This is reflected in examples as the City of Bremen's modern Sustainable Urban Mobility Plan (SUMP), re-designed main roads with good cycling infrastructure, an increasing number of cycle highways and technical upgrades of bicycle infrastructure by digital services. Cycling 4.0 includes aspects of urban planning, the development of new technologies and a change of minds.Bicycle highways in conjunction with Pedelecs unlock the potential of longer distances and new target groups of users.

Furthermore, a range of further digital solutions boost cycling. Digital devices may control the personal, physical or technical status of driver, vehicle and environment. Smartphone apps become powerful tools to deliver more information about the trips made by the users which contribute to better planning of bicycle infrastructure.

Therefore, in recent years, the bicycle has become more than only a means of transport. It is also a lifestyle product and professional marketing and mobility management campaigns contribute to changing the perception of people and decision makers towards a bicycle culture.

The bicycle has a brilliant future. New digital technologies may support cyclists and improve the quality of cycling. On the other hand, cycling must remain as easy, cheap and uncomplicated as it is. Further research on new technologies and its implementation may fill knowledge gaps and develop infrastructures, services and technologies further.

INTRODUCTION: CYCLING 4.0

The term 4.0 has recently been used in connection with modern information and communication technology, combining intelligent technology, digitalization and the network perspective via mobile computers and cloud computing.

200 years after the invention of the bicycle, cycling is entering the digital era. Cycling has become a "serious transport mode" for daily mobility (again) in many parts of the world. The last years have shown a dynamic development, which goes even further. The bicycle has potential to become part of a new urban mobility system, which provides more livable, healthier and economically successful cities.

In our view there are four main stages in the development of cycling policies:

- In its early days, cycling was a natural part of rural and urban road traffic;
- later, when car traffic took over, the concept of separation was established to remove cyclists from the road.
- The third period of cycling policy is an era of compromise. The bicycle is not seen as a serious transport mode, the integration into a car dominated environment is improvisational and patchy. Besides, the bicycle is seen as a leisure and tourism topic.
- Nowadays, cycling is more and more connected with a new level of political recognition of cycling, and the stronger consideration of quality factors to exploit the potential of bicycle traffic as a means of transport; digital devices and marketing activities support this development.

2016 has been a year of breakthroughs. After years of work at the highest political level, the first European Cycling Strategy is coming to life. The ECF successfully placed cycling in one of the United Nation's top policy documents, the new Urban Agenda. Nationally, a wave of ground-breaking policies is sweeping across Europe: cycle highways officially became part of Germany's new infrastructure planning, Finland set a 30 % cycling modal share as national transport target, the first National Cycling Strategy received cross-party endorsement in Spain, Italy is releasing millions of Euros for cycling infrastructure, and the list goes on. So, the framework conditions for developing cycling further are improving in many countries.

This paper examines three different fields that contribute to "Cycling 4.0":

- Transport planning and infrastructure: cycling in integrated planning approaches, re-distribution of public space, cycle highways and technical upgrades of cycling infrastructure (digital services, lightning, WLAN, solar cell road);
- Digitalisation, data availability and connectivity: location based services using GPS, multifunctional assistance systems, spin-offs from traffic automation and smartphone tracking data for bicycle planning;
- Mobility culture: marketing campaigns and the bicycle as lifestyle product.

Key reference for this paper is the situation in Germany, but it also takes into account some international developments.

TRANSPORT PLANNING AND INFRASTRUCTURE

"Cycling 4.0" cannot be dealt with in an isolated way. It needs to be linked up to urban planning, integrated transport planning and the development of a high-quality cycling infrastructure. In most cities this is more an evolutionary process that takes many years than a disruptive quick process. Some developments during the last years however have shown that cycling has become an integral part of modern urban transport planning with new qualities for the user. Forerunners tested new approaches and helped to make them mainstream measures.

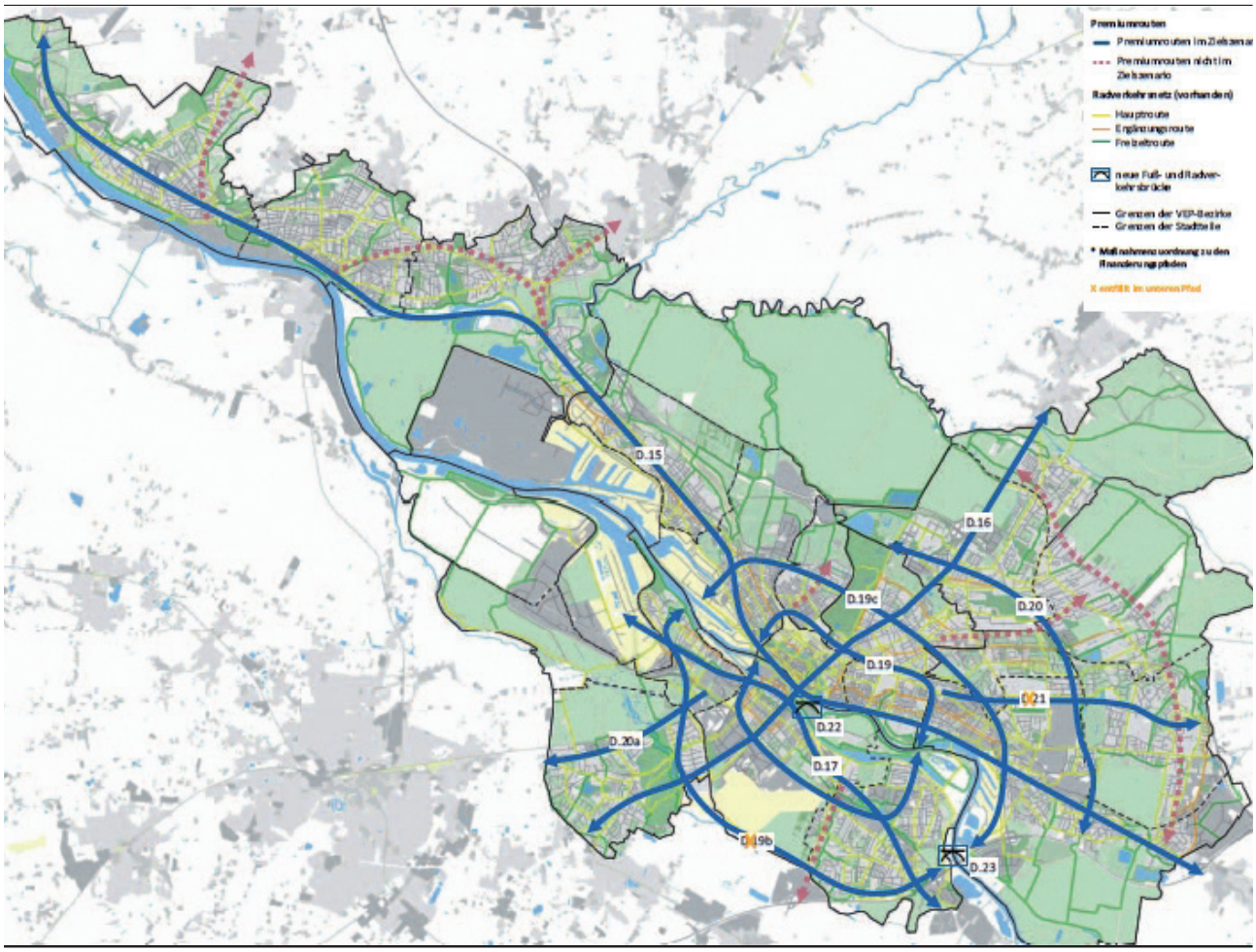
Cycling in integrated planning approaches

In modern transport planning, cycling is included. In Sustainable Urban Mobility Plans (SUMP) as promoted by the European Commission cycling is an important part of an attractive mobility portfolio that can reduce car use in the cities.

The "Verkehrsentwicklungsplan Bremen (VEP)" was developed from 2012 to 2014 in a participatory process with the public administration, political stakeholders, economic representatives and the public. It included an extensive online participation. The plan was adopted by the local council and is an important basis for the further development of urban mobility in the city. A clear set of targets and three possible financial paths have been defined, enabling the city to work on a broad and flexible set of measures to foster sustainable urban mobility. Cycling is already an important means of transport in the city. 25 % of all trips in the city are done by bicycle. The plan aims at increasing this number by improving the cycling

Figure 1

Premium route network in Bremen's Sustainable Urban Mobility Plan



Source: „Maßnahmen zum Radverkehr im Zielszenario", Freie Hansestadt Bremen, Verkehrsentwicklungsplan Bremen 2025, S. 148:

infrastructure that in many parts is not up-to-date to the user requirements any more. There is broad consensus that cycling needs to be promoted in Bremen within an integrated approach. The transparent and participatory approach contributed to high acceptance and a clear political mandate to implement a range of specific cycling measures (Hamburger 2015).

Re-distribution of public space

A crucial and much disputed aspect for successfully integrating high-quality cycling infrastructure in dense urban areas is the re-distribution of road space. In advanced cities more and more space is allocated to pedestrians, cyclists and public transport, less for cars. Many cities however struggle with strong opposition, especially when it comes to redesigning main roads. This opposition can be overcome as good examples show; the paradigm of the car oriented city is removed by new concepts.

The re-design of main roads is a particularly difficult field, when it comes to give more space to cyclists and pedestrians. While Copenhagen established in the inner city at most main roads broad bicycle routes, fewer traffic lanes and waived some parking spots, most other cities struggle with such a clear shift in priorities.

In Germany different cities have taken on this challenge and re-designed important main roads, however in a less radical way than Copenhagen. The cities of Berlin, Munich, Leipzig, Stuttgart, Karlsruhe, Kassel or Hamburg, to name a few, have closed gaps in the bicycle network by integrating bicycle lanes or paths on main roads. In some cases the number of parking spots or traffic lanes was reduced. A principal challenge is that usually a lot of resistance is met, if the re-design of a main road leads to a reduction of capacity for car traffic or a reduction of parking spaces.

Good examples for the re-design of main roads and the better integration of the bicycle are Osterstrasse in Hamburg, Warschauer Strasse in Berlin, Georg-Schumann-Strasse in Leipzig, Friedrich-Ebert-Strasse in Kassel (Difu 2016), Kapuzinerstrasse in Munich (Zorn 2015), Waiblinger Strasse in Stuttgart or Sundgauallee in Freiburg, just to name a few.

More and more German cities declare so-called bicycle streets (Fahrradstrassen), which is possible since the road traffic regulations were changed in 1997. A bicycle street can be implemented where cycling is already or is expected to become the dominant mode of transport. The original idea was to permit cars only as exception. In practice most bicycle streets allow car traffic; they are however very safe routes for cyclists (GDV 2016) and become more and more important for giving space to cyclists (e. g. as part of fast cycling routes), especially in inner cities. Still, bicycle streets are implemented across the country in different ways and more studies are needed to find out how to design and implement bicycle streets best. The message however is clear. Cycling needs more space and high quality routes.

Some cities also implement "shared space" solutions, which aim at reducing segregation between different transportation modes and foster traffic calming. This facilitates amongst others better cycling conditions. The small City of Bohmte for example has implemented a shared space area in the city centre, the City of Duisburg has traffic calmed several squares (e. g. Opernplatz, declared as "Verkehrsberuhigter Bereich") and the City of Meckenheim has made the city centre a 20 km/h zone (Verkehrsberuhigter Geschäftsbereich) (Blase 2016).

Fig. 2 Re-designed main road, Leipzig (© Jörg-Thiemann Linden)

Fig. 2a Re-designed Osterstrasse, Hamburg (© Jörg-Thiemann Linden)

Fig. 3 Fahrradstraße Linienstrasse, Berlin (© Alexander Hunger)

Fig. 4 Traffic calmed Federal Road, Duisburg (© Jörg Thiemann-Linden)

Cycle highways

Improved bike paths open up new potential for longer distances that bike commuters can drive and address new target groups of users.

The original idea came from the Netherlands, where cycle highways are already well established. The "Fiets filevrij" program fostered the implementation of cycle highways in agglomerations to reduce congestion. Since 2005 eight cycle highways were implemented, till 2025 20 more are planned. Other prominent examples are the "Cyclesuperstier" in Copenhagen, the London "Cycle Superhighways" and the "Fiets-o-Strats" in Flanders.

In Germany the topic has received a lot of attention and many cities or regions have plans to implement so-called "Radschnellverbindungen" (Deutsches Institut für Urbanistik 2016). In the City of Göttingen the "eRadschnellweg" (eCycle-Highway) has already been implemented (Stadt Göttingen 2016) and parts of the RS1 cycle highway through the Ruhr District have been completed recently (AGFS NRW 2017). Some Federal States and the Federal Government provide funding support for new projects. The challenge however lies in implementing high standard cycle highways in urban areas with little space.

New technologies for cycling infrastructure include WLAN services, lightning concepts or innovations as solar cell roads.

Fig. 5 eCycle Highway, Göttingen (© Sebastian Bührmann)

An example of integrating new technologies in a long-distance bicycle route (1.100 km) is the "Cycle Path German Unity (Radweg Deutsche Einheit)". Along the whole route modern service areas will be established that offer free WLAN, digital touchpads and solar powered charging stations for Pedelecs. Touchscreens provide information and service to travellers who want to discover milestones of the German unity (BMVI 2016). A project that combines new technologies with a gamification approach is a tunnel on the Dutch "RijnWaalpad", a fast bicycle route between Arnhem and Nijmegen. The tunnel under a highway is illuminated by colourful light sculptures that remind of a bicycle chain. Incoming cyclists or pedestrians are detected via sensors at both ends of the tunnel. Depending on the amount of people in the tunnel, different light mood programs are shown. A completely unique aspect of the project is the implementation of an app, with which the users of the tunnel can earn points, which they can in turn use to influence the colours of the light-artwork (Snelfietsroutes 2017).

Also worth mentioning is a new technology called "SolaRoad". Solar Roadways® (SR) is a modular system of specially engineered solar panels that can be walked and driven upon. A pilot project incorporating solar modules in a bicycle path exists in Krommenie in the Netherlands (Taguiam 2017).

Fig. 6 Technology Station at the German Radweg Deutsche Einheit (© Bundesministerium für Verkehr und digitale Infrastruktur (www.radweg-deutsche-einheit.de))

DIGITALIZATION, DATA AVAILABILITY AND CONNECTIVITY

"Cycling 4.0" also means the application of digital solutions to the bicycle itself but also in a connected environment and for planning purposes. Many ideas are still niche products, but the field is rapidly developing.

Location based services using GPS

GPS devices are popular for riding, training, touring and navigation (Immediate Media Company Limited 2017). Applications include navigation, mapping, collecting and analysing cyclist's and running data for personal health (cyclists' performance), and battery performance with pedal electric bicycles. In addition, more and more technologies from car assistance systems have been applied for cycling.

As GPS-trackers can locate the current position of bicycles, more and more location based services are being developed, e. g. safety applications against bicycle theft and for emergency calls. Trip related applications include dynamic routing and services using data exchange with service providers (e. g. booking of train, coach or boat carriage), infrastructure facilities (green wave) or other vehicles (e. g. lorry alert). Some applications are already well established, others are being under development or just ideas.

One of the GPS-trackers against bicycle theft is spybike's system Velocate (PSP Pauli Services & Products 2017). Its trackers are mounted invisible in or on the bike. Once a bike has been stolen, a Push-Message will alarm the owner's mobile phone. At the same time the GPS-System is activated and uploads constantly and live the current position of the bike. If the alarm was not activated automatically, one may remotely activate the system. This allows tracking down the thief and recover the stolen property; preferentially with the support of local police.

With Bikefinder® from IDS-Identsysteme (2017), bicycle tracking is combined with conventional bicycle coding. The system enables the police to identify the legal owners of retrieved vehicles or to carry out a targeted bicycle control. It is supported by parts of the bicycle industry, trade and insurance companies and the police.

An emergency call solution is technically based on a system by Canyon Bicycles and Deutsche Telekom originally used in the automobile industry and now adapted to the bicycle. The system detects an emergency situation and, if necessary, sends an emergency call (eCall). It may be helpful in remote areas. Until a person is missed, in the worst case, hours which can be vital for a timely treatment are lost. GPS localizes the victim and doctors can provide faster help.

At the heart of the solution is a small communication unit with the size of a small ruler (on-board unit). It is equipped with a SIM card, a microcontroller, a motion sensor and a GPS module. In addition, the bike is equipped with sensors at various points that send data to the on-board unit. The data is sent autonomously and without further action of the cyclist, even very unintentionally, regularly on a special server.

The examples above are not finite. Apps for cyclists and location based tools may serve various other needs on the route: e. g. inform about nearby toilet facilities, shelter places, bicycle shops, train stations and connection times, prices and availability of all type of commodities, options for shared rides and information about nearby friends.

Multifunctional assistance systems

An increased number of features combines cycling services with other functions. Recently, The German software developing company SAP and the Japanese consumer electronics manufacturer Cerevo introduced the Ride-1, an 'Internet of Things' (IoT) device that collects data from various sensors on (e-)bikes (Bike Europe 2017). Ride-1 allows riding data to be shared and analysed.

Ride-1 communication features include ANT+, Bluetooth and Wi-Fi, in addition to various sensors such as GPS. Its advanced internal sensors collect the data for a safer, and more efficient everyday bicycle ride in combination with an enhanced smartphone application, and temperature, atmospheric pressure and brightness sensors. The system provides data like: bike performance, kilometres biked, real-time ranking, virtual race, real-time location tracking, real-time incident alert, real-time over speed alert, calorie consumption and CO_2 emission savings.

Another assistance system provided by COBI (COBI 2017) combines basic bicycle functions with intelligent software functions. In addition to the usual smartphone functions it serves as power bank, provides navigation, a mobile weather station and intelligent light control. It includes a smartphone holder (handle) for the handlebar with integrated charging station and handlebar remote control, a cycling app with bike navigation and voice guidance, a lighting system for automatic front and cable backlight, alarm system, digital buzzer and authentication.

At SmartHalo's system (SmartHalo 2017) an additional tin gadget attached to the handlebar provides a call and message display, navigation system, fitness tracker, theft alarm and a bicycle light. SmartHalo connects to the smartphone via Bluetooth. The circular LED display can then be used as a navigation system towards a pre-selected destination on the mobile phone; butit is also a fitness tracker, which gives the user information about speed, distance and burned calories. SmartHalo includes a notificator for calls and messages, which also informs the driver of incoming calls and messages and warns of bad weather. The user receives a corresponding optical signal on the screen. In addition, the phone can be detected at any time with the smartphone app, for example, if the owner has forgotten the location or in case of theft. In case of theft, the integrated bicycle light automatically switches on depending on the light conditions. In addition, SmartHalo has even more security features. The gadget can only be removed using a unique key that comes with the product. An intelligent alarm system is also integrated: when a stranger moves the bike, an audiovisual alarm sounds. This security feature will automatically turn off as soon as the owner approaches the smartphone.

Spin-offs from traffic automation

A study of the Dutch road research institute SWOF identified a number of spin-offs from car automatization for cycling (Vissers et al. 2016: 10). Automated cars use data from smart infrastructure based on loops embedded in the road, cameras, and matrix signs as well as on-board sensors and data from other vehicles.

The basic idea of cooperative driving is that information about the road system and the traffic scenario is sent to the individual car so that they can automatically respond. However, further research is necessary on how to include cooperative cycling into cooperative traffic.

In addition, automation may bring substantial changes of how pedestrians and cyclists interact with cars. A special challenge will be faced when (partly) automated vehicles interact with pedestrians and cyclists.

In future, vehicle safety tools and devices may ease the interaction of cyclists and cars. Cars may be warned of oncoming cyclists on the side of parked cars or poorly visible cycle paths, and cyclist's about oncoming lorries, speeding or abnormal driving.

A "Green Wave" for cyclists (Siemens 2017) may be used to prioritize cyclists at traffic lights. "Sitraffic SiBike" is developed by Siemens, along similar applications for car traffic. With the help of a smartphone app, cyclists may be prioritized at traffic lights.

As smartphone telephone calls may disturb driving, an auto responder App may ensure minimum distraction while riding a two-wheeler. Smart bike mode Auto Responder™ is an Android mobile app. (Google Play 2017). The feature automatically replies to calls with pre-recorded text messages and does not notify the rider until it is an URGENT CALL request from the caller.

An ongoing project to develop safety-oriented driver assistance systems for pedelecs is the goal of the project "SIFAFE" at the University of Kaiserslautern. As active safety devices such as driver assistance systems are hardly available for cycling. The technical prerequisites for active safety devices, in particular the power supply are no barrier to electric bicycles. The aim of the project, which is funded by Germany's National Cycling Plan, is to warn cyclists against obstacles and other dangers and provide specific support in critical situations (Görges et al. 2016).

Smartphone tracking data for Bicycle Planning

The installation of a smartphone tracker app allows the location of the smartphone. Based on the stored movement data, the route and transport selection of the smartphone users can be identified.

Data collection methods based on the Global Positioning System (GPS) have spread in recent years. The few systematic cases of cycling or walking tracking data analysis have been reviewed in the EU funded TRACE project. Its purpose is to assess the potential of movement tracking services to better plan and promote walking and cycling in cities, and to develop tracking tools that will fuel the take up of walking and cycling measures. (Trace 2017; Bernardino 2016).

The Dutch Bike PRINT (Bike Print 2017) tool, one of the few applications so far, can be used to translate GPS data of bicycle movements into policy-relevant information. It provides a detailed picture of up-to-date bicycle use, network quality and bicycle accessibility.

Bike PRINT delivers the following policy-relevant information per area:

- Real bicycle speeds: section speeds including waiting times, and relative speed (bottlenecks);
- A picture of bicycle traffic movements at various moments of the week and during the day;
- The various routes of all cyclists that make use of a specific stretch of road (selected link);
- The detour factor between the actual route compared with straight-line distance and compared with the shortest route;
- Isochrones for travel time, the actual distance to be covered from a certain area within a certain period of time;
- Travel times, traffic volumes and choice of travel modes over a day (hour), over a week (per week day) and per distance category;
- Potential bicycle accessibility between residential areas and working areas;
- Number of potential new cyclists as a result of changes in bicycle infrastructure.

Bike PRINT is used for collecting data on cycling use in the Netherlands and Flanders during the Bike Count Week (Fiets Telweek). Bicycle users download the “FietsTelApp” on their smartphone and provide with their data to a better understanding of their travel patterns (Gorris 2016; fietstelweek 2016).

Another product on the market is Strava. The San Francisco based company Strava has been storing the sports and daily routines of its users recorded by GPS since 2014. The aggregated and anonymous data sets are being offered to interested stakeholders in bicycle traffic planning (e. g. municipalities, planning offices, associations). In a German project within the context of the National Cycling Plan, the Technical University of Dresden examined the usability of such behavioural data in cycling and developed an evaluation guide on cycling (Francke 2016 et al.; Francke/Lißner 2017).

An important project objective was to find out how well GPS-Data represent reality, i.e. how representative they are. For this purpose the Strava data was compared with the real number of cyclists by using numbers from manual counts. Although the data were poor, they allowed a first insight into the distribution of bicycle traffic over the city area of the pilot municipality.

Another project within the German National Cycling Plan, radSpurenLeser (InnoZ 2015), analysed intermodal behaviour via smartphone tracking. The recording of intermodal travel patterns took place by using the app-based survey tool modalyzer (www.modalyzer.com). This free app for Android devices and iPhone recorded mobility patterns of the interviewees in a defined survey period. The chosen means of transport as well as the distance and duration of the journey were identified automatically and were analysed spatially and in the course of time. Regrettably, the question of the validity and representativeness of the data were not investigated within the framework of the project.

An example of a quality management tool is the Saarland deficiency detection app (Wallach 2014): In the German Federal State of Saarland, tourist guests are given all the important information needed to carry out his outdoor activities via the "Saarland Tour App". At the same time, the customer can react spontaneously and directly in the case of complaints. For this purpose, the "deficiency detection" was developed. This way the cyclist becomes a cooperation partner in quality assurance.

The customer sees his location on the display of his smartphone. If one detects a problem, e. g. a damaged signpost, one can take a picture directly from the application and describe the problem in text form. At the same time, the exact location is transmitted automatically. Without delay, the message will be sent as an e-mail with picture to the tourist centre of Saarland (TZS) and can be processed promptly. After receipt of the message, the TZS team will enter into dialogue with the customer. For example, if more accurate information is requested. After solving the problem (if this was done promptly and with a concrete result), this is also reported back to the customer.

MOBILITY CULTURE

"Cycling 4.0" also means that the bicycle has become more than only a means of transport. It is a lifestyle product and professional marketing and mobility campaigns contribute to change the perception of people and decision makers towards the bicycle. The bicycle becomes a symbol of a more livable city, a healthier life style and attractive places to invest in.

A good example of a campaign that contributes to change minds towards more cycling culture is the "Radhauptstadt München" (Bicycle Capital Munich, Germany). The campaign started in July 2010 with the aim to establish a bicycle culture in the city. Communication measures were taken to encourage more people to cycle and to increase traffic safety. Soft measures are considered as necessary add on to the improvement of cycling infrastructure. A measure of Radlhauptstadt is the Munich Radlnacht (bicycle night). Parts of the city centre are closed for traffic and cyclists take over in a big bicycle parade. In another activity, people could present themselves and their bicycle as "Radlstar" (bicycle star), and the public voted online for their favourites. Furthermore bicycle safety checks are offered, welcome tours on bicycle for new cities take place and even a bicycle fashion show has been established, just to name a few activities (Radlhauptstadt München 2017). An evaluation showed that 60 % of the respondents of a survey knew about the campaign and 80 % rated it as very good or good. The costs of the campaign were about 0,50 EUR/inhabitant.

The Federal State of Baden-Württemberg in Germany is a good example of how to promote cycling culture in a larger region. The Ministry of Transport provides funds for local municipalities and other stakeholders to develop and implement communication campaigns that aim to increase the use of the bicycle. Since 2012 events, campaigns and competitions are carried out together with local municipalities that can apply for funding and are supported by communication professionals (Nahverkehrsgesellschaft Baden-Württemberg mbH 2012).

In Vienna, a „Mobilitätsagentur" (Mobility Agency) was founded in 2011 to promote cycling within the municipality. Since 2013 also walking is on the agenda of activities. The agency runs campaigns, events, service activities and is contact point for all questions around cycling and walking. It also reports on cycling and walking in Vienna and commissions studies (Mobilitätsagentur Wien 2017).

The bicycle becomes more and more a lifestyle product. This trend is catered by special bicycle fares and shops. The "Berliner Fahrradschau" for example labeled itself as "The World's Leading Cycle Lifestyle Fair" (Berliner Fahrradschau 2017). The bicycle has become much more than a means of transport. Similar to the car, it becomes a very emotional product. This is also part of bicycle culture, especially in big cities.

CONCLUSIONS AND FURTHER RESEARCH

"Cycling 4.0" means to look at cycling in a network perspective together with urban planning, development of new technologies and a change of minds. It will change urban planning and design. Further digitalization and data provision will create business cases for startups and new services.

The fast development of the bicycle as a (digital) product and a new planning culture for urban mobility enhances the role and possibilities of the bicycle.

Future developmnent may lead towards intermodal services, reservation services for shared bikes and more integrated planning approaches. Cycling will become more convenient, e. g. by indicating the right cycling speed to reach a green traffic light. New digital tools may may help to eliminate wrong parking on bicycle infrastructure and improve online participation in order to facilitate a better involvement of citizens in planning.

New digital technologies may support cyclists in various ways and improve the quality of cycling. On the other hand, cycling must remain as easy, cheap and uncomplicated as it is. We should not exclude anyone not interested in new emerged technologies.

As automated detection may identify risky interactions between motorized vehicles and bicycles and considerably contribute to safety, further research should improve the technical specification of systems as well as the social, political and economic factors for implementation.

Digital applications may develop infrastructure, services and technologies further.

Fig. 7 Vienna „Radsommer am Donaukanal" (© Mobilitätsagentur Wien/Christian Fürthner)

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RESEARCH

Social practices and the importance of context

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ABSTRACT

Social practice theory provides insight not only for analysis of existing social habits but also into their formation. Better understanding of the complexity of practices also allows insight into their relative degrees of obduracy: the potential for change or resistance to change. Characteristic of much work in recent analysis of cycling promotion is a tendency towards abstract generalization that ignores the specificities of practices as they occur in given locations. Cycling practices are not only located in space but also in time, and meanings, competencies and technologies are all inheritors of particular histories.

This paper argues that much current promotional activity and research into changing behaviour is problematic inasmuch as it is ahistorical, lacking in analysis of the social and political forces that are responsible for the sedimentation of current practices. Following Oosterhuis' (2016) argument, the paper argues that without embedding analysis of transport processes in a much broader context, that pays heed to forms of governance, citizenship, the relative competencies of different levels of polity and the ways in which these forces are historically constructed, interventions aimed at behavioural change have little chance of success. Developing the work of Aldred (2010) on cycling and citizenship and Shove (2015) on social practice and policy, the paper links these to the field of comparative environmental politics (Steinberg & Van Deever 2012) through a lens of historical analysis. Drawing on a survey of over 100 recent papers analysing problems and interventions designed to promote modal shift in general and toward cycling in particular, the paper considers the degree to which these are sensitive to the social political and historical forces against which they operate. It then uses a comparison between historic campaigns for change in the UK and Germany to argue that the impact of interventions is less to do with their design than with the political context into which they are introduced.

INTRODUCTION

In recent papers, Oosterhuis (2014, 2016, 2017) has argued persuasively that, while government policies have been introduced for the promotion of cycling as an everyday mode of transport, and studies analysing the factors from a social science and traffic planning approaches have proliferated, little correlation is to be found between policy implementation and changes in modal share. Indeed, he argues that: "... the influence of historical and cultural factors on levels and practices of bicycle use has basically been underestimated if not overlooked." (Oosterhuis, 2017:1). The purpose of this paper is to advance that argument by examining specific case studies[1] through a comparative lens. In order to do so, it draws on arguments from social practice theory and from new social movement studies and its theorization of citizenship.

1 Please notice that space prevents presentation of the full scope of our empirical research and case studies. Further details on the corpus can be obtained from: peter.cox@chester.ac.uk and heikebunte@gmx.de

CYCLING AS A SOCIAL PRACTICE

Shove, Pantzar and Watson's (2012) development of social practice theory provides a useful lens through which to interpret cycling practices, indeed they have used cycling as an archetypal case study through which to illustrate their framework. Briefly stated, they identify social practices as dependent on the connections between three interacting primary elements: 'meanings', 'competencies' and 'materials'. Thus, for example to understand automobility, they look at the constitution of specific historical practices of driving rather than the car itself. Meanings are not only formal understandings but also include symbolic meanings, ideas and aspirations'. Competencies are not only the individual skills and performances of practitioners but also the collective performances and actions, – including the capacity to act – embodied in social structures. The material technologies of cycling are not simply those of the machine technology but include the material environments of travel in which riding takes place (Cox, forthcoming 2018). Using this framework in his own investigation, Larsen (2016) picks up Shove, Pantzar and Watson's (2012) emphasis that practices also need to be understood in relation to other practices that they may be 'bundled with'. Specifically here, riding as a practice will need to be interpreted with its interactions with other mobility practices not as a distinct but as an interrelated element, particularly in relation to the material spaces of travel and the conceptual spaces of the traveller as a citizen (and conversely, the citizen as a mobile subject).

Perhaps the most relevant element arising from the social practices perspective in relation to policy is explored in Shove (2015). Once more, it is understanding the co-evolution of practices that is picked out as more relevant than identifying specific interventions in practices. The focus in her essay is on the potential of future developments, and Shove (2015) suggests, for example, that: "...rather than promoting electric vehicles it might make better sense to identify and actively promote sets of practices into which electric mobility might fit." (Shove 2015: 42). As a framework for looking at policy, this approach is being used to shift attention away from isolate interventions in policy to understanding how practices interlock. While the emphasis in that particular study is on future potential development, the same analytical frame may be fruitfully applied in order to understand historical trajectories and how diverse results be produced from similar circumstances, because of the wider context and the other practices with which they are 'bundled'. This suggests that to understand the limitations of current cycling policy approaches it will be informative to look at historical similarities and differences.

In order to proceed, we first consider the extent to which current writings on policy intervention reflect upon the historical processes and forces that contribute to the situations in which current interventions are planned. Since proposing this paper, the documentary survey planned has been overtaken by a much broader study of over 200 papers by Oosterhuis (2017) and, rather than replicating his analysis, we simply draw on his conclusions with acknowledgement.

"Notwithstanding the more general pleas for a cultural turn in transport and mobility studies, policy-oriented bicycle researchers have not taken notice of the many cultural-historical works on bicycling that have been published in the past three decades – at least I did not find any references to such studies in their papers. Some of them only refer in passing to the possible impact of history and culture, in particular if their surveys fail to establish correlations between wheeling levels and other factors, while at the same time they play down that influence." He argues: "...only a few social-scientific researchers clearly acknowledge that historical factors may be highly relevant and deserve more serious attention." (Oosterhuis, 2017:1).

While Oosterhuis (2017) goes on to propose a typology of historical patterns, our intention here is to provide two case studies in order to identify some of the specific categories of social forces and the bundling of practices that enable researchers to consider the very real impacts of "soft" forces. Comparative lenses have been valuably used in the analysis of environmental politics to understand the "...divergent national implementation of international accords." (VanDeever/Steinberg 2014: 151). In terms of cycling policy and practice one can draw direct parallels in as much as shared transnational understandings of the problems of automobility and the potential of cycling as a means of addressing these have indeed produced divergent national strategies and intervention. More pertinently perhaps there is more than 45 year history of divergent intervention, strategies and changing practices even among geographically close European nations in terms of cycling practices that can be mapped to understand hence such divergences might arise.

METHOD

Drawing on a survey of 100 papers for UK and Germany focused on analysing problems and interventions (i.e. official policies, processes of democratisation) for cycling; the intention was to code case studies to explore the extent to which proposed interventions are dependent on design and or political context. Table 1 gives a snapshot[2] of how the papers were characterised and analysed. Characteristics were defined by key words. In order to condense the list of papers they were structured into full and short articles and grey papers. Official governmental papers were put into a separate category. For each case studies potential sources were identified towards the historical divergence and their implications for intervention policies to stimulate cycling. The case studies collate a series of sources to analyse how cycling has been produced as a practice in different contexts.

CASE STUDY 1: UK

By 1969 half of households in Britain were reported by the Department of Transport to have access to a car, and a there was growing public and official realisation of the problems of urban traffic. Conversely, as Rivers (1972) pointedly commented, that also meant that 80 % of the population had no exclusive access to a car. The household data however, obscures the very highly gendered nature of car ownership and access within household: driving was a predominantly male (and still quite strongly middle class) activity.

The salient role of the car in the public imagination had been strongly encouraged by a series of policies since the late 1950s. A year after his 1959 appointment

2 Again: due to a limited number of characters we can't show the full details of the survey. Here, we show the table as an example.

Table 1

Systematic of List of surveyed papers – Example*

Short title of paper i.e.:	Full article** plus category: "civil participation"	Short article*** plus category "subcultural attitudes"	Official intervention plus category: government etc.	Grey papers	Other
Fahrräder stinken nicht	x				
Cycling UK			x		
SUM plus comments					

* Again: due to a limited number of characters this table is just an example to get an idea about the used method.
** Full article means 10 pages plus.
*** Short article means 2–5 pages.

as Transport Minister, Ernest Marples (on his appointment, chief shareholder in specialist road-building firm Marples Ridgeway) addressed his Conservative party conference declaring: "...we have to rebuild our cities. We have to come to terms with the car". It was not too surprising that the conclusions of Traffic in Towns, the report by Professor Colin Buchanan, selected and commissioned by Marples in 1960, echoed this analysis. In the Preface to a mass market paperback version, Sir Geoffrey Crowther, former editor and chairman of The Economist, wrote that: "... to liberate the motor vehicle ... we shall have to make a gigantic effort to replan, reshape and rebuild our cities.". "... what the Victorians built, surely we can rebuild. Nor is this an unpleasant necessity. Our cities, most of them, are pretty depressing places, and to rebuild them would be a worthwhile thing to do even if we were not forced to it by the motor car." (Crowther 1964: 14–15).

Marples also appointed Dr Richard Beeching as Chairman of the British Transport Commission. Similarly, Edward Heath, leader of the Conservative Party, stated as he opened the 1966 Motor Show: "Of course traffic in towns creates a problem. My approach is not to restrict, to hamper or confine the motorist. Instead, we must learn to cope with the motor car and care for the motorist." (cited in Rivers 1922: 40). The Labour Party (in office 1964–1970), in thrall to Wilson's modernising rhetoric did little to change this direction, only reinforcing the justification of policy through a determinist depiction of technology. The 1970 White Paper (published shortly after Heath's election victory), Roads for the Future laid out a strategy for a 4 billion pound investment in trunk roads to double capacity in the next 20 years. Although these plans were not immediately implemented (and subsequently significantly reduced in a 1977 White Paper), the clear implication was that both the urban and rural environment should be rebuilt to accommodate motor traffic. Also in 1970, official reframing of the concept of environment in government thinking and the relation between transport and environment came to the fore as the Department of Transport was abolished as a separate government ministry and absorbed into the Department of Environment – but the primary policy driver was the roads programme. It was only to re-emerge as a separate department in 1976.

The bicycle's legal status in Britain was (and remains) as a "carriage" i.e. a vehicle with technically the same rights and obligations as any other vehicle on the road. Thus, to understand cycling one must see it as 'bundled' with other road users. The fact that the roads as environments of travel were deliberately being redesigned and reconceptualised as spaces specifically for motor travel means that confrontation was structured in to the development process, with the odds stacked against non-motorists. The emphasis on motor traffic was clear in the concentration on trunk roads and urban motorways that could resolve the problematic remnants of cycle's traffic by legally eliminating them. The emergence of campaigning groups prompted by these plans focused on comprehensive critique of the place, role and use of the car. The formation of the London Motorway Action Group in 1971 typified the growing critical response to the plans for increasing road building. It united civic societies, residents association and rate payers associations to oppose expansion of the London Ringway inner-city motorway plan that would have erased significant historic areas of housing, displacing and estimates 60–100,000 persons. During the 1930s and 1940s, the CTC had been regarded as a formidable voice for cycling and cyclists in wider society and particularly in parliament. By 1971 membership reach a post-war nadir of 18,564, the lowest since 1925. Its outlook by this time was essentially nostalgic, looking backward to preserve what it could of the memories and rights associated with a social context rapidly disappearing.

Other organised voices appeared to champion cycling in these years of the early 1970s. A National Plan for Cycling was launched in June 1972, after the appointment of Eric Claxton. Claxton had been the Chief engineer for Stevenage and was responsible for the extensive cycleway network which, at the time was acknowledged as a world class example of parallel infrastructure (Jones 2008). However, the existence of both knowledge and examples of good practice were of little avail when it came to most decisions on urban development. As Justice Layfield's (1973:35) report of the Public Inquiry into the Greater London Development plan commented: "Scant attention is paid to the pedal cyclist ... He seems to be regarded as a virtually extinct species. ... the fact remains that in central London, the bicycle is often the quicker way." (cited in Cycle Touring 1973:73). That CTC expressed a complaint that they had already made this point in 1971 only highlights their lack of impact. Another BCB booklet of June 1972 was entitled: "Before the Traffic Grinds to a Halt", urging government to provide better

facilities for existing cyclists and to encourage others to ride. CTC's principal input seems to have been solely concerned with leisure and the countryside not urban riding. (Cycle Touring 1972:119).

That there was perceived to be a crisis in transport in the opening years of the 1970s, prior to the problems posed by the oil crisis of October 1973 is clearly apparent. Though not published until 1974, the Report of the Independent Commission on Transport was compiled between February and December 1973. The Commission (Commission on Transport London, 1973), chaired and organised by Bishop Hugh Montefiore, brought together a range of expertise from industry, academia and the voluntary sector to take a wide ranging overview of what would now be termed the sustainability (or not) of British transport and to make policy recommendations. It framed the problem as a complex one involving financial and energy costs, environmental pollution and increasing social inequality (especially with respect to rural- urban divides and through age). The Report saw cycling as a crucial part of the urban transport mix, requiring support through comprehensive provision in low speed streets and segregated paths where appropriate. In its conclusions it far-sightedly notes that, "... the real goal is not ease of movement but access to people and facilities. Movement is desirable only to the extent that access requires it." (Commission on Transport London, 1974:260). The clear understanding of transport as an environmental issue is outlined in the chair's preface in which he describes its origins in a previous Commission on "Man's Stewardship of the Environment" at a church leader's conference in September 1972.

At a grassroots level others voices appeared. "Commitment" a group (initially related to the Young Liberals) organised its first demonstration in late 1971. Its actions were reported in Peace News indicating both the conceptual linkage to other nonviolent activism and the practical adoption of road occupying tactics familiar from other marches and demonstrations (Wall 1999). In the cycling press the editorial in the October/November issue of Cycletouring, the bi-monthly member's magazine of the CTC, carried an extensive review of this new wave of activism for its readers' assessment. "Commitment" is the name of a new group whose activities have gained press recognition in the past few months as a result of 'bike-in' demonstrations in London in the past few months. One newspaper described how supporters had 'swept down Oxford street, wearing slogans like bike power', and had delivered a letter to the Greater London council demanding a network of car free cycle ways.

'We will concentrate on bikeways for commuters, not only within central London but through arterial routes to the suburbs', says a Commitment spokesman. 'Bike ways for pleasure, linking parks, theatres, concert halls and railways stations, are also planned. We believe we are fighting not only cars on the road, but cars in the head." (Cycle Touring 1972:150).

In short, British cycle campaigning in the 1970s asserted the right to the road and utilised rationalist arguments against an entrenched view of a well-organized (motor) road lobby that held full sway in parliament. Effectively it remained within the parameters of argument set by the hegemony of the motorist, ironically advocating its potential to unlock a faster moving, more efficient city. Since the 1930s the political context of traffic management has remained essentially as laissez-faire as possible – hence the adoption of a non-statutory code of behaviour (The Highway Code) rather than comprehensive traffic regulation. These approaches are impervious to power asymmetries that would demand a comprehensive re-thinking of, for example, the allocation of road space and provision of separate infrastructure. Indeed separated infrastructure would be largely incomprehensible as special treatment for a given class of road users that is in law an equal partner (regardless of the actuality of the conditions of travel). The historical legacy of both polity and of almost a century of cycle campaigning implicitly refuted any aspirations that particular campaigners had toward the value or utility of segregated infrastructure[3].

3 That is not to say there had been no segregated infrastructure built. Considerable measure were taken in the 1930s but the CTC remained generally ambivalent

CASE STUDY 2: (WEST)-GERMANY

Cycling as a social practice in Germany during 1970s

Understanding and trying to get access to the topic "cycling and social practices in Germany" during 1970s and onwards it is relevant to start looking at the post war period including the time of the so called "Wirtschaftswunder" (economic miracle). As in many other western European countries Germany went also for mass-motorisation and transformations of cities under the common expression of the "Autogrechte Stadt" (car-orientated city) (Oosterhuis, 2016). During 1945–49 modal share of cycling was by 55 % on average in Germany. By 1962 in the middle sized city of Hannover for example, cycle use had dropped to 18 % (Bruhèze/Emanuel, 2016). During 1960–1965 private car ownership increased in Germany from 4.489.407 (1960 inhabitants of 73.147.000) up to 13.941.079 cars in 1970 (inhabitants of 78.069.000) and went to a number of car ownership in 1980 to 23.191.616 1 (inhabitants of 78.397.000)[4]. Oldenziel/ Bruhèze (2016) point out that this development stands for a common development that car ownership increased, gender roles and habits of mobility behaviour went into a one single direction.[5] There is considerable asymmetry between the rise of individual motorised transport (IMT) and the increased awareness of and statements concerning its environmental impacts.

Different forms of protest started in western countries during the oil crises in 1973 and 1979.[6] Here official proclamations through government like car-free Sundays[7] demonstrated the endless of resources for individual motorised mobility while forms of protest against current energy consumption followed and were drivers for a general growing (greenish) social movement.[8] Here the bicycle was used as a symbol for freedom, peace and as a guard for the environment. Symbols of urban gardening, repairing and recycling, knitting were typical items to support the political attitude. Famous buttons/stickers appeared: "Fahrräder stinken nicht" (bikes don't stink), "Atomkraft – Nein danke" (nuclear power- no thanks) and the sunflower which is still used by the Green Party till nowadays. Citizen's movement's concentrated on specific forms of protest and tried to get city councils to build a separate system for cyclists (Imbery, 2015).

Cycling initiatives and their symbols

Cycling groups in Germany were inspired by Danish and Dutch movements (Oosterhuis, 2014). The "greenish cycling community" pronounced one main target: better conditions for cyclists in cities. After the period of being in the status of "civil movements" they moved over to a constitutional period. Different associations were set up officially: the ADFC (Allgemeiner Deutscher Fahrradclub e.V. – German Cyclists' Association) was founded in 1979 with clear visions how to create a cycling friendly city.[9] The "every day bike" stood in the centre of the movement which rides safely on separate infrastructure through cities including taking groceries, kids to child care and so on. The "Verkehrsclub Deutschland e.V. – VCD e.V. (German Transport Association) was set up in 1986 (Bruhèze/Emanuel, 2016) and could be characterised as a harmonised form of association to support all eco-friendly modes of transport (walking, using public transport, cycling) equally.

The development of technical (bicycle) innovations were also a strong driver at that time focusing on the topic how to use human power most efficiently while cycling. Behind that stood also the idea to create a real alternative to the car to cover longer distances environmental friendly outside and between cities (Schmitz/Hadland, 1999) than the pronounced 5km inner city radius (Difu 2010). Recumbents and velomobiles appeared all over Europe and in 1986 the German association HPV (Human Powered Vehicles) Deutschland e.V. were set up. Aerodynamically efficient recumbent cycle designs were anticipated to change individual motorised mobility behaviour by showing that human powered machines can cover

4 Kraftfahrzeugbundesamt http://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/FahrzeugklassenAufbauarten/b_fzkl_zeitreihe.html?nn=652402 download 24.05.2017/Definitions of different vehicle classes:http://www.kba.de/DE/Statistik/Fahrzeuge/fz_methodische_erlaueterungen_201701_pdf.pdf?__blob=publicationFile&v=5 download 24.05.2017.
5 See also Oosterhuis (2014).
6 It is also mentioned that the eastern part of Germany has difficulties with this period and its end of resources. It is said that this period took a different development. http://www.pnn.de/campus/791081/Download from 27.05.2017.
7 (http://www.energieleben.at/sprit-sparen-die-autofreien-tage-der-70er-jahre/ (Download 2018-01-30 – 09:15am)
8 https://www.lbe.bayern.de/service/lexikon/neue/24955/index.php)(Download 2018-01-30:09:10am oder Otthein Rammstedt: Soziale Bewegung, Suhrkamp Verlag, Frankfurt am Main 1978/ Dieter Rucht: Modernisierung und neue soziale Bewegungen. Deutschland, Frankreich und USA im Vergleich. Campus Verlag, Frankfurt am Main/New York 1994 Roth, Roland; Rucht, Dieter: Die sozialen Bewegungen in Deutschland seit 1945. Ein Handbuch. Campus Verlag, Frankfurt am Main 2007)
9 https://www.adfc-nrw.de/projekte/still-leben-a40/das-laengste-fahrradmuseum-der-welt/station-4-adfc-30-jahre-jung/geschichte-adfc-nrw.html Download 2018-01-31 at 08:30am

longer distances while as also offering weather protection (Pooch, 2005). The "Fahrradlabor Köln" (bike laboratory Cologne) of Professor Dr. Paul Schöndorf from the University of Applied Science Cologne gave different answers to the pure definition of the bicycle and presented several HPV's during the IFMA (Internationale Fahrrad und Motorrad Ausstellung – International Cycling and Motor-Cycling Fair Trade) in Cologne from 1978 onwards (Pooch, 2005). It is thus worthwhile taking a closer look at the different groups working on the same topic of independent human powered mobility (Schmitz/Hadland 1999) which supports the argument why the impact of interventions have less to do with their design than with the political context into which they are introduced.

1970s campaigns in Germany

Social movements in Germany used the bike as a symbol for lifestyle, efficiency in cities, technical innovation and environmental justice. Different forms of protests like cycling naked were not necessarily ideologically occupied by "convinced nudists" and interpretations between "feeling freedom" and "natural ways of movement". It explains different forms of living attitudes (Schenkel 2008) whereas NGO's gave impact on traffic policies. The idea to create more bike friendly cities was manifest by campaigns with using instruments like "Fahrradstraßen" (bike streets) and "Spielstraßen" (playing streets). The purpose was to get separate bike (and child friendly) infrastructure. The ADFC e.V. and VCD e.V. were leading organisation to make first contacts to the federal level and getting registered at the Deutsche Bundestag (German Parliament)[10] which was an important step to manifest political strategies. The overall target was to set up a "National Cycling Strategy" till the period up to 2000 (Bruhèze/ Emanuel, 2016) in the style of the Dutch Masterplan (Oosterhuis 2014). ADFC e.V. and VCD e.V. (German Transport Association) succeeded in 2002 and Germany's federal government set up the first "National Cycling Plan" running from 2002–2012[11].

The two main 1970ies "cycling movements" ADFC e.V. and VCD e.V. managed to create from the 1980ies onwards a growing interest within society for cycling related environmental issues[12]. Their political demands fitted in a "greenish context of participation and forms of protest" in general and political demand turned into action on governmental level in specific. The involvement of other modes of (public) transport had positive impacts for mobility by bike: Transport of bicycles, trailers and tandems on trains was an important issue and taking folding bikes for free on long distance trains[13]. The VCD e.V. (German Transport Association) developed the campaign "Bahn Card" (Rail Card) which allowed travellers to use trains for a reduced prices (50 %/100 %)[14].

In comparison the Human Powered Vehicles Association Germany (HPV e.V.) initiated sportive and technology based campaigns. Its intention was to show that HPVs are more efficient than "normal" bikes for cycling further distances with same amount of energy (Pooch, 2005). Acting in a more sportive and technology orientated way these goals have been ably demonstrated but their impact remains theoretical. The (political) intention that recumbents and especially velomobiles should replace the car for daily and longer routes between cities is still unimaginable[15].

Germany's cycling initiatives kept a strong eye on the development of the cycle friendly town. Within that framework, the political slogan: "Stadt der kurzen Wege" (Difu 2010) (city of short ways) represented a bike friendly city where individual bike mobility was defined (or reduced down/up) to a 5km ratio. In comparison HPV's campaigns pronounced that human power shouldn't be reduced to this distance (Pooch, 2005 /Schmitz/Hadland, 1999). There was the fear that societies a) loose an understanding for a general (normal) ability of what "daily movement" is and b) cars dominate mobility between cities[16]. Even if the technological level and arguments pro aerodynamic effects are convincing one can identify not only different political contexts but also suspicious attitudes between "normal" bike riders and HPV riders.

10 https://www.adfc-nrw.de/projekte/still-leben-a40/das-laengste-fahrradmuseum-der-welt/station-4-adfc-30-jahre-jung/geschichte-adfc-nrw.html; Download 2018-01-30 09:30am
11 https://web.archive.org/web/20120605124605/http://www.bmvbs.de/cae/servlet/contentblob/20450/publicationFile/10766/nationaler-radverkehrsplan-2002-2012-fahrrad-massnahmen-zur-foerderung-des-radverkehrs-in-deuts.pdf Download 2018-01-31 at 09:40am
12 https://www.adfc-nrw.de/projekte/still-leben-a40/das-laengste-fahrradmuseum-der-welt/station-3-geschichte-der-radwege/geschichte-der-radwege.html Download 2018-01-30 at 09:45am
13 https://www.bahn.de/p/view/mdb/bahnintern/agb/gesamt_2017/mdb_259936_befoerderungsbedingungen_der_db_ag_ab_13_11_2017.pdf page 21- download 02-02-2018 at 06:30pm
14 https://www.vcd.org/der-vcd/geschichte-erfolge/ Download 2081-02-02 at 09:00am
15 https://www.planet-wissen.de/technik/verkehr/geschichte_des_fahrrads/pwiebesondereraeder100.html Download 2018-01-30 at 09:50am
16 Different/several grey HPV papers. Another side effect of this attitude that a strong movement of early "Electric-cars" (with solar power) were constructed. The "Tour de Sol" in Switzerland was each summer an event where established car manufactures like Mercedes Benz participated and allowed their students to test prototypes.

NO SOCIAL PRACTICE CYCLING HERITAGE!? OR: SOCIAL PRACTICES AND POLITICAL CONTEXT AFTER 1970S

At the beginning we argued that the design (incl. symbols etc.) of interventions has less to do with a design than with the political context into which social practices are introduced. Notable across the range of these oppositions is the way that the problems faced a frame. This is a crisis of transport and of pollution. The bicycle appears as a potential saviour only inasmuch as it offers a more rational solution to the problems – it offers a potentially faster moving and more efficient city. Existing bicycle lobbying embraces this outlook. What fails to materialise among these many protests is a fundamental reconsideration of what and who the city might be for. Neither UK nor German cycle campaigning was sufficiently integrated with broad social concerns and political institutionalised frames. Instead, it concentrated on cycling as a distinct practice.

After over 40 years of identifying cycling and its social practices in Europe (and beyond) we might come to the point of showing a linkage to get the context of today's movements. Oldenziel/Bruheze (2016) explain the transformation of cities from car orientated planning in post-war Europe to more bike friendly conditions today: Grassroots movements made paths ways for cyclists and vice versa. Now so called "new" subcultures initiate new social practices of cycling for a new generation. They reclaim their terrain by opening bike kitchens, organizing critical mass rides (Hartz 2015/Hilgers 2015/Meier 2015), and combining new urban gardening cafes with (re-)cycling attitudes or establish shared cargo bike concepts within their neighborhood. From an older perspective even yarn bombing "bike knitting" might be dismissed as means to show that the bike and its daily practice turn the bike into a post-modern fetish rather than a means of sustainable transport (Probst 2014). Yet they simultaneously enable new generations of activists to establish the bicycle as belonging to them as transport.

New urban (bike-)"singularities" (Reckwitz, 2017) have to find "special" identities in cities to avoid standardization. At the same time cities have to have to create new urban design in order to create distance from the "standard" ordinary city itself. So called "new" gender discussions about "women and cycling" appear latest again in public while projects attempt to get young woman onto bikes and into public again (Wupperman/Grassick 2009). Even naked bike rides are again an "established form"[17] of regular protest during critical mass.

New dispensation of city movements[18] like "Volksentscheid Fahrrad"[19] (referendum bike) appeared during the last years in cities like Berlin and Hamburg. These movements started to put a demanding pressure on civil services and politicians to change cycling conditions in cities. Here, "successful" recipes of social practices seems to create a central (male) "man of action" who advertises and focuses first on himself. Here, specular activities provide forms of "legal" action on one hand and high quality levels of discussions with the involvement of city councils on the other hand. For these groups (or this man) the official forms of administrational sequences are of central importance to get the connection between public participation and administration of city councils.

The civil citizenships of the 1970s and 1980s that created (or re-created) long serving NGO's in UK and Germany seem no longer to play an important role within post-modern "social practices" of cycling. The long experience of existing groups no longer seems vital as a resource for new movements like the "Volksbegehren". One might assume that the "new generation" of bike activists will bring new ideas for future planning's to the agenda and this will be vital to create their own social practices for patterns and structures of (non-)corporation. Thinking about the discussion Oosterhuis (2014) argues that changing behavior is now considerably more problematic insofar as a) NGO's make little progress within own "cycling system" and b) only little (modal share) change has been made in comparison to last 40 years.

17 http://www.worldnakedbikeride.org, download 26.05.2017.
18 http://www.centrosociale.de/2017-05-28/f-r-ein-volksentscheid-fahrrad-hamburg, download 28.05.2017.
19 https://volksentscheid-fahrrad.de/de/willkommen-beim-volksentscheid/
https://volksentscheid-fahrrad.de/de/2017/05/12/volksentscheid-fahrrad-stachelt-bundesweit-buergerentscheide-und-initiativen-mit-barcamp-drehdeinestadt-in-hamburg-an-3667/ , download 28.05.2017.

CONCLUSIONS

In the UK official policies from a governmental level were strong drivers for the relationship on roads between car drivers and cyclists' and their rights how to act and behave there. Bicycle organisations tried to set up "leisure cycling" instead of "urban cycling" as a form of daily activity while asserting in their campaigns the right to use the road. Germany had a variety of different campaigns which were first set up by grass route movements before official associations tried to give the political demands an official frame in order to act on a democratic legal level. The political concentration lied on increasing urban quality instead of leisure cycling. The political force to build separate infrastructure for cyclists were build up by several different campaigns.

The co-evolution (Shove 2015) of different social practices in the 1970s onwards showed for both case studies that even under a similar historic western development (Ooosterhuis 2016) the interventions of the associations had different outcomes. Even if overall targets i.e. "better conditions for cycling" are a common goal of associations the outcomes differ after over 40 years in both countries. Nowadays new grass route movements neither accept the heritage of experiences of the "old ones" nor using the same symbols/designs. Even if cycling is still pronounced as a key solution for better life quality in cities and a changer for adding value to the sustainable global goals (Neun, 2018). The perspective of active mobility (Held/Schindler/Neun, 2015) and now fusion mobility (Neun, 2018) seems on one hand to stabilise broad knowledge but on the other hand bridge only a little understanding of what "cycling" means.

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http://www.pnn.de/campus/791081/
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http://www.worldnakedbikeride.org/

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https://volksentscheid-fahrrad.de/de/willkommen-beim-volksentscheid/
https://volksentscheid-fahrrad.de/de/2017/05/12/volksentscheid-fahrrad-stachelt-bundesweit-buergerentscheide-und-initiativen-mit-barcamp-drehdeinestadt-in-hamburg-an-3667/

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Footnote 12:
https://www.adfc-nrw.de/projekte/still-leben-a40/das-laengste-fahrradmuseum-der-welt/station-4-adfc-30-jahre-jung/geschichte-adfc-nrw.html

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https://web.archive.org/web/20120605124605/http://www.bmvbs.de/cae/servlet/contentblob/20450/publicationFile/10766/nationaler-radverkehrsplan-2002-2012-fahrrad-massnahmen-zur-foerderung-des-radverkehrs-in-deuts.pdf

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Footnote 17:
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http://www.bpb.de/politik/hintergrund-aktuell/172918/autofreier-sonntag-1973-25-11-2013

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EXPERT COMMENT

Holger Haubold
European Cyclists' Federation (ECF)

When it comes to promoting cycling, the question "What works and what doesn't for a specific city/region/country?" is fundamental, yet surprisingly often overlooked. New concepts are tried out or copied from elsewhere without studying the context they are implemented in. At the same time, new developments in technology and infrastructure planning might change the concept of cycling quite rapidly in the future. These two issues are treated by the articles of this chapter.

In their article "Social Practices and the Importance of Context", Cox and Bunte look at the historical component in the formation of current cycling practices. They argue that a large share of research on behaviour change lacks this historical component, just as many promotional activities. According to the authors, this compromises the effectiveness of interventions aimed at behaviour change since it ignores the context in which these actions take place. They develop their argument with the help of two case studies, the United Kingdom and West Germany. In both cases, they take a systematic look at the evolution of cyclists' movements and promotional activities with a focus on the 1970s, embedding it into the broader context of social and environmental movements of the time, but also mainstream transport policies of both countries. They find that results differ in both countries due to different contexts and the focus of associations on "leisure cycling" in the UK and "urban cycling" in West Germany. Finally, the authors look at emerging new forms of civil participation in cycling policy, how they relate to the "traditional" forms, and how they might evolve in the future.

The article "New strategies and digital applications to boost cycling" by Bracher and Bührmann looks at new developments that have the potential to increase cycling levels in a decisive way. The authors focus on transport planning and infrastructure, digitalisation and "connected cycling", and mobility culture. They take a rather optimistic approach, stating that changes like better integrated urban planning including cycling, the redistribution of public space, the construction of cycle highways, or new digital location and assistance services for cyclists will help to make cycling more prevalent. They also briefly discuss a new "mobility culture" they see emerging with the bicycle as a new "lifestyle product", helped in part by (public) promotion campaigns.

Looking at the two articles, it appears that there is a considerable gap between researchers and practitioners in this field. On one hand, the practitioner article gives an excellent overview of new planning practices, infrastructure developments and new technologies that could shape the future of cycling. However, it does not pay much attention to the social and political context in which they are introduced, which is exactly what the research article criticises. Taking the viewpoint of Cox and Bunte and looking at earlier promotion campaigns and initiatives, this might compromise the success of these new developments in increasing cycling. The concept of "mobility culture" is addressed by Bracher and Bührmann, but in a very brief way, and without giving empirical evidence for the described "cultural" changes or looking into why they are happening.

On the other hand, the research article, while giving a very concise and easy to grasp historic account of cycling promotion through the two case studies, would benefit from looking a bit more at current developments and applying its approach of contextualisation on them. This would make it even more relevant for practitioners by showing them concretely how they could improve their understanding of context to create successful campaigns and use the potential of new planning approaches and technologies to the fullest in order to increase cycling.

Both sides could learn from each other. For the researchers, it would be important to apply their methodologies to current developments and examples, while the practitioners would benefit from a more systematic approach to designing promotion campaigns and assessing the potential of new technologies and planning processes. Taking the political and social context more into account would help them to better evaluate what works best and predict which measures and campaigns would be the most effective in terms of cycling promotion.

Bracher and Bührmann actually mention some questions that hint towards this contextualisation in their article, for example on how all the technological developments and the emerging of "connected cycling" will go together with the notion of cycling as an easy, cheap and uncomplicated means of transport, or what the "social, political and economic factors for implementation" of connectivity between bicycles and (automatic) motorised vehicles will be. However, they do not delve deeper into these issues other than enumerating them. To study these questions would be an urgent task for researchers, since the mentioned developments could also present threats for cycling – for example by making it more expensive and more complicated, or by framing it as a "problem" that has to be overcome for the development of automated vehicles.

To conclude, there remains a lot to be done to bridge the gap between researchers and practitioners in this field. Introducing (more) classes on the social and political context of infrastructure planning and mobility policy into the training curricula of urban planners could be one way forward; providing more fora for exchange between the different fields another one. This would provide researchers with relevant current research questions, while giving practitioners the chance to improve their measures and campaigns by putting them into a more systematic frame – and in the end hopefully implementing those that are most effective and fitting to the specific social and political context.

2.6 Planning with GPS data

Practice

From people to people – The self-benefit of crowdsourced cycling data as part of the European Cycling Challenge

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Research Comment

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PRACTICE

From people to people – The self-benefit of crowdsourced cycling data as part of the European Cycling Challenge

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ABSTRACT

The European Cycling Challenge (ECC) is a team competition among urban cyclists that takes place every year during the whole month of May. Initiated in 2011 in Bologna as a small test within the CIVITAS Mimosa Project, the ECC is now an event joined every year by thousands of cyclists all around Europe.

The ECC applies a gamification approach to daily commuting. In 2016, 52 European cities from 17 different countries joined the fifth edition of the challenge. 46,000 people cycled 4,000,000 km in a month, producing a large amount of GPS data that was shown as live "cities' heatmaps" during the ECC and which is used by cities for assessing users' needs and for cycle planning. ECC has twice won the CIVITAS Award, in 2013 and 2016, as the best communication initiative given its innovative use of online applications to study and assess users' needs.

Since the number of cyclists influences the chances of winning the challenge (and the amount of GPS data collected), each city deploys its best local communication strategy to involve the maximum number of participants. ECC is a fun initiative at local and international level which is able to facilitate new partnerships between cities, new local groups (NGOs, advocacies, etc.) and countless number of other events. Moreover, the project can trigger behaviour changes among commuters.

The crowdsourced GPS data has multiple uses and impacts in participating cities. There have been different research approaches on a local level: applied data research, GIS mapping and path assessment, safety checking of physical infrastructure and cross matching with GPS data, cyclists' behaviour research, etc.

This paper describes two use cases from Bologna and Rome in which cycling GPS data is exploited for the self-benefit of city users. It is a virtuous circle, since the results of cycling flows analysis are made available to the cyclists who originally produced the data.

Keywords: cycling, gamification, behaviour change, GPS data, participation.

INTRODUCTION

The European level

In 2012, the test carried out in Bologna in 2011 was implemented again and scaled up to a group of cities, by adding a layer of gamification to the challenge. It was the first edition of the European Cycling Challenge with seven European cities challenging each other on the highest mileage cycled on urban trips.

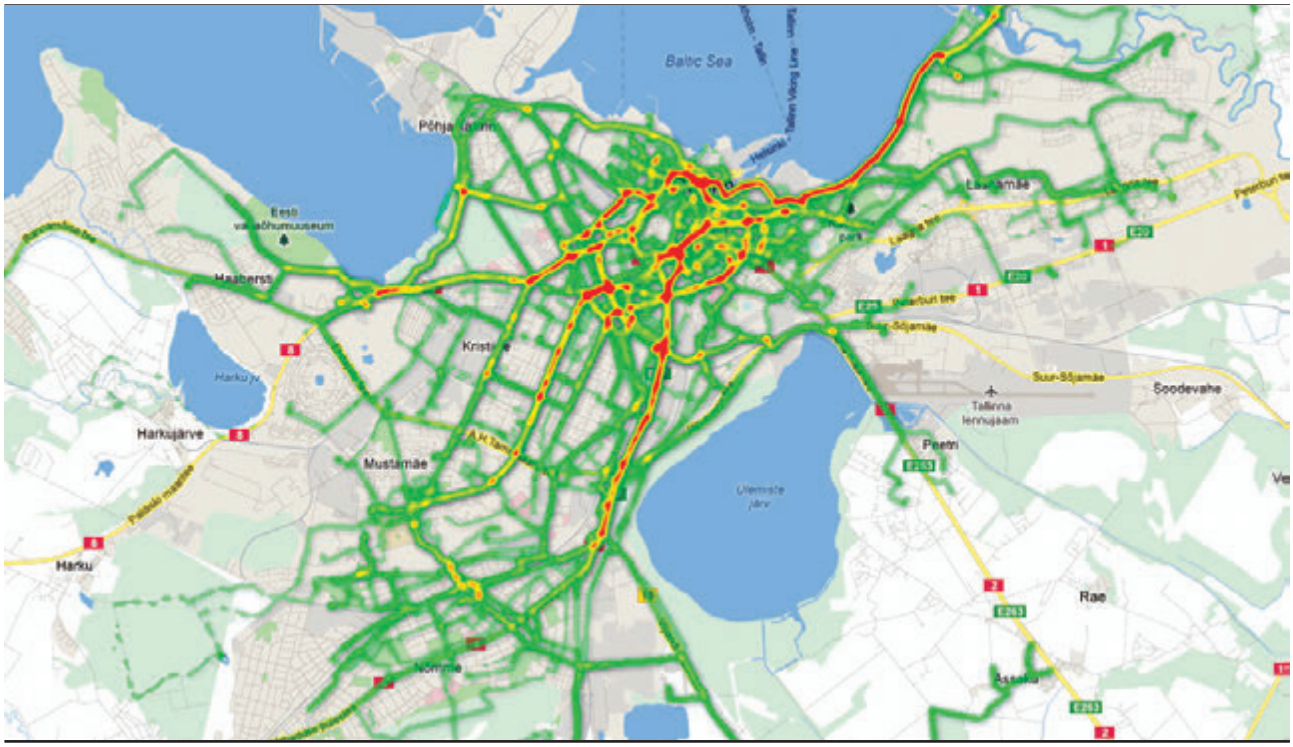
In Estonia (Tallinn), Italy (Bologna and San Lazzaro di Savena), Spain (Barcelona), United Kingdom (Reading), Romania (Iasi) and Greece (Saronikos) 715 people cycled about 90,000 km (more than two times around the Earth along the equator), saving about 20 tons of CO_2.

The challenge has also been an important planning instrument for local bodies. Indeed, mobility behaviour and data on cyclists' trips have not been as available as for car-drivers, because cities have not had the opportunities to collect them. Through ECC the participating cities held detailed data on commuting and mobility by bicycle for the first time. The data could be easily processed and displayed through colourful cities' heatmaps (see Figure 1 below). Thus, the ECC quickly became a behaviour change campaign with great potential for gathering very important data for urban planners and policy makers at city level.

After the end of the CIVITAS MIMOSA project, the ECC adopted a basic business model to ensure cost coverage for the organisers: 1,000 Euro as subscription fee for each participating city and 1,000 additional Euro for the collection and delivery of the raw GPS data. Participation continued to be free of charge for cyclists.

Figure 1

Heatmap of cycling trips tracked in Tallinn (EE) that won the first edition of the European Cycling Challenge



Source: Own illustration

GAMIFICATION AND BEHAVIOUR CHANGE

As with the European Cycling Challenge, behavioural change often is the ultimate goal of policy-makers. A current trend towards promoting sustainable mobility behaviour makes use of game dynamics. This is usually referred to as "gamification", i.e. the use of "game design elements in nongame contexts" (Deterding/ Dixon et al., 2011). It aims at taking advantage of the power of game mechanics for non-entertainment purposes (Nelson, 2012). Gamification mainly endeavours to influence behaviour, and has been explored and used in many sectors, such as education, health and wellness, crowdsourcing, or sustainability. This instrument is also promising for the mobility domain.[1] In general, gamification is used "to influence behaviour, improve motivation and enhance engagement" (Marczewski, 2013). In the transport domain, gamification can be useful for different purposes, e. g. by monitoring users' travel behaviour. It can be used to encourage more sustainable traveling choices, for example through a "trip challenge" or an "emissions reduction challenge". In that way they propose alternative ways to users to make their trips faster or with fewer emissions (Jylhä/Nurmi et al., 2013), or to foster safe driving, by assigning points for economically-friendly driving (Klemke/Kravcik et al., 2014).

The gamified approach of the ECC is based on a mileage challenge at city level and on sub-challenges among groups, companies, schools and individuals. These three levels trigger team competition and communication of the challenge on a "word of mouth" basis. This last feature is an important factor in the ECC, allowing people to recruit more team-mates and gaining more local competitors at city team and sub team level.

The ECC turned out to be a successful tool to motivate people to use their bicycle for daily commuting. Designing gamification preliminary requires analysis and understanding of the problem at hand. The gamification in ECC has the purpose to influence behaviour on the one hand and to monitor users' travel behaviour through collected GPS data on the other hand.

1 See, for instance, CIVITAS Training: Influencing behaviour through gamification (http://www.civitas.eu/content/civitas-training-influencing-behaviour-through-gamification)

COLLECTING GPS DATA

The ECC is a fun and easy way to challenge ourselves, friends, colleagues and other cities to cycle more. At the end of the challenge, the GPS data collected by the app provides very detailed and large amounts of information on the behaviour of cyclists in the participating cities. This data can be very valuable for city planners and decision makers for several reasons: to check the efficacy of the existing cycle-lane network (see example given in Figure 2 below), to plan the future of mobility in their city on the basis of the real needs of citizens, to be used in SUMPs, to be used as a basis in modelling software, etc.

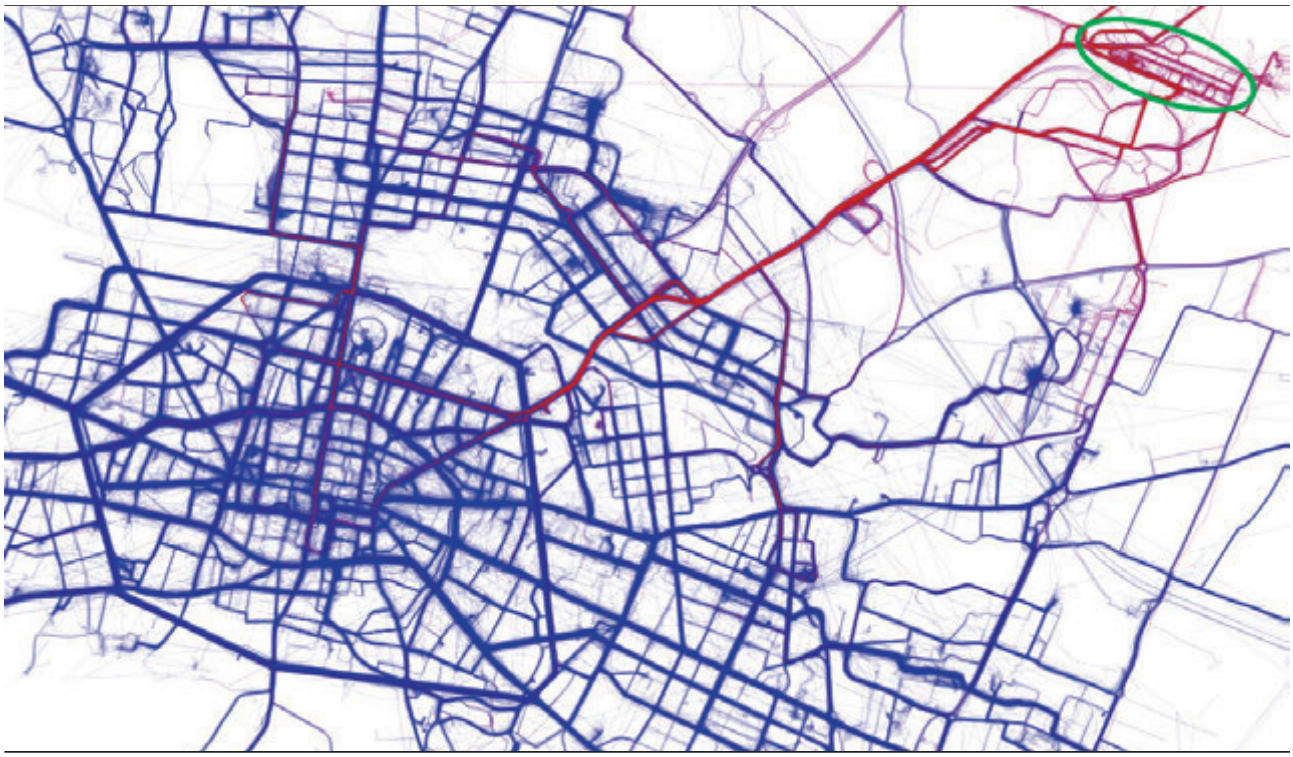
GPS data is easily comparable with data collected from other sources. In the figure below, GPS data collected during ECC2015 is compared with cycle counting data collected by the University of Bologna in 2015 at 7 different sites. The comparison of the two datasets highlighted that the number of cyclists tracking their trips for the ECC was about 1 % of the number of cyclists in the city on the same day (significance between 0.8 % and 1.4 %) and allowed the validation of the data sample collected through the ECC compared to the total number of bicycle users.

The quality of the data is completely different from other data collected from cyclists. It provides a lot of detail on speed, waiting time, volume of traffic, gender, timing, influence of weather conditions, daily users versus infrequent ones, etc.

In order to avoid any privacy-related complaints or misuse, GPS data is always anonymised before it is analysed.

Figure 2

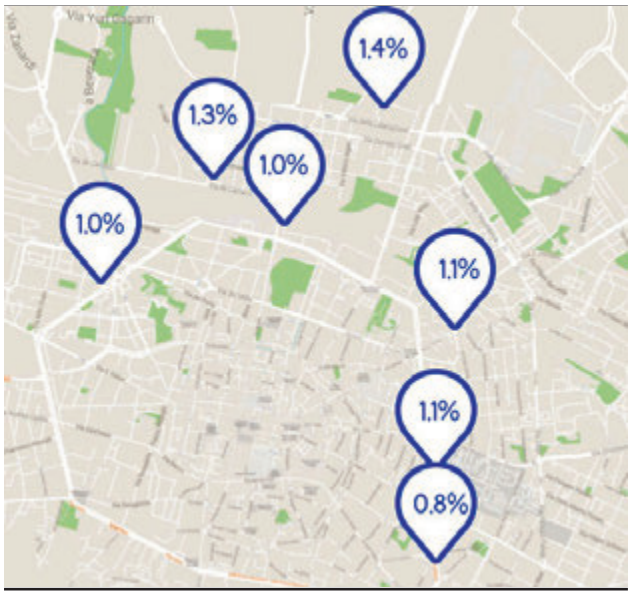
An example for data analysis of customers of a shopping centre (circled in green) in Bologna based on cycling data collected during ECC2015Heatmap of cycling trips tracked in Tallinn (EE) that won the first edition of the European Cycling Challenge



Source: Own illustration

Figure 3

Comparison with cycle counters and significance of data collected in Bologna (sources ECC2015 and DICAM monitoring 2015).



Source: Own illustration

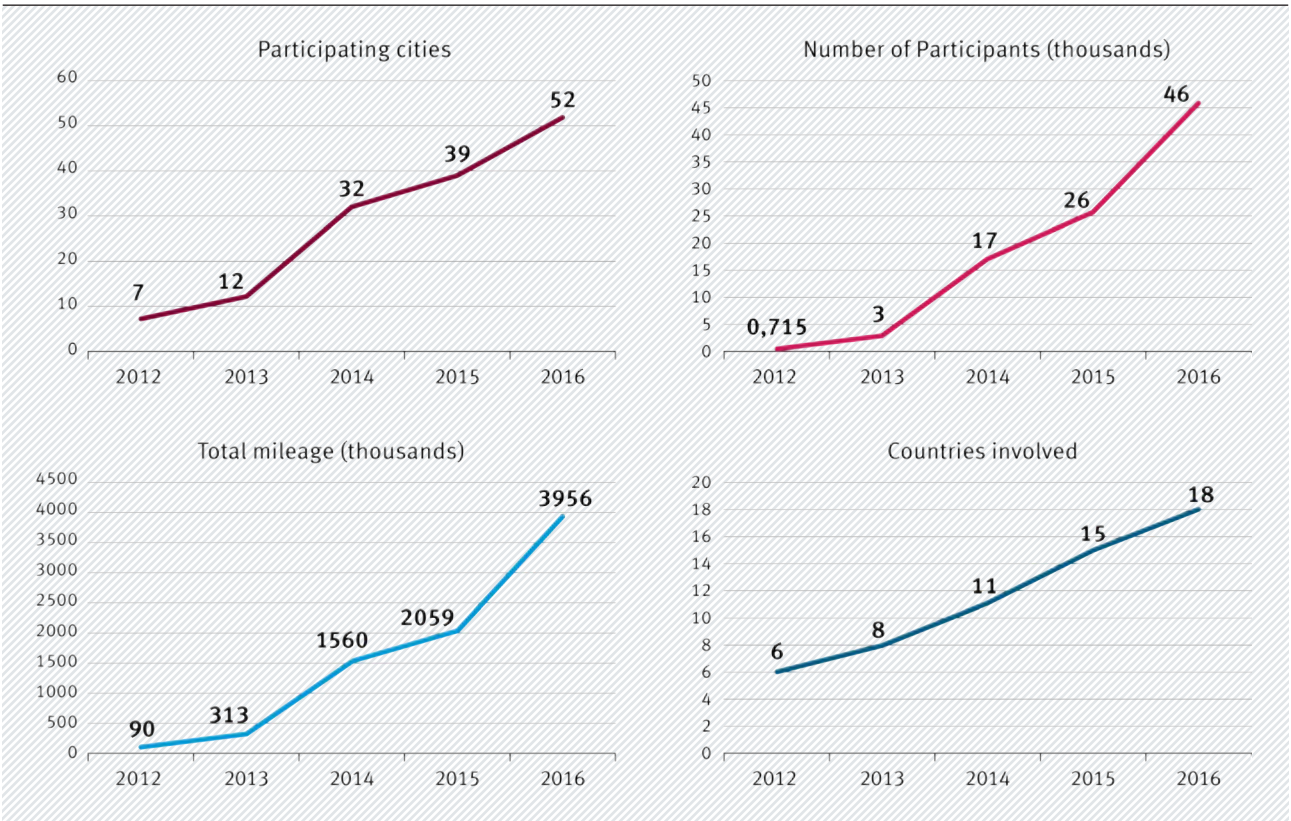
Some figures about the challenge

Since the first European edition, the challenge has grown every year, both in terms of participants and in terms of mileage.

To be as inclusive as possible, the ECC allowed participants to manually insert tracks or to upload gpx files from other devices or other apps. Thus, not all kilometres reported in the leader-boards were actually tracked, but most of them were.

Figure 4

The constant growth of the European Cycling Challenge over the years.



Source: Own illustration

EXPLOITING GPS DATA

It was up to the cities involved to decide how the data collected should be utilized. Data was sent to the cities' coordinators as raw CSV files containing trips and GPS points, then each city was free to use it for their desired purposes, using the most appropriate tools. In the following section of this paper two use cases from the city of Bologna and from the city of Rome will be presented briefly.

1. Data collection

In order to take part in the ECC, users had to install the app Cycling365[2] developed by SRM which has been available for free worldwide.

For every trip recorded, the following data was available: the scope of the trip (work, leisure, study, other), age, gender, job of the user and GPS location measured every 5 seconds (latitude, altitude, longitude, distance, date and time). Each recorded trip was filtered according to some parameters related to maximum speed, average speed and length of the path. The app also provided each user with a personal heatmap of the recorded and validated trips. Moreover, each trip was linked to a "UserID" and a "TripID". Data was stored in a special database on a local host server, managed by an external provider and secured by a password.

Data was exported to a ".csv" format in order to be analysed by GIS software that supports viewing, editing, and analysis of geospatial data.

The system used was designed to be scalable for a large number of cities playing each other and to cope with different initiatives at the same time.

2. Use Case in Bologna

A very simple case of GPS data collection during the European Cycling Challenge is described in this first use case from Bologna.

The cycling modal split in the City of Bologna is about 6 % of total journeys while in the Metropolitan area (partially involved in ECC) it is about 5 %. The car ownership rate in Bologna is still quite high since there are about 500 cars per 1,000 inhabitants (800 cars per 1,000 inhabitants in the Metropolitan area). In 2015 and 2016, ECC participants in Bologna tracked roughly 80,000 and 120,000 km respectively.

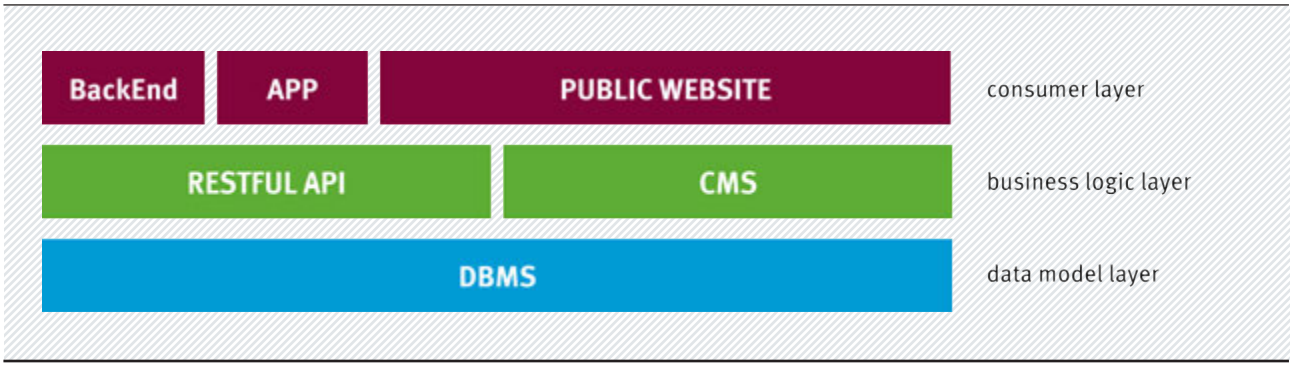
In 2016, the Municipality of Bologna wanted to install 1,000 new bike racks at about 100 different locations throughout the city centre, since the modal share of cycling had been rising in the previous years and illegal parking of bicycles had increasingly become a problem.

The municipality asked citizens and companies through an online survey to report their needs for parking locations for bicycles in the city centre, but also asked SRM to make an analysis of the starting points and destinations of cyclists deriving from the data collected by the ECC.

2 Cycling365 was the app used for the ECC2015 and ECC2016. Previously the ECC used Endomondo as tracking app.

Figure 5

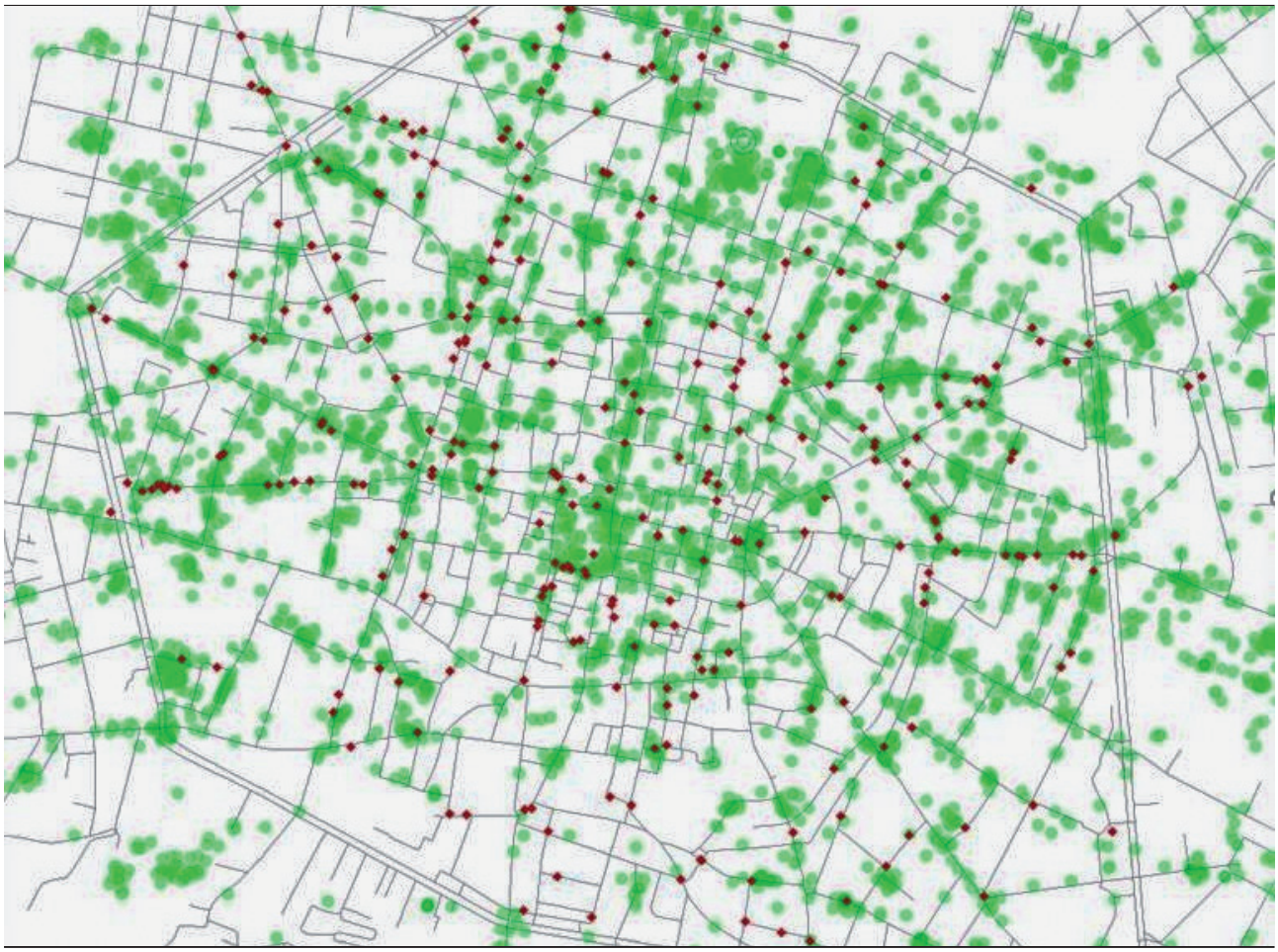
Cycling365 System Architecture



Source: Own illustration

Figure 6

Location of new bike racks installed in Bologna 2016 (red dots) and destination of trips in ECC2015



Source: Own illustration

SRM assessed GPS data with QGIS software and delivered a heatmap and a list of possible locations for the new bike racks to the policy makers. The heatmap extracted from the data analysis refers to any trips to the city centre or areas nearby.

Data was based on 16,773 trips recorded during May 2015. The sample included 9,409 trips tracked by male users, 4,738 tracked by female users and 2,626 by unknown gender (the gender entry was an optional request during the registration phase). The general average age of participants was 37.5 years for ECC2015.

The identified locations were characterized by the presence of aggregation or intermodal sites, such as universities, schools, railway stations, etc. The heatmap helped the technicians with the on-site inspections which were made to evaluate the demand against the availability of parking sites.

After checking the heatmap, the results of the survey (74 respondents) and the on-site inspections, the Municipality of Bologna placed about 1,000 new bike parking racks in several places within the city centre (see Figure 6).

The Municipality of Bologna has currently no data on the actual use of the installed bike racks, but since the places were chosen according to the users' needs (cycling data and survey) it is expected that the racks are well used. Some before/after examples are given in the pictures below:

- a bike rack was installed in Via delle Lame, 160, close to a relatively new cycle lane that connects the city centre to the western area of the city (Figures 7 and 8);

- a bike rack was installed in Via Luigi Calori, close to a business area and the inner-city sports hall (Figures 9 and 10);
- an additional rack was installed in Piazza dei Martiri close to an existing one in front of a supermarket to avoid improper parking (Figures 11 and 12)

This first use case shows how crowdsourced data could help decision-makers to improve existing infrastructure to the advantage of those citizens who most probably produced that data in the first place.

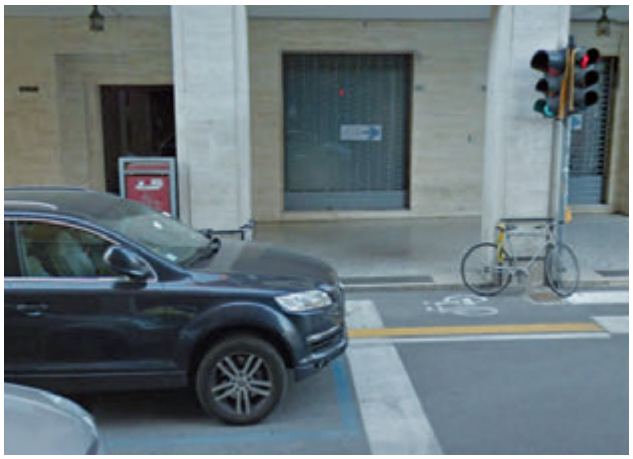


Fig. 7 Via delle Lame, 160 before the installation (© Google Maps (2015))

Fig. 8 Bike racks installed in Via delle Lame, 160 (© Google Maps (2016))

Fig. 9 Via Luigi Calori, 1 before the installation (© Google Maps (2015))

Fig. 10 Bike racks installed in Via Luigi Calori, 1 (© source Google Maps (2016))

Fig. 11 Existing bike racks in Piazza dei Martiri, 1 (© Google Maps (2015))

Fig. 12 Second set of bike racks added in Piazza dei Martiri, 1 (© Google Maps (2016))

3. Use Case in Rome

The modal split of the City of Rome reveals that bicycle use in the city is on a very low level. With a population of about 2.8 million, only 1 % of road users are using a bike for their journeys compared with 54 % travelling in private motorised vehicles. In Rome car ownership is still very popular with 675 cars per 1,000 inhabitants[3]. Thus, the ECC represented an opportunity to nudge people towards cycling, create a community of users and make urban cycling more attractive.

#PedalaPerRoma (Pedal for Rome) was the official hashtag chosen by *Roma Servizi per la Mobilità*, the Mobility Authority of the City of Rome, to launch the European Cycling Challenge 2016 in the City of Rome. During the month of May, ECC was being hosted on the @PastaRoma twitter account, where daily news were available. Together with a new hashtag, a special brochure and most importantly a new challenge were being offered. For the very first time, Rome gathered an unexpectedly large number of local cycling NGOs which significantly contributed to the process of planning and disseminating the 2016 edition.

Thanks to the substantial participation, Rome proved those Romans wrong who still think investing in "cycling measures" is a waste of public money because "Rome is not Copenhagen".

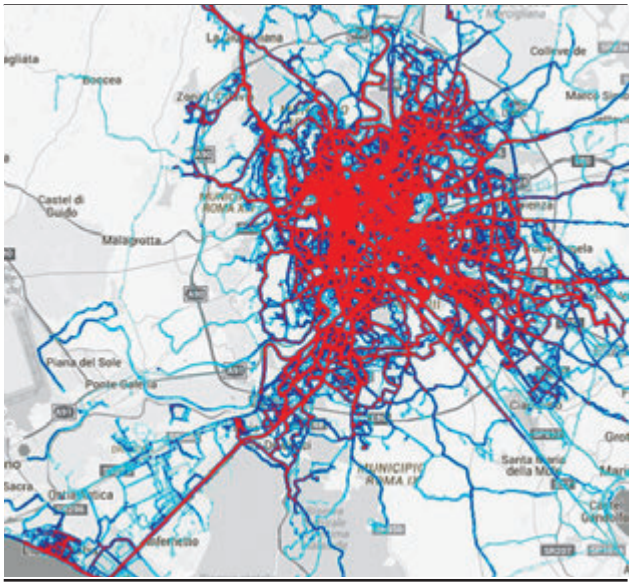
In the two previous editions (2014 and 2015) Rome's participants progressively grew in numbers; in 2016 Rome felt particularly confident and set the audacious goal to reach 200.000 km tracked in one month.

Rome not only reached the goal, it went beyond it and managed to pedal 205.240 km, a +18.5 % compared to 2015. Both participants (+10.7 %) and active cyclists (+14.7 %) also progressed compared to the 2015 edition, showing the potential of cycling throughout the city.

Rome recorded over 28,000 cycle trips in 2016, of which 56 % were bike-to-work journeys. The average distance recorded daily by users was 7.4 km, while the average speed was 13 km/h.

Figure 13

Heatmap of cycling trips tracked in Rome during the European Cycling Challenge 2016



Source: Own illustration

Figure 14

New bike lanes in Rome according to the heatmap of cycling flows

Source: Own illustration

All this data along with the Heatmaps constituted precious information that *Roma Servizi per la Mobilità* gathered and processed in order to improve the existing cycling infrastructures and/or to build new ones.

In the figure 14, newly planned bike lanes, such as the Via Ostiense/Via Aventino are highlighted (in

3 https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/Nussio_Mobility_plan_in_Rome.pdf

blue), following the analysis of cycling flows within the European Cycling Challenge 2016. The project is a fine example of how to take full advantage of this kind of technology for planning cycling measures.

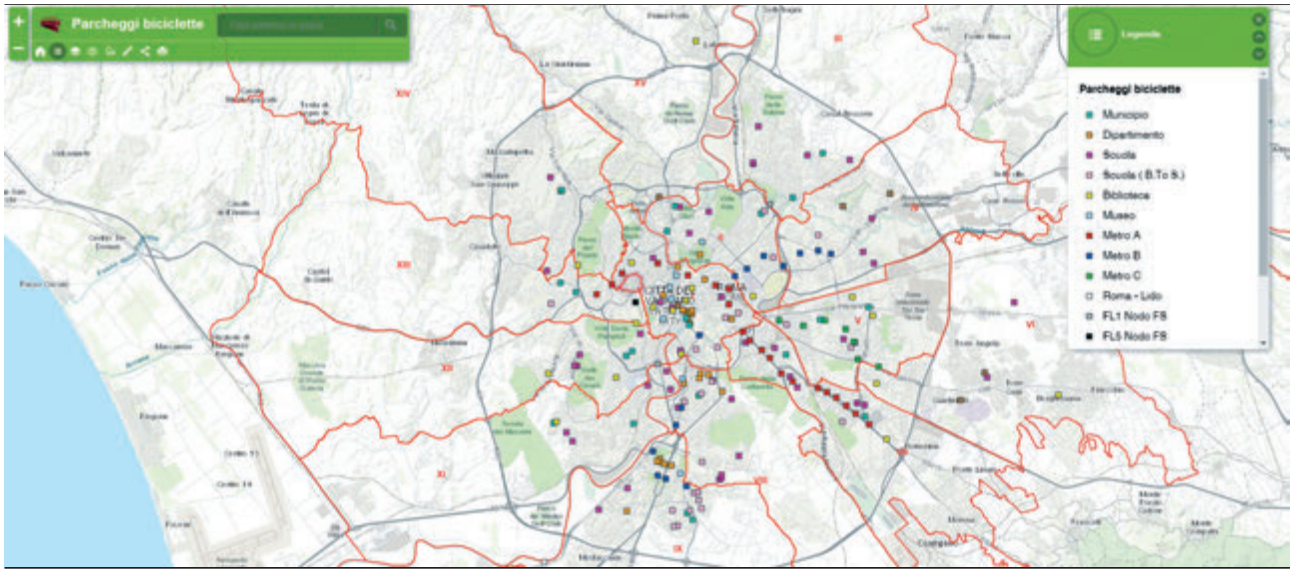
Rome also used its new understanding of cyclists' main routes to identify several spots for 300 new cycle rack locations to be installed by 2017 as part of the PASTA project (Physical Activity through Sustainable Transport Approaches).

Similar to the use case 1 in Bologna, origin and destination of the trips were used to help understand the current needs of cyclists in Rome. Data was generated through interested local stakeholders and institutions as well as urban planning analysis.

Destinations were found to be mainly located near public schools, public offices, metro and bus stops. The map below shows the locations identified by Roma Servizi per la Mobilità, according to the current situation (the offer) and the data collected within the European Cycling Challenge 2016 (the demand).

Figure 15

Locations for 300 new bike racks installations in Rome



Source: Own illustration

CONCLUSIONS

The ECC represents a unique way to promote cycling, have fun and collect data on cycling. Positive competitiveness promotes team spirit among cyclists, and encourages the creation of groups which local authorities can refer to and which can be involved in cycling related activities.

Furthermore, the collected data is of great value to mobility planners, providing high quality information on the real behaviour of cyclists in cities as an input for city and traffic planning.

The use cases presented in this paper, demonstrated that crowdsourced cycling data are the key in a self-benefit process in which the participants are creators and beneficiaries at the same time.

Policy makers and local authorities are the initiators of the data collection and the recipients of large amounts of information provided by the road users. Universities and research centres are key stakeholders in exploiting this information through research and studies. The added value of this process lies in the fact that cities that took part more than once obtained historical and comparable datasets, allowing them to assess policies year on year.

Collected data was exploited through various tools and also combined with other data from other sources.

Following the cyclists' efforts tracking all their trips, cities should take account of the data received, trying to exploit it as much as possible to improve safety and efficiency of road networks for cyclists. Many participating cities could do more regarding this aspect. In many cases a lack of activity is due to budget restrictions but also to the lack of technical support or knowledge.

Even cities such as Bologna and Rome that now own huge historical datasets on cycling, utilised these less than initially expected.

Furthermore, after ECC2015 and ECC2016, SRM withdrew the Cycling365 app from the stores since the maintenance of the app, the hosting of data, the continuous updates requested by different operating systems, turned out to be too expensive in terms of money and staff effort.

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RESEARCH COMMENT

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The article describes in a very practical way the use of GPS data in municipalities – and additionally: all of its difficulties. First it can be stated, that adequate knowledge of cyclists' behaviour and route choice is lacking for a great number of cities. And so, tracking data is definitely meeting a demand in bicycle planning. With the growing number of smartphone ownership in European countries (80 % in 2018 in Germany) and a raising interest for selfmonitoring and citizens science, datasets like the one created by ECC are being generated more often. Similar examples are Strava or the BikeCitizens. When it comes to the scientific research, however, there are only a couple of studies with datasets of this size (Hood, Sall, & Charlton, 2011; Menghini, Carrasco, Schüssler, & Axhausen, 2010). Science is lagging behind in this field.

The strength of GPS tracked bicycle data lies within its spatial availability and its visual power. First: it clearly fills a need not met by automatic counting stations, which can only deliver punctual data in a wide street network. Second: it can offer interesting insights for policy makers. Cyclists become visible in a spatial context. For scientists this kind of data is valuable for a wide range of studies. It can be used to focus on travel patterns or cyclists' behaviour; for planning as described in case one or three in the article; or to evaluate bike paths, which have already been build.

Its strength in numbers (of participants) and spatial distribution notwithstanding, GPS data has also a substantial weakness. The participants are not selected by chance. Instead, there is a significant bias due to self-selection by personal interest. It also has to be considered, that there is a systematic exclusion of people without a Smartphone or GPS-Logger. In fact, GPS data fails when it comes to representativeness of information. It is not even quantified. This is a problem both – scientists and practitioners – will have to deal with within the next years.

Another issue, which has to be solved, is the low number of participants compared to the total inhabitants of a city. This is crucial for short term data collection because a minimum of statistical certainty is needed.

In the article, numbers of participants are rather high compared to other data sources, but show a distinct bias towards middle-aged men. This corresponds with several scientific studies in this field (Broach, Dill, & Gliebe, 2012; Jestico, Nelson, & Winters, 2016). The exact influence of this rather special user group remains unclear at the very moment.

Looking from the scientific side, it is essential to qualify and quantify the influence of selfselected samples on, for example, route choice or speed. A sportive cyclist – like a Strava user – will differ substantially from a young woman taking her child to the kindergarten. A "die hard" cyclist will definitely take a different route from the A to B chosen by a senior citizen. On the practitioner's side, it is important to work with this new data source even though numerous questions arise while doing this.

If we consider the usage of GPS data by practitioners, like in the two use cases in Bologna and Rome, it has to be stated that there is a gap between science and practice. Not in working together, but in having two very different views and opportunities of how data should be used to foster cycling in municipalities. Whereas data from scientific projects has a sound pre-processing, the data in our example was delivered in a very raw manner to the cities taking part in ECC. This is perfect from a scientific view because no information is lost. But an administration has not necessarily the knowledge or man-power to validate or verify GPS raw data. As such, there will be no cleaning for outliers, trip segmentation or mode detection. This can be done by universities or economy. Ways to work with GPS datasets in general were shown by Bikeprint.nl which was initially an open source approach. Further, the context of data collection is also important. Gamification approaches for example can lead to short term behavioural change. This could be a hindering fact in data comparison.

From the practitioners point of view the three use cases state undoubtedly that GPS data can be of substantial use for bicycle planning. Hence, there is a very clear mandate for science to harden the interpretation of data by addressing the representativeness of data sources. Both economy and practitioners have made a first step in using the data as shown in the two use cases. Science now has to work on the degree of reliability of data to obtain a really useful and trustworthy tool for bicycle planning.

As a first step it must be addressed how different types of cyclists differ in their mobility patterns on trip level to filter and weight the self-selected samples in order to improve the representativeness. In a second step, the practitioners, as in our example, should evaluate the result of their planning continuously to check if the measures show the desired results. Following this, it should become clearer for what kind of planning issues GPS data is truly feasible.

If we take a closer look at data recording, some important steps have to be considered. First: the citizen-user has to be in charge of his/her own data and has to know the terms the data is used by the provider. Second: every step has to be in line with EU-DSGVO, to make sure privacy issues are served properly. Third: The point of citizen science and participation has to be sharpened. Practitioners are responsible here. The collected data has to lead to some improvement in cycling infrastructure. Otherwise the users would be disappointed which could lead to shrinking numbers of participants in the data recording approaches.

Liguori et al lead the way of how the last point can be achieved though.

2.7 Health and Active Mobility

Research

Promoting active travel for all in European urban regions –
A review of evaluated initiatives

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Expert Comment

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RESEARCH

Promoting active travel for all in European urban regions – A review of evaluated initiatives

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ABSTRACT

Introduction

'Lifestyle diseases' are a major threat to public health in industrialised countries. Physical inactivity is believed to be one essential factor for the increase of lifestyle diseases in Europe. 'Walking and Cycling' and its embedment in everyday life could become part of the solution to the decrease of lifestyle diseases in European cities. The aim of this review is to provide an overview of recent effectiveness studies on active travel interventions in European cities. It raises the question which barriers and facilitators are addressed, what groups are reached by different initiatives and how most people can be reached.

Methods

A systematic search for evaluation studies of active travel initiatives in European cities was conducted in four electronic Databases published between 6/2011 and 5/2016.

Results and Discussion

Twelve articles about 41 initiatives were analysed in respect of the effectiveness and type of initiative, the procedure of evaluation, addressed barriers and facilitators and their intended and actual reach. The initiatives as well as their evaluations varied greatly and are therefore difficult to compare. Only few initiatives included measures to reach explicitly different groups of people by minimising specific barriers.

Conclusion

More research is needed on high-quality evaluation of existing initiatives despite the difficulties to evaluate active travel interventions on a population level. Inter-sectoral collaborations which support multi-faceted approaches show promise to reach the whole population and could contribute to prevent lifestyle diseases in predominantly sedentary societies.

Keywords: active travel, cycling, walking, non-communicable diseases, healthy lifestyle, equity

INTRODUCTION

1. Lifestyle diseases and active travel (AT)

Especially over the last two decades, urban societies have become 'sedentary' societies. Due to their occupation, their schooling or their pastime activities, many people spend a lot of their time sitting down. Technical advances foster this behaviour. Recent research points out interrelations between this 'sedentarism' and premature mortality (Levine, 2015; Middelbeek/Breda, 2013). Physical activity and its embedding in everyday life, e. g. by increased cycling and walking, is therefore considered a potential key factor in the prevention of non-communicable diseases (WHO- European Region, 2015). Walking and cycling are often named 'active transportation' or 'active travel' due to their additional advantage: A person covers distances getting from A to B while achieving an impact on his/her physical and mental health.

2. Active travel affects both health and environment

The rising awareness of the negative impact of physical inactivity on public health as well as the positive side effect of active transportation on the environment constantly provoke new projects and research in order to promote physical activity in urban regions (E. g. PASTA – Physical Activity through Sustainable Transport Approaches (Gerike et al., 2016)).

3. Equity aspects

The lack of considering equity aspects in initiatives that promote physical activity has been pointed out by several studies in the past decades (Baker/Francis/ Soares/ Weightman/Foster, 2011; Ogilvie/Egan/Hamilton/Petticrew, 2004; Ogilvie et al., 2007). Moreover a policy summary published by the WHO-European Region (2013) stresses the risk of increasing inequalities by one-dimensional campaigns and might therefore increase disparities between groups.

4. Aim of the review

The aim of this review is to give an overview of the initiatives to promote and increase AT in European urban regions. The following research questions will be addressed: What kind of initiatives have been evaluated in respect of their potential to increase AT? Which type of initiative has been effective? What kind of barriers or facilitators were addressed? Who is being reached/affected by different approaches? Are some groups more likely to be (directly) reached than others? The second aim is to identify and discuss the most promising initiatives that enable as many people as possible to increase their level of AT and contribute to a healthier environment and prevent inequalities.

METHODS

1.Types of study; target groups

For this paper peer-reviewed evaluation studies of initiatives whose prior aim is to promote AT in middle-sized or larger cities (20.000 or more inhabitants) and which were published between 1/6/2011 and 31/5/2016 were defined as relevant.

Adults (persons aged 18 years and older) who live in European urban regions are the defined study population. There is no further limitation to specific groups and/or design of the initiative as long as the main target is to promote walking and/or cycling for transport.

2. Criteria for inclusion and exclusion

Studies published in a language other than English or German are excluded due to feasibility reasons. To give an overview of the situation in European urban regions, studies conducted in countries outside of Europe as well as studies conducted in rural areas are excluded. Studies with an exclusive focus in the field of physical activity other than walking and/or cycling are excluded. In line with the exclusion criteria, studies conducted in Europe, published in English or German with an explicit focus on walking and/or cycling for transport in urban areas are included.

3. Search methods

3.1 Databases

For identifying relevant publications, the four electronic Databases PubMed, EBSCOhost, TRID and Web of Science were chosen on grounds of their content related to health and specific other disciplines such as general Medicine, Psychology and Transportation.

3.2 Search strategy

Boolean operators were used for searching the relevant publications in the electronic Databases. The initial search terms were retrieved from another review (Bird et al., 2013) on walking and cycling interventions and have been adapted for being in line with the concept of this review.[1]

4. Assessment of the studies

The studies are assessed in respect of their quality (type of initiative, instruments used for evaluation, results, reach of the initiative, risk of bias, limitations).The different types of initiatives and their reported effectiveness are summarised in the next chapter.

1 For further material please contact the author: e.schabus@alumni.maastrichtuniversity.nl

RESULTS

1. Study selection process

The search strategy identified 897 studies published between June 2011 and May 2016. 285 articles from the Database PubMed, 292 from the Database TRID, 34 from the Database EBSCO and 286 articles from the Web of Science Database.

After a first assessment of the abstracts and de-duplication, 20 articles remained for assessment of full text versions. Access to the full text versions was given for all selected articles. No articles had to be discarded due to language criteria. Nine studies had to be discarded after assessing the full text versions of the articles. All included studies were published in English. Through snowball sampling one additional article was identified as eligible for this review and was therefore included. Consequently, twelve publications have been further analysed. In total, forty-one initiatives from Europe are evaluated in eleven publications.

2. Main characteristics and analysis of the selected studies

2.1 Location/Type of initiatives

Seven studies evaluated initiatives which were conducted in cities in the UK (Blake/ Zhou/Batt, 2013; Goodman/Panter/Sharp/Ogilvie, 2013; Goodman/Sahlqvist/Ogilvie, 2013; Jones, 2012; Lathia/Ahmed/Capra, 2012; Norwood/Eberth/Farrar/Anable/Ludbrook, 2014; Panter/Heinen/Mackett/Ogilvie, 2016), one study focussed on several initiatives in the Netherlands and Denmark (van Goeverden/Nielsen/Harder/van Nes, 2015), another study investigated an initiative in Austria (Götzenbrucker/Köhl, 2012), one publication reported the effectiveness of an intervention in Spain (Marqués/ Hernández-Herrador/Calvo-Salazar/García-Cebrián, 2015) and one publication focussed on a city in Serbia (Mrkajic, Vukelic, & Mihajlov, 2015). Furthermore, a review was included that referred to evaluation studies of Bike sharing schemes conducted in several European cities (Ricci, 2015).

Only five initiatives (Blake et al., 2013; Goodma/Sahlqvist, et al., 2013; Götzenbrucker /Köhl, 2012; Norwood et al., 2014; Panter et al., 2016) addressed both walking and cycling for travel while the majority (seven out of twelve) of studies focussed only on cycling as a mode of AT.

The investigated interventions can be categorised in five approaches: Workplac-based intervention (Blake et al., 2013), improving infrastructure for cycling/walking (Goodman/Sahlqvist et al., 2013; Jones, 2012; Marqués et al., 2015; Mrkajic et al., 2015; Panter et al., 2016; van Goeverden et al., 2015), town-wide initiatives combining improvements of the infrastructure and additional 'soft measures' to promote AT (Goodman/Panter, et al., 2013; Norwood et al., 2014), bike-sharing systems (Lathia et al., 2012; Marqués et al., 2015; Ricci, 2015), and provision of travel information technology (Götzenbrucker/Köhl, 2012).

2.2 Target population; addressed barriers and facilitators

The selected studies vary also greatly in the target population they tried to reach. In the work-based intervention evaluated by Blake et al. (2013), the target population were employees in an NHS work-place. In the study conducted in Serbia, the target population were students and teaching staff from a University (Mrkajic et al., 2015). All other interventions aimed to reach citizens in general. Only one study reported that the analysed town-wide cycle initiatives tried to reach also specific groups such as families with children or people from deprived neighbourhoods (Goodman/Panter et al., 2013).

Looking at the main barriers/facilitators towards AT, the different initiatives primarily tried to address the following factors: self-efficacy, health awareness and social support (Blake et al., 2013; Norwood et al., 2014), time and/or cost-concerns (Götzenbrucker/Köhl, 2012; Norwood et al., 2014), actual and perceived safety (Goodman/Panter, et al., 2013; Jones, 2012; Marqués et al., 2015; Norwood et al., 2014; Panter et al., 2016; Ricci, 2015; van Goeverden et al., 2015), threat of bike-thievery (Mrkajic et al., 2015), bikeability in terms of connectivity and convenience (Goodman/Panter, et al., 2013; Goodman/Sahlqvist, et al., 2013; Jones, 2012; Marqués et al., 2015; Norwood et al., 2014; Panter et al., 2016; Ricci, 2015; van Goeverden et al., 2015), walkability (Goodman/Sahlqvist, et al., 2013; Norwood et al., 2014; Panter et al., 2016) and accessibility of bikes (Götzenbrucker/Köhl, 2012; Lathia et al., 2012; Ricci, 2015).

2.3 Methods, effectiveness & reach of initiatives

All the studies tried to capture the situation before and after an initiative was implemented. Most of the studies were 'natural experiments', the methodologies used for evaluating the effectiveness of the diverse initiatives included various procedures and instruments and not in every case a control group was in place.

Two studies used questionnaires as the only tool for data collection (Blake et al., 2013; Norwood et al., 2014). Two other studies combined data on AT retrieved from questionnaires with indicators for residential distance from the respective intervention (infrastructural elements such as new cycling paths) calculated with programs using GIS data (Geographic Information System) (Goodman/Sahlqvist, et al., 2013; Panter et al., 2016). A study aiming to evaluate effectiveness and equity impacts of eighteen town-wide cycle interventions compared Census data from different years including indicators on small-area deprivation (Goodman/Panter, et al., 2013), while another study which aimed to evaluate traffic-free paths and their potential to support creating a new cycling culture used Census data to compare it with data from an additional questionnaire (Jones, 2012). A study which reported and compared evaluations from five older and seven more recent infrastructure interventions in the Netherlands and Denmark (van Goeverden et al., 2015) listed surveys, bicycle counts and telephone interviews as their data collection tools. Especially the more recent studies tend to use surveys only.

For evaluating a traveller information system 38 users had to fill in questionnaires (before and six weeks after the intervention), participate in focus groups and complete travel diaries (Götzenbrucker/Köhl, 2012). For the study on the change of the registration mode of a bike-sharing system the data from the bike-sharing station sensors were used (Lathia et al., 2012). The review on different bike-sharing systems did not report the different methodologies which were used (Ricci, 2015). The evaluation study by Marqués et al. (2015) used a combination of before-after implementation surveys, bicycle counts, observations of bike-parking lots and data retrieved from the bike-sharing system-sensors . To report changes in the saturation of old and new parking lots in front of a University, observations of the lots were conducted (Mrkajic et al., 2015).

The effectiveness and reach of the various initiatives was reported in different ways. The article by Norwood et al. (2014) focussed in its result on the achievement on recommended levels of PA and did not report detailed effects on AT. A general increase in AT during the last seven days was reported in the study by Blake et al. (2013). A decrease of car use was reported in the study on a travellers information system. No further details of the effect on AT are reported in the study, but the authors estimate that 15 % of daily travelled distances could be made without the car as a consequence of the traveller information system (Götzenbrucker/Köhl, 2012).

The longitudinal study in Wales on new infrastructures for walking/cycling reported 32 % usage of the new infrastructure among the participants of the survey at a follow up after one year and a further increase of 6 % after the second year, although most participants used the new infrastructure for recreational walking and cycling. Lower use was predicted by people aged older than 65 years (Goodman/Sahlqvist, et al., 2013).

The quasi-experimental analysis of the effectiveness of traffic-free cycling and walking routes in Cambridge reported a decrease in overall active commuting (Panter et al., 2016).

The review on bike-sharing systems (BSSs) did not report evidence on effectiveness in detail but stated great variations throughout systems and schemes in respect of effectiveness and reach (Ricci, 2015). Among the other six studies focussing exclusively on cycling, five studies could report an increase in cycling for travel (Goodman/Panter et al., 2013; Lathia et al., 2012; Marqués et al., 2015; Mrkajic et al., 2015; van Goeverden et al., 2015).

Walking and cycling increased significantly in the most deprived areas in the evaluation study of 18 town-wide initiatives. Smaller effects of the intervention were reported for the more affluent towns; initiatives that included work-based interventions were more effective than others (Goodman/Panter, et al., 2013). The change of registration mode for the bike-sharing system in London led to an overall increase in usage of the system. No socio-demographic details of users could be reported (Lathia et al., 2012). The improvement of the cycling infrastructure including the installation of a bicycle sharing scheme

in Seville led to an increase in cycling which could be seen in the saturation of the bike sharing scheme and the saturation of parking lots. Additional surveys reported an increase of female cyclists and that the average user was under the age of 29. No other socio-demographic factors than age and sex were reported (Marqués et al., 2015).

In the study on earlier and recent evaluations of initiatives in Denmark and the Netherlands no detailed results of single studies were reported, but the increase of cycling ranged from 7 up to 42 % (van Goeverden et al., 2015). The study by Jones (2012) could not report changes in cycling for commuting after the implementation of traffic-free paths; no differences by any socio-demographic factors were reported.

DISCUSSION

1. Lack of evaluation studies and geographical spread

The first thing that stands out when looking at the diverse publications is the small amount of evaluation studies and their minimal geographical spread. This is not a new situation. A lack of evaluation studies of high quality was reported in various publications and was for many the main driver to conduct research on effectiveness of initiatives (Goodman/Panter, et al., 2013; Jones, 2012; Scheepers et al., 2014).

A density of studies conducted in the UK is noticeable. As the UK has not always been particularly famous for its cycling culture compared to countries like Denmark or The Netherlands, the effort spent on promoting AT these days could perform as a good practice example for other European countries.

Otherwise, European countries that are not (yet) part of the European Union, such as Serbia, must not be overlooked in their approaches to promote public health, as can be seen in the example of Novi Sad (Mrkajic et al., 2015).

Other countries, such as Denmark or the Netherlands, which are widely known for their cycling culture, apparently have not tried to make their evaluation studies available to a broader, international and scientific audience for a long time (van Goeverden et al., 2015).

There is no 'best practice' example on how to evaluate the effectiveness of an intervention that addresses the population within their natural environment. Not only is it difficult to capture the number of individuals who take advantage of an intervention, it is also challenging to make the potential increase of AT measurable. For this reason, many studies used self-reported questionnaires or Census Data as their main data collection tool. These data include risks of reporting bias that might lead to individual overestimation of AT as AT might be a desirable social behaviour (Motl/McAuley/ DiStefano, 2005; Panter/Costa/Dalton/Jones/Ogilvie, 2014). Moreover, Census Data does not always include questions on AT and if so, the questions might not provide detailed information on travel modes, as for example in the study on the effectiveness of different town-wide initiatives (Goodman/Panter et al., 2013). Consequently, several studies in the field of AT seem to focus on estimations (e. g. Health Impact Assessments) rather than on actual effectiveness (de Nazelle et al., 2011; Mueller et al., 2015; Woodcock/Givoni/Morgan, 2013).

2. Addressed barriers and facilitators and elements of good practice

Safety and connectivity seem to be the factors addressed the most. This could be explained by the fact that most of the initiatives dealt with changes in the infrastructure.

When looking at the effectiveness of initiatives the most promising ones combine different elements such as improvements in infrastructure and interventions at the workplaces or have a strong focus on participation in improvement of the infrastructure (Goodman/Panter et al., 2013; Mrkajic et al., 2015; Norwood et al., 2014). Other studies support the possible advantages of multifaceted approaches for reaching the least active groups and achieving long-term effects (Goodman/Sahlqvist et al., 2013; Jones, 2012). This is in line with previous research, reporting that especially community-based approaches are good practice to minimise disparities between groups (Israel/Schulz/Parker/Becker, 1998; Wallerstein/Duran, 2010).

At the same time, AT itself is a very special concept as it combines different disciplines and should therefore easily provoke an inter-sectoral collaboration of

experts of different fields, such as urban planners or public health experts. In the 'Conclusions from the Roundtable on Transport & Health Polis conference' in 2011 – besides a lack in research on AT – the difficulties to overcome institutional barriers and to share responsibilities were among the main concerns towards 'Securing the health benefits of active travel in Europe' (Clark et al., 2011).

3. Equity considerations – how to reach all?

Only four of the analysed studies reported differences according to different socio-demographic factors, mainly focussing on age, gender or level of PA (Goodman/ Panter et al., 2013; Goodman/Sahlqvist, et al., 2013; Marqués et al., 2015; Norwood et al., 2014). This is understandable considering the quality of the available data that was used to analyse the effectiveness of initiatives, but should be alarming nonetheless. Even if it is difficult to evaluate the effectiveness of population wide interventions, it is surprising how little attention is paid to achieving differentiated results. When initiatives are meant to address the whole population, should this not be reflected in the evaluation? Markers of equity are only discussed in the review of BSSs and in the study focussing on impacts on equity by town-wide cycling initiatives (Goodman/ Panter et al., 2013; Ricci, 2015).

Goodman, Panter, et al. (2013) reported in their study an increase in walking and cycling and underlined a higher increase in cycling among the most deprived areas. The analysed initiatives included measures geared towards more deprived areas.

The pilot study on the traveller information system in Vienna was conducted with mainly young, technically interested male participants; this bears of course a big risk of bias. In the report, the authors make clear that the system will be successful if known and used (Götzenbrucker/Köhl, 2012). This of course means that people do not only need to have access to mobile devices, it also stresses the importance of digital literacy in potential users. According to the literature, there is evidence that digital skills vary between groups of different socio-economic backgrounds (van Deursen, van Dijk/Peters, 2011; Zillien/Hargittai, 2009).

Altogether, these findings reflect the WHO's critical appraisal of policies that promote PA in socially disadvantaged groups (WHO-European Region, 2013).

CONCLUSION

This review shows that there are only a few studies available for European cities and that the studies vary greatly both in the type of observed initiatives and the way of their evaluation. The difficulty to evaluate AT interventions on a population level is a common thread in every described study. The addressed factors were mainly connectivity and safety, with an attempt at improvements by infrastructural elements. The most promising initiatives combined many different measures. As most of the studies did not evaluate different groups reached and the measures were almost never geared towards specific groups, not much can be reported on the reach of initiatives. The second aim of the review was to detect initiatives that are most likely to reach most people. Due to the poor amount of studies and their limited focus on specific groups, this question cannot be answered satisfactorily. Consequently, this review underlines the importance of evidence-based initiatives including high quality evaluation studies.

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EXPERT COMMENT

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The research paper by Schabus reviews a collection of (at the time of completion) recent active travel evaluation papers. The structure of the review provides an idea of what can be found in the existing literature and what is missing. Schabus already points to some of the themes that have been advancing quickly even after her recent review.

Rather than going through all the highlights of this review, I would like to start with a reflection upon the nature of this kind of evaluation itself, particularly its drives and goals.

'Evaluation' is a relatively new word. Its origins seem to come from the mid-18th century from the Latin ex- 'out, from' + Old French word 'value'. The Oxford dictionary defines it as to "Form an idea of the value of". By evaluating we try to extract the "value" of material or immaterial objects or indeed of subjects (e. g. their merits or their performance).

If the practice of evaluation informs us about what the value of an object is (or should be), evaluation should be one of the main practices of both policy makers and researchers. Policy making should have the wellbeing of citizens as its ultimate goal. In order to assess if public investments are actually achieving this crucial goal, evaluation needs to be in place. Nevertheless, evaluation is still underperformed and underreported by the administrations in many cases. It is complex, and it requires resources that should be accounted for in any planning or strategic instruments, and even in any decision-making process in place.

On the scientific side, evaluation is the tool to contrast hypothesis. We hypothesize that an intervention that has been designed to tackle a specific problem or fulfill a particular goal, is actually doing what we expected of it. It can happen that the intervention has effects that we had not foreseen, that these effects are more or less impactful than we expected, faster or slower to be produced, or that there are even rebound effects (undesired effects that produce a bigger problem than the one we wanted to tackle).

We can never make a projection into the future without foreseeing the tools that will be needed to assess this projection against the expectations that we had in the first place, because things change, or we might have misunderstood or overseen things.

Evaluation also needs to employ qualitative methods, in order to help us integrate unforeseen effects and better understand the processes involved in the change. It is quite surprising that none of the selected studies employ qualitative methods. There has been at least one example of a qualitative evaluation of an active travel intervention by Guell et al. (2012) that highlights the importance of qualitative input to define changes, identities and practices and particularly integrate the concept of wellbeing.

Aligned with wellbeing, equity is certainly a relevant aspect of evaluation. Schabus states in the review that it is desirable to make sustainable and healthy lifestyles possible for everyone regardless of their socioeconomic status. But it is also worth noting that active travel interventions evaluated in the literature are generally funded with public money, which means they should be accessible for as many groups of the population as possible. Nevertheless, these interventions are rarely assessed against accessibility and equity criteria.

Although Schabus notes the emphasis that other studies and policy papers put on the importance of considering equity aspects in initiatives that promote physical activity, the interventions found with this review are rarely assessed against accessibility and equity criteria.

The area of active travel policies in which equity evaluation seems to be on the rise is bike sharing. Since Ricci's review (2015) it is worth mentioning Clark and Curl (2016), who perform a socio-spatial analysis of bike sharing equity. Although it is only an aspect of the much broader concept of "access" (Urry, 2007), the spatial equity of bike sharing seems to be the testing ground of equity evaluation in active travel

interventions, most probably due to the availability and the nature of data of some of these specific interventions (Duran et al., 2018; Romanillos et al., 2016).

Most of the studies reviewed by Schabus were natural experiments, and this type of research design is not free from challenges. By definition, natural experiments are not under the control of the researchers. In order to evaluate the impact of policy interventions, the research study needs to be designed prior to the implementation of these interventions. This way, at least two timestamps can be registered: before and after the implementation. In the real world, often there are changes in the implementation of the interventions: in quantity or quality, calendar, funding, location, etc. Uncertainty increases when the evaluated policies are not high enough in the priorities of the political agendas, which is often the case of walking and cycling. Uncertainty and changes imply that any evaluation framework of active travel natural experiments needs to be flexible in its research design (especially recruitment strategy and methods) and timescale.

In an attempt to account for the unpredictable but very likely changes, a close collaboration between researchers and policy makers is crucial. Constant communication needs to be maintained in order to address any political and economic changes that might affect the delivery and characteristics of the resulting intervention(s). In isolation from the policy makers, the researchers are not aware of the changes in the policies implementation and cannot adapt their research design to these changes, which is a major threat for the feasibility of the whole study and the quality of its outcomes. Although flexibility in research projects can be challenging due to the rigidities of the grant agreements, it is worth the effort to integrate in the project proposals the flexible nature of the evaluation of policy interventions to the extent possible.

Amongst the potential changes listed above, the parameter of "quality" was included and it is worth noting its relevance in the broader context of evaluation. Schabus mentions that quality is one of the key recommendations stated in the report by WHO (2013). Although it is not the object of the review, it is common that the active travel interventions evaluated in the papers are not described in sufficient detail for their quality to be assessed. Neither do the evaluation frameworks assess the quality of the interventions against technical standards. This is clearly a shortcoming for the practitioner who intends to design or evaluate similar interventions. Interventions should be clearly defined in detail and audited against the existing scientific evidence and technical guidance.

Another challenge in assessing the impacts of the interventions is the lack of knowledge about the technical details and the quality of the interventions. The lack of reported information about the interventions is also a difficulty for the assessment of their impacts in different population groups. For example, it is well known that some population groups favor segregated cycle lanes over shared spaces more than others (e. g. women, children and older people); for this reason it is important to know which level of segregation was applied in a specific intervention to be able to interpret how the different population groups responded to the implementation (Aldred and Dales, 2017). But oftentimes details such as the level of segregation are not described in the papers and therefore the intervention cannot be assessed against this relevant indicator.

For future steps and in order to bridge research with policy making, it seems that evaluation models need to get closer to the real world by adding qualitative methods for a better understanding of active travel practices, definition of identities and the processes of change. They should also be more flexible in order to adapt to the political and economic nature of policy implementation. This means that evaluation models will become more complex, even more so if we add further elements such as taking more than one

intervention into account, looking into confounding effects, etc. Importantly, evaluation should never miss the equity aspect. Equity should be the main goal of any public policy, which by definition should try to improve the wellbeing of the entire population, not just of certain groups.

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2.8 Cargo bikes

Practice

TRASHH – Opportunities for E-cargo bikes in municipal waste and cleaning services

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Research

The Status Quo of cargo-bikesharing in Germany, Austria and Switzerland

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Expert Comment

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PRACTICE

TRASHH – Opportunities for E-cargo bikes in municipal waste and cleaning services

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While the air quality in the Free and Hanseatic City of Hamburg has significantly improved over the last decades, the upper limiting values for nitrogen dioxide still cannot always be met, like in many other German and European Cities. One of the main causes of the increased nitrogen dioxide pollution[1] is the cities' motorised traffic and here particularly the diesel vehicles[2] (Behörde für Stadtentwicklung und Umwelt, 2012). Consequently low-emission and emission-free driving systems for public and commercial transport as well as for individual traffic are among the key measures defined in the cities Clean Air Programme.

Stadtreinigung Hamburg (SRH), the city's municipal solid waste and cleaning company, contributes to air-quality improvement by gradually substituting its passenger cars with electric vehicles powered by green energy produced in its own incineration and biogas plants.[3]

SRH, a public law company, is responsible for the disposal and treatment of household waste of approx. 920,000 households and 100,000 enterprises, the cleaning of roads, public spaces, green spaces and public toilets as well as for winter services in the city of Hamburg. To complement its services and ensure reuse, recycling and sustainable disposal SRH collects bulky waste from households[4], runs 12 amenity centres and three second hand stores. Since climate and resource protection is a priority, SRH produces electricity and heat from waste incineration, biogas and compost from organic waste and electricity and heat from wind and solar power as well as landfill gas at a former landfill site[5]. Household waste is collected across the entire city separated into residual waste, organic waste, paper/ cardboard and recyclables. The SRH runs information campaigns and educational programmes to improve recycling and reduce waste volumes.[6] To adequately fulfil this variety of tasks, SRH has more than 3,000 employees, operates from 29 locations using 880 vehicles.

The key point for the research project "TRASHH: technological and economic analysis of the application possibilities of cargo-bikes in communal companies through the example of Stadtreinigung Hamburg" was the question, if electric cargo bikes (e-cargo bikes) could be an option for the SRH to further reduce its transport related emissions whilst maintaining the high quality of its services and increasing safety and quality of life. The project is funded by the German Federal Ministry of Transport and Digital Infrastructure within the National Cycling Plan 2020 (NRVP). It is jointly implemented by SRH and the German Aerospace Centre's (DLR) Institute of Transport Research, started in 2016 and ends in 2019.

Key questions, that the SRH seeks answers for are: Is it possible to conduct SRH work processes with e-cargo bikes? If so, which work processes, and will it be necessary to adapt the work flows? What are the advantages and disadvantages of e-cargo bikes? Is it possible to substitute diesel vehicles with e-cargo bikes and therewith save investment, running and maintenance costs? Are our employees ready to use e-cargo bikes? And finally, what are the overall eco-

1 It can have a negative impact on citizens' health, in particular on the respiratory tracts.
2 75 % of the cities nitrogen dioxide originates from motorised vehicles. 80 % of these are caused by diesel vehicles. Source: Luftreinhalteplan für Hamburg, Behörde für Umwelt und Entwicklung, Hamburg Dezember 2012
3 31.12.2015: 31 electric passenger cars, 31.12.2016: 48 electric passenger cars, 31.12.2017: 56
4 16,325t bulky waste have been collected in 2016
5 1,614,179 MWh of energy (heat, electricity) have been produced in total in 2016, related CO_2 savings in 2016: 465,868t
6 CO_2 savings from waste separation and recycling in 2016: 242,528t

Figure 1

Illustration of SRH cleaning services within the annual cycle, SRH

Source: SRH

logical benefits? Methodologically, the SRH pursues a combination of practical testing and academic research.

TRASHH started off with two analyses conducted by the DLR to i) identify work processes from the SRH portfolio, which are theoretically suitable for the use of e-cargo bikes and ii) recommend suitable types of e-cargo bikes for each of those work processes. It quickly became apparent that it would be easier to conduct cleaning services than waste collection with an e-cargo bike, simply due to the large volumes and weights handled by the waste collection teams.

Key criteria for the evaluation of the suitability of conducting SRH work processes with e-cargo bikes have been the average vehicle kilometres travelled, number of team members, volume and weight of transported waste and sweepings, work tools and materials. The DLR conducted interviews with SRH employees and accompanied cleaning teams on a normal work day to collect all necessary information for the evaluation. Additionally, the total cost of ownership (TCO) for both e-cargo bikes and the commonly used platform trucks have been calculated for each work flow to identify economically viable fields of applications (Rudolph/Ehrler, 2017).

In 2016, the SRH collected 42,750t of waste from the city's public spaces out of which 20,553t were street sweepings currently mainly collected by cleaning teams using small trucks and transporters[7] (Stadtreinigung Hamburg, 2016). Since the beginning of 2018, the SRH is also responsible for cleaning public green spaces and roadside greenery and employed more than 400 additional street sweepers, so that the company's cleaning section nowadays has more than 1,000 employees. A huge potential to reduce the carbon footprint if work processes could be conducted by e-cargo-bikes. Equipping new work process from

7 Up to 3.5t

Table 1

Cleaning services with high potential for e-cargo bikes, DLR (Rudolph/Ehrler, 2017)

Cleaning services with high potential for e-cargo bikes		Distance, tools and materials
1	Street cleaning services in sensitive areas, such as CBD, Neuer Wall, HafenCity	20–40 km; shovel, broom, bucket, waste picker, garbage bags
2	Street cleaning in tandem teams	20–50 km; shovel, broom, bucket, waste picker, garbage bags
3	Specialised cleaning services	20–50 km; shovel, broom, bucket, waste picker, garbage bags
4	Cleaning of public green spaces	15–50 km; shovel, broom, bucket, waste picker, garbage bags
5	Cleaning of playgrounds	15–50 km; shovel, broom, bucket, waste picker, garbage bags
6	Removal of illegally dumped waste reported through SRH hotline	25–50 km; shovel, broom, bucket, waste picker, garbage bags
7	District care taker: specialised cleaning services in areas with higher cleaning needs	15–45 km; shovel, broom, bucket, waste picker, garbage bags, paper towels, cleaning products

the start with e-cargo bikes is further expected to be easier than adjusting over the years established and optimised work processes.

DLR calculations (Table 2 below) show, that in theory three e-cargo bikes are needed to replace one pick-up truck while ensuring transportation of the same amount of waste (in kg and m^3). It is important to note that the e-cargo bikes are the cheaper (compare annual total cost of ownership in table 2 below) and environmental friendlier option as their batteries are charged with green electricity produced by SRH.

In general, the requirements of e-cargo bikes for SRH operations are: 50 to 400kg cargo weight, 0.5 to 1.5 m^3 cargo volume, travel distances of up to 80km/day as well as several customised equipment like garbage bins, holding devices for cleaning tools like brooms and shovels, boxes for cleaning materials, board computers, etc.

Parallel to conducting these initial analyses SRH kickstarted the practical test by acquiring two e-cargo bikes for use in work processes with obvious potential and interest by SRH personnel. Since January 2017 one of the district care takers has been using a customised Bakfiets tricycle in the eastern part of the City of Hamburg and a customised Veleon from Adomeit is being used for street cleaning services in the city centre. In both cases work flows had to be adapted to ensure smooth cleaning services with e-cargo bikes. The district care taker used to conduct his work with a non-motorised cargo bike and a platform truck. Shifting to an e-cargo bike saves time and hence allows him to take up further duties to ensure greater cleanliness in the district. Since he is using a tricycle it is possible to collect waste with a waste picker while sitting on the e-cargo bike. An orange garbage bin has been fixed on the load carrying platform at the front for this purpose. Garbage bags that are filled with waste and sweepings and too heavy or bulky to be transported with the cargo bike are being placed at main junctions where he collects them with a platform truck in the afternoon. While other district cleaners operate by car, using a cargo bike has the great advantage of being much closer to the residents. A key factor as one of the main responsibilities of the district care taker is to raise awareness on correct waste disposal and recycling. The Bakfiets tricycle has proven to be a low-cost, robust and reliable e-cargo bike suitable for daily heavy-duty operations.

The second e-cargo bike is being used for cleaning activities in the inner city. The driver leaves the SRH

Table 2

Economic and technical comparison of pick-up trucks and e-cargo bikes, DLR (Rudolph/Ehrler, 2017)

	Pickup truck (depreciation period: 10 years)	Cargo tricycle (depreciation period: 5 years)	
Number of vehicles	1	1	3
Annual Total Cost of Ownership [€/year]	13,937	3,300	9,900
No. of seats	3	1	3
Gross vehicle weight [kg]	3,190	n/a	n/a
Loading capacity:			
Permissible loading capacity in kg	2,000	400	1,200
Permissible loading capacity in m³	8.0	1.8	5.4
Daily mileage [km/day]	35	35	105
Degree of capacity utilization (weight) [%]	35	60	60
Amount of transported rubbish (weight) [kg]	700	240	720
Degree of capacity utilization (volume) [%]	60	90	90
Amount of transported rubbish (volume) [m³]	4.80	1.62	4.86

Picture 1: District Care Taker on the Bakfiets tricycle, SRH

Picture 2 and 3: Street cleaning services in the city centre with Veleon tricycle, SRH

compound and empties rubbish bins along a bicycle path on his way to the city centre. He leaves the filled bags at the main road where they are being picked up by one of the SRH platform trucks. In the inner city he cleans the solar-powered, self-compacting rubbish bins (Big Bellys), empties ash trays and removes any kind of dirt and garbage.

Since most of the Big Bellys are placed in pedestrian areas highly frequented by tourists and shoppers, the e-bike is not only an emission free vehicle but also an eye-catcher. The driver and street cleaner is often interviewed by by-passers and frequently has to pose for photographs. The Veleon clean city e-motion is a tricycle customized to be used for street cleaning services. It has an extremely small turning radius which has proven to be very useful in areas well used by pedestrians, but the sophisticated technology is also prone to error under daily heavy-duty operations. In comparison, the Bakfiets has proven over the past 12 months of practical testing to be much more robust and requires less maintenance.

The acceptance of the e-cargo bike drivers is high among the SRH cleaning staff. In particular those, who have worked as street cleaners for many years, are used to be subject to different weather conditions. With the correct clothing an e-cargo bike often consti-

Picture 4: The Veleon has a small turning radius beneficial in highly frequented areas, but has higher maintenance costs, SRH

tutes a considerable improvement over walking or using unmotorized cargo bikes. The experience shows, however, that workers with a truck driver's license see using a bicycle, even if motorised, as a form of "down-grading". Otherwise the e-cargo opens up a number of new opportunities for the drivers: being sportive during working hours, greater appreciation of work through higher visibility and innovative notion, etc.

There are, however, some scepticism and reservations towards the introduction of e-cargo bikes at a bigger scale as they are currently seen as an obstacle regarding work efficiency. Teams must be reorganised, routes and routines adapted, and e-cargo bikes obviously can't dispose waste directly at the incineration plant – hindrances within the current tight evaluation framework for work efficiency. As a consequence, the higher management, who had observed the contradiction between climate protection and work efficiency, introduced new climate protection goals that justify the adaptation of work flows and related impacts.

During the course of the research project "TRASHH" the SRH will in total test seven e-cargo bikes in real-life work processes while the DLR is contributing technological, economic and environmental analyses to gain knowledge, not only for the SRH but also for the use of e-cargo bikes in other cities and communal companies.

Through a second round of tendering five additional e-cargo bikes, identified through the DLR analyses described above, are currently being purchased. Based on the experiences made with the two first e-cargo bikes and on DLR research on the use of e-cargo bikes in commercial operations, four out of five of the new bikes are heavy duty bikes developed purposely for commercial usage as they contain parts from motor cycles (f.i. rims, spokes, tires, brakes).

From mid 2018 onwards, next to the Bakfiets and Veleon, one Cycles Maximus Trike 910, one Evolo Trike Z2, two Radkutsche Trike Musketier and one Urban Arrow Cargo will be in use throughout Hamburg in different work processes like street cleaning, green space cleaning and removal of dirt and garbage reported through the SRH hotline or by SRH waste watchers (SRH worker investigating illegal waste disposal). The DLR will evaluate the practical test regarding economic, technical and environmental advantages and disadvantages. For this purpose, all drivers keep daily records on the cargo transported, distances travelled, weather conditions, and issues experienced with the e-cargo bikes if any. Since quick maintenance and repair of the e-cargo bikes has proven to be of high importance to assure the execution of the daily work, maintenance packages with a local dealer have been set up for the new bikes. In case of any issues a replacement bike will be provided within 24 hours.

Picture 5: Test drive for the second tender on Urban Arrow Cargo, SRH

Picture 6 and 7: 1st TRASHH Round Table in Hamburg in April 2018, SRH

The Federal Ministry of Transport and Digital Infrastructure is supporting TRASHH not only to test the use of e-cargo bike for SRH operations but to assess the possibilities for communal/ commercial use in general. DLR and SRH are therefore presenting the project on national and international conferences and in technical publications and have established an "E-cargo Bike Round Table". The first Round Table has been conducted in April 2018 in Hamburg with participants from small to medium size cities in Northern Germany. The round table focussed on the exchange of practical experiences, both positive and negative, with e-cargo bikes in solid waste management and cleaning services and included the possibility to test drive the SRH cargo bikes.

The practical test of the e-cargo bikes will continue until the end of 2019, accompanied by academic research of the DLR to gain knowledge and understanding on the environmental and economic benefits of e-cargo-bikes. The results of the pilot project TRASHH will not only allow the SRH to fully understand the potential of introducing e-cargo bikes in its operations, particularly regarding climate change vs. efficiency, but will also be shared in another Round Table with interested public and commercial potential users.

E-cargo bikes are air and noise pollution-free, have the potential to substitute diesel vehicles and are hence among the priority measures of Hamburg's Clean Air Programme. The seven e-cargo bikes used for SRH work services contribute to better air quality in the city. To ensure that the city's upper limiting values for nitrogen dioxide will be met, introduction of e-cargo bikes at scale combined with other measures would be needed. The research project TRASHH is an important step to better understand the potential and the requirements for using e-cargo bikes in commercial transport. Additionally, the customised e-cargo bikes equipped with waste bins and cleaning tools have a strong signalling effect in the cityscape and hopefully encourage dialogue and imitation, in Hamburg as well as beyond the city's boundaries.

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RESEARCH

The Status Quo of cargo-bikesharing in Germany, Austria and Switzerland

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INTRODUCTION

Against the background of pressing environmental and health issues associated with private motorised transportation, bikesharing has become very popular among city dwellers and municipal policy makers within the last ten years (Shaheen/Guzman, 2010). More than 700 bikesharing systems have been launched in various cities worldwide, with various operating models (Shaheen/Guzman, 2010). Meanwhile, the resurgence of cargo bikes is a recent trend, especially in cities. They are used for commercial purposes, but also by young families to transport children and for trips such as grocery shopping. However, at present, only a handful of bikesharing systems provide cargo bikes to private users. Initial empirical research on shared cargo bikes shows a high reduction effect in private car trips (Becker/Rudolf, 2018).

New actors (i.e., cargo-bikesharing operators) have emerged to create a new niche, and established bikesharing operators are tentatively integrating cargo bikes into their portfolio.

The current paper summarises the status and evolving trend in cargo-bikesharing by analysing five essential aspects of current cargo-bikesharing schemes in Germany, Austria, and Switzerland: operators, sharing systems, cargo-bike technology, users, and impacts. We thereby provide orientation on whether cargo-bikesharing can serve as an effective means of reducing both motorised traffic and its associated negative impacts for human health and the environment.

TYPES OF OPERATORS

The current operators of cargo-bikesharing are heterogeneous and diverse, as it is often the case for the early stage of innovation diffusion of a new socio-technical system (Geels/Schot, 2007). Table 1 differentiates eight types of operators. Interestingly, innovation in cargo-bikesharing has not been stimulated by the established bikesharing operators (e. g., Nextbike, Call a Bike), although they have the technical knowledge and resources to do so. They currently operate only one cargo-bikesharing fleet, which was initiated as part of a research project (TINK in Norderstedt). In contrast, citizen engagement led to the creation of 61 so-called Free Cargo-Bikesharing operators in Germany and Austria, since the year 2013. Their social invention of using a “host system” to organise handover of the cargo bike inspired the Swiss Mobilitätsakademie (an innovative “think-and-do-tank” for sustainable modes and future mobility trends) to establish their Carvelo operator in 2015 (Mobilitätsakademie, via personal communication). The Velogistics peer-to-peer sharing platform was already established in 2011 but has not yet realised its full potential. Another actor group that could engage in cargo-bikesharing is station-based carsharing providers. They have an established customer base interested in sustainable mobility, operate extensive

networks of sharing stations, and utilise digital rental platforms that incorporate features such as smart-key infrastructure. Despite these resources at their disposal, they have shown no interest, to date, in expanding their portfolio to cargo bikes.

SHARING PLATFORMS: DIFFERENT DESIGNS

Current cargo-bikesharing platforms are based on various digital and social processes. The specific configuration of these process elements depends on the respective financial and organisational resources of the operator. Moreover, location planning and predicted user acceptance influence the design of cargo-bikesharing platforms. In the following, we compare different platform designs with regard to these aspects.

1. Organising the rental process: host system and smartkey infrastructure

The ability to pre-arrange the rental time and location is a core issue for users and operators. On the level of community cargo-bikesharing, where groups are typically small and closed, reservations and usage can be arranged via direct, bilateral contact among group members. In larger and more anonymous groups, this is not a viable option. Instead, a publicly visible calendar (in paper or digital form) is essential for a functional borrowing schedule. The "*Commons Booking Plug-In*" for WordPress provides one such online solution, and was developed by Free Cargo-Bikesharing operators (dein-Lastenrad.de, 2018). Most of the Free Cargo-Bikesharing operators use Commons Booking to organise the rental process. At the same time, as the plug-in is open source, it is freely available to any other third party; however, one constraint is that, to date, it is not available as a smartphone app[8].

Despite the open-source availability of Commons Booking, most other operators have developed their own software solution, which is usually combined with a digital payment system and so-called smartlocks. This system enables users to lock or unlock the cargo bike automatically via an app, card, or numeric code. The advantage of this system is that cargo bikes are available 24/7, while the disadvantage is that first-time users do not receive personal instruction at the point of collection, about how to handle the cargo bike.

In contrast, most Free Cargo-Bikesharing operators make use of a so-called stationary "host system" which is their own social invention. Here, partners such as cafes, shops, or public institutions hand over the key to the user, asking them for a personal ID document in addition to a password allocated to their online reservation. The partners also provide brief instructions on how to handle the cargo bike, which is greatly appreciated by first-time users. This is an important benefit of the host system because it lowers the psychological barriers to the use of an unfamiliar technology and thereby helps to build capacity. Competencies and capacities are key elements of behavioural change (Michie et al., 2011). However, a shortcoming of the host system is that the shared cargo bike can only be rented or returned during the business hours of the respective host partner. Meanwhile, the largest German cycling association Allgemeiner Deutscher Fahrrad Club (ADFC) was inspired by the Commons Booking and host system of the Free Cargo-Bikesharing system to develop a "Toolbox" for its local member groups. The toolbox was developed in cooperation with the Forum for Free Cargo-Bikesharing and its online wiki (www.dein-lastenrad.de), with the aim of upscaling the number of Free Cargo-Bikesharing operators. It is a step-by-step manual for everyone, on how to start a cargo-bikesharing oneself using the Commons Booking and host system[9].

As electric cargo bikes become more popular among users and operators, many new (Donk-EE, Lasti-Bike) and established (Carvelo) providers are employing various combinations of the stationary host systems and smartlock infrastructure. These solutions are mostly prototypes, and their entire functionality usually has to be proven during day-to-day operations.

8 One reason is that programming an app would surpass the time resources of volunteer work, and the app has not been prioritized by the Commons Booking developer team so far.
9 https://www.adfc-hessen.de/aktiv/hessen-forum/2017/Handbuch_Freie_Lastenraeder_20171106.pdf [accessed June 1, 2018]

Table 1

Types of cargo-bikesharing operators in Germany, Austria, and Switzerland (as of 31 May 2018)

Type of Cargo-Bikesharing Operator	Name	Year Established	Operating Model	Management of Sharing Process (Key, Booking, Payment)
Commons-oriented Free Cargo-Bikesharing	Different local operators, names, and local brands; e. g., Hannah Hannover; FLotte Berlin; Kasimir Cologne	2013	Make cargo bikes available to everybody, without formal membership of an association or group; Commons-oriented, facilitating sustainable modal shift in transportation	Host system, open source commons booking; Currently daily booking, hourly booking planned
Car-related mobility actor	Carvelo	2015	Increasingly profit-oriented	Host system combined with app/Web-login for booking and payment
Scientific pilot project	TINK (operated by the bikesharing company Nextbike)	2016 (project ends in 2018)	Research-oriented	Station system combined with app/terminal/ telephone/card booking for payment and lock opening
Established conventional bikesharing operator	Deutsche Bahn Rent as supplier for RegioRadStuttgart	To be launched 2019	Profit- and product range-oriented (complete portfolio); Cargo-bike integration mandated by municipal tenders	Integration of electric-assisted cargo bikes into the normal RegioRad-Stuttgart bikesharing system
	Deutsche Bahn Rent as supplier for StadtRad Hamburg;	To be launched 2019	Profit- and product range-oriented (complete portfolio); Cargo-bike integration mandated by municipal tenders	Integration of electric-assisted cargo bikes into the normal StadtRad Hamburg bikesharing system
Start-up cargo- bikesharing operator	Lasti-Bike	2018	Profit-oriented	Station system in combination with app (not launched yet, currently host system)
Retail business	Furniture or hardware stores e. g., Bauhaus and Hellweg (Berlin); Obi (Franken); Ikea (Hamburg-Altona)	2014 (Ikea), 2017 (Hellweg), 2018 (Obi)	Marketing and customer service-oriented	Personal handover process at the store
Utilities and energy providers	Municipal companies: e. g. Stadtwerke Konstanz, taking over all TINK Konstanz cargo bikes	2018	Public service-oriented	Station system in combination with app
	Donk-EE for the green electricity provider Naturstrom	2018	Profit-oriented	Host system in combination with app for booking and payment

Reservation >1 Day in Advance	Funding Source	User Fee	Number of Stations (in xx Number of Cities)	Number of Cargo Bikes (% Electric)
Yes	Individual funding by independent operators; From privately owned to crowd-funded or grant funded. Also partially funded or entirely run by communities	No, but fixed-fee participation or donation is encouraged	61 initiatives (in 58 cities; Germany and Austria)	163 (30 % electric assisted)
Yes	Carvelo is an initiative of the Mobilitätsakademie AG (Touring Club Switzerland) in cooperation with the promotion fund, Engagement Migros	Booking fee 5 CHF; Hourly rate (day-time) 2 CHF; Night-time free; Reduced rates available	One operator (37 cities, all in Switzerland)	180 (100 % electric assisted)
No	€392,000 funding for three years from the Federal Ministry of Transport and Digital Infrastructure (BMVI); Total budget €511,000	First half-hour free, thereafter €1/half hour (max €9/24 hr); Reduced rates available	10 stations (Norderstedt); 13 stations (Konstanz)	48 (0 %)
—	Call for tender by the municipality of Stuttgart	—	To be launched April 2019 (Stuttgart; possibly to include neighbouring communities)	10 planned (100 % electric assisted)
—	Call for tender by the municipality of Hamburg	—	To be launched 2019 (Hamburg)	20 planned (100 % electric assisted)
No	Cargo bike acquisition costs 25 % funded by the municipality of Munich	€1 per 10 minutes; €6 per hour; €39 per 8 hours	8 stations (Munich)	20 (100 % electric assisted)
No	Typically, no funding	Usually rent only to customers; First 3 hours free, thereafter fixed fee of €5/hour	Unknown	Unknown
No	Funded by the municipality of Constanz, TINK cargo bikes are expected to generate a loss of €137,000 within the next four years, despite fee increases	More than €1 per 30 mins	See TINK	Half of TINK bikes (0 %)
No	€200,000 funding from the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU)	€3.50 first hour; €2.50/hour from 2–5 hours; €1.50/hour from 6th hour; No reduced rates	43 stations (Cologne, Germany)	46 (100 % electric assisted)

Type of Cargo-Bikesharing Operator	Name	Year Established	Operating Model	Management of Sharing Process (Key, Booking, Payment)
Neighbourhood cargo-bikesharing	Housing associations, e. g., Seestadt Aspern (Austria); Nassauische Heimstätte (Germany)	2015 (Aspern); To be launched 2018 (Nassauische)	Marketing-oriented pilot projects for the residents of a house or housing block	Station-based and induction-charged cargo bikes; Rented via terminal and card
	Citizen associations , e. g., Rothehaus neighbourhood cargo bike (Ehrenfeld, Cologne)	Since the existence of cargo bikes	Provide a cargo bike to a closed community, which may be a neighbourhood, house community, or association	Various, from informal and personal; email and online calendars; Open source commons booking
Peer-to-peer sharing platform	Velogistics	2011	Operates as intermediary platform; free of charge	Conditions and transactions are concluded bilaterally
	LaraShare	To be launched end of 2018	Pilot and research project by the University of Vienna, to enhance helpful tools such as insurance, smartkey, and	

In the worst case, the prototype status of some systems has led to considerable delays in implementing the entire cargo-bikesharing system. There are three examples of these technical challenges and associated delays:

- (1) The Donk-EE system in Cologne was scheduled to be running in May 2017. All of the cargo bikes where ready for use, but the system only became operational in May 2018 as programming the necessary app had taken a year longer than planned.
- (2) Due to software issues, the official inauguration of the Konrad bikesharing system in Constance was postponed at very short notice, for a period of one week in May 2018. Although Konrad considers itself a normal bike sharing system, it uses what can be considered the smallest type of cargo bike, called a “Short John”, which is characterised by a loading area located over a small front wheel (Ghebrezgiabiher/Poscher-Mika, 2018). Additionally, Konrad has now incorporated all TINK cargo bikes following completion of that project’s three-year pilot phase.
- (3) In May 2018, Lasti-Bike (Munich) was launched entirely without its announced smartkey or digital payment system, and with a stationary host system instead.

The stationary host system has also been a key element of the decentralised expansion strategy pursued by the Swiss provider Carvelo. With the use of stationary systems, there is no need to establish a fleet management unit and check the roadworthiness of the bicycles, as is done once weekly by TINK. In contrast to centralised platform providers, locally anchored host stations also serve as local brand ambassadors and knowledge multipliers. Carvelo aims to strengthen the hosts as a central resource of their system. Recently, Carvelo has started to raise a usage fee per booking, in order to provide hosts with more significant remuneration, whereas previously they only benefited from free advertisement on the bikes or free vouchers for cargo-bike use.

	Reservation >1 Day in Advance	Funding Source	User Fee	Number of Stations (in xx Number of Cities)	Number of Cargo Bikes (% Electric)
	Yes	Several funds for high investment costs	First half hour free, then time-dependent fee (€1/hour) at Aspern	1 station (Aspern)	4 (100 % electric assisted)
	Yes	Various, from privately owned to commonly owned; Mostly self-funded	Various, from free to yearly fee	Unknown	Unknown
	Yes	No funding: private initiative	Ranging from free to different individual hourly or daily rates	Cargo bikes mainly listed in central and western Europe	252 listed bicycles
	be launched end of 2018; Will focus on peer-to-peer sharing in Vienna, and might protected parking environments			1 station (Vienna)	Not launched yet

2. Funding sources and business models

Funding sources

A number of cities in Germany and Austria support the acquisition of cargo bikes with a specific buyer's premium[10]. In their early phase, Free Cargo-Bikesharing initiatives counted on crowdfunding to acquire their cargo bikes. Recently, more and more initiatives were able to access local funds for sustainable mobility or funds from climate protection programmes at federal and national levels (e. g., from the programme "Short Ways to Climate Protection" (Kurze Wege für den Klimaschutz), from the National Climate Initiative of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety). Larger pilot projects with commercial character (Donk-EE) or explicitly accompanied by scientific research (TINK) were able to generate even larger subsidies of up to half a million euros (see Table 1).

Acquisition and maintenance costs are usually moderate for users of closed-community cargo bike schemes. Here, cargo bikes are mostly 100 % self-funded or provided by private individuals contributing to the group. In addition, local funding sources, usually provided with the aim of strengthening the sense of neighbourhood and civil community, can be used for partial financing.

Business models

There is currently no "one-size-fits-all" business model for cargo-bikesharing. Instead, a variety of business models is observed (see Table 1). Experimentation with different business models occurs even within a single provider. Of these, the best example is the Swiss provider Carvelo. It is a project of the Mobility Academy, which is a subsidiary of the Touring Club Switzerland (the Swiss equivalent of the German Allgemeiner Deutscher Automobilclub, ADAC). The Mobility Academy has its own budget but, so far, the acquisition of cargo bikes has been financed by the "Engagement Migros Fund". The Carvelo pilot project set itself the target of gradually developing a business model, and tries to build up the business on different pillars. In the first place, user fees are collected via an online payment system. In order to increase the utilisation rate, prices are based on a rather low to medium willingness to pay (see Table 1). Further-

10 For an overview, see https://www.cargobike.jetzt/kaufpraemien/ [accessed August 7, 2018]

more, local businesses pay for advertising panels on the shared cargo bikes, which generates funds. In addition, various municipalities have become partners in the sharing network and pay a considerable fee to use the concept and the sharing platform[11]. Moreover, Carvelo is integrating some peer-to-peer sharing elements: private individuals or companies can offer their cargo bike for rent via the Carvelo platform. These lenders are charged for listing their cargo bike on the platform and for using the digital sharing infrastructure (currently CHF 1,200 as a one-off fee).

One established business model for conventional bikesharing involves public tenders. The local government calls for bids to provide a specified number and kind of shared bikes in the city for a certain period of time. Operators respond to that call, with the winning bidder receiving public funding (or co-funding) to provide the contracted bikesharing service. The public tender model provides a large window of opportunity for city governments to integrate cargo bikes into their call for bids, and to opt for those operators that actually provide cargo bikes as a perfect complement to their conventional bikesharing fleet, which typically offers very limited load-carrying capacity. In this regard, the city-state of Hamburg and the city of Stuttgart (both in Germany and both confronted with serious air quality issues) are taking the lead[12]. They have integrated the demand for cargo bikes into their latest tender for bikesharing services. We assume that other cities that want to address air quality issues caused by motorised traffic will follow this example. That way, professional competence in cargo-bikesharing might become a decisive competitive edge for bikesharing operators in the very near future.

Free Cargo-Bikesharing operators have a commons-oriented "business model". They do not charge their users a fixed rental fee, but ask for donations to cover repair and maintenance costs. The operators are individual volunteers or non-profit organisations that aim to empower citizens to contribute to the local transition toward sustainable transport, and to benefit from the possibilities of cargo-bikesharing.

3. Location planning and user acceptance

One key challenge for all types of bikesharing operators is the planning and dimensioning of rental sites (Schäfer, 2017). Therefore, it is necessary to weigh up the legal, spatial, financial, and technological feasibilities against the predicted user occupancy rate. Currently, all of the above-listed cargo-bikesharing providers utilise fixed stations (see Table 1). Only the Free Cargo-Bikesharing operator LastenVelo Freiburg allows flexible borrowing and return ("free-floating") for its non-electric cargo bikes by using smartlocks (LastenVelo Freiburg, 2017).

The first scientific study on station planning for cargo-bikesharing reports that sites close to residential areas show increased station occupancy rates (Schäfer, 2017). In general, the high percentage of trips that start or end at a residential location underlines the importance of locating stations close to such areas (80 % of all trips; MiD, 2008)[13]. Consequently, new actors enter the field of cargo-bikesharing, such as housing associations (see Table 1). Their local network and connections to the residents could be key factors in the successful implementation of cargo-bikesharing. Such cargo-bikesharing systems are currently planned and designed in the form of pilot projects. Most housing associations want to offer their residents a fully automatic cargo-bikesharing system for booking, smartkey access, and charging infrastructure, which ultimately entail high investment costs. Another approach for housing associations could be to facilitate cargo-bike usage within their premises, for example by offering secure bicycle parking.

Since shopping trips are the most common use of shared cargo bikes (see chapter 5), retailers have begun to introduce cargo-bikesharing stations directly at their business locations in some dense urban areas. These include a large Swedish furniture company and several hardware stores in Germany. No solid data are yet available, on their experiences and occupancy rates; however, it appears that these cargo bikes are not overrun by customers, possibly because the cargo bikes always have to be returned to the retail site after completing the load-carrying trip. However, we assume that the motivation of the retailers is in part to communicate their commitment to sustainable and innovative mobility, as well as their customer focus, by providing shared cargo bikes for their customers.

11 For more information, see https://www.carvelo2go.ch/wp-content/uploads/2018/03/A5_Infos-f%C3%BCr-Gemeinden_4web.pdf [accessed August 7, 2018]
12 http://www.cargobike.jetzt/stadtrad-hamburg-bekommt-e-cargobikes/ [accessed May 31, 2018]
13 http://www.mobilitaet-in-deutschland.de/pdf/infas_MiD2008_Abschlussbericht_I.pdf [accessed May 13, 2018]

THE TECHNOLOGY OF CARGO BIKES

1. Two-wheeled, three-wheeled, or trailer

Cargo bikes and trailers can be characterised by their differing handling characteristics, transport capacities, and suitability for specific transportation needs. Due to the novelty of cargo-bikesharing and new cargo-bike technologies, many users have little or no experience with cargo bikes in general. Moreover, users have little experience with the different types of cargo bikes, e. g., a more agile two-wheeled cargo bike versus a stout three-wheeled one. In this section, we summarise the relative merits of the various configurations of cargo bike[14].

A two-wheeled cargo bike handles quite similarly to a conventional bicycle, of which almost all users will have considerable practical experience. Due to their compact construction, two-wheeled cargo-bikes enable rapid progress through urban traffic, similarly to conventional bicycles — particularly on narrow bike lanes. Furthermore, experienced riders of two-wheeled cargo bikes can easily achieve high speeds. On slopes, it is possible to stand out of the saddle, which allows for greater power transfer, which is of obvious advantage on hilly routes. In these situations, a three-wheeled cargo bike without electric-assist system could barely be ridden when fully loaded. On the other hand, two-wheeled cargo bikes do require greater balance coordination when starting, stopping, or parking the bike. In addition, most of the two-wheeled models have a lower carrying capacity on their loading platforms than three-wheeled models.

Conversely, three-wheeled cargo bikes can transport larger weight and volume. Furthermore, they inherently self-balance when stationary and ride stably at slow speeds, even with heavy loads. These are important advantages for inexperienced users and when riding in congested urban areas that might have multiple stop/start interruptions such as traffic signals. However, three-wheeled cargo bikes have higher risk of overturning when cornering, especially for inexperienced users when travelling quickly in combination with sudden steering input.

Figure 1: Two-wheeled and three-wheeled cargo bikes securely parked in the bicycle parking garage at the main station in Malmö, Sweden. (© Clemens Rudolf)

As for trailers, new three-, or even four-wheeled models especially, provide higher carrying capacities and are characterised by a certain flexibility of use, since they can be attached to conventional (electric) bicycles only when actually needed.

Similarly to three-wheeled cargo bikes, trailers have good stability when stationary and can even be equipped with electric hub motors and overrun brakes that provide braking to the trailer. This combination allows the user to carry heavier loads even in hilly terrain while still being able to safely slow the combined weight. Furthermore, the loaded trailer can be decoupled from the bicycle and used as pushcart, which allows for manoeuvring on narrow paths at loading and unloading points or in urban pedestrian zones (e. g., the Carla Cargo model). Moreover, they can be swapped between multiple bicycles, so long as each has a suitable trailer hitch.

Experiences from Free Cargo-Bikesharing show that inexperienced users have a slight preference for three-wheeled rather than two-wheeled cargo bikes. However, other factors such as the general availability of cargo bikes or proximity to residential locations are also factors in users' decisions (Schäfer, 2017).

14 For an in-depth analysis and historical evolution of the technology of cargo bikes, we recommend the recent book, "Cargobike Boom" by Ghebrezgiabiher and Poscher-Mika (2018).

2. Electric versus non-electric cargo bikes

When considering whether to provide electric-assisted cargo bikes in a cargo-bikesharing system, operators need to consider local topography and user acceptance as well as technical implementation constraints and financial costs. Detailed technical considerations of motors, batteries, and charging infrastructure are beyond the scope of the following analysis. All suppliers of electric-assisted (i.e., e-cargo) cargo bikes have to ensure that batteries are recharged after usage, and that users are capable of properly using these devices. Here, the host system offers a practical and easy solution, where cooperation partners serve as a station for cargo-bike lending (see chapter 3.1). Furthermore, the host stations take care of recharging batteries and mostly serve as an on-site point of contact for users at the time of handover.

In general, electric-assisted cargo bikes enable users to cope with their transport needs with less physical effort. The rise of these small motor systems with light batteries seems to offer a perfect fit for the need to transport smaller goods by cargo bike. Currently, a few housing associations and some classic bikesharing operators are experimenting with more sophisticated charging infrastructure, such as inductive charging (e. g., Seestadt Aspern and Nassauische Wohnen, see Table 1). The goal is to enable a simple and fully automatic lending process at any time.

Nevertheless, very few firms presently offer such high-technology solutions. Thus, these systems are often prototypes, and operators are confronted with typical first-generation implementation issues.

The two biggest bikesharing operators in Germany, Nextbike and DB Call a Bike, are currently developing their own technological solutions for fully-automatic e-cargo-bikesharing with smart charging infrastructure. This development is stimulated by the bikesharing tenders of the city-state of Hamburg and the city of Stuttgart, which have explicitly demanded that electric cargo-bikesharing be implemented into bikesharing stations. Since the operators have experience with conventional e-bikes, they can draw from this professional knowledge to design charging infrastructure and access points.

In sum, electric cargo-bikesharing can reach a broader audience than non-electric equivalents, because even those users that doubt their physical fitness or handling competencies can use e-cargo bikes. This is especially the case in hilly regions like Stuttgart, but also applies to windy areas such as Hamburg. However, the higher maintenance costs and the organisational effort needed for recharging also need to be considered and compared to the aforementioned advantages.

USERS AND USE PURPOSES

The current users of cargo-bikesharing are “early adopters” (Rogers, 2003) of this new socio-technical system. In most cases of socio-technical innovation, early adopters display special characteristics. The following analysis utilises empirical data from two online surveys of cargo-bike share users. Both surveys were conducted in 2016, the first one by the authors of the present paper among users (N=931) of Free Cargo-Bikesharing in Germany and Austria (Becker/Rudolf, 2018; henceforth BR in this chapter), and the second by the Mobilitätsakademie among users (N=413) of Carvelo in Switzerland (Mobilitätsakademie, 2016; henceforth MA in this chapter).

In the context of cargo-bikesharing, it is not surprising that cyclists[15] (71 %, BR) and car-free households (81 %, MA) make up a large proportion of the current user group. In addition, about a third of the early adopters have prior experience of shared mobility services and are registered for carsharing (MA 29 %; BR 35 %). However, almost half of the users gained their first experience of cargo bikes through cargo-bikesharing (44 %, BR), while another 25 % have used the system for only the second or third time. Thus, cargo-bikesharing is an important sphere for experimentation, which contributes greatly to the diffusion of cargo bikes as a sustainable transport technology. Moreover, they incite behavioural change because

15 Here, “cyclist” means that the person cites the bicycle as her/his main mode of transport.

Figure 2: Activists using a cargo bike as a rickshaw for a music performance on "Germany's most polluted traffic junction" at Neckartor, Stuttgart (2015). (© Clemens Rudolf)

users try out new forms of mobility and break with their existing routines.

Sociodemographic analyses reveal that men presently use cargo-bikesharing slightly more than women (67 % men, MA; 63 % men, BR; for an analysis, see Schwartz, 2016). The family situation of current users is characterised by multi-person households, and single-person households are underrepresented (13 %, MA; 17 %, BR). The Swiss user group is dominated by couples with children (51 %, MA), compared with only a third of the user group in Germany and Austria (31 %, BR).

The most frequent use for shared cargo bikes is to transport groceries or bottle crates (cited 356 times[16] and 283 times, respectively, by the 931 respondents in the German–Austrian sample; BR) which is also reflected in the responses of Swiss users: half indicate that they used the shared cargo bike for shopping/errands (50 %, MA). Another important use is to transport children, as indicated by a third of Swiss users (33 %, MA), and 224 times by the 931 German–Austrian respondents (BR). In comparison, Riggs (2016) found that privately-owned cargo bikes are used even more predominantly for transporting children. Transporting materials or products from a hardware store was also a common use (cited 238 times, BR). In addition, 226 of the 931 German–Austrian users indicated that they used a shared cargo bike to create or attend a local event (see chapter 6.2).

16 German/Austrian respondents could name more than one use purpose; Here, the methodologies of the two surveys differ, because the Swiss respondents could only name one main purpose.

IMPACTS

1. Environmental Impacts

To date, no full impact analysis of cargo-bikesharing has been carried out. However, empirical survey data highlight that it has high potential for reducing car trips. Between 31 % (Switzerland) and 46 % (Germany–Austria) of users stated that they would have used a car in the absence of a cargo-bikesharing operator (Mobilitätsakademie, 2016; Becker/Rudolf, 2018). This indicates that cargo-bikesharing stimulates and enables a behavioural change toward sustainable mobility. As Michie et al. (2011) point out, behavioural change generally requires opportunity, capability, and motivation. Most importantly, cargo-bikesharing schemes provide the opportunity to perform load-carrying trips without a car. Users are not obliged to purchase a cargo bike themselves, in order to try it out for daily use or to perform occasional load-carrying trips. Instead, they only need to pay a small rental fee or donate a small sum to the operator, and can experiment with different ways of integrating cargo-bike trips into their mobility routines. Similarly to the benefits of carsharing, cargo-bikesharing reduces the actual and perceived need to own a car oneself.

2. Social Impacts

Users of shared cargo bikes interact with the urban society that surrounds them. They make cargo bikes visible and demonstrate that sustainable mobility is possible and even fun. In our survey among users of Free Cargo-Bikesharing schemes, a majority (539 of 931) indicated that random passers-by approach them to talk about the cargo bike while they are using it (Becker/Rudolf, 2018). Thus, cargo-bikesharing stimulates a discourse on innovative mobility solutions and on practical experiences. The spread of knowledge and information about a technology is an important condition for its diffusion (Geroski, 2000). There is a strong need for such information, since Borgstedt and Hecht (2017) found that, in Germany, 61 % of people have never even heard about cargo bikes.

Another social benefit of cargo-bikesharing is the re-framing of symbolic values associated with certain means of transport (Steg, 2005). Shared cargo-bikes are even used for weddings (see Figure 3) — a scenario in which Germans traditionally prefer a premium brand car (or a white horse and carriage for those that adopt a very traditional approach).

Figure 3: The groom transports his bride by cargo bike after their wedding in Berlin (2016) (© Felipe Trueba Garcia).

A quarter of Free Cargo-Bikesharing users indicated that they have used a cargo bike for a social event in their city (Becker/Rudolf, 2018), which is partly due to their strong social network and proximity to citizen organisations. Detailed survey responses reveal that shared cargo bikes were used for a huge variety of purposes, such as demonstrations, information stands at street festivals, food-sharing or food-saving, music boxes, or even celebrations and gatherings in public spaces that would be impossible to reach by car, such as parks and lakes. Similarly to carsharing (Stocker/Lazarus, 2016), cargo-bikesharing has the potential to improve city dwellers' quality of life and to enable citizens to perform new activity patterns in public spaces.

Last but not least, cargo-bikesharing has benefits for social justice, as they are universally accessible to everyone regardless of income level. This aspect is especially important in districts with a high percentage of low-income households, for young people and families with children, but also for pensioners.

Figure 4: A three-wheeled trailer attached to an E-bike functioning as a bar during a Critical Mass demonstration in Stuttgart, 2015. (© Clemens Rudolf)

CONCLUSION

Many new actors from a broad variety of backgrounds are currently engaging in cargo-bikesharing. They are experimenting with very diverse business models, partially supported by public funds. There is justification for supporting cargo-bikesharing through public funds and provision of adequate infrastructure, as is already the case for car infrastructure and public transport. The environmental and social benefits of cargo-bikesharing highlight the enormous potential of this socio-technical innovation to support sustainable development. This conclusion is based on three main reasons:

- 1. A large proportion of potential cargo bike users do not require a cargo bike every day, and thus are not interested in purchasing one themselves. The occasional use and general availability of cargo bikes within a sharing system enables such users to cover their occasional transport needs without purchasing or using a car.
- 2. Electric-supported cargo bikes as well as normal, good quality cargo bikes are expensive to acquire individually, whereas shared schemes offer a cheap alternative means of accessing a cargo bike. This increases social justice and equality for all kinds of mobility users.
- 3. Secure parking facilities at ground level for overnight parking in residential areas are usually very limited. Shared cargo bikes can provide an alternative for those users that do not have access to their own secure parking facility. In this context, a key factor for high utilisation rates seems to be locating docking stations in residential areas (Schäfer, 2017).

Municipal policy makers and planners should adopt a multi-facetted approach. They should integrate cargo bikes into their conventional bikesharing fleets to increase the car reduction effects of bikesharing, but they should also support different stakeholders and local cargo-bikesharing associations in making shared cargo bikes accessible by all residents near their homes.

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EXPERT COMMENT

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The practice-oriented contribution regarding the pilot implementation of tailor-made cargo bikes for communal use and the scientific article about cargo bike sharing complement one another perfectly.

Both articles address low-barrier starter offers for cargo bike use and provide an outline of the great potential that lies in both fields of application.

In the communal approach the implementation phase starts early in the project with two different types of cargo bikes. The research article however, lists all available rental and sharing systems in a systematic way. The same is true for the different types of cargo bikes and their characteristics.

Overlapping aspects could be: for municipalities to offer test bikes for interested, potential users to facilitate their purchase decision or to rent out cargo bikes to meet peak demands and to replace bike that are maintained. Municipal cargo bikes can also be introduced into rental schemes. For instance, during weekends or after working hours, if the special equipment is easily dismantled and stored. This would result in both, raising the public visibility of cargo bikes as service vehicles and as transport vehicles for the private area. The potential to shift from cars to cargo bikes is enormous in both of these transport areas. Calculations from Cyclelogstics.eu project demonstrated that in the area of services 50 % of all urban transport trips could be shifted from cars to cargo bikes. The potential is even higher for transport trips in the area of private logistics (shopping, leisure), where 77 % of all car trips could be shifted.

Thus, both articles address fields with extremely application potential for cargo bike use.

The practice-orientated article not only demonstrates organizational/technical processes, but also examines the user perspective and the associated challenges. Whereas the scientific article describes the various rental options and general vehicle-related system indicators. It also provides the reader with insight into the diversity of their use.

A common theme of both articles is that maintenance is an important topic when it comes to cargo bike use. Also, organisational issues are a great challenge in both areas. For municipal vehicles the diverse applications as well as multiple usage variations might pose some problems. In the area of rental systems, particularly those operating with changing rental stations and associated hosts can be demanding.

However, both articles leave the reader with the impression that the topic of cargo bikes is an important one for urban transport, which is still in the pioneering stage but is likely to develop a strong increase in the future.

3

Conclusions

CONCLUSIONS

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The research and practice articles do, of course, only represent a small part of the whole picture. So the experts had the difficult task of deducing from the detail to the general and drawing conclusions on the basis of two articles. They performed these two tasks in their own individual ways and produced a lot of fascinating perspectives due to their own expert knowledge of the current discourses in their respective subject areas. The most significant question in this context is therefore whether a common answer exists. Are there common factors regarding the gap between research and practice? Are the proposed solutions similar to any extent?

The most obvious consensus is on the existence of the gap, or the existence of a gap, to be more precise. There is not only one gap, for example between research and practice, but many gaps. Some experts identify the gaps mainly as research gaps. But what else are research gaps than indicators for a discrepancy between research and the object of that research, namely practice?

When John Parkin states in Chapter 2.2 that using certain words in the scientific discussion about safety affects our view of the world, there is a direct connection with the way we deal with traffic hazards. He mentions the designation of cyclists and pedestrians as non-motorized road users, which implies that something is missing or that there is a personification of vehicles when accident reports state: car collides with cyclist. The car driver is absent in this context.

Language is, therefore, crucial to mutual understanding between scientists and practitioners. This is also the conclusion of Henrike Rau in Chapter 2.1, when she points out the importance of a language that is both intelligible and purposeful. However, there is an inherent tension between the language used for the interchange between the two groups and the language used within the peer group. Since they fulfil different functions, they can't be the same. Communicating within science requires a highly complex, precise language that is a kind of code known to all members of that community. While the code does not need to be explained within the community, some form of "decoding" is often essential for outsiders.

All articles use a form and language that can be comprehended and understood beyond the borders of their peer group. Mutual understanding is a prerequisite for bridging the gap. Parvesh Sharawat and Anvita Arora emphasise in Chapter 2.4 how important understanding is, not only of language but also of each other's messages. Each of the articles has a specific message, whether it is about the implementation of policy processes in a single city like Sao Paolo, or a common evaluation concept for several cities in Germany. The messages are, in one case, the experiences made and, in the other case, the provision of guidelines and assistance. Both are very interesting for the other group.

Esther Anaya Boig also reflects in Chapter 2.7 on the nature of evaluation and its need to involve quality and equity aspects.

One aspect that is consistently addressed and that touches both research and practice is the availability of data. This is true when it comes to the evaluation of pedelecs in terms of accident figures. Ceri Woolsgrove explains in Chapter 2.3 that in so-called individual accidents, no distinction is made between infrastructure-related and self-induced accidents. This complicates the evaluation and recognition of policy options for practitioners as well as the analysis by researchers because the actual cause of the accidents is not really known.

Sven Lißner's and Angela Francke's contribution for Chapter 2.6 also concerns data, namely how GPS data can be interpreted and used. This should be seen in the light of the fact that the participants are not chosen by chance, but by personal interest. In this case, middle-aged men are the main user group. Another difficulty is that practitioners can usually do little with pure raw data; they have to depend on researchers to edit and interpret it.

Data can quickly become very abstract if it is not rendered into an easy-to-understand form. But abstractness is not a problem in the contributions to Chapter 2.8 because both articles about cargo bikes are very application-oriented, as Karl Reiter explains. Both show the great potential of cargo bikes, only in different fields of application. Consequently, there is no gap between research and practice in these two specific articles.

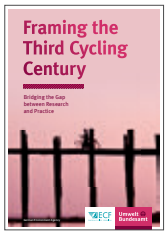
In contrast, there does exist a kind of gap in Chapter 2.5, as observed by Holger Haubold. This is mainly because the two articles have different emphases and largely exclude the focus of the other. What is perfectly appropriate for the single articles leads to interesting conclusions in the overarching consideration of both of them together. This means that not only can individual scientists or practitioners learn which perspectives would be interesting beyond their own focus, but in particular third parties can also benefit.

This ultimately brings us back to our initial questions about what similarities arise from the different perspectives. The discovered gaps are very diverse in terms of their causes and properties. Obviously, there is neither a single answer to the initial questions nor a single solution, but many different ones. The benefit of this publication can therefore not be measured by a single result, but by the results of each topic discussion. This is what bridging the gap means. It is a process that has to be repeated over and over again. And, most importantly, it works best for the specific case, which may be a limited topic such as cargo bikes, or a wider subject area such as active mobility and health. The goal is not to make practice and research identical, but to use their diversity to gain more insights. Quite often, it is precisely this diversity through which we can learn the most about a particular subject – a subject in which we may well already be experts.

Here, the International Mosaic fits perfectly into the picture. It is essential to acknowledge that cycling worldwide has many faces and that research and practice in the various regions of the world have heterogeneous approaches. Cycling research in the past has often been shaped by European and North American researchers (Sagaris 2017)[1]. Europe and North America, however, are not exemplary for all other continents, and specific research with new and more local perspectives is needed. It is also this gap which has to be bridged. Formats such as the International Mosaic are an initial starting point from which to hear what knowledge the Mosaic Ambassadors bring in.

The process the UBA started with the International Cycling Conference 2017 has found its way through this publication, with new, important conclusions. Hopefully, others will pick up on this idea of bridging the gap and carry it on, be it in the form of another conference, another publication, or simply by integrating it into their daily work.

1 Lake Sagaris 2017 in the information brochure to the ICC: https://www.umweltbundesamt.de/sites/default/files/medien/1968/dokumente/170911_international_cycling_conference_2017_broschuere_final.pdf; S.22



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